

The Role of Risk Assessment in Supporting a Positive Organisational Safety Culture

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June 2000

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SUMMARY

Recent years have seen an increasing awareness of the importance of a pro-active approach to safety management in creating a positive organisational safety culture. This is reflected in the move from a rule-based to a risk-based approach to British and European health and safety legislation. This study explores the role of risk assessment within a safety management system and its importance with respect to the safety culture of an organisation. Research was conducted within two major organisations. The first was an electricity generation company, and the second an offshore oil production company.

The effect on safety performance of risk assessment processes both internal to and external to an organisation was considered. An in-depth analysis was conducted of the safety management systems adopted by the two organisations. In particular, procedures for conducting risk assessments and attitudes towards risk assessment within the organisations were considered. The potential impact on both organisations of risk management systems adopted by equipment suppliers was also examined. Compliance with the risk assessment requirements of current health and safety legislation were used as a benchmark against which to assess the performance of each risk management system.

These findings were used to examine the adequacy of existing safety culture methodologies with respect to identifying deficiencies in the risk management processes of an organisation. The adequacy of the guidance accompanying health and safety legislation with respect to risk assessment was also considered.

ABBREVIATIONS

ACoP	Approved Code of Practice
CoC	Certificate of Conformity
CE	Conformité Européen
CEGB	Central Electricity Generation Board
COSHH	Control of Substances Hazardous to Health Regulations 1994/1999
DCR	The Offshore Installations and Wells (Design and Construction etc.) Regulations 1996
DSE	Display Screen Equipment
EC	European Community
FSO	Fire Safety Officer
HSC	Health and Safety Commission
HSE	Health and Safety Executive
HSWA	Health and Safety at Work etc. Act 1974
LMI	Local Management Instruction
MAR	Offshore Installations and Pipeline Works (Management and Administration) Regulations 1995
MHSW Regulations	Management of Health and Safety at Work Regulations 1992
NDT	Non-Destructive Testing
NEBOSH	National Exam Board in Occupational Health and Safety
OH&S	Occupational Health and Safety
OIM	Offshore Installation Manager
PFEER	Offshore Installations (Prevention of Fire and Explosion, and Emergency Response) Regulations 1995
PPE	Personal Protective Equipment

PUWER92	Provision and Use of Work Equipment Regulations 1992
PUWER98	Provision and Use of Work Equipment Regulations 1998
SCR	Offshore Installations (Safety Case) Regulations 1992
SDW	Safety Development Workgroup
SMI	Station Management Instruction
Supply Regulations	Supply of Machinery (Safety) Regulations 1992
VDU	Visual Display Unit

GLOSSARY OF TERMS

Act	In the UK, the prime source of law consists of Acts of Parliament.
Approved Code of Practice	Practical guidance on the legislation provided by an authority that has been approved by Parliament.
CE Mark	Mark affixed to items of machinery by suppliers/manufacturers to show that the equipment complies with relevant European health and safety legislation
Certificate of Conformity	Declaration that an item of equipment complies with relevant European health and safety legislation. The standards with which the equipment complies should be listed on the CoC.
EC Directive	Legislation introduced by the Council of Ministers, the supreme policy making body of the European Community.
Hazard	A hazard may be describes as something that has the potential to cause harm i.e. a hazard is a potential danger.
Guidance Notes	Further practical advise on compliance with the legislation provided by the HSE or the HSC.
Legislation	For the purpose of the current study, the term legislation is used as a general term to describe any form of health and safety law i.e. Acts, Regulations and Directives.
Pro-active	A pro-active approach to managing safety involves identifying hazards and taking steps to reduce risks before an incident actually occurs.
Regulation	In the case of health and safety Regulations this refers to laws introduced by the Secretary of State as a result of proposals put forward by the HSC.

Reactive	A reactive approach to managing safety involves using events that have already taken place such as incidents to identify any areas where action are required.
Risk	Risk is a combination of the likelihood and the consequences of a specified hazardous event occurring.
Risk Assessment	The process of identifying hazards in the workplace, determining the levels of risk to which personnel are exposed, deciding if these risks are tolerable and if necessary implementing control measures.
Safety Culture	The attitudes and behaviour of an organisation and the individuals within the organisations, with respect to the management of health and safety.
Safety Management System	The means by which an organisation controls risk through the management process
Six-pack	Set of six Regulations introduced into the UK legislative system in 1993 following a number of changes to the European legislation

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CHAPTER ONE

Overview

The purpose of this chapter is to give an overview of the contents of this thesis. A summary will be given of the aims and objectives of the research along with justifications for conducting the research. The contents of each chapter are also summarised.

1.1 RESEARCH QUESTION

There is an increasing awareness of the importance of a pro-active safety management system in creating a positive organisational safety culture. This is reflected in the recent move from a rule-based to a risk-based approach to health and safety legislation. The present study explores the role of risk assessment within a safety management system and its importance with respect to the safety culture of an organisation. The effect on safety performance of risk assessment processes both internal to and external to an organisation are considered. The study examines the feasibility of using techniques for assessing the adequacy of risk assessment practices alongside existing frequently used measures (see Chapter 2 for a discussion on what is meant in this context by frequently used measures of safety culture) of safety culture, in order to give a more comprehensive assessment of the safety culture of an organisation. The study was conducted with the co-operation of two major organisations. The first organisation was an electricity generation company, and the second was an offshore oil production company.

1.2 SUMMARY OF OBJECTIVES

The objectives of the research are to:

1. Analyse the risk management systems within both companies
2. Identify deficiencies in the risk management systems.
3. Examine the potential impact on both companies of risk management systems adopted by equipment suppliers.
4. Examine the adequacy of guidance in current health and safety legislation with respect to risk management and risk assessment.

1.3 JUSTIFICATIONS FOR RESEARCH

There are three primary justifications for conducting this research. The first two are organisationally driven. The Electricity Generation Company, the sponsors of this research, sought to further examine the safety culture of the organisation in the light of the results from another study assessing the organisations safety culture. In particular, following a number of incidents, the Electricity Generation Company were concerned about the adequacy of risk assessments conducted by suppliers and the impact this was having upon the organisation. It was agreed that Electricity Generation Company's own risk management system should also be examined and the effect that this has on the safety culture of the organisation considered.

The second justification for conducting the research became apparent several months into the research when the author was approached by the Offshore Oil Production Company. The Oil Production Company were also concerned about their risk management systems in particular with respect to risk assessments carried out to ensure compliance with the Provision and Use of Work Equipment Regulations (1992). In addition they were also concerned about risk assessments carried out by their equipment suppliers. The field work carried out at the Offshore Oil Production Company was approached in a similar manner to that conducted at the

Electricity Generation Company and thus provided additional evidence on the matters under consideration in this thesis.

The third justification for this research came from a review of the literature on safety culture and risk assessment. The review showed that risk assessment (and the risk management systems within which those assessments are carried out) are considered to be an important building block in establishing a positive organisational safety culture. However, it was identified that many techniques for assessing safety culture do not actually consider risk assessment. The current study examines risk management practices of both organisations under consideration. It aims to show that although both organisations have performed well in previous safety culture assessments, these assessments were not sufficient to identify failings in the risk management systems. The adequacy of the guidance accompanying current health and safety legislation has also been examined along with the potential impact that a lack of guidance may have on organisational risk management systems.

1.4 CHAPTER HEADINGS

The following is a list of chapter headings and a summary of the content of each chapter.

CHAPTER	TITLE	CONTENT
One	Overview	Introduction and overview to the research
Two	Introduction	The introduction considers the relationship between risk assessment and safety culture. It also examines the role of risk assessment in current health and safety legislation. The justifications for conducting this research are also considered in greater detail in this chapter.
Three	Research Objectives	Describes in detail the objectives of this research and outlines the hypotheses to be tested.

Four	Research Methodology	Section one of this chapter provides a justification for the methodology used in the research. Section two describes the methodology in detail and section three describes the data analysis.
Five	Results 1: Narrative	This chapter includes a narrative of the results obtained from interviews, documentation and site visits.
Six	Results 2: Questionnaire and Summary	The questionnaire results and calculations are displayed in tabular format. A summary of the major findings of the study, allowing comparison between the two organisations, is also displayed in tabular format.
Seven	Discussion of Results	Discusses the research findings with reference to the organisations and provides suggestions on future work.
Eight	Conclusions	Conclusions from the research.

CHAPTER TWO

Introduction

This chapter introduces safety culture and risk assessment. The importance of risk assessment in achieving a positive organisational safety culture is discussed. The role of risk assessment in current health and safety legislation is also considered. Techniques for assessing the safety culture of an organisation are examined. Detailed justifications for conducting the research, based upon the findings in the literature, are also given.

2.1 INTRODUCTION TO ORGANISATIONAL SAFETY CULTURE

It is now widely acknowledged that organisational, management and socio-technical failures have contributed to a number of recent major accidents involving complex systems. In the past, accident causation has tended to focus upon engineering failure and human error (ACSNI, 1993). However, failures such as inadequate communication systems and training, flawed decision making, below standard maintenance and poor fault reporting have all been contributory causes in a number of recent disaster enquiries (Kennedy and Kirwan 1996a). For example, the reports into the Kings Cross, Herald of Free Enterprise, Chernobyl and Kegworth disasters. Such failures suggest a breakdown of safety management systems which is said to indicate failings in the safety culture of an organisation (Kennedy and Kirwan, 1996a).

The term Safety Culture arose out of the earlier ideas of organisational climate, organisational culture and safety climate. Safety climate, the precursor to safety culture was a term initially used by Zohar (1980). Zohar identified eight factors that he considered to be important in achieving a good safety climate. The factors identified were the importance of safety training, the effects of safety behaviour on promotion, management attitudes towards safety, effects of required work pace on safety, status of safety officer, effects of safety behaviour on social status and the status of the organisations safety committee.

In a validation study by Brown and Holmes (1986) these eight factors were reduced to a three factor model of safety climate which has similarities with the current ideas of safety culture. Brown and Holmes' model stated that a sound safety climate is built upon:

- employee perception of how concerned management is with their well-being;
- employee perception of how active management is in responding to this concern;
- employee physical risk perception.

The concept of safety culture however, was not introduced until the publication of a report into the causes of the disaster at the Chernobyl nuclear power plant (IAEA, 1986). The report stated that in order to prevent the re-occurrence of a similar disaster:

- full authority and responsibility for safety should be placed on a senior member of staff;
- formal plant procedures should be properly reviewed and approved; and

- these measures should be supplemented by the creation and maintenance of a '*nuclear safety culture*.'

The term 'safety culture' was not however, to be confined to use simply within the nuclear industry. In the accident investigation report following the Kings Cross Incident (DoT, 1988), it was stated that;

'a cultural change in management is required.'

In addition, the inquiry into the Piper Alpha disaster (Cullen, 1990) stated that;

'it is essential to create a corporate atmosphere in which safety is understood to be and is accepted as the number one priority.'

Although the concepts of safety culture and safety climate are similar, the term safety culture is generally taken to be more embracing than that of safety climate (Glendon and McKenna, 1995). 'Culture' implies that the concept resides within and is part of an organisation, whereas 'climate' suggests more passive connotations of being subject to the external environment. Safety culture refers primarily to attitudes and behaviour of a company or organisation with respect to the management of health and safety. The Advisory Committee on the Safety of Nuclear Installations Human Factors Study Group defines safety culture more thoroughly as (ACSNI, 1993);

'the product of the individual and group values, attitudes, perceptions, competencies, and patterns of behaviour that determine the commitment to, and the style and proficiency of, an organisation's health and safety management.'

Many studies have sought to determine the characteristics of a company with a positive safety culture (e.g. Glennon, 1980, 1982; Zohar, 1980; CBI, 1990; Ryan, 1991; Toft, 1992; ACSNI, 1993). For example, the CBI (1990) conducted a study to determine the characteristics of an organisation with a positive safety culture. The report was based upon the responses from over 200 organisations to a questionnaire. In depth interviews were also conducted with a further fifty organisations. The study identified the following factors to be important in achieving a sound safety culture:

- leadership and commitment of the chief executive
- the executive safety role of line management
- the involvement of all employees in achieving safety goals
- open communication
- demonstration of care and concern for all those affected by the business.

In another study examining the characteristics of a good organisational safety culture, Toft (1992) proposed a number of measures required to achieve this goal;

- sustained management commitment
- visible management support
- adequate health and safety policy
- allocation of sufficient resources for achieving safety related goals
- use of appropriate safety management techniques
- continuous motivation of all staff
- provision of adequate safety training
- organisational learning
- adopting a 'no blame' culture
- persistence of purpose.

A number of common factors that influence the safety culture of an organisation have been found. For example, the importance of management commitment and leadership with respect to safety, the resources and emphasis given to health and safety, the involvement of all employees in the safety of an organisation, and effective and open communication leading to commonly understood goals and the means to achieve them at all levels. Thus an effective safety management system is important in achieving a positive organisational safety culture.

2.1.1 Safety Management Systems

Wright (1994) defines a safety management system as the;

'means by which an organisation controls risk through the management process.'

There are several approaches to health and safety management outlined in the literature. It is important that an organisation chooses an approach which is appropriate to the needs of the organisation and that may be used within existing management systems within the organisation. However, although the approaches of implementing safety management systems may differ, the basic components required for the formation of a sound safety management system are very similar.

The following summary of the basic components which form the basis of a good safety management system are drawn from the British Standard 'Guide to Occupational Health and Safety Management Systems' BS 8800 (HSE, 1996). The approach is designed to enable the integration of the health and safety management system within an existing overall management system and is based upon the HSE guidance 'Successful Health and Safety Management' HS(G)65.

BS8800 outlines a number of steps required to achieve and maintain an adequate safety management system. The areas that are discussed include:

- initial status review
- company health and safety policy
- organising
- planning and implementation
- measuring performance
- audit and review

These areas are outlined in greater detail below.

Initial status review

The first element of a safety management system, as defined by BS8800, is the Initial Status Review. When implementing a safety management system, an organisation should review any existing arrangements for managing safety. Existing arrangements should be compared against legislative requirements and current knowledge on best practices with respect to safety management systems. The efficiency and effectiveness of existing resources devoted to safety management should also be considered. Such a review will allow the organisation to identify any changes that need to be made to the existing system. Note that even when the safety management system is in place, the adequacy of the system will need to be periodically reviewed to ensure that it is in line with current legislative requirements and best practices.

Health and safety policy

Once an initial status review has been carried out, the organisations most senior management should define, document and endorse the company health and safety policy. The policy should include commitments to;

- recognising the importance of safety as an integral part of the organisations business performance
- achieving high levels of safety performance
- to provide adequate resources to implement the safety policies
- to set and publish safety objectives
- to involve and consult employees in setting and implementing policies and objectives
- to ensure that all employees receive appropriate training and are competent to carry out their jobs.

Note that these commitments are in line with the basic components of a sound safety management system. In addition, the health and safety policy should also include a commitment to periodically reviewing the content of the policy and the management system. The level of compliance with the policy statements should also be audited periodically.

Organising

The third element of an effective safety management system is referred to by BS8800 as 'organising', that is, ensuring that suitable personnel and documentation are in place to carryout the commitments outlined in the safety policy. All personnel should be made aware of their responsibilities for the health and safety of people who may be affected by their actions. Senior personnel should be appointed to ensure that the safety management system is properly implemented. Allocation of responsibilities and accountabilities should be defined in the management structure. The organisation should also ensure that adequate documentation is available to enable health and safety plans to be fully implemented.

Planning and implementation

Once the organisational aspects are in place, the planning and implementing stage may be carried out. This stage involves carrying out any actions that are necessary to meet the safety goals of the organisation. For example, risk assessments should be carried out to identify and control hazards, any legal requirements should be identified and acted upon, and plans should be made for measuring performance and conducting audits and status reviews.

Measuring performance

Once some of the actions outlined in the planning and implementing stage have been carried out, the organisation is then in a position for 'measuring performance.' Performance measurement is important in providing information as to the effectiveness of the safety management system. There are two types of performance measurement;

1. Proactive measures of performance e.g. monitoring compliance with the organisations safety arrangements by conducting surveillance and inspections.
2. Reactive measures of performance e.g. accident, ill health and near miss data.

If any deficiencies in the safety management system are identified, the root causes should be examined and corrective action taken.

Audits and reviews

Note that the development and subsequent maintenance of a safety management system is not a series of discrete steps. In practice, organising, planning and implementation functions will overlap. All of the safety management system components form part of a cycle for continuous improvement of health and safety management and its

integration within the overall management system. For example, regular reviews of the system should be conducted, and the process by which safety goals are implemented regularly updated to suit the need of the organisation. Regular audits should be carried out to monitor all components of the safety management system and corrective action taken where necessary. Furthermore, the safety management system should be designed to accommodate or adapt to internal and external factors such as new legislative requirements, changes in organisational structure and the introduction of new technology.

2.2 CHANGES IN HEALTH AND SAFETY LEGISLATION

Alongside this increasing understanding of the importance of a sound safety management system, there has been an increasing awareness of the role of risk assessment as part of the effective management of safety. This is reflected in a number of recent additions to health and safety legislation. However, before discussing these changes, it is important to first summarise the structure and sources of health and safety law in the UK.

2.2.1 The Structure and Sources of Health and Safety Law

Acts of Parliament

In the UK, the prime source of law consists of Acts of Parliament (Selwyn, 1993). For example, The Health and Safety at Work Etc. Act (1974) sets out a number of duties applicable to both employers and employees relating to the health, safety and welfare of persons in the workplace. These requirements include; the duty of every employer to ensure the health safety and welfare at work of all his employees and any other persons not in his employment who may be affected by his undertaking; the duty of designers, manufacturers, importers and suppliers of equipment and substances to ensure that such items are, so far as

reasonably practicable, designed and constructed so as to be safe for use; and the general duty on employees to take reasonable care for the health and safety of themselves and any others who may be affected by their actions.

Regulations

An Act of Parliament may give a Minister the power to make new or additional law by means of regulations (Selwyn, 1993). In the UK, health and safety regulations are made by the Secretary of State (generally the Secretary of State for the Environment) as a result of proposals made to them by the Health and Safety Commission (HSC). For example, the Management of Health and Safety at Work Regulations (1992), the Electricity at Work Regulations (1989), and the Provision and Use of Work Equipment Regulations (1992 & 1998) were all made under the Health and Safety at Work Act (HSWA). These regulations set out more detailed and specific requirements than those set out in HSWA regarding health and safety in the workplace. As with Acts of Parliament, Regulations have the full force of the law until they are repealed or amended in some way.

Approved Codes of Practice

Parliament may give an organisation authority to issue codes of practice which provide practical guidance on the legislation. Section 16 of HSWA gives the Health and Safety Commission the authority to issue practical guidance on the general duties set down in sections 2-7 of HSWA and any health and safety regulations. The HSC may also approve codes of practice drawn up by other bodies, for example British Standards, although the HSC must first gain the consent of the Secretary of State and consult with Government departments and other appropriate bodies.

Approved codes of practice give practical guidance on compliance with the legislation to those whom duties are placed upon by that legislation. Codes

of practice do not constitute the law. However, codes of practice are guides to good safety, and a court of law may take the advice given in the codes into account during criminal proceedings. Unless the accused can show that he has complied with the law in some method equally effective to that suggested in the codes of practice he may be guilty of an offence (Selwyn, 1993).

Guidance Notes

Guidance notes give further practical advice and suggestions on compliance with the legislation. Both the HSC and the Health and Safety Executive (HSE) may issue guidance notes. The notes may either be issued alongside Codes of Practice or independently of them. Guidance notes have no legal standing. However, they are admissible in court as evidence of the current state of knowledge.

European Directives

The Council of Ministers is the supreme policy making body of the European Community (EC). At each meeting of the council, a minister from each of the member states is in attendance. The Council of Ministers may issue Directives which are binding on all member states as to the results to be achieved. However, the method by which these results are achieved is generally left to the discretion of each individual member state. In the UK, EC Directives are generally enforced by means of the introduction of new regulations. Examples of such regulations will be discussed below.

Enforcement of the legislation

The HSE primarily gives advice to employers and others persons regarding compliance with legislation and meeting required health and safety standards. The HSE also has the authority to bring about criminal proceedings for non-compliance with the legislation. However, the purpose

of the HSE is to establish high standards of health and safety rather than to punish offenders. Therefore an HSE inspector may first give verbal or written advice as to the steps which must be taken to ensure compliance. If these actions are not followed, or the dangers are sufficient to warrant immediate action, the inspectors may issue an improvement or prohibition notice. Such notices may for example, require relevant articles to be taken out of service until the safety of the articles has been adequately improved. As a last resort, criminal proceedings may be brought by the HSE (Selwyn, 1993).

2.2.2 The New Health and Safety Legislation

In 1989, the European Community adopted the Health and Safety 'Framework Directive' 89/391/EEC. The purpose of the new Directive was to provide a set of general principles on health and safety at work, which could be applied throughout the EC, thus increasing the homogeneity of the legislation within the Community. In addition, five 'Daughter' Directives were also introduced to deal with a number of more specific areas of health and safety. These Directives were; the Workplace Directive 89/654/EEC, Use of Work Equipment Directive 89/655/EEC, Manual Handling of Loads Directive 90/269/EEC, Display Screen Equipment Directive 90/270/EEC, and the Personal Protective Equipment Directive 89/656/EEC. Further Directives on Carcinogens, Biological Agents, Construction Sites, Safety Signs, and Pregnant Women were also adopted by the EC member states.

In order to implement these EC Directives, six new regulations, known as the six-pack, were introduced into the UK health and safety legislation system. These six new regulations were;

- *Management of Health and Safety at Work Regulations (1992)* - implement the provisions of the EC Framework Directive 89/391/EEC and also the Temporary Workers Directive 91/383/EEC.
- *Provision and Use of Work Equipment Regulations (1992)* - implement EC Directive 89/655/EEC on the minimum health and safety requirements for the use of work equipment in the workplace. Note that since the six-pack were introduced, the work equipment legislation has been updated. As a result, the Provision and Use of Work Equipment Regulations (1998) were introduced in December 1998.
- *Workplace (Health, Safety and Welfare) Regulations (1992)* - implement the majority of the requirements of the Workplace Directive 89/654/EEC. The remaining requirements of the Directive are already dealt with by existing legislation.
- *Personal Protective Equipment at Work Regulations (1992)* - implement EC Directive 89/656/EEC on the minimum health and safety requirements for the use of Personal Protective equipment in the workplace.
- *Manual Handling Operations Regulations (1992)* - implement EC Directive 90/269/EEC on the safe manual handling of loads in the workplace.
- *Health and Safety (Display Screen Equipment) Regulations (1992)* - implement the Display Screen Directive 90/270/EEC on the safe use of display screen equipment in the workplace.

The new legislation operates under HSWA. Although the legislation covers many of the same areas of health and safety as HSWA, the new legislation gives the reader further guidance on many aspects which were previously thought to be inherent within the original Act.

Other health and safety legislation which was adopted in the United Kingdom as a result of EC Directives include; the Electricity at Work Regulations 1989, the Noise at Work Regulation 1989; and the Control of Substances Hazardous to Health Regulations 1999 (COSHH).

2.3 THE ROLE OF RISK ASSESSMENT IN THE NEW LEGISLATION

The new legislation emphasises the importance of a pro-active approach to health and safety management. In the past, a more reactive approach has tended to be adopted with actions being implemented as the result of an accident or incident. However improvements in techniques such a risk assessment have resulted in a greater ability to predict and identify potential dangers before an accident or incident actually occurs. This is reflected in the new legislation. Before the requirements of the new legislation are discussed in greater detail, the concept of risk assessment will be introduced.

2.3.1 Introduction to Risk Assessment

Risk assessment is defined in the British Standards; Guide to occupational health and safety management systems BS8800 (BSI, 1996) as;

'The overall process of estimating the magnitude of risk and deciding whether or not the risk is tolerable or acceptable.'

Risk assessment is important in the workplace as it allows employers to determine whether planned or existing controls are inadequate. If the control measures are judged to be inadequate and the risks to personnel to be at an intolerable level, steps may then be taken to control those risks before any harm occurs.

There are no fixed rules as to how a risk assessment should be carried out (Selwyn, 1993). The methods used will depend on the nature of the undertaking and the types of hazard and risks present. The assessment of simple articles and tasks may only require a simple process based on judgement. More complex articles and tasks may require the involvement of specialists and specialist techniques in order to carry out an effective assessment. However, in all cases the process of risk assessment should involve the same basic steps. These steps have been described by a number of authors (e.g. BSI, 1996; Glendon & McKenna, 1995; AIChE, 1989) and are outlined below.

1. Identify the nature of the assessment

The first stage of any risk assessment is to identify the tasks and equipment to be assessed. This stage is important as an ill defined assessment may result in wasted effort and resources, or more critically, to relevant tasks and equipment being overlooked during the assessment. Any technical and human information required for the assessment should be gathered at this stage. In addition, if a large number of tasks and equipment are to be assessed, it may be useful to produce a prioritised list of tasks and equipment in order that those considered to be most hazardous, or those that may be dealt with particular ease and speed, may be dealt with first.

2. Hazard identification

A hazard may be described as something which has the potential to cause harm (HSC, 1991), that is, a hazard is a potential danger (Scalon, 1990). For example, fire and explosion, trapping or entanglement in machinery, excessive weight associated with manual handling, noise, high vibration levels, and sharp or abrasive surfaces are all considered to be potential hazards in the workplace.

All significant hazards relating to a work activity should be identified taking into account who might be harmed and how. Hazards may be directly observable in the workplace or may be predicted from knowledge of a system, task or equipment (Glendon, 1987 a, b). Hazard identification is critical to the risk assessment process as any hazards omitted at this stage will not subsequently be analysed or considered thus biasing latter results. In order to minimise the risk of omitting hazards from the assessment, assessors may use a hazard checklist to act as a prompt when conducting an assessment. However, in using a checklist approach to risk assessment, assessors must be aware of becoming blinkered with respect to the hazards listed and missing hazards that have not been included on the checklist.

3. Risk estimation

Estimating the level of risk associated with a particular hazard will assist the assessor in determining whether or not the risks are at a tolerable level and the also whether any actions are required to reduce the level of risk.

Risk is a combination of the likelihood and consequences of a specified hazardous event occurring (BSI, 1996). Risk is not directly observable. Some level of calculation is required in order to assess, or more generally estimate, the level of risk present (Glendon, 1987a, b). The following definition is frequently used to assist in the estimation of risks (Glendon & McKenna, 1995):

$$\text{Risk} = \text{Probability of occurrence of an event} \times \text{Consequences, for a given period of time}$$

When determining the probability of occurrence of an event, that is the likelihood of harm, the assessor should take into account the adequacy

of existing control measures. For example, the adequacy of guarding, controls and personal protective equipment. Aspects such as the number of personnel exposed to a hazard and the frequency and duration of exposure to the hazard should also be considered. Unsafe acts (e.g. unintended errors or intentional violations of procedures) may also result in exposure to hazards. For example, operators may be unaware of the hazards present, they may not have the knowledge or skills to do the work, or they may underestimate the hazards involved in completing a task. The adequacy of training, health and safety information provided to the operators, procedures and supervision should also be taken into account.

For complex and highly hazardous systems it may be considered necessary to give the probability of occurrence quantitatively, for example to satisfy regulators as to the safety of the system as part of a safety case. However, for the vast majority of assessments this is neither necessary, nor is sufficient information available to give an accurate quantitative assessment. The most common method of placing a value of the probability of occurrence is to evaluate the probability qualitatively. For example, the assessor may decide to use the values high, medium and low, or likely, unlikely and highly unlikely in estimating the probability of occurrence. In addition, in order to place parameters around these qualitative values, the assessor may decide for example that likely means that the event is likely to occur many times during the life of the system, and that highly unlikely means that the event is likely to occur only once during the life of the system. The qualitative values used and the parameters set should be chosen to suit the type of assessment being conducted.

When seeking to establish the potential consequences of an event the assessor should take into account the parts of the body likely to be

affected (e.g. head, eyes, neck, torso, arms, hands, feet, whole body) and the nature of the harm. For example, the nature of harm may be described as:

- **Slightly harmful** e.g. superficial wounds such as minor cuts and bruises.
- **Harmful** e.g. lacerations, open wounds or burns and minor fractures.
- **Extremely harmful** e.g. amputations, multiple injuries or fatal injuries.

When estimating the nature of harm, the assessor should consider the worst possible outcome of exposure to the hazard under consideration. Note that as for the probability of occurrence, other categories of harm such as high, medium or low may be used depending upon the nature of the assessment and the preferences of the assessor.

4. Decide if risk is tolerable

Once the probability of occurrence and potential consequences have been determined a risk estimation matrix may then be used to assist in estimating the level of risk. A example of a risk estimation matrix is shown in table 2-1.

Table 2-1: A simple risk estimation matrix

		Potential Consequences		
		HIGH (e.g. extremely harmful)	MEDIUM (e.g. harmful)	LOW (e.g. slightly harmful)
Probability of Occurrence	HIGH (e.g. likely)	HIGH	HIGH	MEDIUM
	MEDIUM (e.g. unlikely)	HIGH	MEDIUM	LOW
	LOW (e.g. highly unlikely)	MEDIUM	LOW	LOW

If risk levels calculated from the risk matrix are low, then the risk levels may be considered to be at a tolerable level and no further preventative action is required. If risk levels are medium, efforts should be made to reduce the risk as far as reasonably practicable, that is, taking into account the cost benefits of implementing control measures. If the risk levels are high, they should be considered to be intolerable. Work should not be started until the risk levels have been reduced.

Note that depending upon the nature of the assessment and individual preferences, some organisations may choose to develop more sophisticated approaches for assessing risks. For example, the use of four by four or five by five matrices, or more rigid and detailed categories of likelihood and consequence. However, the British Standard 'Guide to Occupational Health and Safety Management Systems' BS8800 states that simple approaches such as that outlined in table 2-1 are a 'reasonable starting point' for the majority of workplace risk assessments.

5. Prepare action plan

The outcome of any risk assessment should be a list of actions, in priority order to reduce or eliminate risks in the workplace. Ideally hazards should be eliminated altogether, for example by using different equipment, or altering a way in which a task is conducted. However, if this is not possible then suitable control measures should be put in place such as guarding, interlocking devices, suitable controls (including emergency stop devices), warnings and markings. Procedural controls may also be used to supplement physical controls. Personnel protective equipment (PPE) should only be used as a last line of defence after all other control options have been considered since PPE does nothing to prevent the hazard from being present in the first place.

6. Document significant results

All significant findings and actions arising from a risk assessment should be documented. This documentation should include details of the significant hazards identified during the assessment, existing control measures and the actions arising from the assessment.

7. Review assessment

It is important to note that risk assessment should be seen as a continuous process rather than a discrete event. All risk assessments should be periodically reviewed in order to ensure that the assessment is still valid and that control measures have been implemented and are reducing risks. In addition, to these periodic reviews, risk assessments should also be reviewed if for example, the way in which a task is conducted has been changed, if the machinery has been altered or new machinery introduced.

2.3.2 Risk Assessment and Health and Safety Legislation

As has already been discussed, since 1992, risk assessment has featured heavily in the health and safety legislation. The following outlines a number of requirements in current legislation relating to the duty placed upon employers to conduct risk assessments in the workplace.

2.3.2.1 The Management of Health and Safety at Work Regulations 1992

The Management of Health and Safety at Work Regulations 1992 (MHSW) set out a number of requirements detailing how health and safety should be managed within the workplace. Duties imposed by the regulations include the provision of health and safety surveillance, the appointment of health and safety personnel, the provision of emergency procedures, to ensure co-operation and co-ordination between personnel

with respect to health and safety, and the provision of information and training with respect to health and safety.

Regulation 3 of the MHSW Regulations requires all employers to carry out suitable and sufficient assessments of the risks to the health and safety of employees and non-employees from his place of work. The regulations also requires risk assessments to be updated if there is reason to suspect they are no longer valid, or if there has been a significant change in the matters to which the assessment relates.

The preparation of an action plan to eliminate or minimise the risks identified in a risk assessment is a requirement of regulation 4 of MHSW. Employers are also expected to monitor and review the proposed actions. Such assessments allow the employer to identify the risks present in the workplace, and therefore also to identify the measures which need to be taken in order to comply with the relevant health and safety legislation.

Although the MHSW Regulations provide guidance on the basic steps required to perform a risk assessment, the guidance on the hazards to be considered and suitable controls measures is somewhat limited. Details of the issues and hazards that should be considered during general workplace risk assessments can be found in other more specific health and safety legislation. An example of such legislation is the Provision and Use of Work Equipment Regulations 1992/1998.

2.3.2.2 The Provision and Use of Work Equipment Regulations 1992

The Provision and Use of Work Equipment Regulation 1992 (PUWER92) were introduced on 1st January 1993. The Regulations were immediately applicable to all equipment purchased after 1st January 1993. However, for equipment first provided for use before this date, employers were given

a four year period of grace in which to comply with the detailed requirements regulations 11-24 of the legislation.

Scope of PUWER92

PUWER92 defines work equipment as:

'any machinery, appliance, apparatus or tool and any assembly of components which, in order to achieve a common end, are arranged and controlled so that they function as a whole.'

Thus the scope of work equipment is extremely wide. PUWER92 is applicable to items ranging from hand tools such as spanners, hammers and portable drills, to single machines such as lathes and circular saws, and plant such as electricity generating equipment and drilling equipment for use on an offshore oil rig.

In addition, PUWER92 is not only applicable to new or existing work equipment, but also to second-hand work equipment and hired or leased work equipment.

Regulations 5-9 of PUWER92 set out a number of general requirements relating to work equipment. Employers are required to ensure that:

- all work equipment is suitable for the purpose for which it was provided,
- work equipment is maintained in good working order,
- personnel are provided with adequate training and information on the risks to health and safety associated with the use of work equipment, and;
- where the use of work equipment involves specific risks to health and safety, the use of that equipment should be restricted to authorised personnel only.

Regulation 10 of PUWER92 deals with conformity with community requirements. Under this regulation, employers are required to ensure when buying/hiring/leasing equipment that the equipment complies with any relevant EC Directives. Schedule 1 of PUWER92 lists the relevant Directives and the British legislation which implements them. The legislation listed covers areas such as construction plant and equipment, lawnmowers, roll over protective structures, and simple pressure vessels. However, probably the most widely applicable of the Regulations listed in Schedule 1 is the Supply of Machinery (Safety) Regulations 1992.

2.3.2.3 The Supply of Machinery (Safety) Regulations 1992

The Supply of Machinery (Safety) Regulations are, with a few exceptions, relevant to all non-manually powered machinery with moving components. The Supply Regulations are aimed at manufacturers and suppliers of plant and equipment. Under the Regulations manufacturers and suppliers must comply with a number of essential health and safety requirements similar to those laid down in regulations 11-24 of PUWER92 (see below for a discussion on these regulations). In order to demonstrate compliance, manufacturers/suppliers must put together a technical file on the plant/equipment to be supplied. Such a file should generally include a risk assessment of the item of equipment. Manufacturers/suppliers must also provide adequate information on the safe use of the plant/equipment and provide a Certificate of Conformity listing all of the relevant health and safety standards to which the item complies. A CE (Conformité Européenne) mark should also be affixed to the item in order to declare that the item complies with the requirements of the relevant EC Directive.

In order to comply with regulation 10 of PUWER92, when purchasing/hiring/leasing equipment, organisations are expected to ensure that all relevant equipment is CE marked and holds an adequate

Certificate of Conformity. In addition, employers should check the item of equipment for any obvious defects and ensure that adequate instructions for the safe use of the equipment are provided by the supplier.

Not all equipment is covered by a product Directive. However if an item is adequately CE marked then it should already comply with the requirements of regulations 11-24 of PUWER92. For work equipment not covered by a product Directive or supplied before January 1993 or for any other reason lacking an adequate CE mark, regulations 11-24 of PUWER92 set out a number of detailed requirements relating to the safety of work equipment. These regulations cover areas such as:

- the restriction of access to dangerous parts of machinery e.g. via the use of guarding and interlocking;
- the provision of adequate controls and control systems e.g. ensuring the stop and emergency stop controls are suitable and that all controls are clearly visible and identifiable;
- methods to isolate equipment from sources of energy;
- ensuring that equipment is adequately stabilised where necessary;
- the provision of adequate lighting;
- protection from hot and cold surfaces; and
- the provision of suitable warnings and markings.

