HSE
Health & Safety Executive

Factoring the human into safety: Translating research into practice

The development and evaluation of a human factors accident and near miss reporting form for the offshore oil industry

Volume 2 (of 3)

Prepared by the **University of Aberdeen**
for the Health and Safety Executive 2003

RESEARCH REPORT 060

HSE
Health & Safety Executive

Factoring the human into safety: Translating research into practice

The development and evaluation of a human factors accident and near miss reporting form for the offshore oil industry

Volume 2 (of 3)

Kathryn Mearns, Sean Whitaker, Rhona Flin, Rachael Gordon and Paul O'Connor
Industrial Psychology Group
University of Aberdeen
King's College
Aberdeen
AB24 3FX

The ultimate purpose of this project is to improve accident analysis in order to learn from previous incidents and consequently reduce the likelihood of similar incidents recurring. The specific aim is to develop an incident reporting form which would be used to gather 'human factors' data from individuals involved in incidents on offshore installations, collect data using this form, and evaluate the form using this data. An accident reporting system will be developed based on previously developed models of accident causation (e.g. Reason, 1990; Wickens, 1992) with a potential to deliver greater accuracy of human factors incident data.

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

HSE BOOKS

First published 2003

ISBN 0 7176 2695 4

Preface

This volume forms the second part of a series of reports for project 3661: 'Factoring the Human into Safety: Translating Research into Practice'. Volume 1 of the report is 'Benchmarking Safety in the Offshore Oil Industry' and Volume 3 is 'Developing Crew Resource Management for Offshore Crews'. The overall aim of the project was to develop practical programmes for the offshore oil and gas industry which can lead to;

a) A better understanding of human and organisational factors in safety,

b) Continued improvements in safety management and

c) An improved 'safety culture' throughout the industry as a whole.

In order to achieve this overall objective, three work packages were proposed which build on previous work (see Mearns, Flin, Fleming and Gordon, 1998).

1. A bench-marking study to identify, analyse and share best practice on human factors safety-related issues.

2. Developing crew resource management (CRM) packages specifically for training supervisors and offshore teams in human factors issues.

3. Systematically analysing for trends in human factors causes of accidents so that the information can be used to develop training programmes for CRM and for training accident investigators. The information could also be used in the bench-marking study.

Acknowledgement

This project was funded by 13 offshore oil companies and the Offshore Safety Division of the Health and Safety Executive. The views presented here are those of the authors and should not be taken to represent the position or policy of the organisations involved or of the Health and Safety Executive. We would like to thank all the offshore personnel who have participated in the research and the onshore personnel who facilitated access and arranged offshore visits. We are particularly grateful to the following members of our project steering group for their support and advice during the project: Joan Donohoe (Agip), Alan Armstrong (AMEC Process & Energy), Dave Cutteridge (BP Amoco), Alan Hannah (Coflexip-Stena), Ray Daniels (Conoco), Martin Wheeler (ELF), Gordon Thom (Halliburton), Bill Brazendale and Ged Adams (Kerr-McGee), Charlie McLaughlin (Salamis), Marty Weber (Sedco Forex), Diarmid McAllistar-Hall (Shell Expro), Hywel Evans (Texaco), David Henson and Chris Allen (Total Oil Marine).

Executive Summary

The ultimate purpose of this project is to improve accident analysis in order to learn from previous incidents and consequently reduce the likelihood of similar incidents recurring. The specific aim is to develop an incident reporting form which would be used to gather 'human factors' data from individuals involved in incidents on offshore installations, collect data using this form, and evaluate the form using this data. An accident reporting system will be developed based on previously developed models of accident causation (e.g. Reason, 1990; Wickens, 1992) with a potential to deliver greater accuracy of human factors incident data.

Chapter One describes seven accident reporting systems, indicating large differences in their structure and content. However, one consistency between those systems based on accident causation models is that they are all based on Reason's accident causation model. The evaluation of the various accident reporting systems has helped to determine the content and structure of the accident reporting forms (WSFI and WSFII) described in this report.

Chapter Two describes the development and evaluation of the WSFI which was based on an open reporting form used by British Airways. Individuals involved in an incident were required to describe the events leading up to the incident in their own words using the WSFI with the expectation that more detailed information would be collected. The WSFI contains 11 open questions covering the following topics: a narrative description of the activities engaged in before the event; job planning; tools and equipment; working conditions; procedures; how they were feeling at the time of the incident, others involved in the task, training; better ways to handle the situation; how well the situation was handled; other comments on how to prevent this type of incident.

The level of detail in the WSFIs was evaluated indicating that over half the respondents completed the narrative description comprehensively and the majority of the respondents completed the remainder of the WSFI in very little detail. Incidents which were reported using WSFIs were found to produce significantly more immediate and underlying codes than were the reports which did not use WSFIs. In summary, the results illustrate that the WSFIs have helped increase the quantity of detail given in the analysis of the causes, however, there are still problems with the form. The outcome of this examination of the Witness Statement Forms has shown that:

- The level of detail in the WSFIs was limited, especially in questions 2-11
- Personnel needed additional instruction and guidance on how to use the form, such as more guidance within the reporting form itself

A second form, the Witness Statement Form II, was proposed providing respondents with more prompts within the reporting form. Although the form contains similar topic areas to the WSFI, it is based on Reason's Accident Causation Model and Wicken's Information Processing Model. This form was tested using ten offshore case studies to assess of its effectiveness in obtaining greater numbers and

more specific human factors causes. Overall, the examination of these case studies showed that the form has helped to extract additional information than the company's original report. Although some of this information may not be directly relevant to the investigation, it sheds light on possible hazardous situations. The following tables indicate the advantages and disadvantages of the Witness Statement Form II.

Advantages and Disadvantages of the Witness Statement II

ADVANTAGES	DISADVANTAGES
❖ More specific information	❖ Reluctant to give open answers
❖ Sets the scene	❖ Difficulty completing some sections
❖ Categorising & grouping information	❖ Ambiguities in the questions
❖ Involving personnel in investigation	❖ Not all responses are relevant to the incident
❖ Easier to respond to in writing to sensitive/ personal questions	❖ Too simplistic
❖ Guiding which types of training should be introduced	❖ Form is too long
	❖ Not all findings can be dealt with
	❖ Removal of some sections

Conclusions

- Both Witness Statement Forms provide investigators and management with additional information about incidents compared to the Original Reports.

- The WSFII showed the greatest increases in the number of human factors causes compared to the WSFI.

- The main problem in gathering human factors causal data was respondents reluctance to give open and candid responses to the forms

Recommendations

- Although the WSFII requires further testing (with a larger number of incidents), it is recommended that this form be used, in addition to companies current investigation system, to collect additional human factors causes from personnel involved in incidents.

- It is recommended that this form is tested as part of a confidential reporting system to obtain more open and full responses in order to optimise the quality of the completed forms.

Table of Contents

1. Introduction

The collection of accurate accident data is seen as an important step for the improvement of industrial safety. Industries, such as the offshore oil industry, have accident reporting systems which are vulnerable to underreporting, have incomplete recordings and do not necessarily provide a complete picture of the conditions under which accidents take place (Stoop, 1997). There is currently no standard accident reporting form in existence across the oil industry. Instead companies tend to develop their own specific forms. Despite this, the majority of companies operating on the UKCS base their accident reporting system on the ISRS (ILCI) system (Bird, 1989), which along with other systems in use, lacks a firm theoretical framework containing a comprehensive set of the psychological factors that can potentially affect accident involvement. Although information produced from current accident reporting forms is extensive, its quality and quantity concerning the human factors causes of accidents is generally poor in a number of ways; such as the sparse inclusion of human factors codes and the lack of understanding of these codes when present.

This chapter has been divided into two sections, the first describes the most commonly used accident causation model (Reason, 1990) which will be used to design a accident reporting form for the offshore oil industry (in Chapter Two). The second section describes the other reporting systems which have used this accident causation model to code accidents ((Wiegmann, 1999); (Hudson, 1994); (Fahlbruch, 1997)) as well as systems not based on the Reason model which have also been used as a basis for the current reporting forms.

1.1 Accident Causation Models

Although to date there are many different accident causation theories and even more investigation systems in use, the accident causation system which has been used the most extensively is that of James Reason (Reason, 1990), based on theories by Rasmussen *et al* (1987) and Donald Norman (1998). The reporting forms developed in this report will be based on Reason's model as described in the following section.

It is now widely recognised in the offshore oil industry that the aim of accident analysis should be extended from focusing only on individuals at the 'sharp-end', to examining the role of organisations up to top-level management in the aetiology of accidents. However, the purpose of this analysis is not to necessarily shift the blame from the sharp-end to the board room, instead it is to make organisations aware that all the detrimental consequences of strategic decisions cannot be completely eliminated. The offshore oil industry, as other complex technological industries, is at the age of the 'organisational accident' (Maurino, 1995), in which pre-existing 'latent' failures arise in the organisational and managerial departments and when combined with local triggering conditions in the work site, can penetrate the defences to cause an accident.

1.1.1 Reason's Accident Causation Model

In order to analyse the causes of accidents, a theoretical framework that can be applied to events is needed. A framework can provide a theoretical basis for both the understanding of the causes of organisational accidents and for the invention of practical remedial actions. For this framework to have credibility, it must lead to improved remediation and prevention of incidents. Maurino *et al* (1995) state that all technological systems have the following common processes: organisational processes, local working conditions and defences, barriers and safeguards which are described below.

Organisational Processes

The 'culture' of an organisation is made up of the attitudes and beliefs that emerge from the way in which the company carries out its core business processes all of which entail decision making at the highest level. These cultural factors take a long time to develop, they are slow to change and their influence is widespread and persuasive. High level decisions are shaped by external economic and political factors and often represent the starting point for various failure pathways (see Mearns (1998) for a detailed description of culture).

Local Working Conditions

The efficiency and reliability of human performance is affected by the conditions in a particular work context. Wherever workers are involved in the core business of the organisation, they are often in close proximity to the local hazards. The negative consequences of the top-level decisions are transmitted along various departmental and organisational pathways to the work site, creating work sites which promote the commission of unsafe acts. Fortunately, only few unsafe acts will penetrate the defences to bring about damaging consequences. Local working conditions can be divided into two interacting groups: those relating to the task and those relating to people's mental and physical states.

Defences, Barriers and Safeguards

These measures are aimed at removing, mitigating or protecting against operational hazards and they consume the majority of resources of organisations involved in potentially dangerous activities. They are so diverse and widespread that it is difficult to distinguish between them and the non-defensive parts of a system.

Failures can occur in either the workplace or in relation to the defences. According to Reason (1990), failures occurring in the work place are mainly 'active' and those which are associated with weaknesses in or absences of defences are mainly 'latent'. Active and latent failures are distinguished by the length of time it takes for them to reveal their adverse effects – where active failures have immediate and direct impact upon the integrity of the system. Latent failures, whose adverse consequences may lie dormant within the system for a long time, only become evident when they combine with other factors to breach the systems defences. *Active errors* are most likely to be caused by front-line operators (e.g. control-room crews, production operators), whereas *latent errors* are more likely to be caused by those who are removed from the direct control interface (e.g. designers, high-

level decision makers, managers, construction workers and maintenance personnel). In most cases, safety programmes are aimed at the operators, at reducing active failures in order to reduce specific causes which are unlikely to occur in the same combination.

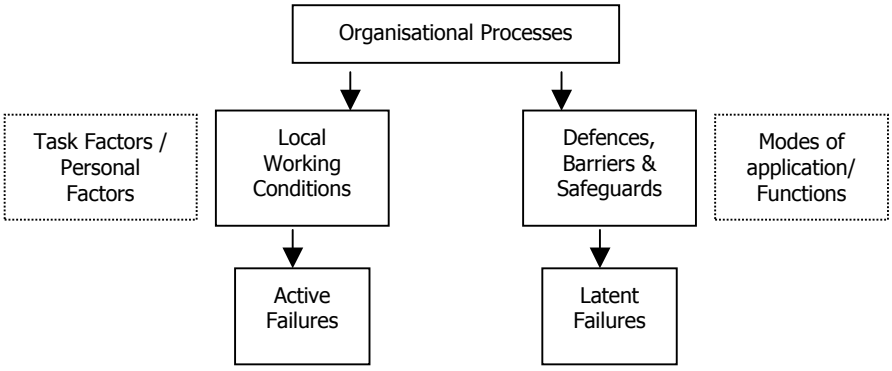


Figure 1.1 – Accident Causation Model (Maurino *et al*, 1995)

1.1.2 Active and Latent Failures

An accident model should consider the involvement of both active and latent failures, which originate from the strategic organisational processes and develop simultaneously within the local working conditions (situation, task, personal) and the system's defences. These interact dynamically to initiate a damaging outcome.

Active Failures

In the past, the three most prominent frameworks which have been used to categorise human error (active failures) accidents are:

1. A traditional model of information processing (Wickens, 1992). This model assumes that a series of stages or mental operations occur between information being first perceived by a person and the person responding. The model isolates and characterises each of these stages: i) perception and attention: involves the association of meaning to sensory stimulation; ii) memory: is where information is retained until its translation into action; iii) decision-making: involves the evaluation of several sources of information, the judgement of probabilities and the value and cost of the decision; iv) selection of action: the speed of responding to unexpected environmental events under stress/ time pressure.

2. A model of internal human malfunction (Rasmussen, 1987). *Rasmussen's Skill-Rule-Knowledge Model* contains three levels of performance, which are now used within the systems reliability community as the market standard. The three levels of performance are: i) skill-based, ii) rule-based and iii) knowledge-based. At the *skill-based* level, performance is governed by patterns of pre-programmed instructions. The *rule-based* level performance applies stored rules (such as if-then rules) to form solutions to. Errors at this level usually occur when situations are misclassified leading to the use of wrong rules or not using the correct procedures. *Knowledge-based*

performance is used in novel situations, where actions are planned on the spot by using stored knowledge and conscious analytic processes. Errors arise when the resources are limited, or there is incorrect or incomplete knowledge. As expertise in an area increases, control of performance moves from knowledge-base towards skill-based levels and all three levels can exist together.

3. A model of unsafe acts (Reason, 1990). *Reason's Generic Error Modelling System (GEMS)*. GEMS is a conceptual framework, used to locate the origins of basic human error types. Reason (1990) based the basic human errors on Rasmussen's three performance levels: i) skill-based slips and lapses, ii) rule-based mistakes and iii) knowledge-based mistakes. GEMS attempts to integrate i) slips and lapses and ii) mistakes, which have, in the past, been two distinct areas of error research. One would expect slips and lapses to stem from unintended activation of automatic and procedural routines and mistakes to stem from failure of higher-order cognitive processes involved in judging the available information. However, both slips and lapses and mistakes can take the same form. At the *Skill-Based* level, performance is without conscious control (after an intention has been stated) and is usually used to deal with routine and non-problematic activities in familiar situations. Distraction or preoccupation can lead to slips and lapses. *Rule-based* and *Knowledge-based* performance are only brought into play after an individual has become conscious of a problem. For an error to occur at this level, attention would not necessarily have to stray far from the problem.

These frameworks, however, do not describe accidents in their entirety, as they do not take into account latent failures, such as supervisory errors, or contextual factors, such as the environment.

Latent failures

According to Reason (1990), latent failures include organisational processes (fallible decisions) and the local working conditions (line management deficiencies and the psychological precursors of unsafe acts). The majority of systems accidents can be traced back to *fallible decisions* made by designers and high-level managers. The adverse consequences of these decisions could be alleviated if line management was competent to do so. However, if line-management is limited by resources, is put under undue time pressure, has inappropriate perceptions of the hazards, is ignorant of the hazards or has motivational difficulties, it is unlikely that they will identify these problems. In this case, *line-management deficiencies* could result in a management failure (such as deficient training) revealing itself as a human error (such as carrying out a task incorrectly). However, if the management failure had been rectified, the task may have been carried out correctly.

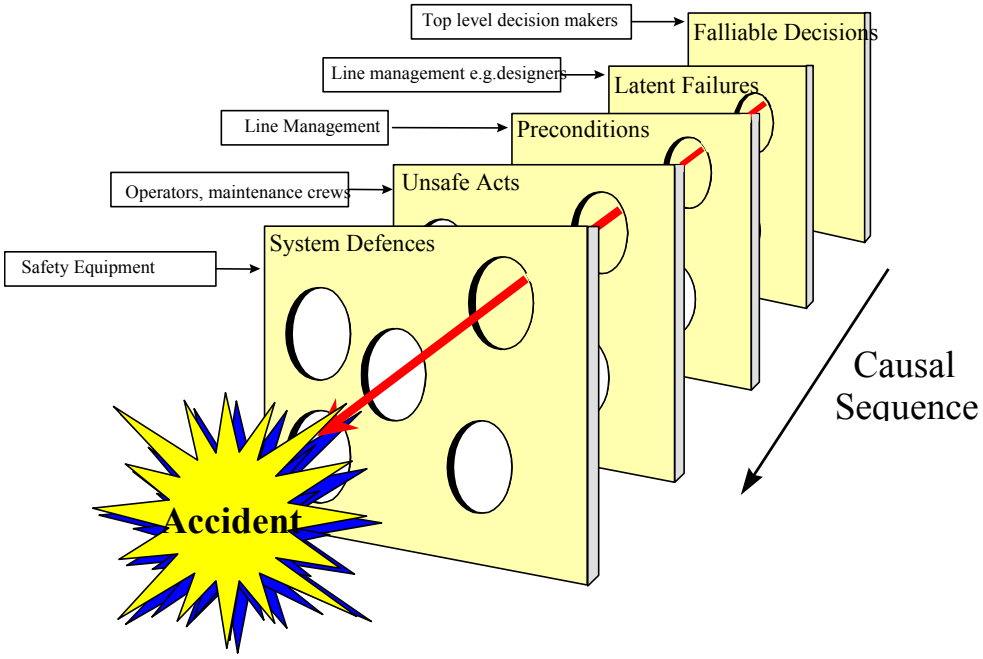


Figure 1.2 - The Five Stages in the Accident Causation Sequence (Reason, 1990).