2.3.2.4 The Provision and Use of Work Equipment Regulations 1998

The Provision and Use of Work Equipment Regulations 1998 (PUWER98) were introduced on 5th December 1998 and supersede the requirements of PUWER92. The primary differences between the two sets of Regulations are that PUWER98 includes new requirements relating to mobile work equipment, lifting equipment, and inspection of work equipment. A number of more minor changes have also been made to the wording of the regulations and the accompanying guidance. The aims, scope and format of the two sets of Regulations have however, remained very similar. The

differences between PUWER92 and PUWER98 are discussed in greater detail in Chapter seven.

2.3.2.5 Other health and safety legislation

The other four members of the six-pack have already been briefly discussed in section 2.2.2. The Manual Handling Regulations and the DSE Regulations in particular may be used by the assessor to determine the areas that should be considered under a general workplace risk assessment. For example, the Manual Handling Regulations take the reader step by step through the hazards that may be present in conducting manual handling operations and make recommendations for the types of control measures that may be implemented to reduce the risks to personnel. The DSE Regulations consider all aspects of health and safety associated with display screen equipment including the VDU monitor, keyboard, mouse, printer and other associated equipment, the worksurface type, location and dimensions, the chair, environmental conditions and software design. The DSE Regulations are therefore particularly relevant for (although not restricted to) identifying and controlling hazards in an office environment.

The Personal Protective Equipment at Work Regulations may be used by the assessor to assist in determining suitable PPE when other measures to reduce risks to a tolerable level are not possible.

Other legislation which may be used to assist in identifying areas that should be considered during a general workplace risk assessment include the Control of Substances Hazardous to Health Regulations (COSHH) 1994, the Electricity at Work Regulations 1989 and the Noise at Work Regulation 1989.

COSHH requires that no work is carried out that may expose employees to substances hazardous to health unless a suitable and sufficient risk assessment has been carried out and appropriate control measures implemented.

The Electricity at Work Regulations require precautions to be taken against the risk of death or personal injury from electricity in work related activities. The Regulations apply to all electrical equipment and systems and require employers to consider hazards such as electric shock, electric burn, electrical explosion or arcing, and fire or explosion initiated by electrical energy.

The Noise at Work Regulations place a duty on employers to reduce the risk of hearing damage in the workplace to as low a level as possible. The Regulations require employers to take action at three different noise exposure levels. If daily personal noise exposure levels are 85dB(A) or above a noise assessment must be made and suitable control measures implemented. In addition, if noise exposure levels exceed 90dB(A), or 200 Pascals (peak level for impact noise), then ear protection zones must be marked with warning signs and all employees working in these areas must be provided with hearing protection such as ear defenders.

Note that the legislation discussed above are not an exhaustive list of the health and safety legislation that requires employers to conduct risk assessments. They do however, cover the some of the most widely used Regulations with respect to general workplace risk assessments and the primary legislation discussed and considered during the current study.

From the above discussion, it can be seen the risk assessment features heavily in current health and safety legislation. However, risk assessment is not just important in meeting the requirements set down by current health and safety legislation. Risk assessment also plays an important

role in setting down the foundations of a sound safety management system and a positive attitude to risk assessment is important in achieving a positive organisational safety culture. The importance of risk assessment to an organisational safety culture is discussed below.

2.4 RISK ASSESSMENT AND SAFETY CULTURE

2.4.1 The Importance of Risk Assessment in Organisational Safety Culture

ACSNI (1993) suggests that hazard identification and risk assessment play an important role in the development of a positive organisational safety culture. An effective safety management system should be proactive in its approach to managing safety, the primary aim being the prevention of accidents. The continuous process of hazard identification, risk assessment, control and monitoring allows both latent and active failures in a system to be identified and prevented.

ACSNI (1993) summarises the four key functions present within a positive organisational safety culture as:

- policy and planning;
- organisation and communication;
- hazard management; and
- monitoring and review of safety performance.

Thus it would appear that risk assessment (or hazard management as it is referred to by ACSNI (1993)) is not only important within a safety management system, but also within an organisations whole safety culture. There is further evidence to support this in a report by the CBI (1990).

The CBI (1990) suggest that a number of building blocks must be put in place in order to achieve a good organisational safety culture. These building blocks are as follows:

- write a company statement on health and safety;
- provide resources;
- set standards on health and safety for all company activities;
- identify responsibilities and accountabilities;
- involve employees;
- set up communication;
- make provision for training; and
- lay down monitoring systems.

An adequate company health and safety policy should include a commitment to reducing risks in the workplace. The CBI (1990) state that the aim of setting health and safety standards is to control risk and protect employees and property in order to achieve goals set down in the company health and safety policy. However, this should be done in such a way as to strike a balance between the cost and complexity of the control measures and the size of the risk. In order to control these risks, hazards must be identified and the associated risks assessed. In order to carry out an adequate assessment the working environment, equipment and materials used must be considered, along with peoples attitudes and behaviour. The measures required to control the risks may then be determined. It is important both when assessing the risks and determining control measures to involve employees, as they have the greatest knowledge of the processes and machinery. In addition, they are more likely to follow any measures that are introduced if they have been involved in developing them.

The CBI (1990) also state that adequate monitoring systems are important building blocks in the development of a sound safety culture. Monitoring is also an important part of the risk assessment process.

From the above discussion it can be seen that risk assessment plays an important role in laying the foundations of a positive organisational safety culture. The results of risk assessments can be used not only to identify and control hazards, but can also be used to improve plant procedures and training programmes. Employees' attitudes and beliefs with respect to these risk assessments play an important role. Employee involvement in the assessments will not only encourage the use of any control measures which are implemented following an assessment, but will also assist forming employee beliefs that their workplace is in fact a safe place to work and that management are taking steps to ensure safety within that workplace. Thus it is suggested that without an adequate risk assessment process where the employees are involved in and believe in the process, an organisation cannot achieve an optimal safety culture.

2.4.2 Techniques for Assessing Organisational Safety Culture

However, despite the apparent importance of risk assessment in the development of a positive organisational safety culture, many techniques for assessing the safety culture of an organisation do not consider risk assessment. Those that do consider risk assessment tend to do so only at a very superficial level. A number of safety culture assessment methodologies were reviewed (e.g. Walters 1996; O'Loughlin, 1995, Kennedy 1996; Kennedy and Kirwan 1996; ACSNI 1993; CBI 1990). These methodologies work on the basis of interviewing personnel, asking personnel to complete questionnaires and providing checklists for indicators of a sound safety culture. The questions used in each of the methodologies are based upon the characteristics of a good safety culture

outlined earlier in this chapter. These questions are used to give a measures of the adequacy of the organisations safety culture.

In each case, as many personnel from within an organisation as possible should be consulted in order to give an accurate a picture as possible of the culture within that organisation. Note that it is important that both management and non-management members of staff are interviewed as they may have differing opinions on the adequacy of the safety systems and management's commitment to safety.

2.4.2.1 Frequently used measures of safety culture

It was found that the most frequently used measures of safety culture were based upon the following topics:

- company health and safety policies
- health and safety rules and procedures
- safety training and knowledge
- safety committees
- communication
- health and safety responsibility
- company emphasis on health and safety
- safety reward systems and sanctions for breaking safety rules
- safety auditing
- accident investigation
- commitment of staff at all levels to health and safety
- allocation of resources

Of the safety culture assessment methodologies reviewed, the checklist developed by ACSNI (1993) was the only one to include any specific questions relating to risk assessment. ACSNI (1993) suggests that an organisation should have procedures in place to ensure that hazards are

identified, that risks are adequately assessed, and that workable and effective control measures are selected. However, the report does not give any detailed guidance as to how the adequacy of a risk management system or peoples attitudes to risk assessment may be assessed.

As has already been discussed, the CBI (1990) does recognise the importance of risk assessment within an organisational safety culture. However, the checklist of features essential to achieving and maintaining a positive organisational safety culture does not make specific reference to risk assessment.

The techniques developed by Walters (1996) is questionnaire based and does ask participants whether they think that;

health and safety practices (within the organisation) are managed pro-actively or tend to react to events when they have happened?

However, it is suggested that non health and safety personnel may not understand the full meaning of this question. That is, whether pro-active techniques for managing safety, such as risk assessment, are used alongside reactive techniques such as accident investigation. Indeed, in the study by Walters (1996) 29% of the participants failed to respond to the question (compared to an average failure rate of 0.8% for the remaining questions), suggesting a possible lack of understanding. It is possible that this lack of response was at least in part because respondents did not know enough about the safety management system operated by the company to respond. However, given the low failure rate for the remaining questions, it is suggested that this is unlikely.

In addition to this possible lack of understanding, the questionnaire makes no attempt to discover the attitudes of individuals to risk

assessment and pro-active safety management. Instead the question simply focuses on the apparent approach of the organisations as a whole.

It should be noted that although the efficacy of one question within the study conducted by Walters (1996) has been questioned, there is no evidence to suggest that the remainder of the study is invalid. The remaining questions appear to be well thought out, to have used plain English and avoided the use of technical jargon. This is supported by a mean response rate of 99.2% to these questions.

2.5 CONCLUSIONS ON SAFETY CULTURE AND RISK ASSESSMENT

No further evidence of any consideration of risk assessment could be found within the literature on safety culture assessment. Thus it would appear that, in general, risk assessment does not tend to be considered in depth within safety culture assessment methodologies. As has already been discussed, risk assessment forms an important building block in any safety management system. Unless adequate risk assessments are performed, the hazards present within the workplace cannot be adequately identified and dealt with. Failure to adequately identify hazards present in the workplace can have a knock on effect on the rest of a safety management system.

For example, procedures cannot adequately protect personnel from hazards if those hazards have not been identified. No amount of communication, training and information can adequately inform and train personnel of any dangers if those dangers have not been identified. A positive attitude to risk assessment is therefore vital to maintaining a positive organisational safety culture.

It is also important that this attitude is consistent at all levels within the organisation. Management commitment is important to ensure that adequate support and resources are provided. Personnel responsible for managing safety and conducting risk assessments must view risk assessment as an effective tool for managing safety if the assessments are to be conducted to the best of their ability. In addition, personnel on the shop floor must also view risk assessment as an effective tool if they are to trust the results of the assessments and to always use any control measures implemented following an assessment.

A number of the safety culture assessment methodologies examined did consider the adequacy and effectiveness of accident investigations conducted within organisations. Whilst accident investigation is a valuable tool in managing safety, it is also a reactive tool. Such tools should always be combined with pro-active measures such as risk assessment so that wherever possible hazards are identified before an accident actually takes place. By examining reactive measures without looking at pro-active measures as well, there is a danger that the assessments will fail to pick up on those organisations where the bias is towards a reactive approach to safety management.

It is therefore suggested that whilst the importance of measures such as adequacy of communication, procedures and training are not in question, a failure to consider risk assessment and the impact that these assessments have on aspects such as procedures, training and communication, may in some circumstances give an over optimistic view of an organisations safety culture. In order to give a true picture of an organisation safety culture, it is proposed that attitudes to all aspects of the organisations safety management system, including risk assessment, should be assessed.

The current study aims to demonstrate this need to include risk assessment within methods for assessing safety culture. Two organisations that had already performed well in previous safety culture assessments were chosen for the study. The field work aims to show that although both organisations had performed well on those frequently used measures of safety culture identified in section 2.4.2.1 of this chapter, there were areas of the safety management system relating to risk assessment in which neither organisations performed as well as the previous safety culture studies may have indicated.

The safety management systems of both organisations were examined. In particular procedures for conducting risk assessments and attitudes towards risk assessment within the organisations were considered. As has already been discussed, risk assessment features prominently within current health and safety legislation. Compliance with the risk assessment requirements of current health and safety legislation were therefore used as a benchmark against which to assess risk assessment performance. The research objectives for the study are outlined in greater detail in chapter three and the methodology is given in chapter four.

CHAPTER THREE

Research Objectives

3.1 INTRODUCTION

The present study explores the role of risk assessment within a safety management system, and its importance with respect to the safety culture of an organisation. The risk assessment process both internal to, and external to an organisation is considered in the light of the move from a rule-based to a risk based approach to health and safety legislation. Case studies of two organisations have been carried out. The primary study was conducted at an Electricity Generation Company. A secondary study was conducted at an Offshore Oil Production Company.

3.2 CASE STUDIES

The Electricity Generation Company is one of four privately owned electricity generating companies which were formed when the publicly owned Central Electricity Generation Board (CEGB) was sold. The Electricity Generation Company own a number of sites throughout the UK and worldwide. During the study, the company head office, the company workshops and a power station were visited. Occupational health and safety, the company's central safety department, are based at head office. They are responsible for company health and safety policy and procedures. They also act in an advisory capacity to the other UK sites. Each individual UK site also has its own health and safety department which are responsible for the day to day health and safety activities of the sites.

and carry out accident investigations and safety audits. However, it is suggested that although a company may perform well on the more frequently used measures of safety culture, this is not necessarily a true indication of performance with respect to the risk assessment and risk management process. Risk assessment policies and practices both internal and external to an organisation may have an effect on the safety performance of that organisation.

3.3 HYPOTHESES

In order to test this theory the following hypotheses will be considered.

Hypothesis 1 - Good performance on the more frequently used measures of safety culture (as defined in chapter two, section 2.4.2.1) implies that an organisation adopts suitable and sufficient risk management strategies.

Hypothesis one will be tested in two stages. Hypothesis 1a relates to internal risk assessments initiated by the organisation under consideration. Hypothesis 1b relates to risk assessments carried out external to the organisation, for example by equipment suppliers, which may also impact upon the safety of that organisation.

Hypothesis 1a - Suitable and sufficient internal risk management strategies and risk assessments are being carried out.

Hypothesis 1b - Adequate arrangements are made to ensure that equipment suppliers also carry out suitable and sufficient risk assessments.

Inadequacies in an organisations risk management strategy may not solely be caused by a failure in that organisation. The adequacy of information and guidance available to that organisation may also be a contributory factor. A second hypothesis therefore examines the adequacy of guidance supplied by the Health and Safety Executive (HSE) regarding the new legislation.

Hypothesis 2 - HSE guidance on the legislation is adequate to allow suitable and sufficient risk management strategies to be adopted by an organisation.

The method by which these hypotheses have been tested is outlined in chapter four.

CHAPTER FOUR

Research Methodology

This chapter outlines the methodology for conducting the research. The methodology is described in three sections. The first is a philosophical methodology justifying the techniques used to conduct the research. The second section describes the qualitative methodology used for data collection. The final section outlines the data analysis procedure.

4.1 PHILOSOPHICAL METHODOLOGY

The purpose of the philosophical methodology is to justify the use of the methodology and the data analysis procedures outlined in sections 4.2 and 4.3 respectively. The research methodology was primarily determined by the explorative nature of the research. Research constraints such as the practical problems in conducting fieldwork within the two organisations were also taken into account. These are outlined in greater detail in section 4.1.2.

4.1.1 Methodological Justifications

Due to the explorative nature of the research, a primarily qualitative rather than quantitative methodology was chosen with which to conduct the research. A qualitative methodology may be defined as research which produces findings not arrived at by means of statistical procedures or other means of quantification. Merriam (1988) states that qualitative researchers are;

*'concerned primarily with **process** rather than outcomes or products.'*

In the case of the current research, the researcher is primarily concerned with the process by which risks are managed within the two organisations under consideration. The following approach is taken when conducting qualitative research.

'Qualitative research is conducted through an intense and/or prolonged contact with a "field" or life situation. These situations are typically "banal" or normal ones reflective of the everyday life of individuals, groups, societies, and organisations.'

Miles & Huberman (1994)

This research approach is perhaps the most significant reason for selecting a qualitative methodology. The researcher was offered the opportunity by both Electricity Generation Company and Asset A of the Offshore Oil Production Company to carry out the study via the use of intense and in the case of the Oil Company study, prolonged contact with relevant personnel, departments and situations within the organisations. The primary objective of the research being to study the ways in which risks are managed within the organisations on a day to day basis.

Marshall and Rossman (1995) describe the four fundamental methods used by qualitative researchers for data collection as;

- participation in the setting,
- direct observation,
- in-depth interviewing, and
- document review.

These methods may also be supported by a number of supplementary methods of data collection. These secondary methods include the use of questionnaires.

4.1.1.1 Interviews

The primary data gathering method used in the current study was in-depth interviewing. Cohen and Manion (1989) describe an interview as a conversation;

'initiated by the interviewer for the specific purpose of obtaining research-relevant information and focused by him on content specified by research objectives of systematic description, prediction or explanation.'

As the research objectives were relatively clear fairly early on in the data collection phase of the research, it was felt that interviews were an appropriate method of gathering information. Interviews are an effective method of gathering information as they are a flexible and adaptable way of finding things out. However, there are a wide range of types of interview ranging from totally structured to completely unstructured interview techniques. For the purposes of the current study, a semi-structured interview technique was judged to be most appropriate. In a semi-structured interview, the interviewer has;

'worked out a set of questions in advance but, is free to modify their order based upon her perception of what seems most appropriate in the context of the 'conversation.'

Thus, with respect to the questions, the interviewer can:

'change the way they are worded, give explanations, leave out questions which seem inappropriate with a particular interviewee or include additional ones.'

Semi-structured interviews are advantageous in that they provide a certain level of consistency between interviews whilst still allowing the interviewer

to explore unexpected or interesting areas that emerge during the interview. They also allow the interview to be tailored to the expertise of the interviewee.

Three types of questions are used during research interviews. These questions may be open, closed or scaled (Robson, 1995). Closed questions require the respondent to choose from two or more fixed alternatives. Open questions do not set such restrictions on the content or manner of the reply. Scaled questions require the respondent to make a response in the form of agreement or disagreement with a particular statement given by the interviewer. Thus scaled questions may be regarded by some researchers as a form of closed question.

Open questions were chosen for the current research as they do not restrict the respondents to answers pre-determined by the interviewer. This allows the interviewer to determine more detailed and wider ranging information about an organisation as the answers are less restricted to the researchers pre-conceived ideas about a subject matter.

4.1.1.2 Observation and documentation

As was discussed earlier, Marshall and Rossman (1995) identified four primary techniques for qualitatively collecting data. Two more of these techniques were adopted during the field studies conducted at the Electricity Generation Company and the Offshore Oil Production Company. The statements given by the interviewees during the in-depth interviews were supported with evidence from direct observation (in the form of site tours and safety inspections) and from relevant company health and safety documentation.

4.1.1.3 Questionnaires

However, a number of constraints on the field work resulted in the researcher being unable to gather all the necessary information via the use

of these three techniques alone. Logistical problems in getting offshore to interview personnel in Asset A of the Oil Production Company and time restraints imposed on the work carried out within both organisations made it difficult to interview sufficient numbers of personnel to determine their attitudes and beliefs with respect to risk assessment and risk management. Questionnaires are described by Marshall and Rossman (1995) as an appropriate technique for providing supplementary information to that gathered via techniques such as interviews, observation and documentation.

The interviews were sufficient to identify the risk management practices used within the organisations, as fewer respondents were involved in this phase of the research (primarily because the subject matter was such that the respondents needed to be members of the organisations safety personnel). The questionnaires therefore concentrated on attitudes and beliefs with respect to risk assessment. The questionnaires were aimed at a wider audience than the interviews in order to gain some insight into how workers 'on the shop floor' felt about risk management within their respective organisations.

The use of questionnaires allowed the question sets to be sent to the individual sites where they could be completed at a time convenient to the respondents. The subject matter under investigation was suitable for a questionnaire format as the researcher required answers to a relatively small number of very specific questions. This kept the questionnaire easy and quick to complete to encourage a good response rate. The specific nature of the questions meant that the adequacy of the information gathered by the researcher was not unduly hindered by the inability when using such a format to further probe the respondent for additional information.

A number of different styles of question were considered for the questionnaire. For example, closed questions, the use of scaled responses such as the Likert scale, and open-ended questions such as those used in

the interviews. Closed questions and scaled responses provide the data most suitable for statistical analysis. However, it was known prior to distribution of the questionnaires that it would only be possible to distribute them to a relatively small number of personnel within the two organisations. It was therefore important to obtain as much information as possible from each of the questionnaires. In addition due to the nature of the questions to be included, the use of scaled responses would have resulted in the need for a number of different scales, which may have been confused or misread by the respondents. Due to the wide spectrum of the workforce to which the questionnaires were aimed, it was important to keep the questions as simple as possible. The need for simplicity and in-depth information outweighed the desirability for statistical data. Open-ended questions were therefore used for the questionnaire as they not only encourage in-depth answers, but they also do not restrict responses to the pre-conceived ideas of the researcher.

4.1.1.4 Data analysis

For both the interviews and the questionnaires, the use of open ended questions does make data analysis more difficult and time consuming. Statistical techniques cannot be easily applied to results from such questions. However, the difficulties arising from data analysis were outweighed from the advantage of the additional and more insightful information obtained by using this type of questions.

Miles and Huberman (1994) suggest that it is appropriate for the analysis of qualitative data to be;

'...done with words... They can be organised to permit the researcher to contrast, compare, analyse, and bestow patterns upon them.'

This was primarily the approach taken to the data analysis phase of this research. Miles and Huberman (1994) state that data reduction is an

important part of the analysis. The first stage of this data reduction process was to produce a narrative of the results obtained from the interviews, observations and documentation. (See chapter five). This chapter provides the reader (particularly those with little knowledge of the risk management process) with valuable background information on the detailed findings summarised in chapter six.

Extended text is a well used method of displaying information (Miles & Huberman, 1994) and is useful in providing information regarding the context of the discussion points. However, Faust (1982) has suggested that extended text can overload humans' information-processing capabilities if used directly for discussion purposes. Methods of summarising data such as matrices, graphs, tables and networks are therefore favoured. For this reason, the data outlined in chapter five is further summarised in a table in chapter six. The table highlights the primary findings discussed in chapter seven. In addition, the format of the table allows a direct comparison of the findings from the two organisations under consideration.

The data analysis arising from the questionnaire responses is less cumbersome. The data was suitable for direct entry into a tabular format without the need for an explanatory extended text. In addition, the data was sufficiently concise and consistent to be displayed in the form of descriptive statistics, which further aids in the ease of understanding the results for discursive purposes. The data analysis procedures are further described in section 4.3.

4.1.2 Constraints of the Research

The primary problem associated with conducting the current study was the lack of control that the researcher had over organisational events. Visits to the sites (particularly the Electricity Generation Company sites) were very much opportunistic in nature. For example, the researcher had to wait for relatively quiet periods in production before a visit to a site could be

arranged. Other factors such as logistical problems in getting offshore due to the weather and the expense to the Oil Company of unscheduled offshore flights, along with the heavy workload of personnel created further problems in collecting data.

It was important to the research that the researcher was accepted into the organisations under consideration. This was achieved at the Electricity Generation Company by being introduced to the personnel at each site by a representative from the Occupational Health and Safety Department at Head Office. As is discussed in the results section (chapter five) the OH&S department have a positive relationship with the other Electricity Generation Company sites and are respected and trusted by them. The introductions therefore allowed the researcher to be viewed in a non-threatening manner and encouraged co-operation from site personnel. A similar effect was achieved at Asset A of the Offshore Oil Production Company by spending time working alongside Asset A personnel and getting to know them before asking detailed questions.

4.2 QUALITATIVE METHODOLOGY

The case studies at Electricity Generation Company and the Asset A of the Offshore Oil Production Company, have been conducted using a combination of semi-structured interviews, questionnaires, safety tours and company health and safety documentation. Both health and safety personnel and general members of the workforce have been consulted as part of the field work in order to give an indication of the impact that risk assessment has had on each organisation.

4.2.1 Semi-Structured Interviews

A set of semi-structured questions were developed for use when interviewing health and safety personnel at the Electricity Generation Company and Asset A of the Offshore Oil Production Company. Semi-structured questions were used as they allow the interviewer to expand upon areas of interest whilst still keeping some level of consistency between the questions asked in each interview. Wherever possible, the questions were open ended to encourage the interviewee to give full and detailed answers rather than for example, one word answers.

The interview questions were aimed at health and safety personnel with a detailed knowledge of the health and safety provisions within each organisation, rather than at the general workforce. This is because the questions were aimed at establishing how health and safety issues associated with risk assessment are managed within each organisation, and required a detailed knowledge of the company health and safety management systems. Note that the impact of both organisations risk management systems upon the *general* workforce (i.e. non-health and safety personnel) is examined via the questionnaire discussed below. A number of the interview questions were also of relevance to personnel responsible for the procurement of equipment.

The interview question set was developed taking into consideration literature on the elements necessary within an organisation in order to establish a positive safety culture (e.g. ACSNI, 1993; Glennon, 1980, 1982; Zohar, 1980; CBI, 1990; Ryan, 1991). In addition, the requirements of current health and safety legislation and current health and safety guidance in the Guidance Notes, Approved Codes of Practice and British and European Standards were also taken into account.

As discussed earlier, regulation 3 of the MHSW Regulations requires that employers carry out suitable and sufficient risk assessments within the workplace. Other legislation such as PUWER92/98, the Personnel Protective Equipment Regulations, the Display Screen Equipment Regulations, COSHH, and the Noise at Work Regulations give more detailed requirements relating to the types of hazards that should be considered as part of the assessment and suitable control measures which may be put into place in order to reduce the risks. In addition, the guidance notes on the MHSW Regulations and BS8800 provide guidance on the steps which should be taken in order to carry out an effective risk assessment.

There are therefore questions in the interview question set relating to the circumstances under which risk assessments are carried out including assessments carried out under permit-to-work systems. For example, whether risk assessments are used pro-actively or tend to be used reactively following an incident. A number of questions also relate to the risk assessment techniques adopted by the organisation. Limitations on time and resources are such that it would be impractical to study in depth each organisations compliance with all current health and safety legislation. PUWER92 is widely applicable to both organisations. Therefore, a detailed analysis of each organisations level of compliance with the requirements of PUWER92 has been carried out. This is intended to give an indication of how effective their management strategies are in meeting the detailed requirements of the legislation relating to risk assessment.

Regulation 10 of PUWER92 places a requirement on employers to ensure that, when purchasing new equipment, it complies with all relevant European health and safety legislation. A number of questions relating to the procurement of new equipment were therefore included in the question set. These questions were aimed both at health and safety personnel and procurement personnel.

Risk assessment is a continuous process which does not end once the initial assessment has been completed. Questions relating to control measures used by the organisation, including procedures and the modification of equipment, and the monitoring and review of assessments were included in the interview question set. These questions were based upon recommendations on the risk assessment process given in the guidance notes accompanying the MHSW Regulations and BS8800.

Current literature on the development of a positive organisational safety culture indicates that an effective safety management system is important in achieving this goal. As the management of risks is an important part of such a safety management system, a number of questions in the interview question set relate to the organisations risk management system. A number of common factors relating to management have been found that influence the safety culture of an organisation. As discussed earlier, these factors include the importance of management commitment and leadership with respect to safety, the resources and emphasis given to health and safety, the involvement of all employees in the safety of an organisation, and effective and open communication and a means to achieve them at all levels.

Questions relating to employee involvement in assessments, training, and communication of results are included in the question set. Management commitment and resources given to safety and risk management are also examined throughout the interview question set.

The interview question set can be found in full in Appendix A.

4.2.2 Questionnaire

The purpose of the questionnaire was to give an indication of attitudes to and knowledge of risk assessment within the general workforce, in order to determine whether each organisations risk management system has had a positive effect upon the general workforce. As with the interviews, the questions were open-ended wherever possible in order to encourage full and detailed answers. Questionnaires rather than interviews were used for this stage due to time restrictions when carrying out site visits and difficulties in getting offshore to interview relevant personnel.

The questionnaire asks general members of the workforce about their level of involvement in risk assessments and whether they think this level of involvement is sufficient. It also asks whether they have received any training in risk assessment and whether the results of risk assessments are adequately passed on to them. Employees are asked how effective they view risk assessment to be as a method for improving safety, whether they would always follow any changes brought about as a result of a risk assessment, and whether they think safety should be put before production. The questionnaire also asks personnel if they think management put safety before production, and if they feel that management provide sufficient resources for safety related activities such as risk assessment. Finally, personnel are asked if they have any suggestions for improvements to the way risk assessments are carried out in the workplace.

Before being sent out, the questionnaire was piloted on three personnel from Asset A of the Offshore Oil Production Company. A small number of minor adjustments to the wording of the questions were made as a result of the pilot study. The questionnaire takes around five to ten minutes to complete depending upon the level of detail given by personnel in their answers. The questionnaire was distributed amongst personnel at the

Electricity Generation Company and the Offshore Oil Production Company. Two responses were obtained during a site visit to the Electricity Generation Company. A further ten copies were sent to the Electricity Generation Company and all ten were returned, giving a total of twelve responses. Twenty-five questionnaires were sent to the Offshore Oil Production Company and seventeen responses were received.

The questionnaire can be found in full in Appendix B, along with the cover letter given to all personnel involved to explain the purpose of the questionnaire.

4.2.3 Personnel Confidentiality

All personnel participating in either interviews or completing the questionnaire were offered complete confidentiality. This was necessary in order to encourage personnel to give honest and detailed answers and to help avoid situations whereby participants felt they could not answer questions, particularly about sensitive issues such as accidents and failure to follow procedures, for fear that their answers might then be passed on to senior personnel. Names of participants therefore have not been given in this report. In addition, wherever precise job titles are sufficient to identify individuals, these have not been given. Instead, an indication of job area and level of responsibility has been given. For example, safety, production, or procurement and manager, supervisor, or technician respectively.

This level of information regarding the identification of personnel is sufficient for the analysis of the results of the present study. This is because such information is only required to give an indication of whether safety personnel are adequately meeting the requirements of current health and safety legislation and guidance, and whether safety related information is passed on and utilised by other departments and through all levels of the organisation from management through to the shop floor. Names and

precise job titles (where these may be used to identify personnel) are therefore not necessary.

4.2.4 The Electricity Generation Company Study

As part of the Electricity Generation Company case study, a number of visits were made to the Occupational Health and Safety Department at the Electricity Generation Company Head Office between January 1997 and December 1997. In addition, a visit was made to the Electricity Generation Company Workshops in August 1997 and to Power Station A in December 1997. Questionnaires were sent to Power Station A and Electricity Generation Company Workshops in March 1998. Unfortunately, despite follow ups, no responses to the questionnaires were forthcoming on this occasion. The questionnaires were therefore reissued with the assistance of the Occupational Health and Safety Department, in early 1999.

4.2.4.1 Work carried out at the Occupational Health and Safety Department

The Electricity Generation Company's Occupational Health and Safety (OH&S) Department are based at the Company's Head Office. OH&S have a responsibility for health and safety at corporate level. The OH&S department's duties also include advising the Electricity Generation Company's power stations and workshops with respect to current health and safety legislative requirements and best practices.

This advisory role of OH&S along with the corporate policies relating to risk management were examined during semi-structured interviews with two safety engineers from the OH&S department. The question set in Appendix A was used as guidance during both interviews.

In addition, a number of documents were examined at head office to further explore the Electricity Generation Company's policies on risk assessment

and risk management at a corporate level. Documentation was examined on the following topics:

- The Company philosophy on risk assessment;
- Guidance provided by Head Office in conducting risk assessments;
- Health and safety training an course outlines;
- Safety advisory bulletins on the 'six-pack' of Regulations;
- Purchasing new plant and equipment; and
- Checklists and guidance on conducting PUWER and MHSW audits.

The documentation examined also included reports from a number of accident investigations involving electrical systems, along with the risk assessments and recommendations which followed the initial investigations. This was to give an indication of the effect that a lack of risk assessment both by manufacturers and suppliers and the owners of the equipment can have on the safety of such equipment.

The contents of these documents are explained in greater detail in chapters five and six.

4.2.4.2 Work carried out at the Electricity Generation Company Workshops

The workshops carry out maintenance for Electricity Generation Company power stations and for a number of other onshore and offshore companies. Typical machinery in the workshops include lathes, grinders, guillotines, and hand tools. The interview questions relating to PUWER92 were therefore particularly applicable to the workshops.

Semi-structured interviews were carried out with a safety engineer and a production engineer at the workshop using the question-set in Appendix A. The purpose of the interviews was to examine the workshops approach to risk management, and to gain insight into the workshops relationship with

the OH&S department at Head Office. The workshops current position on PUWER92 and CE marking, along with the level of knowledge of European standards and legislation were also discussed.

A tour and safety inspection of the workshop was carried out during the visit in order to further determine the workshops current level of compliance with the requirements of PUWER.

A number of items of documentation were also examined. The workshops are responsible for developing their own procedures and approaches to risk management based upon guidance provided by the OH&S department at Head Office. Documentation on the workshops approach to risk management was examined along with procedures for conducting risk assessments. The results of a number of PUWER92 assessments conducted at the workshops were also examined, along with the action plans arising from the assessments.

A number of questionnaires were sent to the workshops for completion. However, despite follow-ups no responses to the questionnaires were forthcoming.

4.2.4.3 Work carried out at Power Station A

During the visit to Power Station A, seven personnel were interviewed using the semi-structured question set in Appendix A for guidance. Three safety personnel were interviewed (a safety manger, a safety co-ordinator, and a team leader), two personnel from the procurement department, a production engineer, and an electrical engineer with responsibilities for electrical safety.

As was indicated earlier, a number of accident reports were studied during site visits to the OH&S department at the Electricity Generation Company's Head Office. One of the accidents studied occurred at Power Station A in

1994. In order to examine the impact that the accident had upon Power Station A and any changes that have been implemented in the power station since the completion of the accident investigation, a number of additional questions were asked during the interviews. The personnel interviewed were asked to outline any changes that have been introduced since the accident. In particular, they were asked whether the control measures introduced since the accident have been primarily procedural or whether design changes have also taken place. Personnel were also asked whether European Standards are consulted when design changes are made to equipment or other additional control measures such as PPE are introduced.

A tour of the power station and safety inspection of the mechanical workshop was also carried out. During the inspection of the workshop, two workshop technicians were asked to complete the attitudes and knowledge of risk assessment questionnaire in Appendix B. Due to time restrictions and a lack of availability of suitable personnel, no further questionnaires were completed during the site visit. Further questionnaires were sent to Power Station A in March 1998 to be given out to personnel. However, as for the workshops, no responses to the questionnaires were forthcoming. The questionnaires were therefore re-issued, with the assistance of the OH&S department at a training course in early 1999. Ten further responses to the questionnaire were obtained, giving a total of twelve responses.

A number of items of documentation were also obtained during the site visit to Power Station A. This included information on:

- the power stations approach to risk assessment;
- a hazard identification checklist developed by the station;
- the personal risk assessment scheme developed by the station;
- procedure for conducting PUWER92 audits; and
- a methodology for assessing the risks to personnel from electrical arcing.

4.2.5 The Offshore Oil Production Company Study

The approach to the case study at Asset A of the Offshore Oil Production Company was slightly different to that conducted at the Electricity Generation Company. The Electricity Generation Company study involved relatively short visits to sites during which time it was not possible to get to know personnel. Interviews were quite formal and carried out in one session rather than over a period of time. The circumstances under which the Offshore Oil Production Company study was conducted were a little different.

The work at Asset A of the Oil Production Company was carried out as a result of a report by Raafat (1996) on the Asset's level of compliance with PUWER92. The report identified a number of deficiencies in compliance with the regulations. Asset A therefore set up a safety development workgroup specifically to tackle a number of health and safety issues, including the problem of the Asset's lack of compliance with PUWER92.

It was whilst working as a member of this workgroup that the Offshore Oil Production Company case study was carried out. Due to being able to spend a greater amount of time at Asset A, it was possible to get to know the personnel. Interviews were therefore carried out on an informal basis and tended to be carried out over a period of time rather than in one session. The interview question-set in Appendix A was referred to throughout the work at Asset A in order to maintain a certain level of consistency between the studies at the Electricity Generation Company and the Oil Production Company.

The purpose of the work at the Oil Production Company was to further examine the lack of compliance with PUWER92 within Asset A and to study the Asset's general approach to risk management and the impact this approach has on the workforce as a whole. As part of the study, work was carried out both onshore and offshore. The onshore work was carried out

primarily at the onshore offices of the Asset A Health and Safety department and the Asset A Offshore Engineering department. The offshore work was conducted on four of the Asset's manned platforms, referred to here as installations A, B, D and E. Due to bad weather and a lack of field flights it was not possible to visit the remaining manned platform, installation C.