The *psychological precursors for unsafe acts* are dependent on the task under completion, the environmental influences and whether or not there are hazards present. These *psychological precursors* are latent states which can play a significant role in encouraging and shaping a large set of unsafe acts. An unsafe act can only be defined in relation to the presence of particular hazards and therefore acts, such as not wearing ear protectors or a hard hat, are only unsafe when they occur in a potentially hazardous situation (i.e. in a noisy environment, or when objects are likely to fall from above). At the lowest level of *safety defences*, Personal Protective Equipment (PPE) for the work force and guards for preventing direct contact with dangerous materials can help prevent injury, while at the other extreme, there are control room operators and automatic safety devices. The various levels of defence can really only be breached by many causal factors occurring simultaneously, some of which will be latent failures while others will be triggering events. The practical application of this theory is described later in this chapter.

Latent failures have been classified by Maurino *et al* (1995) in terms of their function (i.e. the level of vulnerability) and their mode (i.e. types of defences, barriers and safeguards). Using a matrix to plot the modes and functions, it is possible to classify latent failures in an organisation in general and with regard to specific incidents. However, the matrix is confined to a particular organisation and does not take external factors (such as external regulation) into consideration.

The following section reviews and evaluates accident causation models developed for industry in order to gather relevant information for the development of an accident reporting system which would contain psychological factors.

1.2 Accident Reporting and Investigation Systems

There is currently much research (particularly in the aviation industry) into the development of models of accident causation (such as ADAMS, Aircraft Dispatch and Maintenance Safety). Reporting systems which have used Reason's model to base their accident investigation on include HFACS (Human Factors Analysis and Classification System), Tripod, ADAMS and SOL (Safety Through Learning) and are discussed below. Investigation systems which are not based on Reason's Model but have been used for the development of the current reporting form are discussed at the end of the section: HPIP, IRS and HFRP.

1.2.1 Human Factors Analysis and Classification System (HFACS)

HFACS was developed using over 300 Naval aviation incidents obtained from the U.S. Naval Safety Center and has since been refined using data from other military (U.S. Army Safety Center and the U.S. Airforce Safety Center) and civilian organisations (NTSB and FAA) (Wiegmann, 1999). This system is based on Reason's model of active and latent failures, which have been organised under four types of failure: I) unsafe acts, ii) preconditions for unsafe acts, iii) unsafe supervision and iv) organisational influences.

Unsafe Acts

Unsafe acts have been divided into errors and violations, where errors represent the activities of individuals who fail to achieve their intended outcome and violations refer to the non-compliance to the safety rules and regulations. These unsafe acts are further divided to provide more detailed information for investigations, where errors can be either skill-based, decision-based or perceptual, and violations can be either routine or exceptional. *Skill-based* errors are particularly vulnerable to attention (e.g. distracted, preoccupied, to focus on one thing) and/or memory failures (e.g. omitted items in a checklist, place losing, forgotten intentions) and also aptitude of person. *Decision errors* (or *Rule-based errors*) occur during highly structured tasks where the intentional behaviour proves to be inadequate or inappropriate for the situation (e.g. procedural, poor choices and problem solving). *Perceptual errors* refer to the situation where the sensory information is unusual and the brain tries to 'fill-in the gaps'. *Routine violations* tend to be habitual and often tolerated by supervision (Reason, 1990) and *exceptional violations* appear as isolated departures from authority that are not necessarily typical of the individual's behaviour nor tolerated by management.

Preconditions for Unsafe Acts

The pre-conditions for unsafe acts have been divided into two categories: *substandard conditions of operators* and *substandard practice of operators. Substandard conditions of operators* are further divided into Adverse Mental States (e.g. situational awareness, task fixation, mental fatigue, personality traits such as overconfidence and complacency and attitudes), Adverse Physiological States (e.g. medical/physiological conditions, physical fatigue) and Physical/Mental Limitations, where the task requirements exceed the capabilities of the operator (e.g. visual system severely limited at night,

time pressure, operator does not have the physical strength to do job). *Substandard practice of operators* are further divided into Crew Resource Mismanagement (e.g. poor communication skills, team co-ordination and leadership) and lack of Personal Readiness (e.g. operator fails to prepare physically or mentally for duty).

Unsafe Supervision

At the next level of defence, unsafe supervision has been divided into four categories: inadequate supervision, planned inappropriate operations, failure to correct a known problem and supervisory violations. *Inadequate Supervision* includes the inadequate provision of: guidance, training opportunities, leadership, motivation and proper role model. *Planned Inappropriate Operations* is when the operational tempo or scheduling of work is such that individuals are put at unacceptable risk and performance is adversely affected. (e.g. inadequate brief time and crew composition). *Failure to correct a known problem* is when deficiencies, such as among individuals, equipment and training, are known to the supervisor yet are allowed to continue (e.g. failure to report unsafe tendencies). *Supervisor Violations* are when the existing rules and regulations are disregarded by supervisors (e.g. failure to enforce rules and regulations).

Organisation

The top level of defence is the organisation. This section has been divided into three categories: resource management, organisational climate and operational processes. *Resource Management* refers to corporate-level decision making regarding the allocation and maintenance of organisational assets (human resources, monetary/budget resources and equipment/facility resources*). Climate* is the working atmosphere within the organisation, which is reflected in the Structure (e.g. the chain-of-command, delegation of authority, communication channels and formal accountability for actions), Policies – the official guidelines that direct management's decisions (e.g. hiring & firing, promotion, use of safety equipment and accident investigations) and Culture – the attitudes, values, norms and beliefs which a particular group of people share with respect to risk and safety. *Operational Process* refers to the corporate decisions and rules that govern the everyday activities within an organisation, including: Operations (e.g. operational tempo, time pressure, incentives), procedures (e.g. standards, clearly defined objectives) and Oversight (e.g. risk management and safety programmes).

This system bridges the gap between theory and practice by providing investigators with a comprehensive tool for identifying and classifying the human causes of aviation accidents. To date it has been applied to the analysis of approximately 1,000 military aviation accidents (in the U.S. Navy, Marine Corps, Army, Air Force and Coast Guard) and the tool has been repeatedly tested for its reliability and content validity. Wiegmann (1999) have found that the HFACS framework has helped to identify global human factors safety issues (e.g. trends in aircrew proficiency), specific accident types (e.g. controlled flight into terrain) and human factors problems (such as CRM failures). The system has allowed the U.S. Navy/Marine Corps to develop objective, data-driven intervention strategies.

1.2.2 Tripod (BETA and DELTA)

Tripod is a name used to describe a theory of accident causation that has been developed by Manchester (Reason and colleagues) and Leiden (Hudson and colleagues) Universities, from research they have carried out over the past decade into the contribution of behavioural factors in accidents (described in Section 1.1). Two tools developed by the Royal Dutch/Shell Group to measure safety and investigate accidents based on the Tripod theory are Tripod-BETA, which is a retrospective tool for use in accident investigations, and Tripod-DELTA, which is a pro-active tool that can be used to identify latent failures in the organisation.

The Tripod-BETA tool is a methodology for conducting an accident analysis in parallel with (as opposed to at the end of) the investigation; highlighting avenues of investigation leading to latent failures and assigning GFT categories to latent failures.

The Tripod-DELTA tool is a methodology for identifying weaknesses in the Safety Management System; providing a pro-active tool for planning Safety management actions; getting workforce involvement in the identification of weaknesses and planning of corrective actions; and development of root cause thinking to promote a learning organisation.

Theoretical Background

Tripod takes its name from three key aspects of accident causation, represented as a three-footed diagram (Figure 1.3), which represents the association between latent failures, unsafe acts and accidents. The purpose of Tripod is to 'capture' the underlying causes of accidents. It acknowledges that human error often features as a trigger to incidents (unsafe acts), however it highlights that organisational deficiencies may also have contributed to these errors or magnified the consequences (latent failures).

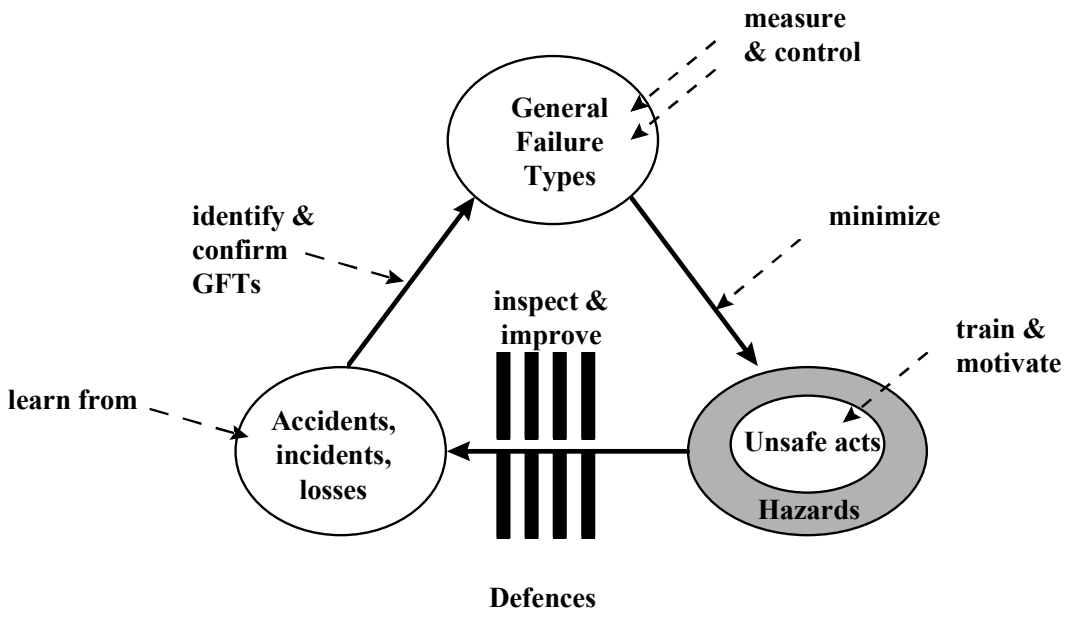


Figure 1.3 - The three 'feet' of Tripod: General Failure Types, unsafe acts, negative outcomes (Shell, 1997).