The work carried out on the Asset A offshore installations and at the Oil Production Company's onshore offices was influenced by the recommendations made by Raafat (1996) in his review of Asset A's compliance with PUWER92. As discussed earlier, the report identified a number of areas in which Asset A were failing to comply with the requirements of PUWER92. A summary of the recommendations given in the report is shown below.

1. For the majority of work equipment assessed on Installation A there is a need to review the standard of safeguarding in order to demonstrate compliance with regulation 11 of PUWER. It was recommended that Asset A should adopt relevant EN technical standards for guard design and construction as company standards.
2. General workplace risk assessments should be carried out on all equipment on Asset A's offshore installations in accordance with the requirements of regulation 3 of MHSW. Such risk assessments are an important step in demonstrating compliance with PUWER92 and also allow site management to demonstrate compliance with other legislation.
3. Many of the suppliers of hired and leased equipment for use in the Asset A field, do not appear to comply with the Supply of Machinery (Safety) Regulations. Site management need to ensure that potential suppliers can demonstrate compliance, and in the meantime tighten up procedures for training, safe systems of work, notices and supervision as a last line of defense in order to ensure compliance with PUWER92.

4. Raafat (1996) carried out safety assessments of a number of items of equipment on Installation A. In the galley, a vegetable slicing machine, potato peeling/slicing machine, and a heavy duty food mixer were identified as possibly not complying with the requirements of PUWER92. The safety assessments also identified that a sack slitter used on Installation A did not adequately comply with the Supply of Machinery (Safety) Regulations. A waste compactor also used on Installation A was also identified as not complying with the Supply Regulations. Raafat's (1996) report sets out a number of recommendations for improving the sack slitter and waste compactor.

Asset A's progress with respect to implementing these recommendations and complying with the requirements of PUWER92 was studied as part of the current report. In addition, Asset A's general approach to risk management, and techniques used for risk assessment, were reviewed. Current levels of training and knowledge with respect to risk assessment were examined. Attitudes of the workforce towards risk assessment were investigated. The development of an integrated approach to risk assessment for use when carrying out plant maintenance and modifications and during the design and construction stages of new projects was also followed.

4.2.5.1 Work carried out offshore

Due to time restraints, the report by Raafat (1996) only allowed the inspection of five items of equipment on one of the five manned offshore installations. Therefore in order to give a more detailed overview of the scope of the problem and the resources required to achieve compliance with PUWER92, a further offshore study of Asset A's compliance with PUWER92 was carried out. The assessment involved carrying out a number of risk assessments and interviewing personnel to determine whether any PUWER92 type risk assessments had been carried out and the current level of knowledge within the workforce of the requirements of PUWER92.

In order to ensure that the scope of the work was manageable within the time scale available, the PUWER92 compliance study considered two platform areas; the galley and the workshop area on each of installations A, B, D, and E. The large similarities between the results found on each platform, along with the difficulties in arranging a visit resulted in no inspection being carried out on Installation C.

For each item of equipment, the date it was supplied, hired or leased was identified. It was also established whether any risk assessment regarding PUWER92 had been undertaken, and whether the equipment was CE marked and holds an EC certificate of conformity. For equipment which was identified as having no PUWER92 risk assessment, preliminary risk assessments were carried out in order to determine the level of non-compliance with PUWER92. For equipment which was CE marked, the certificates of conformity (where available) were examined to determine whether appropriate European standards had been listed on the certificate. Where available, documentation on PUWER92 assessments conducted on the offshore installations was examined to determine the adequacy of the assessments.

A technician in each of the workshops and steward in each of the galleys was also interviewed to determine whether any risk assessments had been carried out on any of the equipment and the maintenance programme for each item of equipment.

At all times a Fire Safety Officer (FSO) is available on each of the platforms. FSOs have chief responsibility for safety on the installations. The Fire Safety Officers (FSOs) on each of the four platforms were interviewed using the interview question set in Appendix A as guidance. These interviews allowed both PUWER92 compliance and other issues relating to risk assessment and risk management to be discussed thus giving a broader view of the risk management systems in place offshore.

The attitudes and knowledge of risk assessment questionnaire (see Appendix B) was given out by a member of the Safety Development Workgroup (on behalf of the author of this study) during two safety meetings on Installation B. This allowed the questionnaires to be given out to a cross-section of the workforce. Seventeen questionnaires were completed. Due to time constraints of offshore visits, it was not possible to obtain any further responses to the questionnaire.

4.2.5.2 Work carried out onshore

During June 1997-March 1998 information regarding Asset A's general approach to risk management was obtained from three of Asset A's safety advisors. Two engineers with responsibilities for risk assessment and safety were also interviewed. The Safety advisors were members of the Asset A health and safety department. The engineers were members of the Asset A Offshore Engineering department. As indicated earlier, discussions took place over a period of time rather than during one long interview. The interview question set was used as guidance throughout.

A number of items of documentation on the Offshore Oil Production Company's approach to risk assessment were examined. In addition, documentation on Asset A's own approach to risk assessment, risk management and compliance with PUWER92 was also studied.

4.2.5.3 Sack Sitter, Waste Compactor and Galley Equipment

Raafat's (1996) report identified five items of equipment which did not appear to fully comply with the requirements of PUWER92. In particular, a sack splitter and a waste compactor on Installation A appeared to significantly breach the requirements of regulation 11 of PUWER92 relating to access to dangerous parts of machinery. The sack splitter was CE marked. However, this CE marking appeared to be unsuitable since the manufacturer had not undertaken a suitable risk assessment and the equipment appeared to be unsafe. The waste compactor had no CE marking

despite being supplied after January 1995. Two engineers from Asset A's Offshore Engineering department were interviewed with respect to the Asset's procurement policy. The section from the interview question set on procurement and CE marking was used as guidance (see Appendix A). Documentation on Asset A's official procurement policy was examined. The suppliers of the above items of equipment were also contacted in order to determine the level of knowledge of Asset A's suppliers with respect to PUWER92, risk assessment, CE marking and the Supply Regulations.

The manger of the company that supplied the waste compactor was interviewed in January 1998. A representative from the catering company responsible for supplying the galley equipment was also questioned in January 1998. A product engineer from the suppliers of the Sack Slitter was interviewed in August 1997 with respect to company's approach to risk management and the design modifications to the sack slitter that had been requested by Asset A following Raafat's (1996) report. A meeting to discuss the suppliers progress with the modifications to the sack slitter was also attended in November 1997 along with two safety advisors from Asset A and four representatives from the supply company. A number of items of documentation produced by the supply company in relation to changes made to the sack slitter were also examined.

4.2.6 Adequacy of the Guidance Accompanying Current Health and Safety Legislation

Throughout the interviews conducted at the Offshore Oil Production Company and the Electricity Generation Company, responses relating to the adequacy of health and safety legislation were noted. The comments given by personnel at the Oil Production Company and the Electricity Generation Company, along with a comparison of the areas in which each organisation failed to fully comply with the legislation, were used to give an indication of the adequacy of the guidance accompanying current health and safety legislation.

4.3 DATA ANALYSIS PROCEDURE

As is discussed in section 4.1.1 the results of the interviews, site visits and information obtained from documentation is displayed in the form of a narrative. Both the results from the Electricity Generation Company study and the Oil production Company study are given in this form in chapter five. The results are displayed in the same format as the interview question set given in Appendix A. Thus the narrative is given under the following headings:

- criteria for carrying out risk assessments;
- permit to work system;
- employee involvement;
- training;
- risk assessment techniques;
- control measures including procedures;
- communication of results;
- monitoring and reviewing assessments;
- PUWER92;
- purchasing new equipment;
- equipment modifications, and;
- support from head office.

This structured approach to displaying the information allows the results of each of the interview questions to be easily tracked. It also allows for a comparison between the results obtained at each of the two organisations under consideration. A similar structure is used in chapter six where the results of the interviews, site visits and documentation are displayed in a summary table.

The results of the questionnaires obtained from the Electricity Generation Company and the Oil Production Company are also displayed in tabular format in chapter six. The results obtained from the questionnaires were

sufficiently concise and consistent for the results to be given in the form of descriptive statistics. The structure of the tables is the same as that used for the questionnaire (see Appendix B). As for the interviews, this allows for the results of each of the questions to be easily tracked and also allows for a direct comparison between the results obtained from the two organisations under consideration.

CHAPTER FIVE

Results 1: Narrative

Chapters five and six outline the results of the case studies. Chapter five gives a narrative of the results obtained from the interviews, company health and safety documentation, and site visits to allow the reader to gain an in-depth understanding of the safety management systems adopted by the two organisations under consideration. Chapter six summarises all of the results obtained during the field studies, in order to allow the reader to identify the key points under discussion in chapter seven. The results and calculations from the questionnaire are displayed in tabular format in Chapter six. This is followed by a summary of the results given in the narrative. This information is also displayed in tabular format so as to allow a direct comparison of the results from the two case studies.

The narrative is given in two sections. The first outlines the results from the Electricity Generation Company, and the second the results from the Offshore Oil Production Company. Where applicable (see Chapter 4 for applicability) and unless otherwise stated, the structure of the narrative corresponds to the structure of the interview question set given in Appendix A.

5.1 RESULTS FROM THE ELECTRICITY GENERATION COMPANY STUDY

The results obtained from the Head Office of the Electricity Generation Company are given, followed by the results from the Company Workshops and Power Station A.

5.1.1 Results of Interviews and Documentation from Head Office

The following outlines the results of interviews with two personnel from the Occupational Health and Safety (OH&S) department based at the Electricity Generation Company's Head Office. The interview results are supported by evidence from health and safety documentation produced by the OH&S department.

A primary role of the OH&S department is to act in a supervisory capacity to the Electricity Generation Company's power stations and workshops. Guidance and information is provided regarding safety issues and new legislation. This guidance is used by the individual sites to develop their own safety management systems.

Guidance provided to the company sites on conducting risk assessments is discussed. This is followed by an outline of the safety bulletins used to inform the sites of changes to health and safety legislation, safety audits instigated by Head Office, and the health and safety training courses provided to each of the sites. The consistency between sites of risk assessments is considered. The results of two incident investigations are also discussed.

5.1.1.1 Guidance on Conducting Risk Assessments

Head Office have produced a number of documents outlining the general principles of conducting a risk assessment (e.g. Electricity Generation Company, 1995; Wedgwood, 1995; and Wedgwood, 1994). The documents outline the various steps involved in conducting a risk assessment (these are similar to those outlined in chapter two). The use of checklists to act as a prompt when conducting risk assessments is also promoted.

The criteria that the Electricity Generation Company use to determine whether a risk is an acceptable risk are explained within the

documentation. For general workplace risk assessments a five point scale is used for estimating severity and likelihood. The likelihood scale ranges from; 'the hazard is extremely unlikely to be present', through to 'the hazard is almost certain to be present'. The severity rating scale ranges from; 'the hazard has the potential to cause only minor injuries', through to 'the hazard has the potential to result in the death of an individual'. An estimate of the process or task risk is then made by multiplying the numerical estimate of the hazard likelihood by the numerical estimate of the severity. These multipliers are set out in a matrix which is divided into high, medium and low risk levels.

Low risks are considered to be acceptable and only require that existing standards and controls are maintained. Medium risks are considered to be tolerable and require that existing control measures are monitored and strictly maintained. It is only high risks (i.e. at a minimum, the hazard is unlikely to happen but contact may result in death, or the hazard is certain to be present and likely to result in injured personnel requiring up to three days off work) which are considered to be unacceptable. High risks are expected to be either eliminated, or further control measures introduced to reduce the likelihood of the hazard occurring.

5.1.1.2 Safety Advisory Bulletins

Head Office send details of new legislation to location managers via regular safety advisory bulletins. Such bulletins have been produced on all the recent legislation which makes up the 'six-pack'. The bulletins briefly outline the requirements of the legislation and provide some guidance as to how the sites should ensure compliance with the legislation.

For example, a bulletin on the Management of Health and Safety at Work (MHSW) Regulations (Burraston, 1993) was issued in 1993, summarising the requirements of the legislation and giving detailed guidance on conducting risk assessments in order to ensure compliance with regulation

3 of the MHSW Regulations. The bulletin also included a detailed list of generic hazards. The individual sites were advised that the generic hazards identified;

'may also give rise to a particular risk dependent upon specific station activities'.

The safety bulletin went on further to say that in circumstances where a hazard gives rise to a particular risk;

'there is a need to carry out further risk assessments and in particular follow-up to accidents and incidents. Details of accidents, incidents and near misses that occur at a location should be recorded with sufficient information to allow the Station Manager to identify particular hazard/risk areas and thereby initiate a suitable and sufficient risk assessment.'

This appears to somewhat miss the whole purpose of risk assessment which is to identify hazards and eliminate them, or introduce control measures, before an accident actually takes place.

Two Safety Advisory Bulletins were issued on the Provision and Use of Work Equipment Regulations 1992 (PUWER92) (Burraston 1993b, Burraston 1996). The first was issued in April 1993, three months after the Regulations were introduced. It briefly went through the requirements of each of the regulations and stated the Electricity Generation Company's then current stance on each of the requirements. For the majority of the requirements, the bulletin stated that existing measures already in place were likely to be sufficient to ensure compliance (for example, training, maintenance procedures, guarding, controls and control systems, warnings and markings and lighting). The only regulation where it was suggested that further action was likely to be required was with respect to regulation

10 of PUWER92 (conformity with community requirements). Personnel were advised to make themselves aware of the requirements relating to CE marking and compliance with EC Directives.

The second Bulletin on PUWER92 was issued over three years later in October, 1996. The purpose of the bulletin was to remind personnel that the transitional period for application of PUWER92 was due to end at the end of the year. The bulletin did point out that the HSE guidance on the Regulations does give;

‘installed plant (e.g. for electricity generation)’

as an example of Work Equipment. However, the bulletin did not stress that the definition of work equipment given by the HSE is very wide and does include the majority of plant/equipment on each of the company’s sites.

The bulletin went on further to state that in practice all relevant plant and equipment on site should already comply with the legislation, but that it would be prudent to ensure that plant and equipment is actually compliant.

5.1.1.3 Safety Audits

One way in which the OH&S department ensure that the individual sites are compliant with the legislation is via the use of safety audits. Head Office do not conduct the audits themselves. Instead, around every three years they ask the individual sites to conduct their own audits based upon the audit forms issued by Occupational health and Safety. A number of different audit forms are issued (Electricity Generation Company, undated a & b) and between them they cover the requirements of all relevant health and safety legislation. The audit forms simply ask a number of Yes/No questions relating to the requirements of the legislation. Space is provided for additional comments and references are provided by Head Office as to where further guidance on each of the questions can be found.

5.1.1.4 Health and Safety Training

The OH&S department at Head Office are also responsible for developing a number of health and safety training courses. These include a course on Manual Handling Assessments (Electricity Generation Company, 1997a) and an Electrical Systems Awareness Workshop (Electricity Generation Company 1997b).

The manual handling course outlines the stages that are required in carrying out a manual handling assessment. The course gives a great deal of guidance on the things that an assessor should be looking out for when conducting an assessment (e.g. size and shape of the loads, the way in which objects are actually lifted, postural considerations etc.) A detailed list of generic tasks which should be considered are also given. The guidance is very comprehensive and goes beyond that given in the HSE's guidance on compliance with the Manual Handling Operations Regulations 1992.

The OH&S department have also developed an Electrical Systems Awareness Workshop. The Workshop was developed following a number of incidents at the Electricity Generation Company's sites involving electrical equipment and was introduced in 1997. Two of these incidents are outlined below. The purpose of the workshop is to 'raise the level of understanding in fault analysis situations and help the team member choose the appropriate course of action for the benefits of personal safety, plant integrity and efficiency' (Electricity Generation Company, 1997). The workshop takes place over five days and involves a mix of classroom and equipment based training. The emphasis of the workshop is largely on practical experience. This is supported by relevant theoretical work, and information on legislation and procedures. Participants are assessed against recognised National Standards of Competence, leading to the possible future achievement of a National Vocational Qualification.

Interviews with personnel at OH&S revealed that they have also developed a training course for general workplace risk assessments. However, the literature on this course could not be found by personnel during any of the visits to Head Office and thus the author of the current study can make no comment can be made on the adequacy of this course.

However, personnel interviewed at Head Office did express some concern about the adequacy of risk assessment training. They suggested that the courses were not adequately detailed for the power station staff to feel they had 'ownership of the risk assessment.' The interviewees suggested that this may have been one of the reasons why, in their opinion, risk assessments within the power stations tend to be viewed as more as 'pieces of paper' which should be filed away, rather than useful documents which assist in improving safety standards. They went on further to explain that once an initial programme of risk assessment training had been conducted, the training was then handed over to the location managers. Concern was expressed that little further training has taken place as, in the opinion of the interviewees, the effectiveness of such training is seen as limited by location managers.

5.1.1.5 Consistency of Risk Assessments

The personnel interviewed also suggested that there was a lack of consistency in the risk assessments carried out at the different Electricity Generation Company sites. They stated that there is a great deal of duplication of effort in carrying out the assessments and that there is little communication between the power stations.

5.1.1.6 Accident Reports

Personnel interviewed at OH&S indicated that that in their opinion a number of incidents at The Electricity Generation Company's power stations have been contributed to by a lack of risk assessments carried out by the manufacturers and suppliers of the equipment. In fact this concern

was one of the motivations for conducting the current research (see Chapter One).

Electricity Generation Company personnel expressed concern that (in their opinion) many suppliers, in particular foreign suppliers, do not design sufficient protective measures into a system, relying rather upon the expertise of the operator to avoid dangerous situations. They went on further to explain that although the Electricity Generation Company's tender proposals do include health and safety issues, they are somewhat restricted as to the requirements they can impose with respect to safety, as changes to the manufacturers designs incur large costs. It was suggested that this is because suppliers tend to use standards components. If the Electricity Generation Company impose higher specifications, non-standard components may be required and costs rise significantly. As a consequence the interviewees stated that the Electricity Generation Company frequently find themselves retrofitting in order to bring equipment up to the required safety standards. This results in increased costs and may also result in less than ideal solutions to safety issues to the restraints of the existing equipment. In addition, Electricity Generation Company do not currently audit their suppliers to ensure they are complying with relevant health and safety legislation.

Two of the incidents which have caused concern are discussed below.

Incident at Power Station A, 24 July 1994

The following outlines the sequence of events that led to an incident in a switchroom at Power Station A. The account is taken from the incident investigation report issued by the Electricity Generation Company (Electricity Generation Company, 1994).

At 3pm on 24 July 1994, a problem was identified with clean drains pump 4A. The pump was taken out of service and the fault reported and

documented. At around 6pm, permit engineer collected the permit to work authorising the isolation of the 415V clean drains pump. The engineer proceeded to the switchroom to carry out the isolation. However, he experienced difficulties in carrying out the isolation and therefore telephoned for assistance at around 6.10pm. The engineer spoke to the assistant shift manager who agreed to help in rectifying the problem. The assistant shift manager arrived at the switchroom 3-4 minutes after the telephone call. On arrival, he found the switchroom to be full of smoke and the clean drains pump to be on fire. There was no sign of the permit engineer who had been conducting the isolation, although the engineers damaged hat and overalls were found in the switchroom. The engineer was found following a search of the site and effective first aid was administered.

Following the incident at Power Station A an investigation into the circumstances which caused the incident was conducted by a Panel of Enquiry. The report found that the damage was caused by a fault to earth on one phase of the isolator which quickly developed to a three phase fault. It was concluded that the fault to earth arose due to the combination of the use of incorrect measures to lock off the isolator and the subsequent attempt to test the isolator without waiting for assistance, despite earlier difficulties. The report suggested that the worker knew that he had selected the wrong isolating mechanism and had attempted a makeshift mechanism because he was unable to find a suitable isolating mechanism.

The incident investigation report recommended that the station manager of Power Station A should ensure that all staff at the station are familiar with all equipment required for electrical isolation. In particular, it was recommended that all staff should be familiar with the specific locking off devices and procedures to be employed for each individual case of electrical isolation. The steps taken by Power Station A to ensure that these recommendations are implemented are discussed in section 5.1.3.10.

Incident at Power Station B, July 1995

The incident at Power Station B involved the live earthing of an 11kV circuit breaker and enclosure (Electricity Generation Company, 1995). The fire and explosion in the enclosure resulted in station shut down. Two Electricity Generation Company employees were injured and extensive damage was caused to the circuit breaker and enclosure. It is estimated that the incident cost the Electricity Generation Company £1 million in lost generation income, and a further £1 million in repairs.

The incident investigation report indicated that the operators involved in the incident mistook the controls for the earth switch with those of the heating and ventilation controls. The control panel in the enclosure did not have any descriptive labelling indicating that it contained both air conditioning and primary earth circuits. The report also concluded that the interlock system, and the contactors and wiring for the earth switch controls were not adequate to have prevented mal-operation of the switch under all foreseeable circumstances. In addition, the contactors and wiring for the earth switch and the controls for the ancillary circuits within the control panel were not adequately segregated.

As a result of the incident at Power Station B, a risk assessment was performed to quantify the risk of a further explosion occurring in the Generator Circuit Breaker enclosures at the Power Station. The assessment was carried out by an external consultancy firm. The focus of the assessment was to consider the effects of explosions which occur as a result of malfunction or mal-operation of equipment.

The report on the risk assessment included a number of recommendations, the majority of which involved design changes to the equipment. The report also recommended that risk assessments should form an integral part of the design process for future installations. In addition, it was recommended that risk assessments be carried out on existing installations in order to

satisfy regulatory authorities that all reasonable measures have been taken to reduce risks.

As has already been discussed, the purpose of examining the above incidents was to explore the Electricity Generation Company's concern that the incidents had been caused, at least in part, by a failure on the part of the equipment manufacturers and suppliers to conduct suitable and sufficient risk assessments when designing the equipment. A discussion of the causality of these two incidents is given in chapter seven.

5.1.2 Results of Interviews and Documentation from the Company Workshops

The following outlines the results of the interviews carried out with two personnel from the Electricity Generation Company's Workshops. The first was a production engineer and the second was a safety engineer. The statements given by the two members of staff are supported by evidence from documentation produced by the workshops and from observations made during a tour of the workshops.

5.1.2.1 Criteria for Carrying out Risk Assessments

Risk assessments at the workshops are carried out in order to meet the requirements of the Health and Safety at Work etc. Act 1974 and the Management of Health and Safety at Work Regulations 1992. In particular, assessments relating to noise control and the Control of Substances Hazardous to Health (COSHH) are conducted under the authority of the non-destructive testing (NDT) engineer. The duties of the NDT engineer with respect to noise control and COSHH are outlined in the Workshops Safety Policy Statement (Workshops, 1995). These duties includes the assessment of work areas and substances and the provision of recommendations to the workshop manger with respect to suitable control

measures. The NDT engineer must also keep personnel informed of any relevant changes to equipment or substances and provide suitable training in the use of equipment or substances where necessary. The NDT engineer is also responsible for the co-ordination of any risk assessments carried out in the workshops. A number of PUWER92 and manual handling assessments have been carried out. The PUWER92 assessments are discussed in greater detail in section 5.1.2.9.

Risk assessments are primarily used pro-actively within the workshops. All accidents and dangerous occurrences must be reported to the Team Leaders. Following an incident, Team Leaders are responsible for reporting to management on the cause and recommended action to prevent recurrence. Other safety hazards should be reported using the Electricity Generation Company Workshops Safety Hazard Report Form (Workshops, 1995). In all cases the workshop management will decide whether further investigation, for example via the use of risk assessment, is required and any measures necessary to prevent recurrence.

5.1.2.2 Permit to Work System

The author found no evidence of a permit to work system at the workshops. Instead, safety from hazards is ensured by (Workshops, 1995);

- the physical prevention of access to plant and apparatus e.g. guarding of machinery and screening of live conductors
- the provision of written operating and maintenance instructions
- ensuring that work is carried out only by properly trained staff
- the provision of adequate supervision
- the provision of proper tools and equipment
- the rigorous application of Local Safe Systems of work.

In addition, if for example a substance is to be used in a novel situation, a further risk assessment must be carried out before the work may progress (Workshops, 1996).

5.1.2.3 Employee Involvement

As discussed earlier, the NDT Engineer is responsible for the co-ordination of risk assessments at the workshop. On the spot risk assessments tend to be carried out by Team Leaders. Other, more detailed assessments are frequently carried out by consultants. A report on a number of recent PUWER92 assessments carried out by a consultant (Greenway, 1997) stated that 'some of my proposals arose from suggestions made be staff.' This indicates some level of involvement of the general workforce in carrying out these particular assessments.

5.1.2.4 Training

OH&S offers a one-day risk assessment training course. The course runs through the basics of risk assessment and introduces the use of checklists to carry out assessments. Four personnel from the workshops have attended this course. In addition, OH&S also ran a one-day training course to introduce the six-pack and to explain the effect the new legislation would have upon Electricity Generation Company. This course was attended by one of the interviewees. One of the interviewees had obtained several NEBOSH (National Examination Board in Occupational Health and Safety) certificates in health and safety, and it was understood that three other personnel were studying for NEBOSH certificates. These certificates would have included an element of instruction in carrying out risk assessments.

5.1.2.5 Risk Assessment Techniques

The workshops primarily use methods suggested in the Electricity Generation Company's Safety Policy Handbook, issued by Head Office, for carrying out risk assessments. The handbook advocates the use of checklists and this is backed up by the use of checklists in the one-day risk assessment training course. As discussed earlier more detailed and complex assessments are frequently carried out by external consultants. No

information was available on the methods typically used by such consultants.

Human error is considered as part of assessments carried out on site. Human error is also discussed during tool box talks with staff in order that they may understand the reasons for introducing control measures relating to possible human error. However, foreseeable misuse is not generally considered as part of a risk assessment as it is considered to be just 'human nature' rather than something that can be predicted and potentially controlled.

5.1.2.6 Control Measures Including Procedures

At the time of the visit to the workshops, a number of risk assessments had been carried out on several items of machinery in compliance with the requirements of PUWER92. As a result of these assessments a number of control measures were introduced including equipment modifications such as improved guarding and emergency stops. British Standards were referred to, for example BS 500 on machinery guarding, in order to assist with the implementation of these control measures. The library at Power Station A is used by the workshop to obtain information on current British Standards.

In addition, Local Management Instructions (LMI) (Safety) are written where applicable following a risk assessment. The workshops LMIs (Safety) are safety procedures specific to the workshop. They are used to accompany the Electricity Generation Company's Safety Rules which are implemented by Head Office and are applicable to all of the Electricity Generation Company's sites.

5.1.2.7 Communication of Results

The results of risk assessments and the implementation of additional control measures are discussed with personnel during tool box talks. Tool box talks are given by Team Leaders and are used to cascade information to individuals.

However, there is some evidence that this system does not always work as effectively as it should. The risk assessment report by Greenway (1997) indicated that information on the COSHH requirements for a number of substances did not appear to be available to personnel. The report went on further to suggest that the workshops should set out a policy on the use of PPE and ensure that personnel are aware of the levels of protection recommended when using various hazardous substances.

5.1.2.8 Monitoring and Reviewing Assessments

There was no documentary evidence to suggest that risk assessments themselves are monitored and reviewed. However, it is the duty of heads of department to ensure that regular monitoring is carried out on the safety systems (e.g. control measures such as guarding, interlocking and procedures) set up within their department, and that these safety systems are effective (Workshops, 1995). In addition, the workshops are required at regular intervals under the instruction of Head Office to carry out safety audits of the workshops.

5.1.2.9 The Provision and Use of Work Equipment Regulations 1992 (PUWER92)

It is important to note that at the time of the site visits, PUWER98 had not been introduced. The following is therefore based on the workshops compliance with PUWER92. The relevant areas of PUWER98 are however, not significantly different and similar comments would apply to the workshops level of compliance with PUWER98. The differences between

PUWER92 and PUWER98 and their impact upon industry will be discussed in greater detail in chapter seven.

As discussed earlier, the workshops had carried out a number of assessments in order to ensure compliance with PUWER92. A prioritised list of hazardous machinery was produced and the equipment considered to be most hazardous was assessed first. The assessments appear to be reasonably comprehensive with respect to regulations 11-24 of PUWER92, that is, aspects such as guarding, interlocking, controls and control systems, lighting, stability, warnings and markings, and adequacy of isolation methods. Note however, that there was no mention of ergonomics having been considered in any of the assessments, for example, with respect to adequacy of guarding, lighting and controls.

In addition, there was no evidence that regulations 5-10 (in particular maintenance, information and instructions, training and conformity with community requirements) have been adequately examined. Greenway's (1997) report states that there had been the intention to examine the LMIs and procedures, but that there was insufficient time during the assessments to carry out this task. A full and detailed assessment of these issues is therefore required.

A tour of the workshop identified a number of items of machinery which had not been assessed. For example, a power press, two guillotines, and a plate roll. The smaller Prosaw guillotine could be used without guarding, and the plate roll had no guarding resulting in a trapping/drawing in hazard. It is therefore important that these items are adequately assessed to ensure compliance with PUWER92. However, the requirements of PUWER92 are more wide ranging than simply assessing large items of power equipment. The Regulation also specifies that smaller items such as hand held tools, including manually powered items, be assessed. It is recommended that the workshop reviews the list of equipment to be assessed.

5.1.2.10 Purchasing New Equipment

It is understood that the workshops do not currently request CE marking when purchasing/ hiring equipment for use in the workshops. It is a requirement under regulation 10 of PUWER92 (and PUWER98) that the Electricity Generation Company ensure that all equipment conforms with relevant European Community Legislation. In the case of work equipment used in the workshops, this implies that the workshops must ensure that suppliers have complied with the Supply of Machinery (Safety) Regulations 1992. Compliance with the Supply Regulations is indicated on the equipment by a CE mark.

At present a Electricity Generation Company Official Purchase Order Form is used to purchase equipment. Equipment is bought from known reputable suppliers. The Conditions of Purchase (1990) which accompany the Purchase Order Form do state in a paragraph outlining general requirements relating to 'Quality etc.' that 'goods shall comply with all relevant statutory requirements.' However, it is suggested that it would be advisable for the workshops to take a more active role in ensuring that their suppliers have complied with any relevant EC Health and Safety Legislation.

5.1.2.11 Equipment Modifications

The workshops LMI on Risk Control Management (Copland, 1995) states that the Noise Control Officer (the NDT Engineer) is to be involved at an early stage in the design and installation of new plant or modifications to existing plant to ensure that Codes of Practice with respect to noise are met. However, this document did not appear to specify such requirements in relation to hazards other than noise.

5.1.2.12 Support from Head office

The SMEs regarded the support from Head Office to be adequate. Head Office inform the workshops of changes in health and safety legislation and any changes in the Electricity Generation Company Health and Safety procedures. Head Office will also provide additional guidance and support if required by the work shops.

5.1.3 Results Interviews, Documentation and Safety Tours from Power Station A

The following outlines the results of interviews with six personnel from Power Station A. The safety manager and safety co-ordinator were interviewed, as were two other safety personnel with responsibilities for the operational aspects of the station and electrical equipment at the station respectively. The two remaining interviewees were senior members of the procurement department. The statements of the interviewees are supported by evidence from the power station's health and safety documentation.

5.1.3.1 Criteria for Carrying out Risk Assessments

As for the workshops, the risk assessments carried out at Power Station A are conducted in response to the requirements of the MHSW Regulations. In a document outlining the management responsibilities for health and safety at the station (Bradford, 1997), the stations approach to risk assessment is discussed. The document states that in addition to the MHSW Regulations, risk assessments are also carried out in order to comply with the Manual Handling Regulations. The requirements of other health and safety legislation are covered by a number of Station Management Instructions. These management instructions consider the following areas;

- Personal Protective Equipment
- Control of Substances Hazardous to Health

- Noise at Work Regulations
- Control of Micro Organisms Hazardous to Health
- Guidance on Health & Safety When Using VDUs
- Hot Work

However, although the use of VDUs is listed in the categories above, the interviews revealed that the requirements of the DSE Regulations take a very low priority at Power Station A. The Regulations are not considered to be particularly applicable to the site as the majority of risks lie outside the office areas. A DSE questionnaire was sent to the office staff. However, one member of the safety department stated that they were 'not really bothered about the results.' This is despite there being a considerable number of offices on the site.

The station tends to work from guidance in the Station Management Instructions rather than from the legislation themselves. No mention is made in the above document of the Electricity at Work Regulations or PUWER92. In addition, the requirements of the Manual Handling Regulations do not appear to be covered under any Management Instruction.

Risk assessments are used pro-actively at the station. There is an integrated approach to risk assessments. The requirements of a number of different Regulations are considered during an assessment rather than carrying out separate assessments for each set of legislation. General workplace risk assessments tend to be generic. All equipment covered by a generic assessment are listed. For example, the hazards associated with workshop equipment and the training required to use the equipment are considered by safety personnel at Power Station A to be similar. Thus there is a generic risk assessment covering all workshop equipment. Although this approach is effective in ensuring that there is no wasted effort in conducting risk assessments, caution should be exercised in using a purely

generic approach as specific problems associated with individual items of equipment will be missed.

Line Managers are responsible for conducting risk assessments in their designated areas. They are also responsible for ensuring that adequate procedures are in place and that personnel and contractors under their authority have received appropriate training and instruction. Contract companies are expected to be responsible for carrying out risk assessments for the hazards their own staff are exposed to. However, it should be noted that under the HSWA, the Electricity Generation Company has a duty to protect all personnel working on site, including contractors. Thus although it is not unreasonable to expect contractors to take some responsibility for their own safety on site, responsibility ultimately lies with the Electricity Generation Company.

Each area of the power station has safety targets as part of its business plan. These plans include risk assessment targets. It was indicated by personnel that there is some inconsistency in the number of targets reached by each work area. For example, in one work area 18 tasks (or groups of tasks) had been identified as requiring risk assessments. However, only three had actually been carried out. Statistics produced by the safety department at the station show that in 1993/94 only 25 risk assessments had been carried. In 1996/97, this number had risen to 294. In addition, the number of health and safety audits rose from one in 1993/94 to ten in 1996/97; the number of near misses investigated rose from zero to 69; and the number of hazards reported rose from 20 to 265 (note that this is not necessarily an indication that the number of incidents have risen, but that more incidents are actually reported and investigated). Furthermore, the number of lost time accidents dropped from two in 1993/94 to zero in 1996/97; and the number of first aid accidents dropped from 112 to 19.

In addition, all employees (including contractors) are required to carry out informal personal risk assessments prior to carrying out a task. The scheme is known as STAR and was set up in June 1997 by a team tackling a number of topics including safety and risk assessment. The scheme was introduced following interviews with staff on the shop floor and examination of incident reports. STAR stands for the following;

Stop - for a moment, before you proceed.

Think - about the risks and hazards and control measures associated with the activity you are planning. Do you need to seek further advice before continuing?

Act - carry out the work in the way you have just planned applying all necessary control methods and safety systems you have considered.

Review - constantly reconsider the methods you are using to repeat this process (STAR) as often as needed (especially if the job content changes) to complete the task safely.

The purpose of STAR is to encourage personnel to examine their own jobs and report any hazards that cannot be put right immediately to their supervisors. It is particularly useful for routine tasks as supervisors do not have time to check every job. The scheme is informal and involves no paperwork. In order to monitor the scheme, managers do a weekly check of safety aspects on site and informally ask staff about the personal risk assessments they have carried out.

5.1.3.2 Permit to Work System

Personnel interviewed at the station estimated that around 90% of the tasks carried out at the power station require a permit-to-work. Shift managers are responsible for determining whether a task requires a permit. The permits are issued by a Senior Authorised Person. In addition, it is the responsibility of the shift team leader to check aspects such as access and lighting prior to commencement of the task.

Both hot work and cold work permits-to-work are issued. As the majority of jobs carried out under the system are routine, generic risk assessments are generally used. These are displayed on the back of the permits and also include a list of precautions to be taken when carrying out the task. Only one risk assessment is used for the cold work permits as the majority of the tasks are similar. If a novel task is carried out which requires a permit-to-work, a new risk assessment is carried out.

In addition to the permit-to-work system, a certain amount of responsibility is placed upon personnel not to enter certain areas or use certain equipment without proper authority. In some areas a key system is operated to restrict access. For example, access to the switchroom is via the key system. However, there is currently some disagreement within the station as to whether the key system is actually needed.

5.1.3.3 Employee Involvement

As has already been discussed, all employees (including contractors) are involved in the personal risk assessment scheme STAR. Line managers are responsible for the more formal risk assessments. Wherever possible risk assessments are a team effort and include the personnel who actually carry out the task under assessment. Employee involvement in formal risk assessments will be discussed in greater detail in the questionnaire results.

5.1.3.4 Training

The interviewees stated that all risk assessments carried out at the station are conducted by teams of personnel who have been trained in assessment techniques. Risk assessment training is conducted via an in-house one day course. Note that the duration of the course has been reduced from two days to one day as awareness of risk assessment within the station has increased. At the time of the interviews, 43 members of staff were

considered to be competent to carry out risk assessments. The total number of staff at the station is around 500 with approximately 200 of these being employed directly by the Electricity Generation Company and the remainder being contractors.

PUWER92 training was given to risk assessors as part of a half day introduction to the six-pack. The course was based upon guidance notes sent to the station by the Head Office. In addition, the workshop supervisors at the power station were given a half day course on the requirements of PUWER92. However, at the time of the site visit only one person on site was considered to be competent to conduct PUWER92 audits.

All staff have a safety training plan which is the responsibility of their line manager. Everyone on site is given some form of training with respect to COSHH. Refresher training is carried out every few years. In addition, all personnel are given manual handling training and have been given training on the personal risk assessment scheme STAR. Further training such as NEBOSH diplomas is provided at the discretion of the Personnel Services Manager.

5.1.3.5 Risk Assessment Techniques

The methods used by Power Station A when conducting general workplace risk assessments are very similar to those used by the company workshops. Both methods are based upon guidance produced by the OH&S department at Head Office. Teams of two or more carry out the assessments with the aid of a hazard checklist. The severity and likelihood of each hazard occurring are estimated on a five point scale. The residual risk is then calculated by multiplying the severity by the likelihood. In order to assist in prioritising any actions that may be identified during an assessment, an exposure factor is also estimated. This takes into account the number of people exposed to the hazard whilst doing the job/task and their frequency of exposure.

The systematic hazard identification checklist used during the assessments is made up of the following categories;

- **Contact with machinery** e.g. from setting, operating, cleaning, maintenance.
- **Struck by object(s)** e.g. falling from above, handling materials, ejected from machinery or equipment, rotating machinery.
- **Striking against object(s)** e.g. walking into projections, working underneath fixed objects, walking into low beams.
- **Manual handling** e.g. lifting, carrying, pushing, pulling objects.
- **Slips, trips or falls.**
- **Hand tools** e.g. use of powered tool in confined areas, use of hand-made tools, use of test equipment.
- **Contact with electricity** e.g. contact with live conductors during fault finding, electrostatic shock
- **Contact with chemicals and other hazardous agents** e.g. biological hazards, chemical hazards, radiation, asbestos, noise, heat stress, radiation.
- **Transport/vehicle movements** e.g. fork lift truck movements, safety of a task relying on good traffic control.
- **Fire/Emergency conditions of hazard created by interruption of a task** e.g. specific hazard from fire while using flammable liquids or dusts, increased hazard to a person due to the task limiting their means of escape, emergency shut down of a plant exposing a person to an increased hazard, interruption of an activity that is not controlled properly such as an excavation left unguarded overnight.
- **Special groups at higher risk from the above hazards** e.g. pregnant women, lone workers, young or inexperienced persons, disabled persons.

Thus the hazard list covers a wide variety of hazards/situations and does appear to be comprehensive with respect to use within the majority of areas within the power station. Note that the checklist is biased towards more

major hazards, and therefore would not be suitable (and indeed is not used as such) for use within the office areas of the station.

In addition to the methodology for conducting general workplace risk assessments outlined above, the power station has also developed a risk assessment process for assessing work which is to be carried out on electrical equipment installed at any of the Electricity Generation Company's locations (Burchall, 1997). The process is used to examine the risks from electrical arcs, rather than the more commonly known electrical hazards of electrical shock and fire.

The process was originally developed because Power Station A had identified that electrical arc hazards had caused the majority of the electrical injuries in the Electricity Generation Company in recent years. Arcs produce extremely high temperatures and the associated blast forces can cause severe burn injuries to personnel in the vicinity of the arc.

Work has been carried to examine the level of PPE required for different energy levels. This information has been incorporated into a guidance note which accompanies the risk assessment documentation. The guidance is based upon data supplied by the Du Pont European Electrical Safety Team.

Using the risk assessment process, the assessor must calculate the energy levels of any arcs that may potentially be produced when carrying out a task. This information along with the guidance notes on PPE, can then be used to establish the type of PPE that is required to carry out the task (Burchall, 1997). Although the primary aim of the process is to identify suitable PPE for carrying out the task, the assessor is also expected where possible to use additional control measures to reduce the energy levels associated with the task. These control measures include for example, altering the distance from the equipment at which the operator must

perform the task, and altering the type of equipment used to perform the task so as to reduce the energy levels.

The member of staff responsible for the development of the process indicated an awareness that the HSE regard PPE as a last line of defence against exposure to hazards. However, he stated that the Electricity Generation Company have only recently begun to look in detail at the hazards associated with electrical equipment. The implementation of design changes takes a considerable amount of time and in the mean time tasks involving the equipment must still be carried out. He has therefore chosen to target the use of adequate PPE first as the measures are relatively quick to implement and provide some level of protection until adequate design changes can be made.

5.1.3.6 Control Measures Including Procedures

Control measures used within the station are generally procedural, although design changes may on occasions be implemented following a risk assessment. The safety rules which are in place at the station have been adopted from the former CEGB. Following a risk assessment however, the procedures may be adjusted if necessary. It is the responsibility of the OH&S department at Head Office to make adjustments to procedures. If the findings of a risk assessment conducted by an individual site may have a potential impact on other sites, that site will inform Head Office. Head Office will then make the decision as to whether the company safety rules require updating. Any changes are then interpreted by the individual sites and local procedures may be adjusted accordingly. For less significant findings which are unlikely to impact upon other sites, only the local procedures will be adjusted and Head Office need not be informed. Findings from accident and incident investigations may also impact upon procedures in a similar manner.

PPE is also relied upon quite heavily, particularly for tasks where personnel may be at risk from electrical arcs. At the time of conducting the interviews, the PPE on site had just been reviewed to bring it in line with EC health and safety standards.

Where design changes are made, for example the provision of additional guarding, EC standards are consulted. Where necessary, the station will consider making guards if standard guards cannot be fitted. However, it was suggested that some of the machinery at the station is too old and requires too many changes to bring it up to EC standards. In addition, it appeared that there were insufficient resources made available at the station to implement all the necessary changes. One member of staff interviewed stated that they 'wished they could afford to make changes to equipment.'

It was also stated during the interviews that many of the contractors have no knowledge of EC health and safety standards. It was stated that the station relies upon informing Electricity Generation Company's own staff about the standards and hoping that the message will gradually filter through to the contractors, rather than directly educating the contractors themselves.

5.1.3.7 Communication of Results

Meetings are held every morning by the managers to inform personnel of anything that is happening in the department, including the results of risk assessments. In addition, if a permit to work is required for a job, the person carrying out the task must read through the associated risk assessment prior to commencing the task. The Senior Authorised Person issuing the permit should also go through the job with the worker. They must then both sign the permit to confirm that the worker understands the job and any associated risks.

5.1.3.8 Monitoring and Reviewing Assessments

Risk assessments are reviewed if circumstances change such that the assessment is suspected to be no longer valid. In addition, the stations documentation states that risk assessments should be reviewed a minimum of once per year. However, the interviews indicated that in practice most reviews tend to take place around every two years, although some may be carried out sooner.

Health and safety audits are carried out every three years by trained teams of staff from the power station. The audits are based on protocols set by the Electricity Generation Company's OH&S department at Head Office. The audit process is audited by Internal Audit. Audit reports are issued to the Station manager who is responsible for ensuring that any shortfalls are addressed.

In addition, every two years, the Electricity Generation Company's OH&S department conduct independent safety audits on the application of the Electricity Generation Company's Safety Rules. No evidence of an independent review of the stations risk assessments or risk assessment processes could be found.

5.1.3.9 Provision and Use of Work Equipment Regulations 1992 (PUWER92)

Note that as for the company workshop, the site visit to Power Station A took place prior to the introduction of PUWER98. The following is therefore based on compliance with PUWER92.

The interviews revealed that safety personnel at Power Station A felt that the requirements of PUWER92 tend to get lost amongst the requirements of other health and safety legislation. As was discussed earlier, only one member of staff at the station was competent to carry out PUWER92 audits.

The stations hazard near miss reporting scheme is relied upon to identify the majority of the hazards associated with work equipment as defined in PUWER92. In addition, generic risk assessments are in place for the workshops. However, it was not clear whether individual machines were checked.

PUWER92 audits take place every twelve months at the station. At the time the interviews were conducted, a PUWER92 audit had just been completed. The results of the audit were however still to be published. The audits are conducted on the workshop vehicles and also in the workshops. Other areas of the station did not appear to be considered.

As a result of past audits a number of guards and stop/emergency stop buttons have been added to workshop equipment. A tour of the workshops on site showed that a significant amount of work had been carried out to upgrade the workshops equipment. Those items which did not meet EC standards had not been upgraded either because the necessary guards and foot plates could not be bought 'off the shelf' and would be unreasonably expensive to provide, or because the addition of guarding would create an unacceptable amount of additional hazards or prevent the operator from adequately carrying out his job.

A PUWER92 compliance questionnaire is used to assist in carrying out PUWER92 audits. The questionnaire simply goes through the requirements as they are listed in the legislation. The legislative requirements have been re-worded in the form of Yes/No questions. Space is also provided for additional comments. No additional guidance or suggestions to assist/prompt the assessor are included in the questionnaire.

The questionnaire includes a question asking whether equipment is CE marked. However, little appears to have been done to ensure that

equipment is CE marked. This is further discussed in the section on the procurement of equipment.

5.1.3.10 Power Station A's Response to the Switchgear Accident in July 1994

As was discussed earlier, the accident report and subsequent risk assessment following the incident at Power Station A in July 1994, identified a number of hazards which could potentially have been identified if an adequate risk assessment had been carried out of the area. For example, PUWER92 considers the adequacy of warning signs and labelling and the adequacy of training and information provided to personnel. In addition, the scope of work equipment as defined within PUWER92, includes plant used for the purpose of generating electricity. Therefore, if a comprehensive assessment had been conducted, such as that required under PUWER92, the incident at Power Station A could potentially have been avoided.

Power Station A's response to the results of the investigations was to provide additional training and warning sign in the stations switchrooms. The investigations had identified that several different types of clamp could be used for isolation purposes. The operator conducting the an isolation procedure at the time of the accident has selected the wrong type of clamp. Staff have now been familiarised with the different types of clamp and signs have been placed in all switch rooms highlighting the differences between the clamps. Record sheets for tracking the training received by each member of staff have also been introduced.

5.1.3.11 Purchasing new equipment

Interviews with two senior members of the procurement department at Power Station A indicated that when purchasing large items of equipment, the station does request that a risk assessment is carried out prior to the installation of the equipment. However, for smaller items, no risk

assessments are requested. In addition, neither of the procurement personnel interviewed had any knowledge of CE marking. When buying smaller items of equipment it is simply assumed that the equipment complies with British Standards or other similar standards.

At the time of the interview, the procurement department stated that it was the responsibility of the engineer who had requested the equipment to request any standards relating to safety that the equipment should comply with. The engineer is also responsible for accepting the equipment and signing it off when it is installed in the station.

Discussions with the safety department at Power Station A indicated that the procurement department do occasionally seek advice regarding health and safety matters. However, the safety department suggested that such advice is not sought as often as it should be.

During the interviews, the procurement department stated that they would be happy to include a request for CE marking (where appropriate) in their procurement contracts. In addition, the safety department agreed to further discuss the matter of CE marking with the procurement department and advise them on compliance with regulation 10 of PUWER92. In addition, the safety department stated that they would consider writing a policy document relating to CE marking and the procurement of equipment. They also suggested introducing the idea of CE marking at weekly safety meetings and discussing the matter the engineers who are responsible for putting in requests for new equipment and signing off the equipment when it arrives on site.

5.1.3.12 Equipment Modifications

As has already been discussed, personnel have indicated that EC health and safety standards are consulted when design changes are made to equipment. In addition, the documentation on general workplace risk

assessments states that risk assessments should be reviewed if there are any changes to the equipment. There was no evidence however, to suggest that design changes are risk assessed prior to the modifications actually being conducted.

5.1.3.13 Support from Head Office

The support given to Power Station A by the OH&S department at Head Office is the same as that given to the Workshops. Safety personnel at the power station felt that the system worked well as Head Office have the confidence in the station to allow them control over health and safety issues within the station, but also provide assistance when it is needed. Head Office monitor progress with respect to health and safety within the station via corporate audits and standards. It is considered the responsibility of the individual sites to ensure that they are compliant with the legislation and not the responsibility of Head Office.

5.1.3.14 Additional Comments

Interviews with safety personnel at Power Station A revealed that they felt that some of the legislation was good and easy to follow while others were poor and difficult to follow. In particular, personnel disliked prescriptive legislation. It was felt that the DSE Regulations were badly put together, particularly if VDU is not the primary task carried out by an individual. PUWER92 was criticised as being too wordy although those personnel familiar with the legislation were generally happy with the requirements of PUWER92.

5.2 RESULTS FROM THE OFFSHORE OIL PRODUCTION COMPANY STUDY

The following outlines the results of interviews with personnel from the offshore industry. Interviews were carried out with personnel from Asset A of the Offshore Oil Production Company (both onshore and offshore personnel), Asset A Offshore Engineering, the Central Safety Department of the Oil Production Company, and with a number of equipment suppliers. The statements of the personnel interviewed are supported with information from health and safety documentation from Central Safety, Asset A, Asset A Offshore Engineering, and the equipment suppliers. Additional information was also obtained from safety tours and risk assessments carried out offshore and from inspections of equipment manufactured by the suppliers.

5.2.1 Criteria for Carrying Out Risk Assessments

The Offshore Oil Production Company's Safety Manual outlines a set of generic procedures for carrying out risk assessments within the Company's Assets. Asset A's HSE Practices on Task Risk Assessment are based upon these procedures and have also taken into account the specific need and requirements of the Asset A oil field.

The Oil Production Company's procedures are based primarily upon the requirements of the HSWA and the MHSW Regulations. Other legislation such as the Offshore Installations (Safety Case) Regulations 1992 (SCR), COSHH and the Manual Handling Regulations have also been taken into account. Note that when Asset A are conducting risk assessments, in order to comply with the requirements of the health and safety legislation, they tend to conduct separate assessments for each of the Regulations rather than adopting an integrated approach to risk assessment. This results in duplication of effort and the increases the possibility of hazards being missed because the assessor has assumed they will have been covered under other assessments.

Risk assessments carried out under SCR form part of a safety case which must be presented to the HSE for approval. The Offshore Installation (Design and Construction, etc.) Regulations 1996 (DCR) and the Offshore Installations (Prevention of Fire and Explosion, and Emergency Response) Regulations 1995 (PFEER) also place a duty upon Asset A to carry out risk assessments. However, risk assessments carried out under SCR, DCR and PFEER are only required to consider those hazards which have the potential to result in a major accident. SCR defines such accidents as those with the potential to result in five or more fatalities or to severely effect the structural integrity of the platform.

Thus risk assessments carried out by Asset A under these regulations tend to focus primarily on hazards such as hydrocarbon release, blowouts, fire, explosion, dropped objects and impact. For example, dropping a particularly heavy object during a crane lift, or collision with a boat or helicopter could effect the structural integrity of the platform and result in fatalities. Blowouts are the uncontrolled release of hydrocarbons. Such a release is may be catastrophic, particularly if there is a source of ignition present.

This bias towards such hazards is reflected in the hazard checklists described in the Company and Asset A safety manuals. The checklists are provided as guidance as to the type of hazards that should be considered during any risk assessment. However, they look primarily at hazards which could result in major accidents and consider very little in the way of occupational hazards.

Permits to work are considered in most cases to be sufficient for assessing task risks (i.e. risks associated with a particular task rather than a particular item of machinery). Permits to work are discussed in greater detail below. For example, routine operating tasks, production monitoring, deck operations, housekeeping, catering and cleaning all tend to be considered purely under the permit to work system. Such tasks are usually

assessed via a periodic assessment of training needs. Risks associated with such tasks tend to be reduced by the implementation of appropriate training requirements.

If the hazards are severe, the permit to work may not contain sufficient risk assessment details. In such situations a more structured team approach is used. Such tasks may include entry into confined spaces, isolation of high pressure systems, hot work and complex lifting tasks. As discussed earlier, the checklists suggested in the Company and Asset A safety manuals for use during such assessments are somewhat biased towards major hazards.

All the types of risk assessment discussed above are pro-active, that is they are carried out prior to any incidents/ accidents occurring rather than simply taking place once an accident has occurred.

5.2.2 Permit to Work System

Due to the hazardous nature of the work carried out offshore, Asset A operates an extensive permit to work system. All but a handful of routine non-hazardous tasks are covered by the system. Prior to the commencement of any such task, the work area must be inspected and hazards identified by the Area Authority. Precautions which are to be taken by both the Area and Performing Authorities must then be determined. Requirements for protective equipment and safety equipment must also be determined. The permit for work to be carried out over a certain period of time (usually up to the length of one shift i.e. twelve hours) may then be issued by the Area or Performing Authority.

Permits to work are issued in the following categories;

- Hot work (naked flame) permit i.e. for tasks which involve the use of a flame or other source of ignition, for example, welding and flame cutting.
- Hot work (spark potential) permit i.e. if task may produce or expose a possible source of ignition.

- Cold work (special task) permit i.e. for tasks which do not involve hot work but have a high risk potential.
- Cold work (other task) permit i.e. for tasks which do not fall into the above categories but still require a permit. For example, general maintenance, erection and dismantling of scaffolding, work on isolated electrical equipment.

For particularly hazardous tasks, a supplementary certificate may also be issued. For example, when carrying out entry into a confined space or moving heavy equipment.

Certain low risk tasks of a routine nature may be performed under a written Formal Procedure rather than a permit to work. The Formal Procedure must identify the full scope of the task along with any hazards which may be present, and the precautions which must be taken. The Formal Procedures must be authorised by the Offshore Installation Manager (OIM). Such tasks may only be performed by suitable competent personnel. Standing Orders may also be issued under certain circumstances rather than a permit to work. They may be used to cover hot work and other tasks carried out within the confines of a specified workshop. Standing Orders must also be approved by the OIM.

Area authorities may allow certain specific, routine, non-hazardous tasks to be performed in his area without a permit to work or formal procedure. The Oil Production Company's safety manual states that the area authority must satisfy himself that the risks are as low as reasonably practicable and that the tasks are performed by a suitable competent person. No advice is given as to how the area authority should ensure the risks are sufficiently low.

Tasks which do not require a permit to work include; routine production and drilling operations, routine crane operations, routine materials

handling, routine helideck operations, general cold work in workshops, routine work in domestic offices, and domestic activities.

5.2.3 Employee involvement

Risk assessments required under the permit to work system are generally carried out by the Area or Performing Authority. Other risk assessments may be carried out by a variety of personnel including the Fire Safety Officer (FSO), Area Authority and shift team leaders. External consultants may also be called upon to carry out more large scale assessments.

It is intended that those personnel carrying out the job be consulted during risk assessments including those assessments carried out under the permit to work system. Employee involvement is discussed in greater detail in the questionnaire results section 6.3, Table 6-1.

5.2.4 Training

Permit to work systems, such as that described above, are standard within the British offshore oil and gas industry. Before personnel are allowed to work offshore in British waters, they must complete a 2 1/2 day Basic Offshore Safety Induction and Emergency Training Course. The course includes an introduction to the basic principles and procedures involved in a permit to work system. The importance of such a system is also stressed. In addition, Asset A also operates its own induction training for all personnel new to the Asset A field. The training is carried out during the first day on an installation by the FSO and lasts approximately two hours. Included in the training are details of the Asset's own permit to work system.

Area Authorities and Performing Authorities, who are responsible for the issue of permit to work, are all required to attend approved permit to work training courses. They are also required to be formally assessed and confirmed as competent. Refresher training takes place every three years or

when an Area/Performing Authority has been absent from an asset for more than twelve months and wishes to resume working for that asset.

However, although the Area and Performing Authorities may have been taught about the principle of risk assessment during their permit to work training courses, the training on permit to work systems given to the rest of the personnel offshore does not include risk assessment.

At the time of commencement of this study, Asset A's onshore personnel expressed concern at the level of risk assessment training received by offshore personnel. As a result, the Safety Development Workgroup (SDW) were tasked to develop a risk assessment training course. In addition, the offshore study of PUWER92 compliance conducted by the author of the current study with the assistance of the SDW, identified a severe lack of knowledge of the requirements of PUWER92 within the offshore community. The opinions of personnel working offshore with respect to the adequacy of their risk assessment training are discussed in greater detail in the section 6.3, Table 6-1 which outlines the results of the attitudes to risk assessment questionnaire.

As a result of the concerns of Asset A's onshore personnel, a three day risk assessment course was developed by the Safety Development Workgroup. The first two days of the course outlined the general principle of risk assessment and was aimed at all offshore personnel. The third day of the course detailed the requirements of PUWER92 along with practical methods of implementing the requirements of the legislation. The PUWER92 element of the course was aimed at those personnel offshore who had been tasked to carry out PUWER92 assessments. Thus the majority of personnel would only attend the first two days of the course, with personnel responsible for PUWER92 compliance attending an additional day.

The aim of the training course was not only to explain the theory of risk assessment, PUWER92 and CE marking, but to give the participants as much practical experience as possible of carrying out risk assessment and PUWER92 compliance assessments. For logistical reasons it was not possible to hold the courses offshore. They were therefore conducted at an onshore based oil refinery. Much of the equipment is similar to that used offshore. The location therefore allowed the participants hands on experience at carrying out assessments.

A pilot course was run in December 1997 to determine the response to the course content. After minor adjustments to the course, it was rolled out in February 1998.

5.2.5 Risk Assessment Techniques

Risk assessments are generally initiated either by the issue of a written/verbal job request, or as part of the process of issuing a permit to work. The assessment is carried out with the assistance of a hazard checklist. The risk associated with each hazard is then estimated using four by four risk evaluation matrix. The risk evaluation matrix makes use of the relationship;

risk = hazard effect x probability.

Estimates (either very high, high, medium or low) are given as to the hazard effect i.e. the potential consequences of exposure to the hazard, and the probability that the hazard will arise when a job is carried out. The potential risks to personnel can then be worked out from the matrix (again very high, high, medium or low).

Unless the level of risk is judged to be low, steps must be taken to reduce the level of risk as far as reasonably practicable. The control measure which may be considered are discussed below.

5.2.6 Control Measures Including Procedures

Discussions with personnel from Asset A Offshore Engineering and offshore personnel, indicate that design changes, changes to procedures and additional PPE are all considered as possible actions following a risk assessment. Offshore Installation B were familiar with European legislation regarding machinery safety . They also indicated that they do consult the legislation regarding changes in equipment design.

The Oil Production Company's safety manual states that where detailed risk assessments are carried out to look at either special types of hazard e.g. those associated with manual handling or COSHH, or where potential hazards are severe, a hierarchy of safeguards or control measures should be used. This hierarchy is as follows:

- **Physical safeguards** e.g. guarding and interlocks.
- **Procedural safeguards** e.g. procedural methods for carrying out a task in a safe manner.
- **Human safeguards** e.g. instructions, warnings, definitions of roles and responsibilities, supervision.
- **Time** e.g. time saving measures, limit duration of task.
- **Contingency safeguards** - *control measures* e.g. emergency shutdown, deluge and blowdown systems
- *mitigation measures* e.g. temporary refuge, emergency response system, fire/blast walls, water curtain, provision of PPE and rescue equipment.

However, although this may be the case for large scale risk assessments, the Company safety manual states that for assessments carried out as part of the permit to work system where no further detailed risk assessment is required, risks are reduced via training.

In addition, Asset A's Health Safety and Environment practices on task risk assessments state that once the hazards associated with a particular task

have been identified, the Area Authority should consider which of the Company HSE Practices and Local Site Procedures can be used to address the risks created by the hazards. They also state that if a task can be completed without deviation from standard procedures, then the risks can be assumed to be under adequate control. No indication is given of any risk assessments carried out to ensure that execution of these procedures is in fact safe.

Raafat's (1996) report , suggested that knowledge of EC standards was somewhat limited within Asset A Offshore Engineering. However, since the report was issued, Offshore Engineering have revised their approach to risk assessment and knowledge of EC Standards has significantly improved. Both design and procedural changes are currently implemented following larger scale risk assessments.

However, there is currently no formal procedure for using the results of accident investigations to adjust offshore procedures. Neither was it clear whether design modifications using EC standards would be implemented following an accident investigation.

5.2.7 Communication of Results

A significant number of the risk assessments carried out in the Asset A field are conducted via the use of the permit to work system. The results of the assessments must be shown to personnel carrying out a task prior to the permit to work being issued. Risk assessments and safety issues are also discussed during regular tool box talks.

5.2.8 Monitoring and Reviewing Assessments

Area Authorities are responsible for ensuring that safeguards are implemented following a risk assessment. They must also ensure that all the necessary paperwork is completed. The Oil Production Company's safety manual states that it is generally not necessary to retain a record of a

risk assessment for more than twelve months. Asset A's procedures for task risk assessments state that risk assessments should be reviewed every twelve months or whenever there is reason to believe that the risks have changed, for example if modifications have been made to the equipment used during a task.

5.2.9 Provision and Use of Work Equipment Regulations 1992 (PUWER92)

Note that at the time that the field was being conducted at the Offshore Oil Production Company, PUWER98 had not been introduced. The following therefore examines the company's compliance with PUWER92.

5.2.9.1 Offshore Compliance

The offshore study of Asset A's level of compliance with PUWER92 identified that only Offshore Installation B had taken somewhat limited steps towards compliance with PUWER92. Installation B had carried out PUWER92 risk assessments on five items of equipment in the mechanical workshop. The risk assessments identified the control measures which were already in place and determined whether additional control measures were required. A hazard checklist was used to assist in the assessment. The potential hazards included in this checklist were:

- Traps
- Entanglement
- Impact
- Contact (e.g. with chuck)
- Ejection (e.g. of swarf)
- Rotating parts
- Reciprocating parts
- Manual Handling

Hazard, likelihood and risk ratings were given for the equipment. All the required actions were recorded on an action log sheet. The actions were also traced within the Installation B's Audit Tracking System in order to ensure that any required changes reached completion.

In addition, an inspection report form summarised for each item of equipment which PUWER92 regulations each item complied with and any required actions. However, the summary sheet only listed regulations 11-24 of PUWER92 suggesting that regulations 5-10 of the legislation (covering suitability of work equipment, maintenance, specific risks, information and instructions, training, and conformity with community requirements) may not have been considered within the assessment.

No other offshore installations had carried out any risk assessments relating to PUWER92. Results of safety tours conducted offshore by the author, as part of this study indicate that a number of items failed to comply with the legislation. In particular, a number items of equipment were identified as having inadequate guarding to prevent access to dangerous parts of machinery. A number of items of equipment, particularly in the workshops of the installations were either lacking emergency stop buttons or the buttons were inaccessible. Inadequacies were also found in the warnings and markings on or near equipment.

Interviews with offshore personnel indicated that the level of knowledge on the installations regarding PUWER92 was limited. In particular there was a great deal of confusion on all installations as to the type of plant and equipment to which PUWER92 is applicable. A frequent misconception being that PUWER92 is merely applicable to workshop equipment. A number of staff on Installation E were aware of the regulations and they had been discussed briefly during tool box talks. However, no practical steps had been taken by the platform to ensure compliance and personnel on board felt that some form of training instigated by the Asset A's HSE

department was required. This need for PUWER92 training was reiterated by a number of personnel on other installations.

5.2.9.2 Onshore Response to Lack of Offshore Compliance

As discussed earlier, although offshore personnel are responsible for running the installations on a day to day basis, Asset A's HSE department take responsibility for implementing new measures for compliance with health and safety legislation. In a report by Installation B (Installation B, 1997) they indicate that personnel from the HSE department had previously been given responsibility to organise a system for compliance with PUWER92. Personnel from Installation B however suggested that due to changes in personnel this process had been overlooked both on and offshore. It was as a result of this delay that Installation B carried out a small number of PUWER92 risk assessments themselves.

The primary outcome of the study into Asset A's level of compliance with PUWER92 was the development of a PUWER92 training course. This course has already been discussed in section 5.2.4 on training above. In addition, Asset A set about developing a plan of action to ensure PUWER92 compliance.

On each installation, a core team of personnel were identified to act as 'PUWER92 champions'. Each of the PUWER92 champions was to attend the three day course on risk assessment and PUWER92 prior to commencing a programme of PUWER92 assessments. It was intended that the PUWER92 champions could carry out the assessments with the assistance of other personnel who had attended the risk assessment section of the course. Wherever possible, these personnel would be responsible for using the items of equipment under assessment on a day to day basis.

At the time of completion of the field work at Asset A, an onshore system for monitoring progress offshore in carrying out PUWER92 assessments, was

also under development. The onshore monitoring was to be used to ensure that the installations kept to targets regarding the completion of assessments and were implementing suitable control measures where applicable. In this way it was intended that full compliance should be achieved as quickly as possible.

In order to assist with carrying out the PUWER92 assessments, a PUWER92 assessment form was developed by the SDW. The form asks a number of questions to take the assessor step by step through the requirements of the legislation. The form also provides the assessor with a checklist of hazards to guide the assessor through a risk assessment to identify the types of hazard identified in PUWER92.

As has already been discussed, one of the areas of PUWER92 which had caused the most confusion, both with onshore and offshore personnel, was the PUWER92 definition of work equipment. A common misconception is that PUWER92 is only applicable to workshop equipment. Although the PUWER92 guidance notes do list a number of items to which PUWER92 is applicable, few of these examples are relevant to the offshore industry.

5.2.9.3 Equipment Case Studies

A report commissioned by Asset A in 1996 to determine the Asset's level of compliance with PUWER92 (Raafat 1996) identified a number of items of equipment that failed to comply with the legislation. In particular it was suggested that Asset A had failed to comply with regulation 10 of PUWER92 by not ensuring that the equipment complied with relevant EC health and safety legislation. Under regulation 10, Asset A have a duty to ensure that the equipment suppliers comply with the requirements of the Supply of Machinery (Safety) Regulations 1992. Under this legislation, the suppliers of the machinery are required to conduct adequate risk assessments, to produce a technical file of the equipment, to produce an adequate Certificate of Conformity, and to CE mark equipment. The extent

to which the suppliers had failed to comply with the requirements of the Supply Regulations was further examined along with the steps taken by both Asset A and the suppliers to rectify the situation. The effect that such failures in compliance may have upon the safety of the users of the equipment is also discussed.

Waste compactor

Inspection of the waste compactors in August 1997 indicated that no design modifications had been carried out since Dr Raafat's report in December 1996. In addition, there was no evidence that adequate temporary measures to improve safety had been taken until suitable design changes could be implemented. Training regarding the dangers of using the equipment had been carried out on Installation A (the platform upon which the original inspection by Dr Raafat took place). No training had taken place on the remaining platforms, the remaining platforms seemingly being unaware of the problems on Installation A with the compactors.

In January 1998, the Safety Development Workgroup and the author of the current study, contacted the supplier of the waste compactors to discuss the reasons why the design changes recommended in Raafat's (1996) report had not been implemented. It appeared that the suppliers had never actually received a copy of the report. Thus although they were aware of the problems with the CE marking, they were not aware of the detailed requirements of the report. It should however be pointed out that the supply company had been taken over by new management since December 1996 and the confusion may have been partially due to this and not just a lack of communication between Asset A and the suppliers.

At the time of the visit in January 1998, the suppliers were in the process of refurbishing their entire fleet of waste compactors. An inspection of several recently refurbished compactors showed that the changes appeared to go a long way to satisfying the requirements of PUWER92. For example, the

emergency stop buttons were of mushroom type design, making them easier to operate. In addition, the reliability of the door closing circuit was improved so as to decrease the likelihood of the door becoming jammed. In the event that the door does become jammed interlocks ensure that the downward pressure of the platen is greatly reduced when the door is open. Again reducing the risk of the operator crushing limbs beneath the platen.

The suppliers agreed to change out existing compactors in the Asset A field and replace them with refurbished compactors. This was expected to take around two weeks.

The suppliers were also in the process of carrying out a full risk assessment of the design of the compactors with the assistance of Lloyds Register. The risk assessment was expected to be completed within two months. The suppliers then intended to make any further design changes necessary to bring the equipment up to the standards required by the Supply Regulations. Once these changes were completed, the equipment would then be CE marked.

The suppliers also agreed (if required by Asset A) that planned change outs could take place every few months in order that planned preventative maintenance could take place. At the time of the visit the compactors were only changed out and maintenance only took place when the equipment failed. The suppliers indicated that a system of planned preventative maintenance had been offered to Asset A on a previous occasion, but that the Asset had declined. Note that there is no increase in cost to the Asset if the contract is adjusted to allow for equipment to be routinely changed out every few months for preventative maintenance rather than simply when the equipment fails.

Finally, the suppliers provided training videos which highlight safety considerations when using the compactors. These videos were sent to the platform FSOs shortly after the visit to the suppliers.

Sack splitter

Raafat's (1996) report identified that the sack slitters provided for use in the Forties field did not comply with the requirements of PUWER92 and were not adequately CE marked. The suppliers of the equipment were requested by Asset A to carry out an in depth risk assessment of the sack slitters in order to facilitate a full review of any control measures that were in place. The suppliers were also asked to implement any design changes to the sack splitter that were identified as necessary by the risk assessment. Any changes were to conform to EC health and Safety Standards. The suppliers were also asked to re-issue the CE mark and Certificate of Conformity once the modifications had been completed and to change out the equipment in the Asset A field for the newly modified sack slitters.

The proposed risk assessment and the resulting modifications to the equipment were expected to take several months. The suppliers were therefore asked to put into place a number of temporary control measures to reduce the risk of injury from the sack splitter while the risk assessment and design changes were taking place.

During the field work at Asset A, the author of the current study attended a number of meetings with the Asset and the suppliers to discuss the progress of the risk assessment, the modifications to the equipment, and the implementation of the temporary control measures. The results of these meetings are outlined below.

In early 1997, the suppliers produced a detailed Fault Tree Analysis of the Sack Slitters. In May 1997, an email to Asset A from the suppliers indicated that a new Quality Engineer had been employed to review the details of the

risk assessment and to identify suitable control measures and any relevant EC Standards. Prior to carrying out this review, the newly appointed Quality Engineer attended a course on risk assessment, CE marking and EC Standards and familiarised himself with the Standards that were available at the time. An interview with the Quality Engineer suggested that he was sufficiently aware of current EC standards and the legislative requirements relating to CE marking to successfully complete this task.

However, between May 1997 and November 1997, little further progress was made by the suppliers with respect to modifying the equipment so that it was safe to use. In addition, no temporary control measures had been implemented in the Asset A field.

During the final meeting between Asset A and the suppliers which the author of the current study was able to attend, Asset A addressed the lack of progress. The suppliers were asked for the following information;

- A statement detailing how the suppliers intend to ensure the safety of Asset A's personnel working with, or near to the sack slitters during the interim period before full conformity of the equipment with PUWER92 is achieved.
- Detailed formal comments on all the issues raised in the PUWER92 compliance report written by Raafat (1996).
- A schedule to achieve adequate CE marking of the equipment.
- A statement detailing how the suppliers intended to achieve the steps outlined in the above schedule.

The suppliers were given strict deadlines as to when each of the above documents had to be delivered. As this was the final meeting which the author was able to attend (due to the cessation of the Safety Development Workgroup) no information is available as to the outcome of this request for documentation.