Accident investigation studies carried out across Shell, have led the researchers at Leiden and Manchester Universities to classify latent failures in terms of 11 General Failure Types (GFTs) :

1. Hardware - where the failures are due to inadequate quality of materials or construction, non-availability of hardware and failures due to ageing (position in life cycle)

2. Design – where the deficiencies are in layout or design of facilities, plant, equipment or tools that lead to misuse or unsafe acts, which increase the chances of particular types of errors and violations

3. Maintenance management - where there are failures in the systems for ensuring technical integrity of facilities, plant equipment and tools

4. Procedures – where procedures are unclear, unavailable, incorrect or otherwise unusable standardised task information that has been established to achieve a desired result

5. Error-enforcing conditions - where factors such as time pressures, changes in work patterns, physical working conditions acting on the individual or in the workplace encourage the performance of unsafe acts (errors or violations)

6. Housekeeping - where tolerance of deficiencies in conditions of untidiness and cleanliness of facilities and work spaces or in the provision of adequate resources for cleaning and waste removal increase the chances of unsafe acts

7. Incompatible goals - where there is a failure to manage conflict: between organisational goals (such as safety and production); between formal rules (such as company written procedures and the rules generated informally by a work group); between the demands of individuals, tasks and their personal preoccupation or distractions.

8. Communication – where there are failures in transmitting information that is necessary for the safe and effective functioning of the organisation to the appropriate recipients in a clear and unambiguous or intelligible form. Transmission failures indicate that the necessary communication channels do not exist or the necessary information is not transmitted.

9. Organisation - where there are deficiencies in either the structure of a company or the way it conducts its business that allow safety responsibilities to become ill-defined and warning signs to be overlooked.

10. Training - where there are deficiencies in the system for providing the necessary awareness, knowledge or skill to an individual or individuals in the organisation. In this context, training includes on-the-job coaching mentors and supervisors as well as formal courses. Awareness refers to the process of understanding the hazardous conditions present at the worksite.

11. Defences - are failures in the systems, facilities and equipment for control or containment of hazards or for the mitigation of the consequences of either human or component failures. These comprise: detection/alarm; control and interim recovery; protection/containment and escape.

Some of the GFTs cover the underlying structure and organisational/safety culture of the organisation (e.g. incompatible goals and organisational failures) while others assess the current quality of its specific function (e.g. design, maintenance or procedures). Work is currently being carried out to further validate these GFTs.

Tripod-BETA

Tripod-BETA is a structured 'tree' approach to the analysis of accidents and incidents based on the Tripod Theory of Accident Causation (described above) and the Hazard Management Process. The analysis is divided into three distinct phases, and the completion of each phase provides a logical 'tollgate' that can be used to verify the scope and breadth of investigation.

Three Phases of Investigation and Analysis

1. The first phase involves initial data gathering of the facts concerning the event and its consequences and developing a Core Diagram. The core model of a Tripod-BETA tree describes the incident mechanism in relation to hazards, targets and events in cause-effect terms. The basic building block is a hazard, target and event 'trio' (see Figure 1.4). A *hazard* is the agent of harm, which causes the harm or change of state; the *target* is the object of harm which is damaged or changes state, and the *event* is an occurrence where the hazard and target combine to result in an accident (harm) or near miss (potential for harm). Harm is the undesirable change of state. Normally around 3 to 5 of these trios are needed to fully describe an incident. The purpose of this diagram is to understand the conceptual pathways which join hazards and targets with events.

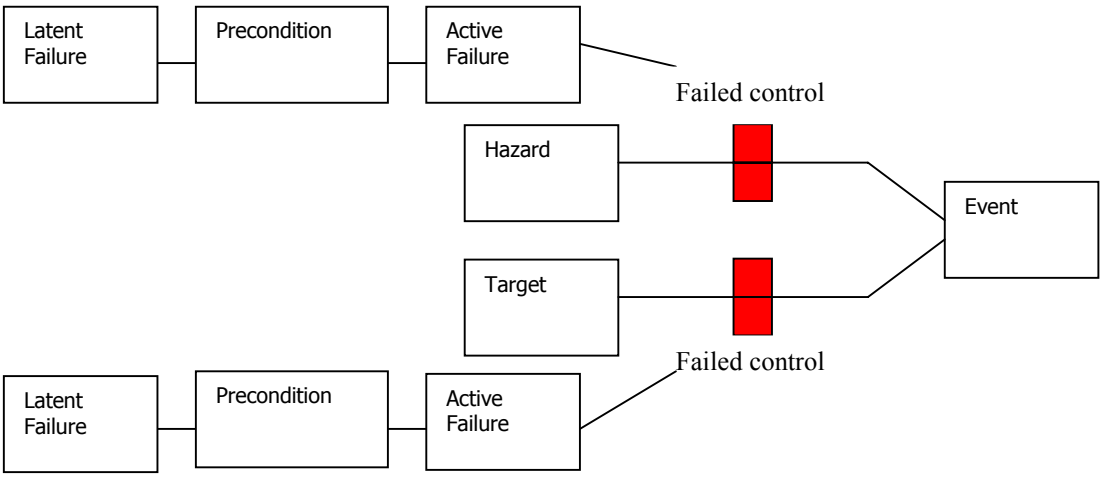


Figure 1.4 – Tripod-BETA Basic Tree (Core Diagram) (Doran, 1996)

2. The second phase is to examine the circumstances of the incident to identify what hazard management measures (controls and defences) failed (see Figure 1.4). Failed or missing hazard

management measures are added to the core model of the Tripod-BETA tree (see Figure 1.4). At this stage, trigger events and the other controls and defences that were rendered ineffective beforehand are identified. The next stage of the investigation is to find out why the various failures occurred, tracing backward to identify the underlying or latent failures.

3. The third phase aims to identify the underlying causes of the incident. The Tripod-BETA tree is completed by plotting causal paths for each failed or missing hazard management measure, leading from immediate failures to underlying causes. Tripod theory emphasises that active failures do not occur in isolation but are influenced by other external factors, such as organisational or environmental preconditions. Causes behind each control and defence failure are examined, many of which originate from failures elsewhere in the business often in decisions or actions taken by planners, designers or managers remote in time and location from the front line of operators. This generates an investigation into the paths from each active failure to one or more latent failures. The Tripod model, while acknowledging that human error often features as a trigger to incidents, indicates that organisational deficiencies may have contributed to these errors or magnified the consequences. This model is a simplification of an event which is designed to give an investigation team a mental picture that helps them recognise relevant facts and likely sequences of events.

Tripod-DELTA

Tripod-DELTA is a pro-active tool which functions by taking a 'safety health check' of an organisation by posing questions (called 'indicator questions') which are tailor-made for the operation in question. (DELTA stands for: Diagnostic EvaLuation Tool for Accident Prevention). The following section describes the methodology by which Tripod-DELTA is carried out, under the following five headings: (i) questionnaire development, (ii) questionnaire completion, (iii) development of GFT Profile, (iv) development of action plans and (v) the technical robustness of Tripod-DELTA.

Questionnaire Development

Each GFT contains a pool of indicators questions which refer specifically to that GFT topic area. Indicator questions have been developed over the years by personnel working on offshore installations and can either be answered 'yes' or 'no'. There are two methods by which facilities can develop their questionnaire: (1) formulation of the facility's own questions or (2) using a set of previously calibrated questions. During a review of Tripod-DELTA, carried out by an independent group contracted by Shell (Shell, 1997), interviews were undertaken with personnel who had been involved in the Tripod-DELTA process. It was found that facilities who had generated their own questions often found it to be an onerous task, but also an important one, such that the questions were customised for their specific site. The problems which have been faced by Tripod-Delta, are not ones of a theoretical nature, instead they are methodological (see section under Technical Robustness for more details). However, one of the plans for Tripod-DELTA is that only calibrated questions will be used.