Galley Equipment

A new catering company have taken over responsibility for the catering in the Asset A field since Raafat's (1996) report. The heavy duty food mixer which was discussed in the report has been replaced by the catering company with a model that is well guarded and adequately CE marked. The potato peeler/slicing machine was not present in the galley when the present catering company took over the contract. A different make of vegetable slicing machine was present in the galley when the catering contract changed hands. Again the machinery is guarded and CE marked.

5.2.10 Purchasing New Equipment

The individual installations are responsible for the procurement of a great deal of the equipment used offshore. The offshore study of PUWER92 compliance revealed that personnel were unaware of the requirement under regulation 10 of PUWER92 to purchase equipment which conforms with EC standards and legislation. The personnel interviewed also appeared to have little or no knowledge of CE marking and there was no knowledge of the certificates of conformity that should be issued by the suppliers along with CE marked machinery.

The procurement policy offshore is to purchase equipment from a list of known suppliers. A number of items of equipment were examined on each installation to determine whether or not they were CE marked. Some of the relevant equipment examined (although not all) was CE marked. In the majority of cases however, the accompanying certificate of conformity could not be located.

Asset A Offshore Engineering have a number of duties relating to the procurement of equipment. In particular, they have responsibilities for any procurement required during major maintenance and modifications of plant or the design and construction of new projects in the Asset A field. Asset A Offshore Engineering issued a report in July 1997 (Asset A Offshore

Engineering) reviewing practises within Offshore Engineering with respect to procurement and equipment modifications. The purpose of the report was to determine whether the practises were sufficient for compliance with current health and safety legislation. The report identified that Offshore Engineering needed to develop a procurement policy to require the purchase of CE marked equipment wherever possible.

In a follow up report (Perkins, 1997) issued in December 1997, Offshore Engineering stated that 'if suitable CE marked equipment is available then it should be provided.' The report also states that if CE marked equipment is available then 'validation of suppliers CE marking would be required.' A flow chart showing the stages required for PUWER92 compliance asks whether the equipment complies with any applicable EC Directives and whether it is CE marked. However, no mention is given of whether there is an adequate certificate of conformity and whether the equipment complies with relevant EC health and safety standards. Neither is there a mention of auditing suppliers to ensure they conduct suitable and sufficient risk assessments prior to affixing the CE mark.

5.2.11 Equipment Modifications

As has already been discussed, Asset A Offshore Engineering are responsible for major modifications of plant and the design and construction of new projects in the Asset A field. In the report issued by Offshore Engineering (Asset A Offshore Engineering, 1997) in July 1997, they identified that any risk assessments carried out on equipment modifications only considered major accident hazards (e.g. hydrocarbon release, blowout, fire and explosion) and did not look at occupational hazards (e.g. mechanical, electrical and manual handling hazards). In addition, the risk assessment process issued by Offshore Engineering was not considered to be effective for work activities not covered by specific procedural controls.

In December 1997, Asset A Offshore Engineering rolled out an integrated risk assessment procedure which may be used to address significant health and safety risks to persons that may be;

- inherent in a proposed modification/ project
- associated with carrying out the modification/ project.

Note that the remainder of Asset A tends to conduct separate risk assessments for each of the health and safety Regulations that are applicable to the installations, rather than adopting an integrated approach such as that developed by Offshore Engineering. This results in duplication of effort and also makes it easier for hazards to be missed on the assumption that they have already been considered under other assessments.

The risk assessment process used is qualitative. It may be used either as a stand alone risk assessment or as a method of identifying requirements for a more detailed risk assessment. The risk assessment process is broadly based on the methodology described in the Offshore Oil Production Company's safety manual. A hazard checklist is used to assist in the identification of hazards. A risk evaluation matrix is used for evaluating the risks. The hazard checklist used in the process is more detailed than that shown in the Company safety manual. In addition, the checklist is not biased towards major hazards and includes:

- Mechanical hazards such as crushing, shearing and entanglement,
- Electrical hazards such as direct/ indirect contact, electrostatic phenomena and short circuit/ overload,
- Work activities hazards such as highly repetitive actions, stressful posture, lifting/ handling, poor workplace design, mental overload/ stress and visual fatigue,
- Work environment hazards such as localised hot/ cold surfaces, noise, vibration, and poor lighting.

A number of other guide words are used during the assessment. These are also listed as hazards although the appropriateness of including them as hazards may be questioned. These guide words include;

- **Process parameters** e.g. temperature, pressure, flow, composition, flash point, toxicity, high pressure/ low pressure interface.
- **Operating Modes and Procedures** e.g. start-up, shut-down, routine operation, emergency operation, service failure, change in instrument location, maintenance operations.
- **Safety Equipment** e.g. Emergency Shutdown System, Fire and Gas detection systems, water/ foam deluge, personnel safety equipment, means of escape, temporary refuge, life boats.
- **Environment** e.g. potential oil spillage, over board spillage, noise/ vibration considerations, materials handling, materials or process with COSHH implications, weather effects.
- **Engineering Hardware and Engineering Design** e.g. electrical/ mechanical isolation for maintenance, handrails, ladders, platforms, trip or collision hazard, hazardous area classification, gas accumulation and ventilation, helideck and operation, emergency lighting, explosion protection, emergency communication systems, emergency power supplies.

5.2.12 Support from Head Office

The Offshore Oil Production Company's Central Safety Department are responsible for the custody and maintenance of risk assessment practices within the Company. They also offer a formal risk assessment and advisory service upon request. The assets e.g. Asset A, are responsible for developing risk assessment methods based upon the guidance produced by Central Safety. The assets are also responsible for self regulation of compliance with legislation, and for appointing competent persons with respect to risk assessment.

Within Asset A, the onshore team act in an advisory role to the offshore installations. The onshore team set out guidelines with respect to risk assessment. Each individual platform is expected to be responsible for conducting its own risk assessments, implementing actions, and ensuring that the platform complies with relevant Company guidance and British health and safety legislation. This approach gives the platforms ownership of their own risk management programmes.

During interviews with SMEs both onshore and offshore, no grievances were expressed regarding the efficacy of this system.

CHAPTER SIX

Results 2: Questionnaire and Summary

Chapter six is the second chapter outlining the results of the case studies conducted at the Electricity Generation Company and the Offshore Oil Production Company. The results of the risk assessment questionnaire are presented followed by summary tables of the narrative results given in chapter five.

6.1 QUESTIONNAIRE RESULTS

The following outlines the results of the risk assessment questionnaire. The questionnaire asked personnel from the two organisations under investigation, a number of questions relating to risk assessment training, involvement in risk assessments, and attitudes to safety and risk assessment.

6.1.1 Responses Obtained from the Electricity Generation Company

Twelve responses to the questionnaires were obtained. As has already been explained in chapter four, due to difficulties in obtaining responses to the questionnaires, all respondents were from Power Station A. Two responses were obtained during the site visit, a further ten were obtained on behalf of the author at a company training course. Of the twelve respondents, seven (58%) were members of management (e.g. team leaders, shift leaders and supervisors) and five (42%) were non-management (e.g. technicians and team members).

6.1.2 Responses Obtained from the Offshore Oil Production Company

Seventeen responses to the questionnaires were obtained. As has already been discussed in chapter four, for logistical reasons, the author of the current study was unable to personally oversee the distribution of the questionnaires. The author therefore had little control over the bias of the results towards responses from managers and team leaders, rather than non-management members of the workforce. All of the respondents work on the offshore oil installations. Of the seventeen respondents, eleven (65%) were members of management (e.g. shift team leaders, foremen and FSOs) and six (35%) were non-management (e.g. technicians and galley stewards).

6.1.3 Summary of Results of the Questionnaire

Table 6-1 summarises the results of the questionnaire. Column one indicates the subject area of the questions that the participants were asked. Columns two and three give an overview of the responses obtained from the Electricity Generation company and Offshore Oil Production Company respectively. All percentages refer to the percentage of respondents who gave a particular response. A copy of the questionnaire can be found in Appendix B.

Table 6-1: Summary of results of the risk assessment questionnaire

Participant Responses	
Subject Area	
Electricity Generation Company	Offshore Oil Production Company
Risk Assessment Training	• 8 out of 12 (8/12) (67%) of the respondents had received some form of risk assessment training. However, the length of the courses taken varies significantly from less than half a day to two days. • 3 out of a possible 8 (3/8) (38%) of those who had received training thought that the training was inadequate. • 6/7 (86%) of the managers had received risk assessment training. 2/5 (40%) of the non-managers had received training. • Of the respondents who had never received any risk assessment training. 4/4 (100%) thought they would benefit from training. • 11 out of 17 (11/17) (65%) had never received any risk assessment training. • 3/17 (18%) had received risk assessment training whilst working for the Offshore Oil Production Company. • 2/17 (12%) had received COSHH training while working for another company. • 1/17 (5%) had received a limited amount of risk assessment training as part of a permit to work training course. • 6/11(54%) of managers had never received any form of risk assessment training. 5/6 (83%) of non-managers had never received any form of risk assessment training. • Of the respondents who had never received any risk assessment training, 10/11 (92%) thought they would benefit from such training. 3/12 (18%) of the total respondents had already been booked on the risk assessment course described in chapter five, section 5.2.4, despite the fact that the course had only just been introduced at

Participant Responses	
Subject Area	Electricity Generation Company
	Offshore Oil Production Company
	the time of issue of the questionnaires.
Participation in risk assessments	• 7/12 (58%) of the respondents had taken part in a risk assessment. • Of the total respondents, 5/7 (71%) of the managers had conducted risk assessments. 2/5 (40%) of the non-management members of the workforce had conducted risk assessments. • Of those respondents that had conducted risk assessments, 3/7 (43%) had never received any formal risk assessment training.
	• 11/17 (65%) of the respondents had led or taken part in a risk assessment. • Of the total respondents, 8/11 (73%) of the managers had taken part in risk assessments, while only 3/6 (50%) of the non-management members of the crew had taken part in risk assessments. • Of those respondents who had led or taken part in risk assessments, 3/11 (27%) had received risk assessment training while working for the Oil Production Company, 1/11 (9%) had received COSHH training while working for another company, and 1/11 (9%) had received some risk assessment training as part of a permit to work course. Thus 6/11 (55%) had received no risk assessment training. • Of those that had received no risk assessment training, 5/6 (83%) acted as team leaders during risk assessments.
Consultation about hazards	• 6/12 (50%) of respondents had been consulted about the hazards involved in carrying out their own jobs. However, • 11/17 (65%) of respondents had been consulted about the hazards involved in carrying out their own jobs.

Participant Responses		Offshore Oil Production Company	
Subject Area	Electricity Generation Company		
involved in own job and suitable control measures.	4/6 (67%) of those that had been consulted stated that it had only happened on one occasion. 3/7 (43%) of managers had been consulted about the risks involved in their jobs. 3/5 (60%) of non-managers had been consulted.	8/11 (73%) of managers had been consulted about the hazards involved in their jobs. 3/6 (50%) of non-managers had been consulted about the hazards involved in their jobs. - However, of the non-managers 4/6 (66%) have only been consulted once or twice, and 2/6 (33%) only appear to have been consulted during the risk assessments that were carried out by the author of the current study to determine the company's level of PUWER92 compliance. 7/8 (88%) of the managers who were consulted about the hazards involve in their jobs were consulted on a regular basis.	
Adequacy of involvement in risk assessments	6/12 (50%) of respondents thought they had sufficient involvement in risk assessments. Of those that thought they had sufficient involvement, 3/6 (50%) are actively involved in conducting risk assessments. 6/12 (50%) of respondents thought they did not have sufficient involvement in risk assessments. Of these, only 2/6 (33%) had never taken part in a risk assessment.	11/17 (65%) of respondents thought they had sufficient involvement in risk assessments. 10/11 (91%) of these respondents are actively involved in conducting assessments on the platform. 6/17 (35%) of respondents thought they did not have enough involvement in risk assessments. Of these, 5/6 (83%) had not had any involvement in conducting risk assessments.	

Subject Area	Participant Responses	
	Electricity Generation Company	Offshore Oil Production Company
	• 3/7 (43%) of the managers thought they had sufficient involvement in risk assessments. 3/5 (60%) of non-managers thought they had sufficient involvement.	• 8/11 (73%) of managers felt they had sufficient involvement in risk assessments. 3/6 (50%) of non-managers thought they had sufficient involvement in risk assessments.
Communication of results of risk assessments	• 9/12 (75%) of respondents stated that the results of risk assessments are regularly passed on to them • 1/12 (8%) stated that the results of risk assessments are occasionally passed on to them. • 2/17 (17%) of respondents stated that they had never been informed of the results of any risk assessments. • 2/3 (67%) of the respondents who rarely or never received the results of risk assessment were managers. 1/3 (33%) was a non-management member of the workforce. • There is a lack of consistency in the ways in which personnel are informed about the results of risk assessments. Some receive information via email, line managers and team briefings. Others merely see re-issued station procedures or are told they can view the paperwork if they want to, rather than being actively informed of the	• 13/17 (76%) of respondents stated that the results of risk assessments were regularly passed on to them. • 1/17 (6%) stated that only the results of one assessment had been passed on to them. • 3/17 (18%) had never received any risk assessment results. • 3/3 (100%) of the respondents who had never received any risk assessment results were non-management members of the work force. • 5/13 (38%) of those respondents who regularly received results of risk assessments, heard about the results by taking part in the assessments. • The remaining 8/13 (62%) were told the results via tool box talks, pre-job safety meetings, written memos and email.

Subject Area	Participant Responses	
	Electricity Generation Company	Offshore Oil Production Company
	results e.g. via team briefs.	
Changes to procedures following a risk assessment.	7/12 (58%) of respondents stated that they would always follow procedures that had been changed following a risk assessment and that there were no circumstances under which they would not follow them. 3/12 (25%) stated that they would follow them unless they thought they compromised safety or were impractical to follow. 1/12 (8%) stated that they would generally follow new procedures unless work pressures were too great, they compromised safety or they were impractical to follow. 1/8 (8%) stated they would be unlikely to follow new procedures to high work pressures. 3/7 (43%) of management respondents would challenge procedures if they felt they it necessary e.g. because they compromised safety, they were impractical or work pressures were too great. 1/7 (14%) of management respondents felt unable to follow new procedures because work pressures are too great.	16/17 (94%) of respondents stated that they would follow procedures that had been changed following the results of a risk assessment. 1/17 (6%) stated they would request to be consulted about the changes before following them. This respondent was a member of management. 9/17 (53%) of respondents stated that there were no situations under which they would not follow the new procedures. 8/17 (47%) stated that they would not follow the procedures if they were unsuitable for the job, compromised safety, if they could not understand the procedures, or if they had not been authorised by the appropriate personnel. 4/6 (66%) of non-management respondents would challenge the procedures for the reasons given above. - Only 4/11 (36%) of the management respondents would consider challenging the procedures.

Subject Area	Participant Responses	
	Electricity Generation Company	Offshore Oil Production Company
	- Only 1/5 (20%) of non-management respondents would consider challenging new procedures under any circumstances. 3/4 (75%) of respondents who stated they would challenge procedures if they felt it necessary, are actively involved in conducting risk assessments.	7/8 (88%) of the respondents who stated that they would consider challenging procedures are actively involved in carrying out risk assessments.
Effectiveness of risk assessment in improving safety	9/12 (75%) of respondents thought that risk assessment is an effective method of improving safety. 2/12 (17%) thought that risk assessment was a fairly effective method of improving safety. 1/12 (8%) thought that risk assessment is an ineffective method of improving safety. - Of those respondents that thought risk assessment is effective, 3/9 (33%) stated that it is only effective if management provide sufficient resources and the assessments are conducted by experienced personnel with sufficient training.	16/17 (94%) of respondents thought that risk assessment was effective in improving safety. 1/17 (6%) declined to give an answer.
Attitudes to safety.	7/12 (58%) of respondents thought that safety should always take priority over production.	13/17 (76%) of respondents thought that safety should always take priority over production.

Subject Area	Participant Responses	
	Electricity Generation Company	Offshore Oil Production Company
	• 2/12 (17%) thought that there should be a balance between good levels of production and achieving these levels as safely as practicable. • 1/12 (8%) stated that it should be up to the individual conducting a job as to whether to put safety before production. • 1/12 (8%) stated that they would consult their manager before deciding whether to put safety before production. • 5/12 (42%) of respondents thought that <i>management</i> give safety priority over production. • 2/12 (17%) thought that management usually put safety before production. • 2/12 (17%) thought that management sometimes put safety before production. • 3/12 (25%) thought that management put production before safety.	• 3/17 (18%) should that there should be a balance between good levels of production and achieving these levels as safely as practicable. • 1/17 (6%) thought that safety should only sometimes take priority over production. • 12/17 (71%) of respondents thought that <i>management</i> give safety priority over production. • 3/17 (17%) thought that management's attitude to safety is dependent upon a cost/risk balance i.e. safety is put first if it pays financially to do so. • 2/17 (12%) thought that management do not put safety before production as management's primary concern is 'to make a profit'.
Provision of resources for safety related activities such	• 5/12 (42%) of respondents thought that management provided sufficient resources for safety related activities. • 3/12 (25%) thought that management do not always provide sufficient resources.	• 11/17 (65%) though that management provide sufficient resources for safety related activities. • 4/17 (23%) of respondents thought that management do not always supply sufficient resources.

Subject Area	Participant Responses	
	Electricity Generation Company	Offshore Oil Production Company
as risk assessment.	4/12 (33%) thought that management do not provide sufficient resources.	2/17 (12%) thought that management do not provide sufficient resources.

6.1.3.1 Additional Comments

At the end of the questionnaire, respondents were asked if they had any additional comments as to how safety could be improved within their organisation. A number of comments were made by the questionnaire respondents. These are outlined below.

Electricity Generation Company

Two of the respondents commented further on the lack of resources available for safety related matters. They suggested that a real management commitment to safety was needed within the organisation and the sufficient time and resources were needed for conducting safety related activities and implementing control measures.

Two respondents commented on the need for better and more structured training with respect to procedures and safety related matters such as risk assessment. One respondent also suggested that a suitable management structure needs to be developed in order that risk assessment can be conducted effectively and that adequate control measures can be implemented.

Oil Production Company

Although the majority of participants thought that risk assessment is an effective method of improving safety, they gave a wide variety of reasons as to why they thought risk assessment improved safety. Five respondents stated that risk assessment makes the person think about the job, identifies hazards and allows suitable control measures to be implemented. One suggested that risk assessment is useful as it allows the cause of an accident to be identified. Two respondents stated that risk assessment makes the crew more aware of procedures. One of these two respondents stated that behaviour should also be considered in addition to carrying out

risk assessments. One respondent suggested that risk assessment is an excellent back-up to the permit to work system.

The majority of respondents thought that management provide sufficient resources for safety related activities. One respondent also suggested that management put too much emphasis on safety. Training was an area where respondents did not think management gave sufficient resources. One respondent stated that personnel are expected to attend courses during their field breaks. It was suggested that management should provide adequate cover so that such training can be completed during normal shift patterns.

A number of other suggestions were made as to how the risk assessment process can be improved offshore. One respondent suggested that more personnel should be involved in risk assessments and that currently it tends to be primarily management that are involved. Several respondents suggested that the paperwork system and forms used during risk assessments could be improved. A central database for the assessments was also suggested. The use of informal risk assessments prior to every job was also suggested as the present formal risk assessment system does not cover all activities.

6.2 SUMMARY OF CASE STUDY RESULTS

Table 6-2 summarises the narrative results given in chapter five. The purpose of this summary table is to highlight the points that will be discussed in chapter seven and to allow a direct comparison the results from the two case studies. Column one of table 6-2 corresponds to the subject areas in the interview question set shown in Appendix A. Columns two and three give a summary of the results obtained from interviews, documentation and site visits from the Electricity Generation Company and Offshore Oil Production Company respectively.

Table 6-2: Summary of results obtained from interviews, site documentation and safety tours

Subject Area	Summary of Results from Interviews, Documentation and Site Tours	
	Electricity Generation Company	Offshore Oil Production Company
Criteria for carrying out risk assessments and general approach to assessments	- Risk assessments are carried out at both the workshops and Power Station A in order to ensure compliance with the HSWA and the MHSW Regulations. Both the workshops and Power Station A appear to have a pro-active approach to risk assessment. - The workshops have conducted assessments on noise, COSHH, manual handling and PUWER92. - Station Management Instructions (SMIs) written by Power Station A state that assessments take into account manual handling, PPE, noise, hazardous micro organisms, risks from VDU use and hot work. The station tends to work from SMIs rather than from the legislation itself. No mention was found in the SMIs of the Electricity at Work Regulations or PUWER92. In addition, despite VDU use being mentioned in the SMIs, personnel at the station expressed a lack of interest in the results of DSE assessments. - Power Station A has an integrated approach to risk assessment, considering the requirements of several different Regulation during one assessment. General workplace risk assessments tend to be generic e.g. one generic assessment covers all the workshop equipment in the power station. Each area of the power station has safety targets as part of its business plan. These targets include risk assessments. Between 1993/94 and 1996.97 the number of risk assessments conducted by the station rose significantly and the number of lost time and first aid incidents dropped.	- Asset A of the Offshore Oil Production Company conducts risk assessments in order to comply with the requirements of HSWA and the MHSW Regulations. Other legislation such as the Safety Case Regulations, COSHH, the manual handling Regulations, DCR and PFEER are also taken into account. - Risk assessments conducted by Asset A tend to focus on major accident hazards such as hydrocarbon release, blowouts, fire, explosion, dropped objects and impact. This bias is reflected in the hazard checklists described in both the company's and Asset A' safety manuals. - Permits to work are in the majority of cases considered to be sufficient for assessing task risks (i.e. risks associated with a particular task rather than a particular item of machinery). However, it the hazards involved in a task are considered to be particularly severe, a task based risk assessment will be conducted. - Asset A appears to operates a pro-active approach to risk assessment. - The HSE department of Asset A and the Assets offshore installations do not operate an integrated approach to risk assessment. Instead individual assessments are conducted for each of the Regulations. This results in a duplication of effort and also increases the potential for hazards to be missed on the assumptions that they have been considered under other assessments. At the time of the site visits, Asset A Offshore Engineering were in the process of introducing an integrated approach to risk assessment.

Subject Area	Summary of Results from Interviews, Documentation and Site Tours	
	Electricity Generation Company	Offshore Oil Production Company
	In addition to formal risk assessments required for compliance with the legislation, Power Station A has also adopted a personal risk assessment scheme known as STAR. The purpose of STAR is to encourage personnel to examine their own jobs and to report hazards to their supervisors. The scheme is informal and involves no paperwork.	At the time the field work was being conducted at the Oil production Company, Asset A and the offshore installations were in the process of training staff to implement a personal risk assessment scheme known as STOP. In a similar manner to the Electricity Generations Company's scheme, the purpose of STOP is to encourage personnel to examine tasks conducted by themselves and others and to report hazards in the workplace.
Permit to work system	- The author found no evidence of a permit to work system at the company workshops. Instead the workshops operate their own system for ensuring that tasks are conducted in a safe manner. This system includes the use of guarding, procedures and supervision. In addition, if a novel situation arises, a risk assessment is conducted before the work may continue. - Approximately 90% of tasks conducted at Power Station A require a permit to work. Both hot and cold work permits are issued by a Senior Authorised Person. As the majority of tasks carried out under the system are routine, generic risk assessments are used and displayed on the back of the permit. Additional risk assessments are however, conducted for novel tasks. In addition to the permit system, a certain amount of responsibility is placed on personnel not to enter certain areas or use certain equipment without proper authority. A key system is used in some areas of the station, although there is disagreement within the station as to whether this system is actually needed at all.	- Asset A operates an extensive permit to work scheme. Offshore personnel estimate that around 90% of the tasks performed offshore require a permit to work. Permits are issued by Senior Authorised Personnel. Tasks that require a permit are usually assessed via the routine assessment of training needs. Risks associated with such tasks tend to be reduced by the implementation of appropriate training requirements. - If hazards are severe the permit to work may not contain sufficient risk assessment details. In such situations an additional risk assessment is conducted. - Certain low risk tasks of a routine nature may be performed under a written Formal Procedure rather than a permit to work. The Formal Procedure identifies the scope of the task, the hazards which may be involved, and precautions which must be taken. - Task which do not require a permit to work include routine production and drilling operations, routine crane operations, routine materials handling, routine helideck operations, general cold work in workshops, routine work in domestic offices and domestic activities.

Subject Area	Summary of Results from Interviews, Documentation and Site Tours	
Employee involvement	Electricity Generation Company	Offshore Oil Production Company
	- At the workshops, risk assessments are conducted either by Team Leaders, or if the assessments are more detailed, by outside consultants. A report by an outside consultant did suggest that there is some level of consultation with the general workforce when conducting the assessments. - Line managers are responsible for conducting formal risk assessments at Power Station A. Wherever possible, risk assessments are a team effort and include personnel who actually carry out the task under assessment. In addition, all personnel at the station are involved in the personal risk assessment scheme STAR. Contract companies are expected to be responsible for carrying out risk assessments for the hazards that their staff are exposed to. - Head Office are responsible for developing a number of health and safety training courses. These include courses on manual handling, electrical systems awareness, and risk assessment. - The electrical systems awareness workshop was introduced in 1997 following a number of incidents involving electrical equipment. - No information on the general workplace risk assessment course could be found by the author on any visit to the Electricity Generation Company, thus the author is unable to comment on the adequacy of the course. However, personnel interviewed at Head Office did suggest that in their opinion the course was not adequately detailed. They suggested that this may be one of the reasons why, in their opinion, risk assessments are viewed as 'pieces of paper which should be filed away, rather than useful documents which assist in improving safety standards'. In addition, concern was expressed at the lack of refresher training.	- Risk assessments conducted under the permit to work system are generally carried out by the Area or Performing Authority. Other risk assessments may be conducted by a variety of senior personnel including the FSO, Area Authority and shift team leaders. - In general, Asset A try to involve personnel responsible for carrying out a task/using an item of equipment in risk assessments of that task/equipment.
Health and safety training		- All personnel working on Asset A installations have received awareness training of the permit to work system via a 2.5 day Basic Offshore Safety Induction and Emergency Training Course and via Asset A's own 2 hour induction course. - Personnel responsible for issuing permits must also attend an approved permit to work training course. The course includes training on risk assessment. Refresher training takes place every three years. - A training record is kept for all offshore personnel. This training takes the form of on the job training relating directly to the tasks performed by the individual. - During the site visits to the Oil Production Company, personnel from the onshore HSE department of Asset A expressed concern about the lack of risk assessment training received by offshore personnel. - Interviews with offshore personnel also identified a severe lack

Subject Area	Summary of Results from Interviews, Documentation and Site Tours	Offshore Oil Production Company
	Electricity Generation Company following the initial risk assessment training course (note that the organisation of refresher training is the responsibility of the location managers). - Four personnel from the company workshops have attended the one day risk assessment training course provided by Head Office. One member of staff attended a one-day course to explain the effect that the introduction of the six-pack would have on the company. Four personnel from the workshops had obtained/where in the process of obtaining NEBOSH certificates. These certificates include some instruction on conducting risk assessments. - At the time of the site visit, 43 members of staff at the power station (out of a total of around 500) had completed the one day risk assessment training course. Personnel interviewed indicated that all risk assessments are carried out by teams of personnel who have been trained in risk assessment techniques. PUWER92 training was given to the stations risk assessors as part of a half day introductory course to the six-pack. - All staff at the Power Station A have a safety training plan. All personnel are given some form of training on COSHH, manual handling and the personal risk assessment scheme STAR. Refresher training is conducted every few years. Further training such as NEBOSH diplomas is given at the discretion of management.	of knowledge about the requirements of PUWER92. As a result of these deficiencies in training, the SDW developed a three day risk assessment and PUWER92 training course.
Risk assessment techniques	Personnel at Head Office suggested that there is a lack of consistency in the risk assessments conducted at each of the sites. In addition, it was suggested that there is a great deal of duplication of effort in conducting the assessments due to a lack of communication between sites. It was suggested that this lack of communication may be due to	- Risk assessments are generally initiated by the issue of a written/verbal job request, or as part of the process of issuing a permit to work. - Task risk assessments are conducted with the assistance of a hazard checklist. The potential risk to personnel is

Subject Area	Summary of Results from Interviews, Documentation and Site Tours	
	Electricity Generation Company recent de-manning of the sites and the subsequent lack of time and resources. - The workshops primarily use risk assessment techniques recommended by Head Office in the Company safety Policy Handbook. This involves the use of checklists to act as a prompt when conducting the assessments. Human error is considered as part of the assessments. However, foreseeable misuse is not considered as it is thought to be just 'human nature' rather than something that can be predicted and potentially controlled. - Power Station A also uses the checklist approach to risk assessment recommended by Head Office. In addition to estimating the severity and likelihood of a hazard (as recommended by Head Office) the power station also estimates an exposure factor which takes into account the number of people exposed to a hazard and the length of time they are exposed to the hazard. The station has developed its own hazard identification checklist which is comprehensive for use in the majority of areas of the power station. It would not however, be suitable for use in the office areas of the station. - Power Station A has also developed a methodology for assessing the risks to personnel from electrical arcs when carrying out work on electrical equipment. The system was introduced because arcing has caused the majority of electrical injuries at the company in recent years. The methodology allows the assessor to determine the level of PPE required to conduct the task in a safe manner. The station recognises that PPE should be used as a last line of defence. However, this is the first time that the hazards associated with electrical equipment have been assessed	Offshore Oil Production Company determined using a four by four risk evaluation matrix which considers hazard effect and hazard probability. Exposure times/frequency of exposure of personnel are not considered. - The author found no evidence that human error or foreseeable misuse is considered as part of the risk assessments conducted by Asset A. - Note that detailed quantitative risk assessments are conducted as part of the offshore safety case. Assistance from external consultants is generally sought in such cases. Assessments conducted as part of the Safety Case consider the integrity of the platform as a whole. Given the complexity of the assessments and that they do not occur on a day to day basis, an evaluation of the Safety Case was considered to be beyond the scope of the current study.

Subject Area	Summary of Results from Interviews, Documentation and Site Tours	
	Electricity Generation Company	Offshore Oil Production Company
Control measures including procedures	and the methodology is seen as a half way mark until suitable design changes can be implemented. - Where applicable, equipment modifications are carried out by the workshops following a risk assessment. British Standards are consulted before design changes are carried out. In addition, changes may also be made to the workshops LMLs (i.e. local procedures). - Control measures used within Power Station A are generally procedural, although design changes may on occasions be implemented following a risk assessment. If the findings of a risk assessment have the potential to impact upon other sites, the power station will contact Head Office who will decide whether or not to make a change to company safety rules. For less significant results, changes may be made to the local procedures at the discretion of management at the power station. PPE is also relied upon quite heavily at the station, particularly with respect to arcing. Where design changes are made, EC standards are consulted. However, it was commented upon that there are insufficient resources made available to carry out all the necessary design changes, particularly with respect to older machinery. In addition, it was suggested that contractors often have no knowledge of EC standards.	- Discussions with Asset A Offshore Engineering and offshore personnel indicate that design changes, changes to procedures and additional PPE are all considered as possible actions following a task based risk assessment or equipment modifications. - The Company safety manual states that control measures following a task based risk assessment should follow the hierarchy of control measures recommended by the Health and Safety Executive. - However, although this may be the case for large scale risk assessments, the manual also states that for the permit to work system, risk should be reduced via the use of training. They also state that if a task can be completed without deviation from standard procedures that the risks can be considered to be under control. However, the author could find no evidence that any assessments have been conducted to ensure that the execution of these procedures is in fact safe. - Installation B were familiar with EC standards on machinery safety. In addition, Asset A Offshore Engineering were taking steps to improve knowledge of the standards within the department. - The Oil Production Company do not have any procedures/policy for using the results of incident investigations (where applicable) to adjust procedures. In addition, personnel were not clear as to whether design modifications using EC standards would be implemented following an incident investigation.

Subject Area	Summary of Results from Interviews, Documentation and Site Tours	
Communication of results	Electricity Generation Company	Offshore Oil Production Company
	- The workshops policy is that risk assessments and the implementation of additional control measures are discussed with personnel during regular tool box talks. However, a report by an external consultant suggested a lack of information available to personnel on COSHH and PPE. - Meetings are held every morning at Power Station A, during which the results of risk assessments may be passed on to personnel. In addition, the results of risk assessments are printed on the back of permits to work, which personnel must read prior to commencing a task.	- Risk assessments accompanying permits to work must be read prior to a permit being issued. - Results of other risk assessments are discussed during regular tool box talks.
Monitoring and reviewing assessments	- The workshops regularly conduct reviews of their safety systems, e.g. procedures, guarding etc. However, the author could find no evidence to suggest that the risk assessments (upon which these safety systems should be based) are reviewed. - Power Station A reviews risk assessments if they have reason to believe that the assessment is no longer valid, e.g. changes have been made to the equipment. In addition, station procedures state that reviews of risk assessments should take place at a minimum of every twelve months. In practice this actually happens around once every two years. - Both the workshops and Power Station A are required by Head Office to conduct regular safety audits.	- Area Authorities are responsible for ensuring that safeguards are implemented following a risk assessment. - The Company safety manual states that is generally not necessary to retain the results of risk assessments for more than twelve months. However, Asset A's procedures for task based risk assessments state that risk assessments should be reviewed every twelve months or whenever there is reason to believe that the risks have changed.
PUWER92	The workshops had conducted a number of PUWER92 assessments. The assessments appeared to be reasonably comprehensive with respect to regulations 11-24, although there is no evidence that ergonomics has been taken into account with respect to for example, adequacy of controls and guarding. In addition, there was no evidence that regulations 5-10 had been considered. Furthermore, a tour	Installation B was the only offshore installation studied to have taken, albeit somewhat limited, steps towards compliance with PUWER92. The assessments were however, limited to five items in the workshops. In addition, regulations 5-10 did not appear to have been considered. The assessments appeared to be reasonably comprehensive with respect to regulations 11-24, although no account had been

Subject Area	Summary of Results from Interviews, Documentation and Site Tours
	Electricity Generation Company of the workshop revealed that a number of items of relevant items of equipment had not been included in the assessment. • PUWER92 audits take place every twelve months at Power Station A. The audits are conducted in the workshops and on the workshop vehicles. No other areas of the station appear to have been considered. Audits are conducted with the aid of a questionnaire which is simply as series of Yes/No questions based on the regulations given in PUWER92. The assessor is given no additional guidance. The stations hazard near miss reporting scheme is relied on to identify the majority of hazards associated with work equipment (as defined in PUWER92). Only one member of staff at the power station is competent to carry out PUWER92 assessments. • Personnel at Power Station A felt that 'the requirements of PUWER92 tend to get lost amongst the requirements of other health and safety legislation. • The two incident reports that were reviewed from Power Stations A & B revealed a number of hazards that could potentially been identified had an adequate PUWER92 assessment been conducted of the area.
	Offshore Oil Production Company taken of ergonomic risks. • Note that in a report issued by installation B it was stated that the Asset A onshore HSE department had previously been given a responsibility for ensuring compliance with PUWER92. The report also stated that in the absence of any action from the HSE department, installation B felt obliged to take their own steps towards compliance. • A tour of the each of the offshore installations identified a number of items of equipment that clearly did not comply with the requirements of PUWER92. These are in addition to the items identified in the report by Raafat (1996). • Interviews with offshore personnel revealed that knowledge of the requirements of PUWER92 was somewhat limited. In particular there was great deal of confusion as to the types of plant/equipment to which PUWER92 is applicable. A frequent misconception amongst personnel being that PUWER92 is merely applicable to workshop equipment. • Personnel on Installation E did have a greater knowledge of the requirements of PUWER92 as they had been discussed briefly during tool box talks. No steps to ensure compliance had however, been taken. • Personnel interviewed on the offshore installation suggested that some form of training on the requirements of PUWER92 should be provided by Asset A's HSE department. Note that following the offshore visits, the SDW did develop a PUWER92/98 training course which was rolled out in February 1998. In addition, the Asset set about developing a plan of action to ensure PUWER92 compliance. This involved appointing offshore personnel to carry out the assessments

Subject Area	Summary of Results from Interviews, Documentation and Site Tours
	Electricity Generation Company
	Offshore Oil Production Company
	and setting target dates for completion of the assessments. Interviews with personnel from the HSE department at Asset A revealed that even once steps were being taken to ensure compliance with PUWER92, personnel were still unsure about the precise nature of the Assets duties with respect to PUWER92. In particular, there was great deal of confusion amongst personnel as to the scope of PUWER92 i.e. which plant and equipment were applicable, and the requirements of regulation 10. Furthermore there was confusion as to what actually constituted a suitable and sufficient risk assessment.
Purchasing new equipment	- At the time of the site visits, the neither the workshops nor Power Station A requested CE marking when purchasing or hiring plant/equipment. Instead, equipment is brought from known reputable suppliers using a company Purchase Order Form. This form does state in the small print on the back of the purchase Order that 'goods shall comply with all relevant statutory requirements'. - Power Station A do request that a risk assessment is conducted prior to the installation of large items of equipment. For smaller items, the equipment is simply assumed to be safe as it has been brought from reputable suppliers. - Neither of the procurement personnel interviewed at Power Station A had any knowledge of CE marking. They indicated that they do on occasions seek advice from the health and safety department at the station. However, the health and safety department suggested that this does not actually take place as often as it should.
	- The offshore installations are responsible for purchasing a great deal of their own equipment. Equipment is purchased from known suppliers. Personnel had little or no knowledge of CE marking. - Asset A Offshore Engineering are responsible for any procurement required during major modifications of plant, or the design and construction of new projects in the Asset A field. Raafat (1996) reported a lack of knowledge of CE marking amongst the Offshore Engineering staff. During the field work of the current study, steps were being taken by Offshore Engineering to rectify the situation by reviewing practices within the department with respect to procurement and equipment modifications. However, in the report issued by the department (Perkins 1997), although mention is made of the need to request CE marked equipment and to validate the suppliers of the equipment, it is suggested that the guidance on how to achieve this is insufficient. For example, there is no mention of certificates of conformity, EC health and safety standards, or auditing suppliers to ensure that they conduct suitable and sufficient risk assessments prior to affixing a CE mark.

Subject Area	Summary of Results from Interviews, Documentation and Site Tours
Equipment modifications	Electricity Generation Company - The workshops LMI on Risk Control Management states that steps should be taken at an early stage in the design and installation of new plant to ensure that Codes of Practice with respect to noise are met. No other hazards are monitored in the document. - Both the workshops and Power Station A consult EC standards when carrying out equipment modifications. Offshore Oil Production Company - As part of the review of procurement and equipment modification practices, Asset A Offshore Engineering identified that any risk assessments conducted on equipment modifications had previously only considered major accident hazards. In addition, the risk assessment process was not considered to be effective for work activities not covered by specific procedural controls. - As a result, in December 1997, Offshore Engineering rolled out an integrated risk assessment procedure to address the problems that had been identified.
Effects of manufacturers/suppliers and external risk assessments	- The Electricity Generation company expressed concern that manufacturers/suppliers failure to conduct adequate risk assessments had contributed to a number of incidents at the company's power stations. The investigation reports from two such incidents were examined. - The first incident took place at Power Station A and involved a fire and explosion in a switchroom, following problems with a clean drains pump. - The second incident occurred at Power Station B and involved the live earthing of an 11kV circuit breaker and enclosure. - Power Station A responded to the incident report by providing additional training in the identification of isolators, and by providing warning signs and posters showing different isolator types in the switchrooms. - Following the incident at Power Station B a full risk assessment was conducted to assess the risks of a similar - A report issued by Raafat (1996) indicated that a number of items of equipment on Asset A's installations were failing to comply with the requirements of PUWER92. In particular, his report suggested that the requirements of regulation 10 were not being met. - Inspection of the waste compactors on board the installations revealed that in the eight months since the report was published, no changes had been made to the compactors. Training with respect to the dangers of using the equipment had been conducted on installation A. However, no training had been conducted on the remaining platforms. Indeed the remaining platforms were not even aware that a problem had been identified with the compactors. Maintenance of the compactor only took place once a fault had been identified with the equipment. - The company responsible for manufacturing the waste compactors were visited following the offshore visits. The suppliers had never received a copy of Raafat's (1996) report, thus although they were aware of the problems with CE

Summary of Results from Interviews, Documentation and Site Tours					
Subject Area					
	<table><tr><th>Electricity Generation Company</th><th>Offshore Oil Production Company</th></tr><tr><td>occurrence. In addition, it was recommended that risk assessments should form an integral part of the design process for future installations.</td><td> marking, they were not aware of the detailed requirements of the report. At the time of the visit, they were in the process of refurbishing their entire fleet of compactors. The changes they were making went a long way to ensuring compliance with PUWER92. In addition, they were working with Lloyds Register to conduct a detailed risk assessment of the product with a view to making further design changes were necessary and CE marking the equipment. • The manufacturing company agreed to change out all existing compactors in the Asset A field. They also agreed that if requested by Asset A planned change outs could be organised every few months in order that planned preventative maintenance could take place. There would be no added cost to Asset A for this service. • Sack slitters used in the Asset A field were also identified in Raafat's (1996) report as failing to comply with PUWER92. Again after several months no changes had been made to the equipment. The suppliers had conducted a fault tree analysis, but no design changes had actually been implemented. One year after the original report was published, a meeting was held between the equipment suppliers and Asset A to discuss the lack of progress. The suppliers were requested to provide a detailed schedule of steps they intended to make to ensure compliance with the Supply Regulations. These were to include interim safety measures until detailed design changes could be implemented. • A new catering company took over the galley shortly after Raafat's (1996) report. All the equipment identified in the report had been replaced. The replacements were adequately guarded and CE marked. </td></tr></table>	Electricity Generation Company	Offshore Oil Production Company	occurrence. In addition, it was recommended that risk assessments should form an integral part of the design process for future installations.	marking, they were not aware of the detailed requirements of the report. At the time of the visit, they were in the process of refurbishing their entire fleet of compactors. The changes they were making went a long way to ensuring compliance with PUWER92. In addition, they were working with Lloyds Register to conduct a detailed risk assessment of the product with a view to making further design changes were necessary and CE marking the equipment. • The manufacturing company agreed to change out all existing compactors in the Asset A field. They also agreed that if requested by Asset A planned change outs could be organised every few months in order that planned preventative maintenance could take place. There would be no added cost to Asset A for this service. • Sack slitters used in the Asset A field were also identified in Raafat's (1996) report as failing to comply with PUWER92. Again after several months no changes had been made to the equipment. The suppliers had conducted a fault tree analysis, but no design changes had actually been implemented. One year after the original report was published, a meeting was held between the equipment suppliers and Asset A to discuss the lack of progress. The suppliers were requested to provide a detailed schedule of steps they intended to make to ensure compliance with the Supply Regulations. These were to include interim safety measures until detailed design changes could be implemented. • A new catering company took over the galley shortly after Raafat's (1996) report. All the equipment identified in the report had been replaced. The replacements were adequately guarded and CE marked.
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Subject Area	Summary of Results from Interviews, Documentation and Site Tours
Support from Head Office	Electricity Generation Company - The OH&S department act in a supervisory role. Individual sites and contractors are expected to take responsibility for ensuring safety and compliance with the legislation. - The OH&S department supply guidance documents, e.g. on risk assessment, which are used by the individual sites to develop their own safety management systems. - Safety Advisory Bulletins are used by Head Office to inform the sites of changes to the legislation. Bulletins have been issued on all the legislation that makes up the 'six-pack'. However, a bulletin issued on the MHSW Regulations appears to advocate a reactive rather than a pro-active approach to risk assessment. Personnel were advised to use the results of incident/accident reports to identify areas that require risk assessment. In addition, the first PUWER92 bulletin was not issued until three months after the legislation was introduced. The PUWER92 bulletins stated that in general existing measures were likely to be sufficient although some actions were possibly required to ensure compliance with regulation ten. Personnel were advised to make themselves aware of the requirements relating to CE marking. No guidance on what these requirements are was given. The PUWER92 bulletins also briefly mentioned that PUWER92 is applicable to installed plant such as that used for generating electricity. - The OH&S department monitor safety at the sites via the use of safety audits. However, these audits are conducted by the individual sites (on the instruction of Head Office) rather than by the OH&S department themselves.
	Offshore Oil Production Company - Central Safety are responsible for the custody and maintenance of Company risk assessment practices. They also operate a formal risk assessment and advisory service upon request. - The Assets are responsible for self regulation of compliance with the legislation. Risk assessment procedures are produced by the assets based on the guidance provided by Central Safety. - The health and safety department at Asset A act in a supervisory role to the offshore installations within the Asset. The health and safety department will generally be responsible for large scale risk assessments such as those required for the Safety Case. They also supply guidance on compliance with the legislation. - The installations are responsible for the day to day running of the installations, including risk assessments, implementing actions, and compliance with health and safety legislation. - During interviews with onshore and offshore personnel, no grievances were expressed regarding the efficacy of this system.

Subject Area	Summary of Results from Interviews, Documentation and Site Tours	
	Electricity Generation Company	Offshore Oil Production Company
	Personnel from both the workshops and Power Station A expressed satisfaction with the level of support received from Head Office.	

CHAPTER SEVEN

Discussion

Chapter seven discusses the implications of the results outlined in chapters five and six. A summary of the previous safety culture studies, conducted by the Electricity Generation Company and the Offshore Oil Production Company, is given. This is followed by an evaluation of the risk management systems adopted by the two organisations. Attitudes to risk assessment within the two organisations are discussed followed by the potential impact on both companies of risk management systems adopted by equipment suppliers. The adequacy of the two companies original safety culture assessments are then discussed. Finally, the adequacy of the guidance accompanying existing health and safety legislation is considered. In particular, the guidance notes accompanying PUWER92 and PUWER98 are discussed.

7.1 PREVIOUS SAFETY CULTURE ASSESSMENTS

Prior to the commencement of this study, both the Electricity Generation Company and the Offshore Oil Production Company had conducted safety culture assessments. The Electricity Generation Company had conducted an assessment of the organisations safety culture using questionnaires sent to members of the workforce across the whole of the organisation (Walters, 1996). Participants were presented with a series of open-ended questions on general health and safety matters within the organisation. In addition, they were given a list of elements that contribute to a positive

organisational safety culture and asked to rate the level of importance of each of the elements on a five point scale (1 is not at all important and 5 is extremely important).

As is discussed in chapter two, the questions were all based on the frequently used measures of safety culture identified in section 2.4.2.1. One question did relate to the pro-activeness of the organisations safety management system. However, it is suggested that the question did not go into sufficient depth to give a true indication of the adequacy of the organisations approach to risk assessment. Furthermore, as discussed in chapter two, the response rate to the question suggests that a large number of the respondents did not actually understand the question, adding further doubt as to the adequacy of the question. Similar problems were not apparent with the remaining questions.

The results of the safety culture assessment conducted by Walters (1996) were very positive and suggested that the company has an extremely positive organisational safety culture. The report concluded that:

- Safety representatives play an important role in maintaining and improving health and safety on site.
- There is employee awareness of the company health and safety policy.
- Managers, directors and employees are committed to maintaining and improving health and safety on site.
- Employees are aware of the health and safety committees held on site.
- There is a strong emphasis on health and safety within the company.
- Health and safety issues are communicated effectively within the company.
- Employees are aware of safety audits.
- Employees believe that accidents are investigated thoroughly.
- Employees believe that the company use a combination of pro-active and reactive measures to ensure safety.

The areas in which the report suggested that health and safety within the Electricity Generation Company could be improved were:

- Continued involvement and ownership by all employees.
- Provision of additional training on the company safety rules and other health and safety matters.
- Raising levels of motivation within the workplace (note that the report did not specify the type of motivation required however, it is assumed that the report is referring to employees motivation to improve safety).
- Giving health and safety an even higher profile than that it has already achieved.

Thus, other than improving employee involvement and training (particularly with respect to the company safety rules), it would appear from the report that the Electricity Generation Company has an extremely positive safety culture with little room for improvement.

The approach taken by the Offshore Oil Production Company to assessing safety culture is less formal than the approach adopted by the Electricity Generation Company. The Oil Production Company rely on informal interviews conducted by senior management with personnel working on the offshore installations. The assessments are performed in an ad hoc manner and thus the company did not deem it necessary to produce any formal documentation of the results of the assessments. Such a methodology is not necessarily a secure basis upon which to judge the safety culture of an organisation. Although informal discussions with personnel may reveal valuable information about an organisation, some structure to the questions and a record of the information obtained will ensure that important areas of discussion are not overlooked. A record of such information and the method by which it was obtained, also allows the data to be validated at a later date. Discussions with members of

senior management revealed that a wide variety of topics similar to those covered in the study conducted by the Electricity Generation Company had been covered during the assessments and that a broad spectrum of personnel had been interviewed. However, as no written data was available to the researcher, this could not be verified. Discussions with senior managers reveal that Asset A is considered to have an extremely positive safety culture. Due to the hazardous nature of the offshore industry, personnel are extremely conscious of the need for adequate health and safety management. The assessments revealed no particular areas, with respect to the organisational safety culture and the attitudes of personnel to safety, that need to be addressed.

The following will discuss whether the previous safety culture assessments conducted by the Electricity Generation Company and the Offshore Oil Production Company are sufficient to give an accurate picture of the safety culture within the two organisation. In particular, the adequacy of the organisations safety management systems and attitudes to risk assessment will be considered. In order to do this, the safety management systems adopted by the two organisations must first be examined in depth.

7.2 ADEQUACY OF EXISTING SAFETY MANAGEMENT SYSTEMS

The following is a review of the safety management systems adopted by the Electricity Generation Company and the Offshore Oil Production Company. As for the results given in chapters 5 and 6, the format will follow that of the interview question set given in Appendix A.

7.2.1 Criteria for Carrying Out Risk Assessments

Both the Electricity Generation Company and the Oil Production Company conduct risk assessments in order to comply with the requirements of current health and safety legislation. In particular, both organisations aim to comply with the HSWA and the MHSW Regulations.

In addition, the Oil Production Company aim to comply with a number of offshore specific regulation including the Offshore Installations (Safety Case) Regulations 1992 and the Offshore Installations (Prevention of Fire and Explosion, and Emergency Response) Regulations 1995.

However, both organisations must be careful to ensure that all legislation given adequate consideration. For example, no mention of the Electricity at Work Regulations or PUWER92 could be found in the Station Management Instructions produced by Power Station A. In addition, the Power Station expressed a lack of concern over the requirements of the DSE Regulations. In addition, at the time the field work was being conducted, only a handful of PUWER92 assessments had been conducted by Asset A, despite the fact that the legislation had been in place for over three years.

Both organisations appear to, on the whole, use risk assessment in a pro-active manner. However, a safety advisory bulletin sent to the Electricity Generation sites by Head Office did recommend that accident/incident reports be used to identify any areas that require risk assessment. This is a reactive approach which is not in keeping with the aims of the risk assessment legislation, these being to identify hazards before an accident/incident actually takes place. At present, this reactive approach to risk assessment does not appear to have filtered through to the individual sites. Care should be taken to ensure that this remains the case. In addition, steps should be taken to ensure that all personnel at Head Office are aware of the pro-active nature of risk assessment.

The Electricity Generation Company have adopted a more integrated approach to conducting risk assessments than the Oil production Company. The Electricity Generation Company consider the requirements of a number of different Regulations when conducting a risk assessment. This avoids unnecessary duplication of effort and reduces the

likelihood of hazards being missed because the assessor has assumed that they have been considered under other assessments. Note that at the time of the field work, although the majority of Asset A conducted separate assessments for each set of legislation, the Asset A Offshore Engineering department were in the process of writing procedures for a more integrated approach to risk assessment. At the time of the study however, there were no plans for this to be implemented throughout the other Asset A sites/installations. Ideally this approach to risk assessment should be implemented across the whole of Asset A.

Risk assessments conducted by the Oil Production Company in particular, tend to focus on major accident hazards such as hydrocarbon release, blowouts, fire and explosion, dropped objects and impact. There was also some evidence of a bias towards major hazards at Power Station A where the results of DSE assessments were not considered to be of great importance. It should be noted that all though incidents caused by the more minor hazards e.g. slips, trips and falls, back injuries etc. do not have the potential to seriously injure as many people as more major hazards, minor incidents occur with a far greater frequency than major incidents and can therefore result in large costs incurred through staff absences. Both organisations should therefore ensure that risk assessments consider both major accident hazards and lesser hazards.

Workplace risk assessments conducted by the Electricity Generation Company, in particular at Power Station A tend to be generic. For example, one risk assessment covers all equipment within the station workshop areas. Whilst it would not be reasonable to expect an individual assessment to have been conducted for all the less hazardous items of equipment, e.g. hand tools, care should be taken to ensure that the differences between each item of equipment are not overlooked. For example each item should be inspected to ensure that aspects such as guarding and control systems are adequate. In addition, it is suggested

that for more hazardous items of equipment, generic assessments are not sufficient and the risk associated with each individual item should be considered.

Both organisations have adopted a personal risk assessment scheme aimed at encouraging personnel to examine their own jobs and to report hazards to their supervisors. Such schemes increase employee involvement and also allows those who are most familiar with a task/item of equipment and the associated hazards to comment on the risks to personnel.

7.2.2 Permit to work system

Both organisations operate a comprehensive permit to work system where appropriate. Because the majority of the tasks conducted at the Electricity Generation Company's Workshops are of a less hazardous nature than at the power stations, the company workshops do not operate a permit to work system. Comprehensive alternatives for ensuring that tasks are conducted in a safe manner are however, in place, including risk assessments if a novel situation arises.

Note that the Oil Production Company relies heavily on reducing risks associated with permit to work tasks via the implementation of appropriate training needs. Furthermore, the permit to work scheme is considered to be sufficient for assessing the majority of task risks, and thus there is frequently no further assessment than that conducted under the permit to work scheme. Given that the HSE considers training to be a last line of defence, it is suggested that these control measures may not be sufficient in all circumstances.

7.2.3 Employee Involvement

Within both organisations attempts appear to have been made to involve members of the workforce in conducting risk assessments. In particular,

both organisations operate an extensive personal risk assessment scheme. In addition, interviews indicated that wherever possible those employees responsible for conducting a task/operating equipment are involved in assessments of that task/equipment. Employees opinions on the adequacy of their involvement in risk assessment will be discussed further in section 7.3.

7.2.4 Health and Safety Training

Personnel at both the Electricity Generation Company and the Oil Production Company have a safety training plan. However, the interviews and documentation identified a number of inadequacies in the training provided by the two organisations.

For example, although the Electricity Generation Company do conduct a one day course on risk assessment, personnel at Head Office expressed concern about the level of detail of the course. In addition, it is suggested that the half day course given by Head Office as an introduction to the six-pack, was insufficient in length to have adequately covered the detailed requirements of the legislation. For example, a number of personnel interviewed at the Electricity Generation Company clearly lacked knowledge of the detailed requirements of PUWER92 which is part of the six-pack. Furthermore, the electrical systems awareness course run by the Electricity Generation Company was not introduced until after a number of incidents at the company's power stations. Ideally, the results of risk assessments should be used to highlight areas where additional training, rather than simply reacting after an incident has taken place.

In addition, during the site visits a number of deficiencies were identified in the training provided by the Oil Production Company on risk assessment and PUWER92. Note that during the study the company took steps to rectify this situation.

7.2.5 Risk Assessment Techniques

Both organisations use a checklist based approach to conducting risk assessments. In addition, risk matrices are used by both organisations which consider hazard likelihood and consequence to determine levels of risk.

Human error is considered during risk assessments conducted by the Electricity Generation Company's workshops. However, foreseeable misuse is not considered as personnel at the workshops suggested that foreseeable misuse is just 'human nature' rather than something that can be predicted and potentially controlled. No evidence was found to suggest that Asset A consider human error or foreseeable misuse when conducting risk assessments. Both organisations should therefore take steps to ensure that human error and foreseeable misuse are taken into consideration during all risk assessments.

Personnel interviewed at the Head Office of the Electricity Generation Company suggested that there is a lack of consistency in the assessments conducted the individual sites. In addition, there is a great deal of duplication of effort in the risk assessment conducted at sites with similar equipment. Duplication of effort is also evident at the Oil Production Company. Each of the company's offshore installations conduct their own assessments with no sharing of results, despite that fact that the installations are almost identical. The sharing of risk assessment results between sites/installations does have the potential to reduce workload. In particular, it is advisable that significant results are communicated to other sites/installations (note that this did not take place at the Asset A installations where Installation A experienced problems with a sack splitter, see section 7.3). However, care should be taken (as when conducting generic risk assessments) that the differences between the individual sites/equipment are not overlooked.

7.2.6 Control Measures Including Procedures

Both the Electricity Generation Company and the Offshore Oil Production Company do consider the use of design changes to equipment, in addition to training , procedures and PPE, as control measures following a risk assessment. Both organisations also consult relevant British, European and International Standards when carrying out design changes following a risk assessment. During the field study, Asset A Offshore Engineering department were taking steps to improve knowledge of such standards within the department. However, personnel interviewed offshore were unsure as to whether such standards would be consulted when implementing actions following an incident investigation. In addition, personnel from the Electricity Generation Company expressed concern that contractors often lack knowledge of EC standards. A high number of contractors work within the sites owned by the Electricity Generation Company. It is therefore important that they are aware of the standards. Both organisations should therefore endeavour to ensure that all relevant personnel are aware of the relevant standards and the importance of consulting them when implementing change.

Personnel at Power Station A of the Electricity Generation Company did comment that sufficient resources are not always available for making design changes and that the station does rely quite heavily on procedural changes. The station also appears to rely quite heavily on PPE, particularly with respect to risks from electrical arcing. The Electricity Company must therefore be careful that it does not rely too heavily on the use of procedures and training, and that any necessary design changes are made where practicable.

Although the Offshore Oil Production Company health and safety manual does advocate the use of control measures recommended by the HSE when conducting task based risk assessments, the manual also recommends that for the permit to work system, risks should be reduced via the use of

training. Furthermore, the manual states that if a task may be conducted without deviation from standard procedure, then the risks may be considered to be under control. Clearly, being able to follow procedure when conducting a task does not guarantee that the task is free from hazards, particularly as there was no evidence that the procedures had been introduced/checked following a full risk assessment of each task. In addition, training should not be solely relied upon in controlling hazards as it does not eliminate the source of the hazard.

7.2.7 Communication of results

Both organisations discuss the results of risk assessment with personnel during regular safety meetings. In addition, within both organisations risk assessments accompanying permits to work must be read, by the member of staff conducting the task, prior to a permit being issued.

However, a report conducted for the Electricity Generation Company Workshops indicated that insufficient information had been communicated to personnel at the workshops on COSHH and PPE. Thus although it would appear that in general communication is good within the two organisations, all sites should ensure that all relevant information is in fact passed on to the workforce. Communication is further discussed in section 7.3.

7.2.8 Monitoring and Reviewing Assessments

Both organisations monitor the actions recommended following a risk assessment to ensure that they are implemented. In general, both organisations periodically review risk assessments. Risk assessments are also reviewed if there is reason to suspect they are no longer valid (e.g. new equipment is introduced). However, the author found no evidence of procedures requiring the period review of risk assessments at the Electricity Generation company workshops. In addition, although the procedures at Power Station A specify that reviews should take place at a

minimum of every twelve months, in practice this generally appears to happen at approximately two years intervals. The Electricity Generation Company should therefore check that all sites do actually conduct review risk assessments at suitable intervals.

7.2.9 PUWER92

A number of inadequacies were identified in the PUWER92 assessments conducted by both the Electricity Generation Company and the Offshore Oil production Company.

The Electricity Generation Company's Workshops and Power Station A do conduct PUWER92 assessments. However, although the workshops appear to have taken steps to ensure compliance with regulations 11-24, no evidence was found to suggest that compliance with regulations 5-10 has been considered. A tour of the workshops also identified that the assessments have failed to cover all relevant items of equipment. For example, a power press, two guillotines and a plate roll were found that had not been assessed. In addition, no assessment had been conducted of smaller items of equipment e.g. hand held electrical items, all of which fall within the scope of PUWER92.

The assessments conducted at Power Station A of the Electricity Generation Company appear to have concentrated on the equipment in the site workshops rather than considering the equipment on the whole site. It is important that health and safety personnel at the Power Station are aware of the wide scope of the Regulations and that assessments are not merely confined to workshop equipment.

The importance of ensuring that all relevant equipment is adequately assessed may be demonstrated by the incident that took place at Power Station B in July 1995. The incident, which involved the live earthing of an 11kV circuit breaker and enclosure is described in chapter five. The

incident report suggested that the incident was caused by a number of factors. The first was a failure to adequately label the earth switch and heating and ventilation controls, and the second a failure to adequately segregate these controls. Thirdly, the interlock system and the contactors and wiring for earth switch controls were not adequate to have prevented the mal-operation of the switch under all foreseeable circumstances.

It is suggested that each of these factors could potentially have been identified via a PUWER92 assessment. For example, the adequacy of warning and markings are considered under regulations 23 and 24. Controls and control systems are considered under regulations 14 to 18. In addition, the adequacy of interlocking systems may be considered under regulation 11. The total cost of the incident at Power Station B to the Electricity Generation Company was estimated to be £2 million. A few moments spent examining the adequacy of the warnings and markings so that the operator did not confuse the earth switch and heating and ventilation controls could have been sufficient to prevent the incident. It is therefore recommended that PUWER92 assessments do not simply concentrate on workshop areas and that all areas of the Power Stations are fully assessed.

At the time the field work was conducted, only Installation B of the Offshore Oil Production Company had taken any steps towards compliance with PUWER92. These assessments were restricted to consideration of the workshop areas of the installations and regulations 5-10 did not appear to have been taken into consideration. In addition, during the field trips to the Asset A's offshore installations, a number of items of equipment were identified in the workshop areas and galleys that did not comply with the requirements of PUWER92. In particular, warning and markings, guarding and emergency stop controls were inadequate on a number of items of equipment.

Note that since this field work was completed, the Offshore Oil Production Company have taken a number of steps to ensure compliance with PUWER92. These are outlined in chapter five.

The wider implications of this lack of compliance with PUWER92 are discussed in section 7.6.2.

7.2.10 Purchasing New Equipment

Neither the Electricity Generation Company nor the Offshore Oil Production Company adequately comply with the requirements of regulation 10 of PUWER92 with respect to the purchasing of new equipment. Power Station A and the Electricity Generation Company Workshops do not request CE marked equipment when purchasing, hiring or leasing equipment. In addition, personnel from the workshops and the procurement department at Power Station A had little or no knowledge of CE marking. Similarly personnel on the offshore installations of the Oil Production Company had little or no knowledge of CE marking, despite being responsible for the procurement of much of the equipment used on the installations. Health and Safety personnel from Power Station A do request that large items of equipment are risk assessed by the manufacturer/suppliers. However, for smaller items they simply rely on purchasing from known 'reputable' suppliers.

Within the Oil Production Company, Asset A Offshore Engineering are responsible for any procurement required during major modifications of plant, or the design and construction of new projects in the Asset A field. Raafat (1996) reported a lack of knowledge of CE marking amongst the Offshore Engineering staff. During the field work of the current study, steps were being taken by Offshore Engineering to rectify the situation by reviewing practices within the department with respect to procurement and equipment modifications. However, in the report issued by the department (Perkins, 1997), although mention is made of the need to

request CE marked equipment and to validate the suppliers of the equipment, it is suggested that the guidance on how to achieve this is insufficient. For example, there is no mention of certificates of conformity, EC health and safety standards, or auditing suppliers to ensure that they conduct suitable and sufficient risk assessments prior to affixing

It is recommended that both the Electricity Generation Company and the Oil production Company take steps to ensure that all relevant personnel are fully aware of the requirements of regulation 10 of PUWER92. Both procurement personnel and health and safety personnel need to be aware of the requirements. In addition, communication between procurement personnel and health and safety personnel (particularly at Power Station A) need to be improved to ensure that all health and safety knowledge available is utilised during the purchase of equipment.

Both organisations should also request that equipment is CE marked (where appropriate), that it is risk assessed by the manufacturers/suppliers and that relevant health and safety standards have been complied with. It is recommended that both organisations should audit suppliers to ensure that risk assessments and CE markings are adequate. For example, it is not sufficient for individual components to be CE marked if the equipment as whole has not been risk assessed and CE marked. This is because although the individual components may be considered to be safe, once they are placed together they may not interact in a manner that may be considered to be safe (see discussion of sack slitter below, section 7.4).

Before accepting an item of equipment, both organisations should check that it has been CE marked and that it holds an adequate Certificate of Conformity (CoC). The Standards listed on the CoC should not be out of date and should be relevant to the item of equipment. Both organisations

should also check the equipment for any obvious defects or hazards prior to its use in the workplace.

If these steps are taken, then any equipment bought/hired/leased in this manner should already comply with the requirements of regulations 11-24 of PUWER92. Thus saving the employer considerable time and expense in ensuring compliance once the equipment has been installed.

7.2.11 Equipment Modifications

Personnel interviewed indicated that both Power Station A and the Workshops of the Electricity Generation Company, consult British and EC standards when carrying out equipment modifications. However, the workshops LMI on Risk Control Management only appears to specify that noise hazards be considered when installing new plant and equipment. The Electricity Generation Company must therefore ensure that all procedures and practices, at all sites, reflect the need to consult relevant health and safety standards when modifying and installing plant and equipment.

Knowledge of British and EC Standards with the Oil production Company appeared to be much improved following Raafat's (1996) report. In addition, as part of a review of risk assessment and equipment modification practices within the Company, Asset A Offshore Engineering had identified that risk assessments conducted on equipment modifications had previously only considered major accident hazards. Furthermore, the risk assessment procedures were not considered to be effective for work activities not covered by specific procedural controls. As a result, in December 1997, Asset A Offshore Engineering rolled out an integrated risk assessment procedure to address the problems that had been identified. It is recommended that these new procedures are reviewed to ensure that they are being used effectively. Any lessons learned by Asset A Offshore Engineering as a result of the review of the

Asset's risk assessment processes should also be passed on to the rest of the Asset and the Oil Production Company as a whole. In particular, as discussed in section 7.2.1, the whole of Asset A would benefit from a more integrated approach to risk assessment.

7.2.12 Support from Head Office

Within both organisations the central health and safety departments are responsible for the custody and maintenance of Company and Asset procedures. In addition, they also act in a supervisory role to other sites/installations and advise on changes to the health and safety legislation. Personnel interviewed at both organisations expressed satisfaction with the level of support obtained from the central health and safety departments.

However, Safety Advisory Bulletins issued by the Head Office of the Electricity Generation Company, appear to advocate a reactive rather than a pro-active approach to risk assessment. Personnel were advised to use the results of incident/accident reports to identify areas that require risk assessment. In addition, the first PUWER92 Bulletins were not issued until three months after the legislation was introduced and although the Bulletin did advise personnel to comply with regulation 10 of PUWER92, no guidance was given as to how this could be achieved.

Within the Offshore Oil Production Company, Installation B had started to conduct PUWER92 assessments as a result of the lack of action regarding PUWER92 from the onshore health and safety department. Although the situation has since been rectified, at the start of the work at the Oil Production Company, knowledge offshore of the requirements (and in some cases, the existence) of PUWER92 was somewhat limited. The health and safety department had failed to adequately inform the individual installations of the introduction of the legislation.

Both organisations should therefore ensure that advice given to individual sites regarding changes to the legislation is given as early as possible. Guidance on compliance with the legislation should be given. In addition, it should be ensured that the individual sites understand the detailed requirements of the legislation and that adequate steps are being taken to ensure compliance.

7.3 ATTITUDES TO RISK ASSESSMENT

The risk assessment questionnaire sent to personnel at the Electricity Generation Company and the Oil Production Company aimed to establish attitudes of members of the workforce to risk assessment and safety. As for the results given in chapter six, the discussion of the results of the questionnaire follow the same format as the questionnaire given in Appendix B.

7.3.1 Risk Assessment Training

Within the Electricity Generation Company, more of the respondents had received some form of risk assessment training than at the Oil Production Company. 67% of respondents had received training at the Electricity Generation Company compared to 35% at the Oil production company.

However, within the Electricity Generation Company there appeared to be a lack of consistency as to the amount of training received by personnel with courses varying in length between two days and less than half a day. In addition, 33% of respondents who had received training felt that the training they had received was inadequate. In particular, the poor structure of training programmes was commented upon. Note that during the interviews, personnel from Head Office commented upon the lack of detail in the risk assessment courses given to personnel. It is therefore suggested that the Electricity Generation Company review its approach to risk assessment training.

Within the Oil Production Company, the number of questionnaire respondents who had received risk assessment training was relatively low (only 18% had received their training from the Oil production Company). However, at the time the questionnaire was being issued, the company were taking steps to rectify the situation and a further 18% of respondents were booked on a risk assessment course.

Within both organisations there appears to be a bias towards providing managers with risk assessment training. Whilst the importance of such training is not disputed, it is important that sufficient non-management members of the workforce understand risk assessments. This is because the personnel actually carrying out the tasks under assessment are the most likely to be able to provide information on the hazards associated with the job and suitable control measures.

The majority of respondents, within both organisations, who had not received risk assessment training felt that they would benefit from some form of training.

7.3.2 Participation in Risk Assessments

The questionnaire results with respect to participation in risk assessments were very similar between the two organisations. A relatively high number of respondents had taken part in risk assessments (58% at the Electricity Generation Company and 65% at the Oil Production Company). As for the training, there was a bias towards management members of the workforce conducting the risk assessments. Approximately three quarters of management members (71% of managers from the Electricity Generation Company and 73% of managers from the Oil Production Company) of the workforce within both organisations had taken part in risk assessments compared to less than fifty percent of non-

management members (40% of non-managers from the Electricity Generation Company and 50% from the Oil Production Company).

Within both organisations a high percentage of those conducting risk assessments had never received any form of risk assessment training. 43% of personnel from the Electricity Generation Company and 55% of personnel from the Oil production Company who conducted risk assessments claimed to have never received any form of training.

The apparent lack of, and inadequacy of, risk assessment training at the Electricity Generation Company has already been commented upon. The number of personnel who conduct risk assessments without any form of training further supports the need for the company to review its approach to risk assessment training.

At the time the questionnaires were sent out, the Oil Production Company was in the process of introducing a new risk assessment course. Care should be taken to ensure that all relevant personnel attend the course.

7.3.3 Consultation About Hazards Involved in Tasks

Within both organisations, a fairly high number of respondents have been consulted during a risk assessment about the hazards involved in their job and suitable control measures. 50% of respondents at the Electricity Generation Company and 65% at the Oil Production Company had been consulted. At the Electricity Generation company, more non-management than management members of the workforce appear to have been consulted. At the Oil Production Company, more management members of the workforce than non-management members are consulted.

However, despite the apparently high number of respondents who had been consulted about the hazards involved in carrying out their jobs,

around two thirds of the respondents from both organisations stated that it had only happened on one occasion.

Employee involvement is important as it gives the general workforce ownership of the assessments, thus making them more likely to follow procedures and use control measures implemented following assessment. In addition, the personnel actually carrying out a task are able to give valuable information on the hazards involved in carrying out the task and suitable control measures. Thus, although both organisations appear to be taking some steps towards involving general members of the workforce in risk assessments, it is suggested that the level of employee involvement could be increased.

7.3.4 Adequacy of Involvement in Risk Assessments

A lack of employee involvement is further suggested by the fact that 50% of respondents from the Electricity Generation Company and 35% from the Oil Production Company felt that they do not have sufficient involvement in risk assessments. Within the Electricity Generation Company, more managers (57%) than non-managers (40%) thought they had insufficient involvement. The situation is reversed at the Oil Production Company with only 27% of managers compared to 50% of non-managers feeling that they insufficient involvement in conducting risk assessments.

7.3.5 Communication of Results

The results of risk assessments are regularly passed on to 75% of the respondents from both the Electricity Generation Company and the Oil Production company. However, this still leaves 25% of respondents, from both organisations, that rarely or never receive the results of risk assessments.

Within the Oil production Company, all of the respondents that never receive the results of risk assessment were non-management members of the workforce. Within the Electricity Generation Company, 67% of respondents who rarely or never receive the results of risk assessments were managers.