Questionnaire Completion

After the development of the questionnaire, additional personnel from the facility are asked to complete it. Up until recently, the majority of answering sessions involved six to eight personnel who were from different departments and were from a cross section of levels (both supervisors and workforce were involved) who completed the questionnaire as a group (i.e. a consensus was reached). The main methodological concern with answering the questionnaire in a small group is that the result is likely to be biased. During discussions with the members of the workforce who had been involved in these sessions, the majority mentioned that they felt intimidated to speak their mind when their supervisor or manager was also in the group. The workforce commented that the answers usually tended to reflect the supervisors opinions rather than those of the group. Supervisors in the group sometimes mentioned that they also found it difficult to answer the questions completely honestly as their motivation was toward obtaining a 'positive' GFT Profile.

Generation of GFT Profiles

After the questionnaire(s) have been completed, GFT Profiles are produced by summing questions within each GFT (via computer programme). From the discussion groups, personnel generally found the profiles quite interesting, however, were less sure as to what to do with them and what exactly they meant. The workforce sometimes felt that the results of the profiles were not meaningful, which gave them less faith in the tool's ability to successfully measure the level of safety.

Action Plan Development

After producing a GFT Profile, the next stage involves the development of an action plan taking the GFT Profile into account. The three most problematic GFTs are examined in more detail and used to produce an action plan. The objective of the exercise is to define approximately three areas of improvement for each GFT and to put corrective actions into place. This process involves 'brainstorming' by a selection of the answering group (line and management personnel) and each item for improvement follows the format: '*what* the action is?', '*when* it will be completed by?' and '*who* is responsible for its completion?' This part of the Tripod-DELTA process gave rise to numerous comments regarding the difficulty of devising action plans based on the problem GFTs. Some members of the workforce who were involved in developing action plans felt intimidated to come up with suggestions, as they felt that they were not knowledgeable in the particular areas that were being focused on and because they were afraid that they would have to see the plan to the end.

Technical Robustness of Tripod.

Repeatability and robustness are essential requirements for the GFT profiles resulting from running the questionnaires if the profiles are to be trusted and used as the basis for action planning and for monitoring performance. A close look at the validity and reliability of the results is therefore required. This is partially underway by Shell and tests to demonstrate re-test repeatability have been carried out on an offshore installation. However, due to sampling size issues, these tests have not statistically demonstrated repeatability although the GFT profiles produced showed a large degree of consistency.

A more rigorous analysis is therefore required to give Tripod sufficient predictive and evaluative power.

The current guidelines for the implementation of Tripod recommend the use of a single questionnaire that is answered collectively by a group of people. Experience during Tripod implementation suggests that this approach does not provide reliable results as the group answers can be influenced by supervisors or other strong individuals. To address this, the guidelines are being modified to recommend that separate questionnaires are issued to all parties involved and they answer them individually.

1.2.3 Aircraft Dispatch And Maintenance Safety (ADAMS)

An accident reporting system which was funded by the European Commission to provide an integrated safety management system for aircraft maintenance and dispatch (ADAMS Project[1]) (ADAMS, 1998), was developed because of a growing number of maintenance related accidents. These accidents can partly be attributed to the increasing volume of air traffic, the complexity of advanced technology in newer generation aircraft and an ageing world fleet. Error reporting systems which are currently used in the aviation industry do not produce the depth of information needed to address and identify the root causes and factors contributing to the maintenance error. Thus the necessity of a structured framework for identifying and classifying human error in the aircraft dispatch and maintenance field has been emphasised. The aim of the project was to develop a framework for a generic human factors safety management system for aircraft maintenance activities, increasing error tolerance through improved systems for error identification and analysis.

Two approaches which are used to address problem factors include a reactive approach, where the causes of accidents and near-misses can be identified in order to prevent recurrence, and a pro-active approach, where the normal activities of a system can be periodically monitored and the level of safety assessed in order to identify potential malfunctions in advance and advise on preventative actions. It has been postulated by McDonald (1998) that accidents and incidents do not provide enough information to adequately assess safety at a site/system. Therefore for a more reliable picture of safety, accident analysis needs to be complemented with the analysis of the system's normal activities. The work programme included not just the development of a human error taxonomy but also a study of the information support systems available to the maintenance engineer and the human factors of task procedures and operational requirements.

A structured framework for identifying and classifying human error in maintenance and dispatch operations was developed, allowing practical understanding of human error in maintenance. In order to develop the error tool, accident and incident data were analysed from existing databases and auditing

[1] Trinity College Dublin, British Airways Engineering, DERA, Joint Research Agency, National Aerospace Laboratory, Scandinavian Airlines System, TEAM, Airbus and Sabena

systems and risk areas and causal contributory factors leading to the development of improved classification schemes were identified. The taxonomy adopts a traditional approach to human error identification, incorporating three broad classifications of: External Error Modes (EEMs); Performance Shaping Factors (PSFs) and Psychological Error Mechanisms (PEMs). There are five sections to the reporting form: (i) General Information; (ii) Erroneous Performance, (iii) External Factors Influencing Performance, (iv) Internal Factors Influencing Performance and (v) Narrative Description.

Section 1. General Information

This section addresses descriptive and background information related to the occurrence and to the events which contributed to the occurrence itself. It is divided into three sections: **Part A, Background Information** is devoted to general information related to the Airline and the aircraft involved in the occurrence. The analyst who fills in the report is identified as well, so that he/she can be contacted in case of further analysis about the same occurrence. **Part B, Occurrence** describes where and when the incident happened and what the consequences were. The local and temporal setting of the occurrence, the operational consequences and the nature of fault are reported. **Part C, Event/s**. This area considers the different errors and events which lead to the occurrence. This is looking back to when the different events happened and is particularly relevant in the maintenance domain, because maintenance errors are often not identified at the time error is made.

Section 2. Erroneous performance

This section focuses on how the events manifested themselves and addresses the erroneous actions which were involved in the events. It contains three sections: **A: General Erroneous Performance** captures the phenomenological aspects of the error, with no attempt to interpret its causes/contributory factors. The focus is on the 'active error' of each event, and not on the causes. **B: Specific Erroneous Performance: Aircraft system and parts** records the phenomenological appearance of the error, but goes much deeper in the description of the error itself. **C: Specific Erroneous Performance: Documentation** refers to erroneous performance related to information and documentation.

Section 3. External Factors Influencing Performance

This section refers to the factors which contributed to the erroneous performance. In particular, it focuses on External Factors Influencing Performance. Here the person or people who were involved in the initial causes need to provide information so that this section may be completed. Other people who support operations may also need to be asked about their involvement in the occurrences leading up to the event. The section is divided into 5 sections: **A: Task Factors** looks at the completion of the tasks that lead to the occurrence: how familiar the task was to the person and characteristics of the task. It records the features of the task that influenced negatively the performance and contributed to the error. A task, for example, could be characterised by being very repetitive; in some circumstances, this monotonous aspect of the task could contribute to promote an error. **B: Task Support** looks specifically at the supporting tools for the tasks that influenced negatively the performance and contributed to the error. These should be considered for how they were used at the time of the

operations, which lead to the occurrence. The categories look at Tools and Equipment, Documentation and Procedures, Technology and Parts. **C: Environmental Factors** also addresses the factors which influenced negatively the performance and contributed to the event, but it focuses on the factors related to the environment, such as 'Weather' and 'Floor/Ramp Surface', and considers the human position required for a task. **D: Socio-Organisational Factors** addresses latent errors at socio-organisational level (managerial level) which led or contributed to the event and it helps in identifying broader possible corrective actions. Example: Training (insufficient training contributed to event), Communication (poor communication practices, lack of communication tools, …), etc. **E: Personal Factors** refers to event contributing factors that are related to the person(s) involved in the event. Examples: physical/mental state.

Section 4. Internal Factors Influencing Performance

This section is about Internal Factors Influencing Performance. It mainly refers to the "Psychological Error Mechanism", i.e. the human cognitive process through which the error took place, and consists of the following areas: Attention Failure, Detection/Perception Failure, Memory Failure, Interpretation Failure, Judgement Failure, Assumption, Execution Failure, Rule violation. The factors refer to basic thought, and how normal thought processes may have affected the task.

Section 5. Narrative Description

This section of the form gives the investigator an opportunity to explain the events and occurrences in his/her own words. The narrative description highlights the temporal sequences and logical relations among the different events and factors involved in the occurrence. Any comments may be written in the section whether or not they have already been covered in the form.

1.2.4 Safety through Organisational Learning (SOL)

SOL, which has been developed by the Research Centre of Systems Safety of the Berlin University of Technology in co-operation with TÜV Rheinland, is an event analysis approach which is based on concepts of the socio-technical systems approach (STSA) and theoretical assumptions about accident causation (Fahlbruch, 1997). SOL conceptualises the safety and reliability of NPP as performance outputs of the total system which includes: technology, humans (including individuals and groups/teams), organisation and external environment. It is based on Reason's (Reason, 1990) theory, where events are considered to result from complex interactions of systematic weaknesses, technical failures and human errors, resulting in breakdowns of defence where more than one failure will be required to produce an incident. Event analysis consists of reconstructing the event from known consequences to identify contributing factors. SOL postulates that together with event analysis (Figure 1.6), a database is needed to collect, analyse and make accident data accessible to an organisation.

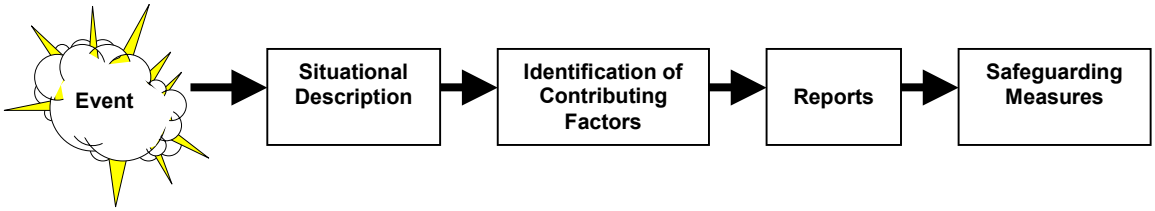


Figure 1.6 - Process of event analysis

SOL proposes that event analyses are conducted by a qualified team of NPP personnel with various backgrounds and operative experience in order to minimise cognitive bias. General guidelines are available for the team to use which will help to exploit their expert knowledge and creativity. People who are immediately involved in triggering and supervising the event should also be involved initially in order to maximise the insights into event episodes and to facilitate immediate learning opportunities for them. SOL favours a standardisation of the event analysis process rather than the standardisation of the itemised content categories of the analysis. This system is not designed to investigate all accidents and near misses, only those which could provide a significant learning potential.

Six instruments were designed to aid the event analysis and to ensure its standardised conduct which are described below:

Event description

1. *Guideline for situational description*. The event is broken down into a sequence of steps, no contributory factors are identified at this stage. The guideline serves as an aid for analysing and describing the situation in which the event occurred, where the situation is broken down into single acts regarding the content and form of the description and about sources of information. It also comprises questions and hints for describing the situation and for charting graphically the course of actions taken in the event. The situational description serves as an information source for the subsequent event analysis.

Identification of contributing factors

2. *Guideline for sequence of event analysis steps*. At this stage every single act specified in the description of the event should be analysed by asking the question "why?". The graphical chart is developed further by adding all the contributing factors

3. *Aid for identification of contributing factors*. The identification aid was developed by deriving contributing factors from a theoretical viewpoint and by gathering empirical data. All contributing factors were grouped in accordance with the five subsystems which contribute to safety (technology, individuals, groups/teams, organisation, external environment). All possible contributing factors are then transformed into general questions, such as the factor 'working conditions' was transformed into the question: 'could there have been an influence of the working conditions on the operator performance?' Examples of answers for each of the general questions are given which can assist in stimulating the problem solving process. For example, for the influence of working conditions 'noise, heat, time pressure, disturbances' are given but are not meant as an exhaustive list. The analysis is not concluded until more than one contributing factor is found.

Reporting

4. *Guideline for event description*. This guideline serves as an aid for the composition of the event description, which provides the basis for the NPP's internal organisational learning.

5. *Guideline for event reporting*. This guideline serves as an aid for the event report addressed to the regulatory bodies or to the national nuclear industry, and ensures standardisation of the reports and contains information regarding the role, form and writing of an event report.

6. *Guideline for descriptors*. This guideline serves as an aid for the allocation of descriptors, which contains information about the classification of contributing factors for later statistical analysis.

Where SOL differs from other investigation methods is that its emphasis is on the problem solving process, where comprehensiveness is reached by the standardisation of the process of analysis and consideration of 5 subsystems as well as leaving sufficient space for human factors experts' problem solving and creativity. Without a comprehensive list of possible causes to base the accident analysis on, it is possible that investigators may overlook certain causal aspects and that inconsistencies between different investigators could occur.

1.2.5 Human Performance Investigation Process (HPIP)

Human Performance Investigation Process is a standard investigation process for use by NRC (Nuclear Regulatory Commission) for investigating human performance related events at nuclear power plants. It was developed by Paradies, Unger, Haas and Terranova (1993) and combines current procedures, field practices, expert experience, NRC human performance research and relevant investigation techniques. The structure of HPIP consists of six main 'modules' of potential human performance failures: 1. Procedures, 2. Training, 3. Verbal Communication, 4. Organisational Factors, 5. Human Engineering and 6. Supervision. Under each of these main 'modules' exist further detailed 'Near Root Causes' which are further divided into 'Root Causes'. The method by which investigators gather information regarding the human performance root causes consists of five steps:

Preliminary Analysis

Preliminary analysis of the event involves developing an E&CF (Events and Causal Factors) Chart of the sequence of events that led to the incident by using information obtained during notification and reports. In addition to the E&CF Chart, a set of basic questions, presented as a "yes/no" logic tree, are to be answered by the investigator to ensure that the breadth of contributors are considered. These questions are listed under the following headings: Stimulus, Operation, Response, Team Performance and Management (SORTM), which highlights the areas of human performance needing further analysis.

Witness Interviews

Interviews with personnel involved in the incident, relevant supervisors and managers, relevant technical experts and training personnel are then undertaken. The collection of technical data, diagrams, photographs, broken equipment and information on environmental conditions would be collected at this stage, so that a more detailed E&CF Chart can be drawn.

Barrier Analysis

To identify the barriers which may have prevented the incident, 'Barrier Analysis' is carried out which entails that the following five questions are asked: 1. What physical, natural, human action and/or administration controls are in place as barriers to prevent this accident? 2. Where in the sequence of events would these barriers prevent this accident? 3. Which barriers failed? (which is recorded on the E&CF Chart) 4. Which barriers succeeded? (record on the E&CF Chart) 5. Any other barriers which may have prevented this accident?

Change Analysis and CHAP

To evaluate whether or not a change in the status of the system, process, procedure or method between the last time the work was completed successfully and the time when the work caused an accident/incident, 'Change Analysis' is undertaken. A human factors technique of task analysis (Critical Human Action Profile (CHAP)) can be used when the sequence or causes of an event are not well understood.

Root Cause Analysis

In order to analyse the root causes, investigators are asked a set of general questions to assist them in determining any human performance contributions. The authors state that not necessarily every possible root cause contribution will be addressed, 90% of the contributors have been designed to be captured. Additionally, the guidance notes suggest that it is possible that more than one root cause to an event is possible. After the investigator has decided on the specific areas for further analysis (from SORTM and E&CF Charting), the investigation modules for those areas (e.g. Procedures) would be completed. At the beginning of each of the six HPIP 'Modules', an introductory guidance section is included (i) information regarding the documents and resources for each module; (ii) the NRC contact for that area; (iii) references for more details on investigation tools; (iv) definitions of words used throughout each module; (v) list of the investigation tools required for that module; (vi) a discussion of the human performance failure in general terms and guidance on how to proceed when faced with certain circumstances; and finally (vii) the root cause branches for each HPIP.

HPIP Modules

Each HPIP Module is structured hierarchically, where between two and five 'Near Root Causes' (e.g. Procedure Not Used) are initially chosen by the investigator due to their relevance to the incident. A Near Root Cause Screening Question (sometimes more than one) is posed regarding each Near Root Cause, in order to determine whether or not it is a contributory factor. If the answer is affirmative, the

investigator is then asked a list of questions regarding each of the Root Cause items to determine whether to eliminate them or highlight them as the root causes. The content of each of the modules contains:

1) Procedures: not used; followed incorrectly; wrong/incomplete

2) Training: no training; understanding less than adequate,

3) Communication: misunderstood verbal communications; no communication or not timely; turnover (handover) less than adequate,

4) Management Systems: standards, policies or admin controls (SPAC) less than adequate; SPAC not used; management attention and oversight; corrective action; employee communication/organisational culture less than adequate,

5) Human Engineering: human-machine interface; work environment; complex system; non-fault tolerant system,

6) Immediate Supervision: preparation; supervision during work.

The complexity of this system would imply that it is to be used mainly by experts in incident investigations or personnel trained in the HPIP technique and would only be used for more serious incidents and accidents. Overlaps between HPIP modules on certain Root Causes are often detailed in the 'screening questions', and directions are given on which other relevant modules to investigate. This problem is highlighted in the 'Communication' Module, where communications between certain members of the crew are listed not under Verbal Communications, rather under Supervisor and Organisational Factors. Since the process of investigation is directive, fairly standardised data could be obtained, although there is not much room for very detailed analysis. Under certain sections, more categories would give investigators the chance to analyse the event in more depth. Although the system is directive in methodology, there is some flexibility given to account of possible differences between plants. For example, one section which should be further developed is: "Turnover (handover) Less Than Adequate" (a Communication Near Root Cause), where the only question asked was: 'Did incorrect, incomplete or otherwise inadequate turnover of information during shift / watch relief contribute to or fail to prevent the event?'.

'Organisational culture' has been included in this incident reporting procedure and is one of the first attempts to be included in accident investigation procedures in general as a Root Cause. This category includes workers' attitudes which is of particular interest although is only briefly refered to and could be developed further by using the work undertaken by Mearns *et al* (1998). Under the module: 'Supervision', the Near Root Cause category 'preparation' provides a comprehensive section on the supervisors role in the selection of workers for a job has been developed. Under the Near Root Cause category: 'supervision during work' however, the questions are often too complex. A topic which has only recently been taken on in the nuclear industry, but has been included in the aviation safety

literature for a decade or more, is 'assertiveness'. Only one question was included in this system which deals with Crew Teamwork. It has the potential for further developments and further questions should be included on this subject in the future. Although the system covers a wide and important list of categories it is by no means a comprehensive listing. Not only is it limited by the number of categories, more specific detail in some areas could help investigators uncover more accurate root causes.