Personnel at the Oil Production Company are informed about the results of risk assessments through a combination of regular safety meetings, memos and emails. Whilst similar methods are used at the Electricity Generation Company, there is a lack of consistency as to how personnel are informed about the results. Some do receive results via safety meetings and email. However, other simply infer results from changes to procedures or are told they can view the risk assessment paperwork if they wish, rather than being actively informed via team briefings. Both organisations should take steps to ensure that all personnel receive the results of any relevant assessments. The Electricity Generation Company in particular should consider the methods by which information is communicated in order to ensure that all relevant personnel are being given adequate information about the risks involved in conducting their jobs.

7.3.6 Changes to Procedures

58% of respondents from the Electricity Generation Company compared to 53% from the Oil production Company, stated that they would always follow procedures that had been changed following a risk assessment and that there were no circumstances under which they would not follow them. The remaining 47% of respondents from the Electricity Generation Company stated that they would not follow procedures if they were unsuitable for the job, compromised safety, if they did not understand the procedures, or if they had not been authorised by the appropriate personnel.

Within the Electricity Generation Company, 25% of respondents stated that they would not follow procedures if they were impractical or compromised safety. In addition, 8% stated that they would not follow procedures if workload pressures became too high, and 8% stated that they already do not follow procedures because of a high workload. Compromising safety and procedures when the workload is high puts not only the person doing the job at risk, but also those around him. There is little point in introducing procedures if they are not followed when work pressures are too great. When the workload is high, safety measures are particularly important as the worker is under pressure and therefore more likely to make a human error. It is therefore important that the Electricity Generation Company ensure that all workers understand the importance of following procedures at all times. In addition, the Electricity Generation Company should monitor workload to ensure that workers are not placed in the difficult position where they are forced to choose between their safety and completing a job.

7.3.7 Effectiveness of Risk Assessment

Within both organisations, the majority of personnel consider risk assessment to be an effective method of improving safety. However, 25% of the respondents from the Electricity Generation Company consider risk assessment to be ineffective or only moderately effective. In addition, a number of respondents from the Electricity Generation Company stated that risk assessments are only effective if management provide sufficient resources and the assessments are conducted by experienced personnel with sufficient training. However, as has already been discussed, the adequacy of risk assessment training at the Electricity Generation Company has been brought into question.

7.3.8 General Attitudes to Safety

Within both organisations, a high proportion of respondents stated that safety should always take priority over production. A number of

respondents also stated that there should be a balance between good levels of reproduction and achieving these levels as safely as practicable.

The majority of personnel at the Oil Production think that management always put safety before production. Only 12% think that management put production before safety.

42% of respondents from the Electricity Generation Company think that management always put safety before production. 34% think management sometimes put safety before production and 25% think that management always put production before safety. This suggests that a number of personnel do not consider management within the company to be fully committed to safety.

7.3.9 Provision of Resources

Only 42% of respondents from the Electricity Generation Company were satisfied with the resources provided by management with respect to safety, compared to 65% from the Oil production Company. Thus the Electricity Generation Company in particular needs to take steps to raise opinions of management's commitment to safety. It is important that personnel at all levels believe that management is committed to safety, otherwise personnel are less likely to follow safety initiatives and control measures introduced by the management. Distribution and provision of safety related resources should be reviewed. In addition, steps should be taken to ensure that where resources are provided and initiatives introduced, all relevant personnel are aware of these activities, thus raising awareness of management commitment to safety within the organisation.

7.4 IMPACT OF EXTERNAL SAFETY MANAGEMENT SYSTEMS

As discussed in chapter three, the purpose of the current research is to not only look at the safety management systems of the Electricity Generation Company and the Oil production Company, but to also look at the impact on the two organisations of risk management systems adopted by external organisations. In particular, the research aims to look at the impact of risk assessments conducted by external manufacturers and suppliers on the two organisations.

Under the Supply of Machinery (Safety) Regulations 1992, manufacturers and suppliers are required to adequately CE mark equipment. Part of this process includes conducting risk assessments of the equipment prior to CE marking. In addition, organisations purchasing equipment are required under regulation 10 of PUWER92 & 98 to check that manufacturers/suppliers have adequately CE marked relevant equipment. However, the discussion in section 7.2.10 has shown that neither the Electricity Generation Company nor the Oil Production Company take sufficient steps to ensure that equipment is adequately CE marked. The potential impact of equipment which has not been adequately risk assessed is discussed below.

7.4.1 Potential Impact on the Electricity Generation Company

One of the justifications for conducting the current research (see chapter one) was the concern on the part of the Electricity Generation Company that a number of incidents at the company's power stations were contributed to by a lack of risk assessments carried out by the manufacturers and suppliers. The investigation reports from two such incidents were reviewed in chapter two.

The first incident took place at Power Station A on 24 July 1994. The incident involved a fire and explosion in a switchroom, following problems with a clean drains pump. The incident investigation report concluded

that the incident was caused by a combination of the operator failing to use the correct measures to lock off the isolator and a subsequent attempt to test the isolator despite earlier difficulties (see chapter five).

The incident at Power Station B took place in July 1995 and involved the live earthing of an 11kV circuit breaker and enclosure. The incident investigation report concluded that the operators involved in the incident had mistaken the controls for the earth switch with those of the heating and ventilation controls. The control panel in the enclosure did not have any descriptive labelling indicating that it contained both air conditioning and primary earth circuits. The report also concluded that the earth switch and the wiring for the earth switch controls were not adequate to have prevented mal-operation of the switch under all foreseeable circumstances. In addition, the contactors and the wiring for the ancillary circuits within the control panel were not adequately segregated.

As has already been discussed, the purpose of examining the above incidents was to explore the Electricity Generation Company's concern that the incidents had been caused, at least in part, by a failure on the part of the equipment manufacturers and suppliers to conduct suitable and sufficient risk assessments when designing the equipment. However, a review of the incident reports does not make it clear that the blame should be placed on the equipment manufacturers and suppliers.

The incident report from Power Station A suggested that the incident was caused by a failure of staff to identify the correct isolating mechanism, and a failure to follow procedures. Whilst some duty should be placed on manufacturers/suppliers to ensure that their isolating mechanisms are clearly identifiable, particularly given the wide variety of such mechanisms available, it is suggested that primary responsibility lies with the employer to ensure that employees are provided with sufficient information and are adequately trained to identify the differences

between mechanisms. In addition, responsibility for ensuring that personnel follow procedures ultimately lies with the employer.

With respect to the incident at Power Station B, the incident investigation report suggested that the incident was caused by a number of factors. The first was a failure to adequately label the earth switch and heating and ventilation controls, and the second a failure to adequately segregate these controls. Thirdly, the interlock system and the contactors and wiring for earth switch controls were not adequate to have prevented the mal-operation of the switch under all foreseeable circumstances.

With respect to the first two causal factors, it would not be unreasonable to expect a supply company to ensure that all controls are adequately labelled, and where necessary segregated. However, it is also the case that something as simple as this should have been picked up by the Electricity Generation Company's own internal risk assessments. In addition, on accepting equipment from suppliers, under the health and safety legislation (e.g. PUWER92) employers are expected to take responsibility for checking that the equipment they are buying is actually safe for use. Thus when purchasing the equipment outlined in the incident report, if sufficient checks of the equipment had been conducted, it would not be unreasonable to have expected the Electricity Generation Company to have noticed that labelling and segregation were inadequate.

With respect to the inadequacies of the interlocking system and the contactors and wiring, it would not be expected that these be identified during a brief inspection of the equipment. These inadequacies do suggest that suitable and sufficient risk assessments were not carried out by the equipment supplier/manufacturer. However, the company purchasing the equipment should not just be briefly inspecting equipment as it is supplied, but should also audit its suppliers to ensure that they do

conduct suitable and sufficient risk assessments. Thus again the blame cannot be laid entirely upon the manufacturer.

Once the equipment was installed, any faults in the system should have been highlighted in internal risk assessments conducted by the Electricity Generation Company subsequent to the installation of the system. Indeed, following the investigation into the incident at Power Station B the Electricity Generation Company recommended that a full risk assessment be conducted on the risks of a similar occurrence within the company's power stations. In addition, it was recommended that risk assessments should form an integral part of the design process for future installations.

Thus it would appear that although there is potentially some room for improvement in the steps taken by the manufacturers/suppliers to ensure system safety, primary responsibility must lie with the Electricity Generation Company. The Electricity Generation Company is responsible for ensuring that all equipment purchased is in fact safe for use. This may include ensuring that equipment is adequately CE marked, that it has been risk assessed, and conducting inspections of the equipment prior to accepting delivery/installation of the equipment. In addition, workplace risk assessments conducted of the equipment following the incidents should have been sufficient to have identified a number of the causal factors in the incidents.

7.4.2 Potential Impact on the Offshore Oil Production Company

A report issued by Raafat (1996) to examine the level of compliance of Asset A of the Oil Production Company with PUWER92, identified a number of items of equipment that were not adequately CE marked. These items were the waste compactors and sack slitters used on the offshore installations and a number of items of equipment in the galley of Installation A. Following publication of Raafat's report, the company

responsible for supplying the galley equipment were taken over by another organisation. All the equipment identified in Raafat's report was replaced. The replacements were adequately guarded and CE marked.

However, an inspection conducted by the author of the current study, of the waste compactors and sack slitters eight months after the publication of Raafat's report, identified that no modifications had taken place to the waste compactors or the sack slitters. Although during this period no serious incidents had taken place involving these items of equipment, there was a potential for loss of limbs from either type of equipment in the event of an accident.

Communication with the manufacturers of the waste compactors revealed that they had never received a copy of Raafat's report despite the belief of the Oil Production Company that a copy of the report had been sent. This suggests a breakdown in communications on the part of the Oil Production Company. A visit to the manufacturing site also revealed that the company were in the process of modifying all their waste compactors, that a full risk assessment was being conducted with the assistance of Lloyds Register and that following the necessary modifications, all equipment would be CE marked. The manufacturing company also agreed to change out all existing compactors in the Asset A field with modified compactors if required by the Asset. Thus although the manufacturers did not take steps to comply with the Supply Regulation until three years after they were introduced, simple communication between the Oil Production Company and the manufacturers could have rectified the situation much sooner than actually occurred.

Communications between the Oil Production Company and the suppliers of the sack slitters were more effective. However, a lack of understanding about the requirements of the Supply Regulations and PUWER92 restricted progress. The situation was exacerbated by a lack of

understanding of the requirements of the legislation by the Asset A onshore health and safety department. As a result, although a number of meetings had taken place and a risk assessment been conducted of the equipment, no steps had been taken to implement any control measures.

It would appear that at the time the waste compactors and sack slitters were purchased neither of the suppliers fully understood the requirements of the Supply Regulations. The manufacturers of the waste compactors took three years to begin to take steps to ensure compliance due to an initial lack of understanding of the requirements of the legislation. Although a number of the components of the sack slitter were CE marked, the equipment as a whole had not been risk assessed and CE marked at the time of purchase. Subsequent meetings with personnel from the supply company revealed that this was again due to a lack of understanding of the legislation. If the Oil Production Company had taken steps to ensure compliance with regulation 10 of PUWER92, this lack of understanding would have been identified. However, at the time the equipment was purchased, Asset A took no steps to ensure that equipment was risk assessed or CE marked. Since Raafat's (1996) report, Asset A Offshore Engineering have taken steps to ensure that all relevant equipment purchased by the department is adequately risk assessed and CE marked. However, these procedures have yet to be passed on to the offshore installations who are also responsible for buying a great deal of the equipment used offshore.

7.4.3 Wider Implications of External Safety Management Systems

From the above discussion it can be seen that equipment which has not been adequately risk assessed by the manufacturer/supplier can have a large impact on the organisation to which it is supplied. In the case of the Electricity Generation Company, the incident which took place at Power Station B cost the Company in excess of £2 million. In the case of the waste compactors and sack slitters supplied to the Oil Production

Company there were no serious incidents. However, there were a number of incidents where the equipment mal-functioned, each of which had the potential to cause a serious injury to personnel in the vicinity. The field work conducted at the Oil Production Company's suppliers has revealed that not all suppliers fully understand the requirements of the legislation.

However, it is not solely the responsibility of suppliers to ensure that equipment is adequately risk assessed. The legislation also places a duty on employers to ensure that the equipment they purchase is adequately CE marked, is risk assessed and that it is in fact safe for use. Neither the Electricity Generation Company nor the Oil Company had taken steps to do this. Thus although a lack of risk assessment on the part of a supplier or manufacturer has the potential to have a serious impact upon safety within the purchasing organisation, sole responsibility in ensuring that equipment introduced into the workplace is safe does not lie with the manufacturer/supplier.

7.5 ADEQUACY OF PREVIOUS SAFETY CULTURE ASSESSMENTS

As discussed in chapter three, the primary aim of the current study was to assess the effectiveness of the most commonly used measures of safety culture (as defined in chapter two, section 2.4.2.1) in assessing the safety culture of an organisation. The study aimed to show that although a company may perform well against these more frequently used measures of safety culture, this is not necessarily a true indication of performance with respect to the risk assessment and risk management processes of the organisation. In order to test this theory a number of hypotheses were put forward (see chapter three).

Hypothesis 1 states that if an organisation does perform well on the more frequently used measures of safety culture, then this implies that the

organisation must also adopt suitable and sufficient risk management strategies.

The suitability of these risk management strategies was tested in two stages. Hypothesis 1a considers the internal risk management strategies that are adopted by an organisation and the risk assessments that are carried out within the company. Hypothesis 1b considers the adequacy of arrangements made to ensure that equipment suppliers also carry out suitable and sufficient risk assessments.

In order to determine whether to accept or reject these hypotheses, the results of previous safety culture assessments of the two organisations will be compared with the results of the current study. Table 7-1 summarises the positive and negative aspects of each organisations' safety management systems and safety culture based upon the discussion given in sections 7.2-4.

7.5.1 Adequacy of Organisational Safety Cultures

	Electricity Generation Company	Offshore Oil Production Company
Positive Aspects	Risk Assessment • Risk assessments are generally used pro-actively and are used to comply with relevant legislation. • The organisation has an integrated approach to risk assessment. • The Workshops consider human error during risk assessments.	Risk Assessment • Risk assessments are used pro-actively and are used to comply with relevant legislation. • Asset A Offshore Engineering is in the process of adopting an integrated approach to risk assessment.
	Employee involvement • Personal risk assessment scheme introduced to increase employee involvement in risk assessments. • A large number of personnel have taken part in risk assessments. • A large number of personnel have also been consulted about the hazards involved in their jobs and possible control measures. However, this has occurred on only one occasion for a number of personnel.	Employee involvement • Personal risk assessment scheme introduced to increase employee involvement in risk assessments. • A large number of personnel have taken part in risk assessments. • A large number of personnel have also been consulted about the hazards involved in their jobs and possible control measures. However, this has occurred on only one occasion for a number of personnel.
	Permit to Work • Permit to work scheme adopted where appropriate.	Permit to work • Permit to work scheme adopted on all installations.
	Control Measures • Hierarchy of control measures generally considered following risk assessments (i.e. design changes are considered before training and procedures and PPE).	Control Measures • Hierarchy of control measures generally considered following risk assessments.

	Electricity Generation Company <i>Training</i> • A significant number of personnel have been trained to conduct risk assessments.	Offshore Oil Production Company <i>Training</i> • During the study, the Oil Production Company were in the process of introducing a comprehensive risk assessment raining programme. A PUWER92 training course was also being introduced.
	<i>Communication</i> • The company has a policy to communicate results of risk assessments to personnel via regular safety briefings. <i>Attitudes to safety</i> • The majority of personnel appear to view risk assessment as an effective method of managing safety. • The majority of personnel appear to believe that either safety should always take priority over production, or that there should be a balance between the two. • The majority of personnel stated that they would follow procedures introduced as the result of a risk assessment. A number of personnel would consider challenging the procedures if they felt them to be unsuitable for the job or if they compromised safety. <i>Audits and reviews</i> • The workshops regularly review safety systems such as procedures and guarding. • Regular reviews are conducted of risk assessments, although reviews are not always as frequent as recommended in procedures. • Regular safety audits are conducted.	<i>Communication</i> • The company has a policy to communicate results of risk assessments to personnel via regular safety briefings and through the permit to work system. <i>Attitudes to safety</i> • The majority of personnel appear to view risk assessment as an effective method of managing safety. • The majority of personnel stated that they would follow procedures introduced as the result of a risk assessment. A number of personnel would consider challenging the procedures if they felt them to be unsuitable for the job or if they compromised safety. • The majority of personnel appear to believe that either safety should always take priority over production, or that there should be a balance between the two. <i>Audits and Reviews</i> • Regular reviews are conducted of risk assessments.. • Regular safety audits are conducted.

	Electricity Generation Company PUWER92 • A large number of PUWER92 assessments have been conducted across the Electricity Generation Company sites. These assessments appear to be comprehensive with respect to regulations 11-24. • A policy is in place across the company which required large items of equipment to be risk assessed prior to installation.	Offshore Oil Production Company PUWER92 • A small number of PUWER92 assessments had been conducted on one of the installations. These assessments appear to be comprehensive with respect to regulations 11-24. • Asset A Offshore Engineering are in the process of developing procedures to ensure equipment is risk assessed and where applicable adequately CE marked, prior to installation.
	Management Commitment • Head Office send regular safety bulletins to individual sites informing them of changes to the legislation another safety related matters.	Management Commitment • A moderately large number of personnel believe that management provide sufficient resources for safety, although there are still a significant number of personnel that believe sufficient resources are not provided. • The majority of personnel believe that management put safety before production.
Negative Aspects	Risk Assessment • Head Office appears to support a reactive approach to risk assessment. • No evidence was found to suggest that human error and foreseeable misuse are considered during risk assessments at Power Station A. Foreseeable misuse is not considered during assessments at the workshops. • There appears to be a bias towards a consideration of major accident hazards when conducting risk assessments. • The organisation needs to beware of being too reliant on generic risk assessments, particularly for more hazardous items of equipment. • Problems with equipment do not appear to be adequately identified by internal risk assessments e.g. incidents at Power Stations A and B.	Risk Assessment • Although Asset A Offshore Engineering are developing an integrated approach to risk assessment, this approach is not being followed by the majority of the Asset. • No evidence was found to suggest that human error and foreseeable misuse are considered during risk assessments. • There appears to be a bias towards a consideration of major accident hazards when conducting risk assessments. • The organisation needs to beware of being too reliant on generic risk assessments, particularly for more hazardous items of equipment.

	Electricity Generation Company <i>Employee involvement</i> Although relatively large numbers of personnel have taken part in risk assessments, a large number of personnel still feel that they do not have sufficient involvement in the risk assessment process.	Offshore Oil Production Company <i>Employee involvement</i> Although relatively large numbers of personnel have taken part in risk assessments, a large number of personnel still feel that they do not have sufficient involvement in the risk assessment process.
	Control measures - Although control measures such as design changes are considered when conducting risk assessments, sufficient resources are not always available to make the required changes. The result appears to be a bias towards procedural measures. - There is a bias towards the use of PPE with respect to the control of electrical arcing hazards. Training - A number of inadequacies were identified in the level of training given with respect to risk assessment and the six-pack of legislation. - A lack of consistency was identified in the level of risk assessment training given to members of the workforce. - A number of personnel expressed dissatisfaction with the level of training on risk assessment given. A large number of personnel thought they would benefit from further training. - There appears to be a bias towards providing risk assessment training to managers. Risk assessments are also more commonly conducted by members of management. - A number of personnel responsible for conducting risk assessments have never received any form of risk assessment training.	Permit to Work - Training appears to be relied upon to address risks identified through the permit to work system. Training - No training had been given on POWER92 at the time of the study and the levels of training for risk assessment were inadequate (note that during the study, Asset A took steps to rectify the situation). - A large number of personnel thought that they would benefit from further risk assessment training. - There appears to be a bias towards providing risk assessment training to managers. Risk assessments are also more commonly conducted by members of management. - A number of personnel responsible for conducting risk assessments have never received any form of risk assessment training.

	Electricity Generation Company <i>Communication</i> • Evidence was found to suggest a lack of consistency, and in some cases a duplication of effort, in the risk assessments conducted at each of the sites. This suggests a lack of communication between sites. • Although procedures are in place to communicate the results of risk assessments, a significant number of personnel within the organisation still do not appear to receive this information. There is also a lack of consistency in the way in which this information is passed on to personnel.	Offshore Oil Production Company <i>Communication</i> • Although procedures are in place to communicate the results of risk assessments, a significant number of personnel within the organisation still do not appear to receive this information.
	<i>Attitudes to safety</i> • A small number of personnel stated that they would not follow procedures introduced as a result of a risk assessment either because work pressures are already too great or if work pressures became too great. PUWER92 • PUWER92 assessments, particularly at the workshops, do not appear to have adequately considered regulations 5-10. • PUWER92 assessments appear to be biased towards consideration of workshop equipment. • A number of items of equipment at the workshops were identified as failing to comply with the requirements of PUWER92. • There is a lack of understanding amongst personnel as to the requirements of regulation 10 of PUWER92. • CE marking not requested when purchasing/hiring/leasing equipment.	<i>Audits and reviews</i> • No evidence was found to suggest that the safety of procedures are reviewed e.g. via the use of risk assessments. PUWER92 • PUWER92 assessments do not appear to have adequately considered regulations 5-10. • PUWER92 assessments had only been conducted of workshop equipment. • A large number of items were identified as failing to comply with the requirements of PUWER92. • There was a lack of understanding amongst personnel as to any of the requirements of PUWER92.

	Electricity Generation Company <i>Management commitment</i> • There was a lack of detailed guidance provided by Head Office on compliance with PUWER92, particularly with respect to regulation 10. The first Safety Advisory Bulletin on PUWER92 was not sent out until three months after the legislation came into force. • Although a fairly large number of personnel do believe that management put safety before production, there are still a large number of people that doubt management commitment to safety and believe that they put production before safety. • A large number of people believe that management do not provide sufficient resources for managing safety.	Offshore Oil Production Company <i>Management commitment</i> • No information was passed on to the offshore installations by the onshore health and safety department about the requirements of PUWER92.
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Table 7-1: Positive and negative aspects of each organisations safety management system and safety culture.

7.5.2 Comparison of Safety Culture Assessment Results

The previous safety culture assessments for the two organisations were discussed in detail in section 7.1. The previous report conducted for the Electricity Generation Company concluded that the company has an extremely positive organisational safety culture. The only areas in which the report suggested that health and safety within the company could be improved were:

- continued involvement and ownership by all employees,
- provision of additional training on company health and safety rules and other health and safety matters,
- raising levels of motivation within the workplace, and
- giving health and safety an even higher profile than it has already achieved.

Previous safety culture assessments for the Oil Production Company also concluded that the organisation has an extremely positive safety culture. No particular areas of concern were identified during the assessments.

Thus the previous safety culture assessments of the two organisations identified very few areas where the safety management systems of each company required improving. Neither assessment identified any inadequacies in the way in which risk are managed by the two organisations.

From table 7-1 it can be seen that the current study has identified a number of both positive and negative aspects of the safety management systems and safety cultures of the two organisations. The results suggest that both organisations have taken significant steps towards achieving a positive organisational safety culture. Within both organisations, the majority of employees appear to have an extremely positive attitude to safety and the majority of personnel appear to believe that risk

assessment is an effective methods of improving safety in the workplace. Both organisations use risk assessment pro-actively (i.e. before rather than after an incident has actually taken place) and have in place a number of procedures for conducting risk assessments. Both organisations have introduced personal risk assessment schemes to improve employee involvement in risk assessments and both have procedures in place with respect to the communication of results of risk assessments. Permit to work schemes are in place in both organisations and safety audits are periodically conducted. Both organisations offer some form of health and safety training.

However, table 7-1 also shows that there are a large number of areas where both organisations could improve their safety management systems and the safety culture of the organisation. This is in direct contrast to the results of the previous safety culture assessments where few inadequacies were identified.

The previous safety culture assessment of the Electricity Generation Company identified a need for continued involvement of employees, additional training and further raising the profile of health and safety within the organisation. These issues were also identified in the current safety culture assessment. For example, despite the introduction of a personal risk assessment scheme, a number of personnel still feel they do not have sufficient involvement in risk assessments. A number of inadequacies were identified in the health and safety training given to personnel, particularly with respect to risk assessment. In addition, a significant number of personnel believe that management do not provide sufficient resources for safety related activities within the organisation suggesting perhaps not only a need for improved resources, but also for improved communication to personnel to raise awareness of the health and safety activities that are conducted within the organisation.

However, although there is some overlap between the previous and the current assessment conducted at the Electricity Generation Company, there are still a large number of inadequacies that were not identified during the previous assessment. A large number of inadequacies were also identified in the Oil Production Company that had not been highlighted by previous assessments. In particular a large number of inadequacies were identified in the risk assessments conducted by the two organisations and in the levels of compliance with PUWER92. Inadequacies were also found in the levels of employee involvement, communication between sites and between personnel, training and management commitment. Thus it is suggested that the internal risk management strategies and risk assessments conducted by the two organisations are not entirely suitable and sufficient. Hypothesis 1a is therefore rejected.

The current study also examined the effect of external risk management strategies on the two organisations and the arrangements made by the two organisations to ensure that equipment suppliers conduct suitable and sufficient risk assessments. From the incidents at Power Stations A and B, and the waste compactors and sack slitters used by the Oil Production Company, it has been seen that the failure of suppliers to conduct adequate risk assessments can have a significant effect on safety within the workplace. This issue was not taken into consideration at all during the previous safety culture assessments of the two organisations. It has been seen that neither organisation takes sufficient steps to ensure that when equipment is purchased, hired or leased that the equipment is CE marked and that the suppliers have conducted suitable and sufficient risk assessments. In addition, the internal risk assessment practices within both organisations do not appear to be capable of identifying hazards present in such equipment once it is installed. This is apparent in the incident at Power Station B, of the Electricity Generation Company, which injured two employees and cost the company £2million. It is

therefore concluded that neither organisation has made sufficient arrangements to ensure that equipment suppliers carry out suitable and sufficient risk assessments and hypothesis 1b is rejected.

From the above discussion it can be seen that both hypotheses 1a and 1b have been rejected. Thus it is apparent that despite both the Electricity Generation Company and the Oil Production Company performing well on the more frequently used methods of assessing safety culture neither organisations adopts an entirely adequate risk management strategy. It is therefore concluded that good performance on the more frequently used measures of safety culture (as defined in section 2.4.2.1) does not imply that an organisation always adopts a suitable and sufficient risk management strategy and hypothesis 1 is also rejected.

7.5.3 Implications of the Safety Culture Assessment Results

The case studies conducted at the Electricity Generation Company and the Offshore Oil Production Company have shown that if an organisation performs well on the more frequently used measures of safety culture (as defined in 2.4.2.1) this does not necessarily indicate that the organisation adopts suitable and sufficient risk management strategies. This is applicable both to the risk management processes internal to the organisation and the policies and procedures that are in place to ensure that poor risk management practices external to the organisation (e.g. equipment manufacturers and suppliers) do not impact upon safety within the organisation.

This suggests that many safety culture assessments may give an over optimistic picture of the adequacy of an organisations safety culture and safety management system. The current study has shown that the adequacy of a risk management system cannot be accurately predicted from other more general indicators of the effectiveness of a safety management system.

An effective risk management strategy within an organisation is important as it forms the foundations for many other safety related activities. If the hazards present in a workplace are not identified and known about, procedures, communications about workplace safety, training and information about workplace hazards and other control measures can never be truly effective. It is therefore important that safety culture assessments take an in depth look at an organisations risk management strategies along side existing frequently used measures (as defined in 2.4.2.1) of safety culture.

7.6 ADEQUACY OF GUIDANCE ACCOMPANYING THE LEGISLATION

A number of inadequacies have been identified in the safety management systems adopted by the Electricity Generation Company and the Offshore Oil Production Company. However, it is suggested that inadequacies in an organisations risk management system may not solely be caused by failures within that organisation. The adequacy of guidance and information supplied to that organisation may also be a contributory factor. The second aim of the current study was therefore to examine the adequacy of the guidance notes accompanying the new legislation.

The field work conducted at the Electricity Generation Company and the Offshore Oil Production Company highlighted two areas of the legislation in which the guidance accompanying the regulations could be improved. The first is the guidance accompanying regulation 3 of the MHSW Regulations and the second is the guidance accompanying PUWER92. These apparent inadequacies are discussed below.

7.6.1 Adequacy of Guidance on Risk Assessment

Regulation 3 of the MHSW Regulations requires employers to conduct suitable and sufficient risk assessments of the workplace. A number of personnel, particularly those from the Oil Production Company expressed a lack of understanding as to what is meant by the term 'suitable and sufficient'.

The guidance notes accompanying the MHSW Regulations do give some information as to what is meant by the term suitable and sufficient. The guidance notes state that a suitable and sufficient risk assessment involves identifying the significant risks arising out of a work activity and that trivial risks can generally be ignored. The guidance notes also state that any risk assessment should allow the employer to identify and prioritise any measures that need to be taken to comply with relevant

statutory measures and that an assessment should be appropriate to the nature of the work such that it remains valid for a reasonable period of time.

Thus the guidance notes are extremely general. This is in line with the recent move away from prescriptive legislation. However, a number of personnel interviewed indicated uncertainty as to what constitutes a trivial hazard and to how often risk assessments should be reviewed. In addition, there was some lack of understanding as to how information from other legislation can be used to assist in determining the types of hazards to be assessed. For example, the Manual Handling Regulations assist in carrying out risk assessments of lifting tasks. PUWER92 and 98 can assist in assessing hazards such as cutting and entanglement where guarding of machinery may be required (regulation 11, PUWER92/98).

It is therefore suggested that more information as to what constitutes a suitable and sufficient risk assessment may be useful. Indeed, the guidance notes accompanying the Manual Handling Regulations have recently been updated (HSE, 1998) to include an example of a suitable and sufficient manual handling risk assessment. Similar guidance in other legislation may assist the employer in determining the steps required to ensure that the risks in the workplace are adequately assessed.

7.6.2 Guidance Accompanying PUWER92 and PUWER98

As part of the field work conducted at the Electricity Generation Company and the Offshore Oil Production Company, compliance with PUWER92 was examined in detail. During the field work it became apparent that that there were a number of aspects of compliance with PUWER92 that were causing difficulties or misunderstanding. These difficulties are discussed below.

A revised version of the Work Equipment Regulations (PUWER98) was introduced in December 1998. The recent changes to the legislation will therefore also be examined to determine whether or not they are likely to be sufficient to resolve the difficulties that have arisen in complying with the requirements of PUWER92.

7.6.2.1 Difficulties in Achieving Compliance

The results showed a high level of consistency between the two companies and the sites/installations in the problems encountered in complying with the requirements of PUWER92. The primary problems associated with the legislation appear to be twofold. The first relates to attitudes within industry to the legislation and the second to problems in interpreting the legislative requirements themselves.

7.6.2.2 Major Accident Hazards

The results indicate that within both the Electricity Generation Company and the Offshore Oil Production Company, there is a relatively poor knowledge of the requirements of PUWER92. Indeed, within the Oil Production Company in particular, a number of the offshore personnel interviewed had no knowledge at all of the requirements of the legislation.

In addition, within both companies, PUWER92 appears to be regarded as being less high profile than a lot of other health and safety legislation. For example, it was not until four years after the introduction of the legislation that the Oil Production Company started to take significant steps towards compliance with the legislation. The Head Office of the Electricity Generation Company did not issue a safety advisory bulletin on the legislation until three months after it had been issued. In addition, personnel at the Electricity Generation Company's sites only received half a days training on the six-pack as a whole. It is suggested that this is insufficient time to have even gone through the requirements of each of the regulations within PUWER92. The PUWER92 assessments conducted

at the company workshops were the only PUWER92 assessments available to the author at the time of the site visits. These assessments, the first conducted by the workshops, did not take place until four years after the introduction of the legislation.

It is suggested that this apparent lack of importance given to ensuring compliance with PUWER92 may be, at least in part, due to a tendency within both organisations to concentrate on major accident hazards. For example, the risk assessment checklists used by the Oil Production Company in particular are somewhat biased towards major accident hazards. In addition, the personnel at Power Station A stated that they were 'not particularly bothered' about the results of DSE assessments as they did not involve any major hazards, suggesting a bias towards major accident hazards. Furthermore, the PUWER92 assessments conducted by the workshops had only considered the most hazardous items of equipment. No assessments had been conducted for items considered to be of a *less* hazardous nature. Indeed, concern relating towards this trend towards focusing on major accident hazards (particularly within the offshore industry) was raised recently by the Health and Safety Executive (Beck and Woolfson, 1998).

This problem relates to attitudes within industry rather than directly to the legislation itself. However, the remaining problems relate directly to problems encountered by those personnel at the two organisations with a more detailed knowledge of PUWER92, in interpreting the requirements of the Regulations.

7.6.2.3 Scope of the legislation

The study identified a great deal of confusion relating to the definition of 'work equipment', as defined in the legislation. All the sites/installations visited, except for the head office at the Electricity Generation Company, demonstrated some misunderstanding as to the scope of PUWER92. A

common misconception being that the legislation is only applicable to workshop equipment. For example, installation B of the Oil Production Company had only conducted PUWER92 assessments within the workshop. In addition, PUWER92 assessments conducted at Power Station A appeared to also be focused on the workshop areas.

Thus, although the Regulations are accompanied by some guidance as to the scope of PUWER92, it does not appear to be sufficient to convey the wide scope of the legislation. This problem is exacerbated within the offshore industry as there is very little specific guidance on the applicability of the legislation to equipment on offshore installations.

7.6.2.4 Overlap with existing health and safety legislation

A second area that caused difficulties is the overlap between PUWER92 and other health and safety legislation. The guidance notes accompanying PUWER92 give very little information about the overlap. This caused particular problems for the Offshore Oil Production Company. Personnel within the Health and Safety department were confused as to whether they need take additional steps to comply with PUWER92 as the majority of equipment had already been assessed under other legislation. For example, machine tools such as lathes a pedestal drills, and lifting equipment all fall within the scope of PUWER92. However, the machine tools would already have been considered to a certain extent under the Offshore Installation (Prevention of Fire and Explosion) Regulations with respect to the inherent safety of the equipment (i.e. whether or not the equipment will produce sparks). In addition, with respect to the lifting equipment, the potential impact on structural integrity from dropped loads would have been assessed under the Offshore Installation (Design and Construction) Regulations and the Safety Case Regulations. Because the Asset would have already given some consideration to these items, it was assumed that *all* hazards had been considered. However, assessments conducted under the above legislation would not have

considered non-major accident hazards such as entanglement, impact and stabbing, all of which could potentially be addressed under PUWER92.

Similar problems were encountered by personnel from the Electricity Generation Company who felt that the requirements of PUWER92 tend to get lost amongst the requirements of other legislation.

To give an indication of the scale of the overlap between PUWER92 and other legislation, extracts from a paper produced for the Offshore Oil Production Company are given below (Rogers, 1997b). The paper was requested by the company as a direct result of the confusion between personnel regarding the relationship between PUWER92 and other legislation.

7.6.2.5 Relationship between PUWER92 and other legislation

Note that the relationships discussed here between PUWER92 and other legislation are also applicable to PUWER98.

The Offshore Installations and Wells (Design and Construction, etc.) Regulations 1996 (DCR)

The requirements of DCR are aimed at ensuring that an offshore installation is designed, constructed, operated and decommissioned so that the level of integrity of the installation is as high as reasonable practicable and the associated risks to personnel are as low as reasonably practicable. DCR defines structural integrity as structural soundness, strength and stability. In addition, regulation 12 and Schedule 1 of DCR set out a number of detailed requirements which are broadly equivalent to the onshore Workplace (Health, Safety and Welfare) Regulations 1992. Aspects such as floors, walls, ceilings, windows, lighting, doors, rest rooms, accommodation and sanitary facilities are considered.

The DCR guidance notes state that since the hazards associated with plant will to some extent affect an installations structure and hence integrity, compliance with PUWER92 is expected to contribute significantly to the requirements of DCR, particularly at the design stage.

Risk assessments carried out under DCR are only required to consider hazards which have the potential to result in a major accident (as defined in the Offshore Installations (Safety Case) Regulations 1992). Therefore, even if an item of plant or equipment has already been risk assessed under the requirements of DCR, a PUWER92 assessment must still be carried out to identify non-major hazards. PUWER92 assessments should be carried in order to assess the potential for injury both to the user(s) of the equipment and person(s) within the vicinity of the equipment. Thus an assessment must be carried out plant and equipment wherever there exists a man-machine interface. Examples of the boundary between DCR and PUWER92 are given in Table 7-3.

A number of items considered within Schedule 1 of DCR are not considered to be work equipment. For example, structural items such as floors, walls, ceilings and stairways do not require assessment under PUWER92. Items in the accommodation and recreation areas used outside shift hours (e.g. items in cabins, TV rooms and the gym) are not considered to be work equipment.

The Offshore Installations (Prevention of Fire and Explosion, and Emergency Response) Regulations 1995 (PFEER)

PFEER deals with preventing fires and explosion, protecting persons from the effects of any fires and explosions which do occur; and with securing effective response to emergencies which have the potential to require evacuation, escape and rescue from the installation. The guidance notes on PFEER state that plant and equipment on offshore installations

provided to comply with PFEER may also be subject to the requirements of PUWER92.

Again, PFEER only considers hazards which have the potential to result in a major accident. Therefore PUWER92 assessments must be carried out on any man-machine interfaces of plant and equipment already considered under PFEER in order that hazards which may result in non-major accidents may also be identified. Examples of the boundary between PFEER and PUWER92 are given in Table 7-3.

Regulation 19 of PFEER requires that all plant and equipment provided in compliance with the Regulations must be suitable for use. Compliance with regulation 19 of PFEER should be sufficient to ensure compliance with regulation 5 (suitability of work equipment) of PUWER92.

PFEER also considers the provision of fire detection systems, mitigation systems and life-saving appliances. The guidance notes on PFEER state that PUWER92 does not cover permanently installed systems such as fire detection systems, mitigation systems such as sprinklers or life saving appliances. Regulation 20 of PFEER defines life saving appliances as survival craft, life-rafts, life buoys, life jackets, and plant for like purposes. All such equipment should be adequately considered under PFEER and therefore does not need a PUWER92 assessment.

Regulation 7 of PFEER requires that suitable equipment be provided for use in helicopter emergencies. Such equipment should be assessed under PUWER92. It is expected that the suitability of the equipment will already have been considered under PFEER.

Offshore Installations (Safety Case) Regulations 1992 (SCR)

SCR requires that the operator or owner of every offshore installation prepares a safety case which must be submitted for acceptance by the

Health and Safety Executive. Only major accident hazards are required to be considered under SCR therefore non-major accident hazards will still need to be assessed under PUWER92. For example, the SCR guidance notes suggest that scaffolding collapse, heavy lifts and pipeline pigging should be considered as part of the safety case. However, scaffolding, cranes and pig receivers are considered as work equipment under PUWER92 and the non-major hazards associated with the use of these items will also need to be identified. Examples of the boundary between SCR and PUWER92 are given in Table 7-3 below.

Offshore Installations and Pipeline Works (Management and Administration) Regulations 1995 (MAR)

MAR sets out a number of requirements relating to the management of offshore installations. Regulation 11 of MAR states that where necessary for the health and safety of personal, written procedures to be observed on the offshore installation must be produced and relevant personnel must be informed of these procedures. These requirements complement the requirements under PUWER92 for information and instruction. Procedures regarding the safe use of work equipment should be verified by carrying out a general workplace risk assessment on the equipment with the aid of the PUWER92 checklist.

MAR also sets out requirements relating to the helideck, including the provision of procedures for safe helideck operations. Such procedures may cover matters such as the operation of cranes near the helideck when helicopter operations are to take place and the refuelling of a helicopter. Suitable plant and equipment for ensuring safe helideck operations (e.g. chocks and tie down straps/ropes, refuelling equipment, equipment for clearing the helideck of ice and snow) must also be provided. Such equipment should be assessed under PUWER92. It is expected that the suitability of the equipment will already have been considered under PFEER.

The Electricity at Work Regulations 1989

The Electricity at Work Regulations require precautions to be taken against the risk of death or personal injury from electricity in work related activities. The Regulations apply to all electrical systems and equipment. Electrical equipment is defined as 'anything used, intended to be used or installed for use, to generate, provide, transmit, transform, rectify, convert, conduct, distribute, control, store, measure or use electrical energy.' An electrical system is further described as 'a system in which all the electrical equipment is, or may be, electrically connected to a common source of electrical energy, and includes such source and such equipment.'

The types of injury which an employer is required to consider under the Electricity Regulations are 'death or personal injury from electric shock, electric burn, electrical explosion or arcing, or from fire or explosion initiated by electrical energy.'

Electrical equipment and systems are included within the PUWER92 definition of work equipment. Although electrical hazards may have been addressed through the Electricity Regulations, other hazards associated with the use of the equipment e.g. mechanical hazards, still need to be addressed. The adequacy of aspects such as guarding, control systems and warning signs also need to be considered.

A number of the requirements of the Electricity Regulations are similar to those of PUWER92. The overlap between the two sets of legislation is outlined in Table 7-2.

Table 7-2 - Summary of similarities between the requirements of the Electricity at Work Regulations and PUWER92.

Electricity at Work Regulation(s)	Equivalent PUWER92 Regulation(s)
reg. 4(4) - ensure that equipment is suitable for the use and that it is adequately maintained.	reg. 5 - suitability of work equipment reg. 6 - maintenance
reg. 12(1)(b) - isolation of electrical equipment	reg. 19 - isolation from sources of energy
reg. 15 - requires adequate lighting	reg. 21 - lighting
reg. 16 - persons to be competent to prevent danger and injury	reg. 8 - information and instructions reg. 9 - training
reg. 13 - precautions for work on equipment made dead reg. 14 - work on or near live conductors	reg. 22 - requirement for measures to be in place such that maintenance operations may be carried out without risk to health and safety.

Full compliance with the Electricity at Work Regulations listed in table 7-2 is likely to be sufficient to ensure compliance with those regulations which are similar under PUWER92. However, it is important to check that adequate measures are in place to ensure compliance with these regulations. A detailed assessment of the electrical equipment and systems will be needed with respect to the remaining regulations (regulations 7, 10-18, 20, 23, 24) to ensure that the requirements are met in full.

Table 7-3 - Examples of the boundaries between PUWER and other health and safety legislation and the type of hazards which may be assessed under each of the regulations.

Plant/equipment	PUWER	Other Legislation
Hand tools e.g. hammers, knives, screwdrivers.	Non-major accident hazards. In particular those involving the interface between the hand tool and the user and persons within the vicinity of the equipment. E.g. impact, cutting or severing and stabbing or puncture. The suitability of the equipment for the task and work area, and foreseeable misuse would also be considered.	The Electricity at Work Regulations may effect tools used for maintenance of electrical equipment e.g. insulation of tools.
Machine tools e.g. lathes, pedestal drills.	Primarily non-major accident hazards. In particular those involving the interface between the equipment and the user or persons in the vicinity. E.g. entanglement, impact, stabbing or	The suitability of the equipment for the work area with respect to its inherent safety (e.g. sparks etc.) may impact upon DCR and PFEER. The Electricity at Work Regs are applicable to electrical

Plant/equipment	PUWER	Other Legislation
	puncture. Adequacy of control measures and guarding and the suitability of the equipment for the task and work area should also be considered.	equipment.
Lifting Equipment	Primarily non-major accident hazards. In particular those involving the interface between the lifting equipment and the user or persons in the vicinity. E.g. entanglement in moving parts of machinery, impact from loads being lifted. Adequacy of control systems and guarding are a major consideration.	Safety considerations regarding the structural integrity of the platform e.g. dropping of loads & the stability of the crane should be considered under DCR and SCR. Safety procedures for the operation of cranes near the helideck are a requirement of MAR.
Plant and equipment for ensuring safe helideck operations e.g. chocks, tie down straps/ropes, refuelling equipment, equipment for clearing the helideck of ice & snow.	Non-major hazards. In particular those involving the interface between the plant/equipment and the user or persons in the vicinity.	The provision of such equipment is a requirement of MAR. It is expected that the suitability of the equipment, in particular with respect to the interface between such plant /equipment and the helicopter/helideck, would be considered under PFEER and DCR. E.g. major accident hazards associated with failure of tie down straps, fuel spillage.
Separator	Hazards associated with hot and cold surfaces	Major accidents such as loss of containment may be considered under SCR, DCR & PFEER
Pig receiver	Depressurisation onwards will be considered under PUWER E.g. hazards associated with pig removal and the use of associated equipment such as trolleys.	Receiving the pig through to depressurisation may be considered under SCR, DCR & PFEER. E.g. major accidents such as loss of containment.
Pump	A PUWER assessment would consider the rotating drive and shaft of the pump for both maintenance and normal operating tasks. Maintenance tasks associated with the internals of the pump and containment of the fluid should also be assessed. E.g. hazards associated with hot and cold surfaces or contact with rotating parts.	The internals of the pump and containment of the fluid will be considered SCR, DCR & PFEER. E.g. major accidents associated with sparks or loss of containment.

NB: Major accident hazards are those hazards which have the potential to result in a major accident as defined in the Offshore Installations (Safety Case) Regulations 1992.

Note that the list of legislation discussed above is non-exhaustive. The legislation listed does however, give an idea of the scale of the relationship

that exists between PUWER92 and other legislation. It is suggested that insufficient guidance is given to industry relating to these relationships, and that this lack of information and understanding may result in hazards being overlooked in the workplace. The guidance accompanying PUWER92 and PUWER98 is discussed in greater detail in section 7.6.2.2.

7.6.2.6 Conformity with Community Requirements

The third area of PUWER92 that caused confusion amongst personnel interviewed from the two industries is regulation 10 on conformity with community requirements. None of the sites/installations that took part in this study adequately complied with the requirements of this regulation. For example, the PUWER92 assessments conducted by the Electricity Generation Company Workshops had not considered regulation 10. In addition, although the audit form used by Power Station A does include a section on regulation 10, personnel interviewed were unsure as to how to actually go about achieving compliance with the regulation. A number of personnel interviewed at the Oil Production Company were not even aware of the requirements of regulation 10. Furthermore, those that were aware of the regulation stated that they did not understand how they could achieve compliance.

Safety tours of both organisations indicated that some, but certainly not all, relevant equipment was CE marked. However, it is suggested that this is because suppliers were aware of the legislation rather than because the organisations had taken active steps to obtain CE marked equipment. Neither organisation actually requests CE marking when purchasing plant/equipment. Instead they rely on using known reputable suppliers.

Certificates of conformity were also generally not available or less than adequate, listing irrelevant standards or important standards having been missed.

Discussions with suppliers indicated that it is not just the buyers that lack knowledge of CE marking. A number of suppliers used by the Oil Production Company (all of which are considered by the company to be reputable suppliers) lacked knowledge of the detailed requirements of the legislation. This suggests that it is particularly important for organisations to be adequately informed about the requirements of the legislation in order that they may make themselves aware of what they are actually buying and that the plant/equipment is in fact safe for use.

7.6.2.7 Lack of guidance on ergonomic risks

The final area of guidance that appeared to be somewhat lacking is that on ergonomic risks in the workplace. A number of the requirements of the legislation ideally require some consideration of ergonomic risks. For example, when considering adequacy of guarding, assessors should ensure that gaps between the guarding and machinery are small enough to prevent insertion of limbs. In addition, an assessment of the adequacy of lighting with respect to performing a task, the adequacy of emergency stops, and the adequacy of warning and markings all benefit from a consideration of ergonomics.

Examination of both organisations documentation on PUWER92 assessments, revealed that neither organisation appeared to have specifically considered ergonomics. It is suggested that this is because, although the need for assessing ergonomic risks may be inferred from the legislative requirements, the guidance accompanying PUWER92 does not actually make an specific reference to ergonomics.

The above discussion suggests that the problems associated with compliance with PUWER92 appear to be twofold. The first is attitudes to the legislation and the second, difficulties in understanding the legislative requirements. These difficulties involve a misunderstanding over the definition of work equipment and the relationship between PUWER92

and other legislation, a lack of understanding over the requirements of regulation 10, and a lack of guidance on ergonomic risks.

As is discussed in chapter two, the work equipment regulations were updated in December 1998. PUWER92 and PUWER98 will therefore be compared to determine whether the new legislation is likely to alleviate any of the problems identified with PUWER92.

7.6.2.7 Comparison between PUWER92 and PUWER98

Table 7-4 compares the requirements of PUWER92 and PUWER98 and the guidance accompanying the Regulations in order to give an indication of whether the new legislation is likely to resolve the issues identified above.

Table 7-4 : Comparison between PUWER92 and PUWER98

Problem Identified	PUWER92	PUWER98	Comments
Confusion as to the type of equipment covered under the legislation.	Work equipment is defined in regulation 2 as 'any machinery, appliance, apparatus or tool and any assembly of components which in order to achieve a common end are arranged and controlled so they function as a whole'. The guidance notes give a brief description of work equipment, and a non-exhaustive list of examples of work equipment is given. There is no mention of the applicability to offshore installations, although offshore drilling equipment is included in the list of examples of work equipment.	The definition of work equipment is simplified to 'any machinery, apparatus, tool or installation for use at work'. Again the guidance notes give a brief description of work equipment. This description appears to be clearer than that given in PUWER92. A detailed description of the term 'installation' is also given. However, no list of examples of work equipment is included in the guidance. The issue of the applicability of PUWER98 to equipment on offshore installations is well addressed.	PUWER98 appears to be an improvement on PUWER92 with respect to the type of equipment covered under the legislation. For example, the definition and explanation for work equipment given in PUWER98 appears to be clearer than that given in PUWER92, and the issue of offshore equipment is well addressed. In addition, although no list of examples of work equipment is included in PUWER98, given that the descriptions of work equipment appear to be clearer and that the examples given in PUWER92 were insufficient to avoid misunderstanding, it is suggested that this may not necessarily be a problem. It remains to be seen whether these changes are sufficient to overcome the widespread misconception that PUWER is only applicable to workshop equipment.
Lack of guidance relating to	Paragraph 12 of the guidance notes states that PUWER92 should be considered alongside	The list of Regulations that overlap with PUWER has been extended to include the	It is suggested that this moderate extension of the list would be insufficient to resolve the problems

Problem Identified	PUWER92	PUWER98	Comments
overlap between PUWER and other health and safety legislation.	the Management of Health and Safety at Work Regulations (e.g. regulation 3 relating to risk assessment). In addition, paragraph 23 of the PUWER92 guidance notes states that PUWER92 overlaps with the Workplace (Health, Safety and Welfare) Regulations 1992 and the Personal Protective Equipment at Work Regulations 1992. The guidance also states that where such overlaps occur, the more specific Regulation will normally be sufficient for compliance.	Construction (Health, Safety and Welfare) Regulations 1996 and the Road Vehicles (Construction and Use) Regulations 1986.	encountered by the Oil Production Company and the Electricity Generation Company. As discussed earlier, PUWER has a relationship with a number of other Regulations other than those listed in the guidance notes e.g. the Offshore Installation (Prevention of Fire and Explosion) Regulations and the Electricity at Work Regulations.
Lack of clarity with respect to the requirements of regulation 10 (conformity with community requirements).	Regulation 10 requires that 'any item of work equipment provided for use... complies with any enactment which implements in Great Britain any of the relevant community Directives listed in Schedule 1' (of the Regulations). The guidance notes do give some	The wording of regulation 10 has been modified within PUWER98. The regulation requires that employers ensure that 'any item of work equipment has been designed and constructed in compliance with any essential requirements, that is to say requirements	The wording of regulation 10 within PUWER98 is still very cumbersome and it is not clear whether it is any easier to understand. In addition, although the guidance on achieving compliance is likely to be of considerable assistance to suppliers, it does not address all issues, particularly with respect to suppliers

Problem Identified	PUWER92	PUWER98	Comments
	information on what is meant by community Directives. However, no guidance is given as to how an employer should actually go about ensuring such compliance.	relating to its design and construction in any of the instruments listed in Schedule 1 (these being instruments which give effect to community directives concerning the safety of products). In addition, the guidance notes do give some advice as to how the employer may ensure suppliers conform with community requirements.	unfamiliar with the detailed requirements of the legislation. For example, employers are not advised to check that certificates of conformity do actually list appropriate standards, neither are they advised to check that the risk assessments and CE marking apply to the equipment as a whole, rather than just the individual components. The field work conducted at the Oil Production Company and the Electricity Generation Company has shown that Certificates of Conformity often list inappropriate standards and that important standards are often missed form the list. In addition, the study has shown that suppliers may take a number of components that have been individually CE marked and put them together without looking at how they interact and whether as a whole they are safe to use (e.g. the sack slitters used on Assets A's offshore installations)
Lack of guidance with	No specific reference is made to ergonomics in PUWER92.	The guidance for regulation 4 (suitability of work equipment)	The guidance provided in PUWER98 is a substantial improvement on that

Problem Identified	PUWER92	PUWER98	Comments
respect to ergonomic risks.		states that ergonomic risks such as operating positions, working heights, and reach distances should be taken into account.	given in PUWER92 as it does indicate some areas that require ergonomic assessment. However, it is suggested that the guidance is somewhat biased towards physiological considerations. For example, regulations 14-18 of PUWER98 deal with controls and control systems. However, there is no mention within the guidance on ensuring that the layout of controls and displays is adequate using the principles of functionality, frequency, sequence and importance of use. Neither is there any mention of factors such as human error which may affect the safe use of equipment.

From the discussion in table 7-4, it would appear that PUWER98 is likely to alleviate some, but not all of the problems identified with PUWER92. For example, the definitions and explanations of what is meant by 'work equipment' appear to be much clearer, and some guidance is given on achieving compliance with regulation 10. In addition, PUWER98 does give some advice on the types of ergonomic risks that should be considered. However, it is suggested that there is still insufficient information on the relationship between PUWER92/98 and other health and safety legislation. The guidance on regulation 10 does not appear to have considered all relevant compliance issues, particularly with respect to suppliers unfamiliar with the detailed requirements of the legislation on CE marking. In addition, the guidance on ergonomic risks is somewhat biased towards physiological considerations. Thus it is suggested that although PUWER98 may improve understanding of the Regulations to a certain extent, there are still areas that need to be improved.

7.6.3 Adequacy of the Guidance

It has been seen that there are a number of inadequacies in the guidance notes accompanying both PUWER92 and regulation 3 of the MHSW Regulations. A number of changes have been made to the work equipment Regulations and the accompanying guidance notes. However, it is suggested that the introduction of PUWER98 guidance notes is unlikely to alleviate all of the problems identified with the guidance accompanying PUWER92.

Regulation 3 of the MHSW Regulations sets out the basic requirements of the law with respect to general workplace risk assessments. The guidance notes accompanying PUWER92/98 may be used by employers to assist in identifying the risk associated with the use of work equipment. Adequate guidance is important to ensure that these assessments are conducted by the employer as effectively as possible.

The current study has identified a number of deficiencies in the risk assessments conducted by the Electricity Generation Company and the Offshore Oil Production Company. This is particularly apparent with respect to compliance with PUWER92. It is suggested that these inadequacies are likely to have been exacerbated by the lack of guidance accompanying the MHSW Regulations and PUWER92/98. Hypothesis 2, which states that guidance on the legislation is adequate to allow suitable and sufficient risk management strategies to be adopted by an organisation is therefore rejected.

7.7 FUTURE WORK

A number of potential areas for future work can be identified from the current study. Further investigation could be carried out into the adequacy of the frequently used measures of safety culture (as defined in 2.4.2.1). For example, other organisations and industrial sectors could be examined to determine whether similar results can be found. Other aspects of a safety management system e.g. safety audits and accident investigation, communication, training needs within an organisation, adequacy of resources and management commitment could also be examined to determine whether they also need to be assessed in greater detail to give a reliable picture of the safety culture of an organisation. This information could then be used to give an indication of how much information needs to be gathered during a safety culture assessment to give a true indication of the adequacy of a safety management system and an organisations safety culture.

Further work could also be conducted with respect to the guidance accompanying current health and safety legislation. Other Regulations besides PUWER92 and regulation 3 of the MHSW Regulations could be examined to determine the adequacy of the HSE guidance notes that accompany them.

At present, the Supply of Machinery (Safety) Regulations 1992 are not accompanied by guidance notes. The current study has indicated that manufacturers and suppliers may not fully understand the requirements of the legislation. The need for guidance notes to accompany the legislation could therefore be examined.

The current study identified a number of problems with the guidance notes accompanying PUWER92. It has been suggested that PUWER98 may alleviate some, but probably not all, of the problems. A further study to examine the effectiveness of the new legislation is suggested.

CHAPTER EIGHT

Conclusions

This chapter summarises the findings of the current study. Conclusions are given on the adequacy of a number of frequently used measures of safety culture. A summary of recommendations is given for the Electricity Generation Company and the Oil Production Company with respect to the adequacy of their safety management systems. Conclusions on the adequacy of the guidance notes accompanying current health and safety legislation are also given.

8.1 ADEQUACY OF MEASURES OF SAFETY CULTURE

The primary aim of the study was to examine the adequacy of frequently used measures (as defined in 2.4.2.1) of safety culture in determining the effectiveness of an organisation's risk management systems. The study examined the theory that although an organisation may perform well against a number of frequently used measures of safety culture, this is not necessarily a true indication of performance with respect to the risk assessment and risk management processes adopted by the organisation.

Case studies were undertaken of two major organisations. The first was an Electricity Generation Company and the second an Offshore Oil Production Company. Both had previously performed well on safety culture assessments which used the frequently used measures of safety culture outlined in 2.4.2.1. Neither of the previous assessments had identified any deficiencies in the risk management systems adopted by the two organisations.

The risk management systems adopted by both organisations were examined in detail to determine if the previous safety culture assessments gave an accurate picture of the adequacy of the two organisations policies and procedures with respect to risk assessment. Two areas of risk management were considered. The first was the organisation's internal policies, procedures and practices with respect to conducting risk assessments within the organisation. The second examined the effect of risk management strategies adopted by organisations external to the Electricity Generation Commune and the Oil Production Company. For example, equipment manufacturers and suppliers. The adequacy of arrangements made by the Electricity Generation Company and the Oil Production Company to ensure that equipment manufacturers and suppliers also carry out suitable and sufficient risk assessments was therefore examined.

The study identified a large number of deficiencies in the internal risk management strategies adopted by the two organisations that had not been identified through previous safety culture assessments. In addition, it was shown that neither organisation has implemented sufficient measures to ensure that all hired, leased or purchased equipment is adequately risk assessed prior to its installation within the workplace. It was therefore concluded that the previous safety culture assessments conducted within the two organisations were not sufficient to identify a number of problems within the two organisations.

These results suggest that the frequently used measures of safety culture described in section 2.4.2.1 are not sufficient to give an accurate picture of the adequacy of an organisations risk management strategies. It is therefore suggested that many safety culture assessments may have given an over optimistic view of an organisation's safety management system and it is recommended that in depth assessments of an organisations risk

assessment and risk management policies and practices be conducted alongside other more frequently used measures of safety culture.

A number of recommendations on how the Electricity Generation Company and the Offshore Oil Production Company can improve their safety management systems were given throughout the report. A summary of the primary recommendations is given below:

Risk Assessment

- Head Office of the Electricity Generation Company appear to support a reactive approach to risk assessment. Care should be taken to ensure that such views do not filter through to the remainder of the organisation.
- Both organisations should take steps to ensure that all the requirements of the any relevant health and safety legislation are met.
- The Offshore Oil Production Company should take steps to ensure that all installations are aware of the integrated approach to risk assessment being adopted by Asset A Offshore Engineering.
- Both organisations should ensure that human error and foreseeable misuse are considered during risk assessments.
- Both organisations avoid being too biased towards major accident hazards when conducting risk assessments and thus failing to identify less serious, but more common place hazards.
- Both organisations need to be careful not to become too reliant on generic risk assessments. It should be ensured that the differences between individual items of equipment are not overlooked, particularly with respect to the more hazardous items of equipment.
- Both organisations must ensure that risk assessment procedures and practices are sufficient to identify any problems with newly installed equipment.

Employee involvement

- Further steps need to be taken within both organisations to involve employees in the risk assessment process. In particular this should involve consulting employees during assessments with respect to the hazards involved in their own jobs and suitable control measures.

Permit to Work

- The Offshore Oil Production Company should avoid reliance on training to address the risks identified through the permit to work system.

Control measures

- The Electricity Generation Company should avoid an apparent bias towards procedural measures when due to a lack of resources to carry out design changes.
- The Electricity Generation Company currently rely upon the use of PPE with respect to controlling electrical arcing hazards. This is not in line with the HSE's hierarchy of control measures. Steps should therefore be taken to ensure that additional control measures are implemented as soon as possible.

Training

- The Electricity Generation Company should make significant changes to the risk assessment training given to personnel. Courses need to be more detailed, and more personnel should receive training. Training on the requirements of PUWER98 should also be given to relevant personnel. This should include training for procurement personnel on the requirements of regulation 10 of PUWER98.
- The Oil Production Company should monitor the effectiveness of the newly introduced risk assessment and PUWER98 training programmes.

Communication

- Communication between the individual sites/installations owned by the two organisations should be improved to avoid inconsistencies in risk assessments or duplication of effort. In addition, this would ensure that any particular problems identified with items of equipment are shared with other sites/installations.
- Although procedures are in place within both organisations to communicate the results of risk assessments, a significant number of personnel still do not appear to receive this information. The adequacy of these procedures should therefore be reviewed. In addition, within the Electricity Generation Company there is a great deal of inconsistency in the ways in which personnel receive information about risk assessments. Standardising the ways in which personnel are given information may assist in ensuring that all personnel receive adequate information.

Attitudes to safety

- A small number of personnel from the Electricity Generation Company stated that they would not follow procedures introduced as a result of a risk assessment either because workload pressures are already too great or if pressures became too great. Consideration should be given to monitoring workload levels within the organisation to ensure that personnel are not being placed under pressure to take short cuts.

Audits and reviews

- The Oil Production Company should consider reviewing procedures for example by conducting risk assessment of the tasks to which the procedures apply in order to ensure that the procedures are in fact safe.
- Both organisations must ensure that risk assessments are actually reviewed at suitable intervals.

Equipment modifications

- Both organisations should ensure that all personnel (including contractors) are aware of the relevant British, European and International Standards when carrying out equipment modifications.
- The Electricity Generation Company should ensure that procedures and practices at all sites/installations reflect the need to consult health and safety standards when modifying and installing plant and equipment.

PUWER92

- Both organisations must ensure that all relevant equipment is assessed under PUWER98. Care should be taken to ensure that PUWER98 assessments are not restricted to a consideration of workshop equipment.
- Care should be taken by both organisations to ensure that all assessments adequately consider the requirements of regulations 5-10 of PUWER98.
- Both organisations should ensure that procedures are in place to ensure that CE marking and suitable and sufficient risk assessments are requested when purchasing, hiring or leasing equipment. It should be ensured that all relevant installations, sites, health and safety personnel and procurement personnel are aware of these procedures.
- Both organisations should periodically audit suppliers to ensure that they do conduct suitable and sufficient risk assessments. Certificates of Conformity should be requested when purchasing equipment and the adequacy of these CoCs should be checked. Organisations should also inspect equipment for obvious hazards before accepting delivery.

Management commitment

- Head Office of the Electricity Generation Company should ensure that all Safety Advisory Bulletins are timely (i.e. not supplied several months after changes to the legislation have taken place), and that

they provide sufficient detail for the individual sites to be able to understand the requirements of the legislation and how they are affected.

- A significant number of personnel within the Electricity Generation Company doubt the management's commitment to safety and do not believe that they provide sufficient resources for safety related matters. Management should ensure that sufficient resources are in fact being supplied. In addition, if it is judged that sufficient resources are being provided, steps should be taken to raise awareness of the resources that are provided and any safety initiatives that are introduced by the management of the organisation.

8.2 ADEQUACY OF THE GUIDANCE ACCOMPANYING THE LEGISLATION

It can be seen that a number of inadequacies were identified in the risk management systems adopted by the Electricity Generation Company and the Offshore Oil Production Company. However, it is suggested that inadequacies in an organisations risk management strategy may not be solely caused by failures within that organisation. The adequacy of information and guidance available to the organisation may also be a contributory factor. A second aim of the study therefore was to examine the adequacy of the guidance notes accompanying current legislation, and in particular, the MHSW Regulations and PUWER92.

A number of inadequacies were found in the guidance notes accompanying regulation three of the MHSW Regulations and the guidance accompanying PUWER92. PUWER98 was introduced recently and replaces the requirements of PUWER92. The guidance notes accompanying PUWER98 were also examined to determine whether they are likely to alleviate any of the problems identified with PUWER92.

8.2.1 Management of Health and Safety at Work Regulations 1992

Regulation three of the MHSW Regulations places a duty on employers to conduct suitable and sufficient risk assessment of the workplace. The guidance accompanying the regulation gives somewhat limited information on what the term suitable and sufficient implies with respect to risk assessment. The current study identified that there is some confusion within industry as to what constitutes a suitable and sufficient risk assessment. Additional guidance on this matter is therefore likely to be of assistance to personnel with responsibilities for health and safety.

8.2.2 Provision and Use of Work Equipment Regulations 1992/1998

This study has shown that the work equipment legislation does not as yet appear to be fully understood by industry. This represents an under-utilised way in which safety and ergonomics can be successfully be incorporated into the workplace. It is suggested that there are two primary reasons why the work equipment legislation has yet to be fully embraced within many organisations health and safety management systems. The first is a tendency of many organisations to concentrate on major accident hazards, thus failing to adequately consider occupational hazards such as those that could potentially be identified through PUWER. In addition, there is evidence to suggest a lack of adequate guidance accompanying the legislation. It is suggested that the introduction of PUWER98 may go some way to alleviate the problems identified with PUWER92. However, from the comparison of PUWER92 and PUWER98, it would seem unlikely that the new legislation will address all the problems identified.

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Note that in order to preserve the anonymity of the two organisations that took part in this study, it has been necessary to replace the names of the two organisations with the words 'Electricity Generation Company' or 'Offshore Oil Production Company' in a number of the references.

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APPENDIX A

Semi-Structured Interview Question Set

Criteria for carrying out risk assessments

1. What criteria do you use to determine whether a risk assessment is necessary?
2. Are risk assessments used pro-actively or do they tend to be used reactively following an incident?

Permit to work system

3. Do you operate a permit to work system?
4. Do a large proportion of tasks require a permit to work?
5. Are risk assessments mostly task based assessments associated with permits to work or are general workplace assessments associated with routine operating and maintenance tasks also carried out?

Employee involvement

6. Who would be involved in carrying out a risk assessment?
7. Do you consult those involved in carrying out a task/using an item of machinery when carrying out a risk assessment both for the purpose of identifying hazards, and in suggesting suitable control measures?

Training

8. What training have those involved in the risk assessments received?
9. Is refresher training given?

Risk assessment techniques

10. Do risk assessments consider foreseeable misuse, human error, maintenance of equipment?
11. What methods of risk assessment do you use?
12. Do you follow recommendations in the safety policy handbook or do you prefer to use your own methods?

Control measures including procedures

13. Have risk assessments resulted in changes to the design of equipment?
14. Are the results of risk assessments fed back into procedures?
15. Have existing procedures been developed as a result of risk assessment?
16. For those procedures that have been in place for a long time, have they been verified via risk assessment?
17. Is there a formal procedure for the results of a risk assessment to be fed into safety related procedures?
18. Are changes made to procedures as a result of accident investigations?
19. Are changes in procedures followed by the workforce? Do you have any way of monitoring this?

Communication of results

20. How are the results of risk assessments conveyed to the workforce?
21. Do you communicate with other power stations regarding results of risk assessments?
22. Are the results of accident investigations communicated to other power stations?

Monitoring and reviewing assessments

23. Once an assessment has been carried out, do you have a tracking system to monitor the progress of the implementation of additional control measures?
24. Do you review the control measures to ensure that they are effective and have not created any new hazards?

25. How frequently do you review risk assessments?

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26. How have you ensured compliance with the Provision and use of Work Equipment Regulations?

27. I understand head office have put together an audit for checking compliance with PUWER. Have you used this audit and was it effective?

28. Have you carried out any risk assessments based on the requirements of PUWER? If so, what risk assessment techniques were used?

29. Did you use any form of checklist to ensure all areas of PUWER were considered?

30. How did you check compliance with regulations 5-10?

Purchasing new equipment

31. What sort of equipment would you purchase yourselves and what would be purchased through head office.

32. Regulation 10 of PUWER requires employers to ensure that new equipment complies with relevant European legislation. How do you ensure that new equipment is, where applicable adequately CE marked.

33. Do you audit suppliers to ensure they carry out suitable and sufficient risk assessments?

34. Is there any input/advice from head office when purchasing equipment?

35. Do you have any requirements for CE marking, compliance with relevant British, European standards in the procurement contract?

36. Do you check certificates of conformity to check that suitable standards appear to have been complied with?

37. Who takes responsibility for accepting a new item of equipment?

38. What safety training have they received?

39. Do you carry out general workplace risk assessments on new equipment to ensure that they are suitable for the environment in which they have been placed?

Equipment modifications

- 40. Do you do any of your own modifications to existing equipment?
- 41. Are the proposed design changes risk assessed?
- 42. If sent away, how do you ensure that design changes have been adequately risk assessed?
- 43. Who has responsibility for accepting the final design?
- 44. Is there any health and safety input from head office?

Support from Head Office

- 45. Do you feel that support from head office regarding risk management is sufficient?
- 46. Is there any additional support/ advice which you think head office could provide?
- 47. How do they let you know about for example, changes in legislation?
- 48. Is advice from head office too prescriptive?

Improvement suggestions

- 49. Are there any changes that you think should be made the organisations current risk management system?
- 50. Are there any proposed changes/ reviews of the system?

APPENDIX B

Risk Assessment Questionnaire

The following questionnaire was distributed amongst personnel at the Electricity Generation Company and the Offshore Oil Production Company. Two responses were obtained during a site visit to the Electricity Generation Company. A further ten copies were sent to the Electricity Generation Company and all ten were returned, giving a total of twelve responses. Twenty-five questionnaires were sent to the Offshore Oil Production Company and seventeen responses were received.

RISK ASSESSMENT QUESTIONNAIRE

To all personnel

My name is Paula Rogers and I am a student at Aston University in Birmingham.

I am doing some research into how risk assessments are carried out and peoples attitudes to risk assessment.

I would be very grateful if you could spare around **five minutes** to complete the following questionnaire.

You do not need to give your name, although it would be useful if you could give your job title. **All answers will be treated with the strictest of confidentiality.**

Thank you for your time and help.

Paula Rogers

1. Have you ever received any training on risk assessment? _____

IF YES: Please describe the training. Was the training useful and understandable? _____

IF NO: Do you think you would benefit from risk assessment training? _____

2. Have you ever taken part in a risk assessment whilst working for the company? _____

IF YES: What was your role? _____

3. Have you ever been consulted while a risk assessment was being carried out as to the types of hazards involved in carrying out your job or about suitable measures which could be put in place to reduce the risks of carrying out that job? _____

IF YES: Please describe how often this has happened and the type of information you were asked to give. _____

4. Do you think you have enough involvement in carrying out risk assessments? _____

5. Are you told about the results of risk assessments e.g. the hazards involved in operating items of equipment, changes regarding procedures, design of equipment? _____

IF YES: How is this information passed on to you? _____

6. If changes to procedures were made following a risk assessment, would you always follow these procedures? _____

Are there any circumstances under which you would not follow the new procedures? _____

7. How effective do you think risk assessment is in improving safety? _____

8. Do you think safety related activities such as risk assessment should take priority over production? _____

9. Do you think management put safety related activities such as risk assessment before production? _____

10. Do you think management provide enough resources for safety related activities such as risk assessment? _____

11. Do you have any suggestions for improvements to the way in which risk assessments are carried out within the company? _____

12. If possible, please could you give an indication of your area of responsibility e.g. Tradesman, Technician, Foreman, Lead Foreman, Team Leader, Manager, Advisor etc. _____

Thanks again for you time and help in completing this questionnaire

APPENDIX C

Conference Paper

The following paper was presented by the author of the current study at the Ergonomics Society Annual Conference in April 1999.

A copy of the paper may be found in:

Hanson, M. A., Lovesay, E. J. & Robertson, S. A. (Eds) (1999)
Contemporary Ergonomics 1999, Taylor and Francis.