Once the root causes are determined, those causes which could be programmatic of the whole system are considered in terms of how frequently they have occurred in the past and whether or not other procedures have this problem.

1.2.6 Incident Reporting System (IRS)

This reporting system is jointly operated by IAEA (International Atomic Energy Agency) and NEA (Nuclear Energy Agency) of the OECD (Organisation for Economic Co-operation and Development) and was developed in co-operation with WANO (World Association of Nuclear Operators) (NEA, 1998). The main aims of the system, which were to retrieve lessons learned on an international scale, were hampered due to problems with the system, such as deficiencies of quality, consistency and completeness of information in the identification of causes relating to human performance. A 'Taskforce on Human Factors' was set up to improve the IRS by identifying types and details of information on expected human and organisational factors and to improve the current IRS coding system with regard to the coding of human errors, human and organisational factors. The system was designed to be used by human factors non-experts and was set out in two formats: (i) a limited list of human and organisational factors codes and (ii) a longer list of keywords that described categories in the shorter list in more detail. The types of information in the form were:

1. Human Factors: Human error types are identified based on Norman's error categories: slips/lapses; mistakes; violations and an additional category of sabotage.

2. Inadequate Human Action: This section describes the type of (i) plant staff involved: maintenance, operations, technicians/engineers; management/administration; and (ii) activity: e.g. normal operations, shutdown operations; equipment start-up.

3. Human Performance Related Causal Factors: This section includes the following categories: verbal communication; personnel work practices; control of task; complacency/lack of motivation; personnel work schedule; use of improper tools; environmental conditions; man-machine interface; training/ qualification; work organisation (shift team size or composition; planning/ preparation of work); personal factors (fatigue; stress/ lack of time/ boredom; skill/ not familiar with job performance standards).

4. Management Related Causal Factors And Root Causes: This section includes the following categories: management direction; communication/ co-ordination; management monitoring and

assessment; decision process; allocation of resources; change management; organisational/ safety culture; management of contingencies.

5. Equipment Related Causal Factors and Root Causes: This section includes the following categories: design configuration and analysis; equipment specification, manufacture and construction; maintenance, testing or surveillance.

6. Recovery Actions And Lessons Learned: This section includes the following recovery actions by: human action (effective actions taken by plant staff in response to equipment failures, inadequate human actions in order to terminate the event); foreseen human actions (recovery actions which are directed by operating procedures); unforeseen human actions (recovery actions in response to observed failures; errors etc which are not prescribed/ directed by operating procedures/documents).

The IRS system covers a comprehensive list of human and organisational factors. One problem with the IRS system is that the topic areas are structured very broadly (only 3 human factors categories) thus making it time-consuming and difficult for non-expert investigators to extract the codes relevant to the incident.

1.2.7 Human Factors Reporting (HFR) Programme

The Human Factors Reporting (HFR) programme is one of three parts to the British Airways Safety Information System, BASIS (O'Leary, 1999). BASIS also includes SESMA (Special Event Search and Master Analysis) - which monitors the Flight Data Recording (FDR) for operational events that lie outside safe norms - and ASR (Air Safety Reporting programme) - which is a system by which staff can report anything that could have safety implications, which extends beyond those required by the CAAs Mandatory Occurrence Reporting Programme. The Human Factors Reporting (HFR) programme is a confidential incident reporting system which is based in the Safety Services Department and is run by line pilots specifically trained in human factors. Issues which are raised in this programme are communicated to line management on a regular basis and care is taken to separate the issues from the incidents to safeguard the identity of the reporters. Only the analysts know the names of the personnel reporting incidents.

Each time that an ASR is filed, crew members involved in the incident are sent a reply and a Human Factors questionnaire. The HF questionnaire asks how and why the event occurred and how the crew coped with the situation or solved the problem. Further information about the event is collected through 'callout' where the analyst telephones the respondent (who voluntary identified themselves) to confirm understanding of the incident and to elicit more information where possible. By talking to the respondent, ambiguities can be clarified.

The aim of this system is to obtain a complete understanding of the sequence of cause and effect. Insight into a particular problem can be obtained by reading individual reports or groups of reports,

however a much clearer picture of the underlying causal factors can be gained from a more analytic approach. A common language was developed to describe dissimilar events by discovering common causes across the database, especially organisational failures, training deficiencies and unrealistic procedures. The description of the event is abstracted using a set of factors which concerns the Crew Actions and the outside Influences (Personal, Organisational, Informational and Environmental). The Crew Actions are directly observable, however, the Influences are not as easily determined and sometimes must be inferred. Inferences must however be based on the ASR, HFR and call-back information, not on the analyser's or crew member's beliefs. The factors are then linked to form an Event Sequence Diagram (ESD) which illustrates the flow of cause and effect throughout the event. The incident report is then read thoroughly to understand the technical, operational and environmental details of the flight and respondents are then called to explore any discrepancies between the two reports. The information from these reports is regularly updated and fed back to the pilots and included in pilot training courses.

1.3 Conclusion

The descriptions of accident reporting systems given in this chapter indicate large differences in their structure but cover the same basic issues. The differences in structure could be due to industry differences – what works in one industry or company may not always work in another. However, one consistency between those systems based on accident causation models is that they are all based on Reason's accident causation model. This evaluation of the various accident reporting systems, will help determine the content and structure of the accident reporting forms described in this report. It would seem that an accident reporting form requires a balance between the attributes of simplicity and thoroughness. Accident reporting forms and investigation methods which are based on robust accident causation models allow safety managers to make sense of their accident statistics at a more strategic level in order to prevent accidents in the future.

The ultimate purpose of this project is to improve accident analysis in order to learn from previous incidents and consequently reduce the likelihood of similar incidents recurring. The specific aim is to develop an incident reporting form which would be used to gather 'human factors' data from individuals involved in incidents on offshore installations, collect the data using this form, and evaluate the form using this data. An accident reporting system will be developed based on previously developed models of accident causation (e.g. Reason (1990); Wickens (1992)) with a potential to deliver greater accuracy of human factors incident data. Since the ultimate purpose of this work is to improve accident reporting analysis in the hope of lowering accident rates, data collected through this system will be formatted in a particular way in the hope that companies will be able to analyse their safety procedures and have a greater awareness of accident causation in their particular industry. Whether the system devised can be generalised for all industries would need to be established and if so whether it would be advantageous to have an all-inclusive system would need to be discussed.

The remaining sections of the report will cover the following:

Chapter Two will develop Witness Statement Form I, based on an open reporting form used by British Airways. Data will be collected using it and an evaluation of its effectiveness in obtaining greater numbers and more specific human factors causes will be undertaken.

Chapter Three will develop Witness Statement Form II, based on Reason's Accident Causation Model and Wicken's Information processing Model. Data will be collected using it and an evaluation of its effectiveness in obtaining greater numbers and more specific human factors causes will be undertaken.

Chapter Four will provide an overall discussion of the findings, methods by which this information can be used to improve the remedial actions and methods by which reporting systems could be improved.

2. Development and Evaluation of the Witness Statement Form I

The following chapter describes the development and evaluation of an incident reporting form focusing on collecting human factors causes from the personnel directly involved in the incident. This form is called the Witness Statement Form I and its development and evaluation will be described in this chapter. The following chapter describes (i) the Original Report Form used by the participating operating company, (ii) the content of the Witness Statement Form I, (iii) method of data collection, (iv) descriptive statistics from the WSFI, (v) comparisons between findings from WSFI and Original Reports and (vi) a discussion outlines the advantages and disadvantages of the revised system and proposed changes are suggested.

2.1 Company's Original Report Form

Within the company's accident reporting form, two spaces are provided for the incident investigator to summarise the immediate and underlying causes of the incident. The codes which are used by the company to describe the causes of incidents are shown in Table 2.1. These codes are similar to those used in the ILCI Model (ISRS) (Bird, 1989). One of the main criticisms which the company had regarding this incident data collection system was that the data collected were not detailed enough to help improve their systems. In addition, they were unsure whether incidents were being coded accurately or not.

Table 2.1 Company's Current Immediate and Underlying Causal Codes

Immediate Causes	
Unsafe Acts:	*Unsafe Conditions:*
Operating without authority	Inadequate guards and devices
Failure to make secure	Inadequate warning systems
Failure to observe / Use warning devices	Work environment
Nullifying safety devices	Excessive noise
Using defective equipment	Hazardous placement or storage
Using equipment unsafely	Inadequate physical contact
Taking unsafe position, Improper physical effort /act	Untidy site
Influence of alcohol / drugs, Horseplay	Weather
Failure to use PPE	Inadequate PPE
Failure to follow procedure; Inattention	Inadequate isolation
Underlying Causes	
Lack of competence	Improper motivation
Inadequate supervision	Inadequate maintenance / inspection
Inadequate job instruction	Inadequate engineering design
Inadequate physical/mental capacity	Inadequate work / safety procedure
Inadequate planning/organisation	Inadequate procedure

An informal evaluation of the company's current coding system revealed that it does not cover an extensive range of possible causes, thus limiting its ability to collect detailed information. A closer

examination of the system revealed that some important codes had been overlooked, such as 'using wrong equipment' in the immediate cause category and 'poor communication' in the underlying cause category. In order to obtain more detailed and possibly more accurate data from accident investigations, it was decided that the new form should be completed by those people who had witnessed the event, and that they should describe it in their own words.

2.2 Witness Statement Form

The Witness Statement Form I was jointly developed by members of the Aberdeen University Industrial Psychology Group and personnel in the participating company's Safety Department. The Witness Statement Form I (WSFI) was designed to be used in conjunction with the company's Original Reporting Form which is completed by an investigation team to collect details regarding the event. Using the WSFI, individuals involved in an incident were required to describe the events leading up to the incident in their own words with the expectation that more detailed information would be collected. The structure of the Witness Statement Form I (see Appendix A) is based on a self-report form developed by British Airways for use in their BASIS system to collect information regarding incidents from flight crews (O'Leary, 1999).

The WSFI contains 11 open questions which are posed to individuals completing the form. The 3-page form contains the following sections:

- *Heading*: Company logo, title and the reference number of the form
- *Instructions*: who should complete the form and the reasons for completing it
- *Incident Reference*: name of the witness, their position and the specific incident reference number
- *Open Questions*:
    1. Narrative description of the activities engaged in before the event
    2. Description of how the job was planned
    3. Deficiencies with the tools and equipment
    4. Contribution of working conditions to the event
    5. Description of how the procedures worked
    6. Description of how the individual was feeling at the time of the incident
    7. Description of others involved in the task and how they responded
    8. Description of how training prepared them for the situation
    9. Description of better ways to handle the situation
    10. Description of how well the situation was handled
    11. Comments on how to prevent this type of incident

2.3 Data Collection

The WSFI was sent out to five installations in May, 1998. Offshore safety personnel were instructed that all personnel involved in incidents (including supervisors) should be requested to complete a Witness Statement Form I, although it was not mandatory. Data from the five installations were

collected between May 1998 and December 1998. Information from the Original Report and the WSFIs were collated and summarised in a table for each installation. The following types of information were collected for each incident which used the WSFI:

2.3.1 Severity Potential Index

The potential severity of each incident was recorded in order to ascertain whether personnel experiencing certain types of incidents were more likely to use WSFIs than others. The Severity Potential Index contains 12 possible categories (see Figure 2.1) where incidents documented in the bottom-left corner of the matrix denote less severe potential consequences:

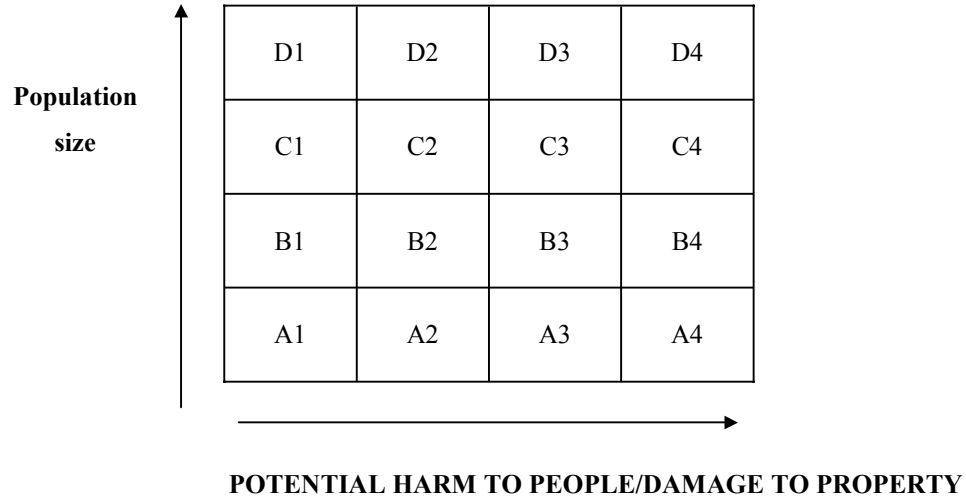


Figure 2.1 Potential Severity Index

2.3.2 Consequence Severity

Incidents have been classified according to the severity of their consequences in order to determine whether WSFIs were completed for certain types of incidents more often than for others. The categories given in the box were collected:

- Lost-time Work Case (LWC)
- Restricted Work Case (RWC)
- Medical Treatment Case (MTC)
- First Aid Case (FAC)
- Environmental (ENV)
- Property damage (PD)
- Near-miss (NM)

2.3.3 Immediate and Underlying Causes

The immediate and underlying causes of each incident were obtained from the Original Report. Comparisons between reports using WSFIs and those which did not use WSFIs were undertaken in order to investigate whether or not the WSFI had an impact on the number of immediate and underlying causes recorded.

2.3.4 Narrative Description

Narrative descriptions (from Question 1 in the WSF) have been categorised into 4 groups according to the level of detail: 'detailed'; 'comprehensive', 'brief' and 'virtually nothing'. This categorisation is based on informal and subjective evaluations by the researcher and thus must be viewed with care.

2.3.5 Questions 2-11

Responses to the remaining questions (Q2-11) from the Witness Statement Forms were summarised, attempting to capture the respondents meaning. Responses to questions 2-11 were categorised according to their level of detail. Respondents were given one point for each question answered and two points when the response was detailed. A maximum of 20 points could be obtained for the overall score.

2.4 Evaluation of the WSFI

The WSFI was evaluated using the following descriptive statistics:

(i) the number of WSFIs collected from each installation
(ii) the number of personnel completing WSFIs in each occupational group
(iii-iv) the severity of incidents (potential and consequence)
(v) the level of detail of responses in the WSF
(vi) the number of immediate and underlying causes.
(vii) differences between the causal analysis of incident reports using and those not using WSFIs are reported.
(viii) Finally relationships between the number of causal codes recorded, the severity of the incident and the level of detail in the WSFI are described.

2.4.1 Descriptive Statistics

Frequency of Witness Statement Forms

Table 2.2 shows the number of incidents reported on the five installations for 8 months from May until December 1998 after the implementation of the Witness Statement Form I. The total number of incidents reported over that time period is shown plus the number of incidents which were reported using the Witness Statement Form I (WSFI). The table also displays the total number of Witness Statement Forms returned, since for some incidents, more than one Witness Statement Form I was completed as more than one person was involved in those incidents. WSFIs were completed by one to five personnel, which included injured personnel, witnesses to the incident and supervisors.

Table 2.2 Number of incidents reported

Installation	Total No. of incidents reported	No. of Incidents using Witness Statement Forms	Number of Witness Statement Forms Returned
Installation A	22	12 (55%)	25
Installation B	28	10 (36%)	33
Installation C	33	16 (48%)	21
Installation D	26	7 (27%)	9
Installation E	15	2 (13%)	2
Total	124	47 (38%)	90

Occupations of personnel completing Witness Statement Forms.

The instructions for the distribution of the WSFIs required that all personnel involved in an incident should be requested to complete a WSFI (which included the injured person, others involved in the job, supervisors and the OIM). Table 2.3 displays the frequency of respondents in each occupation who completed WSFs. No OIMs completed WSFs.

Table 2.3 Occupations of personnel using the WSF

Production	Freq.	Drilling	Freq.	Deck crew	Freq.
Production Supervisor*	2	Driller*	2	Deck team leader*	1
Lead Outside Operator*	1	Assistant driller	2	Construction foreman*	1
Assistant rig supervisor*	1	Drilling operator	3	Abseiling foreman*	1
Operator mechanical	4	Derrickman	2	Lead floorman*	2
Instrument/Op Technician	2	Wireline operator	5	Crane operator	7
Op/LBC	1	**Maintenence**		Assistant crane operator	2
Facilities Mechanic	2	Plater	1	Materials - deck	1
Facilities ops electrical	3	Chargehand pipefitter	1	Roughneck	4
Operations controller	1	Lead foreman*	1	Rigger	6
Control Room Operator	2	**Other**		Floorman	4
Tech op	1	Medic	1	Roustabout	4
Hydraulic tech	1	Hvac engineer	1	Deck crew	7
Electrical supervisor*	1	Safety officer	1	Scaffolder	2
Lab/wellbay operator	1	Head chef*	2		
Plant operator*	1				

(*asterisk indicates supervisors)

The majority of WSFIs were completed by wireline operators, crane operators, floormen and deck crew. Out of the 40 incidents recorded using WSFIs, 15 were completed by supervisors (38%). Table 2.4 displays the frequency (and percentage) of occupational groups completing WSFs.

Table 2.4 Respondents divided into 5 main occupational groups

Occupational Group	Frequency	Percentage
Drilling	16	18%
Deck crew	40	44%
Production	23	26%
Maintenance	5	6%
Other	6	7%

The occupational group which was involved in the largest number of incidents was deck crew (44%). This finding is not surprising since deck crew and drillers carry out some of the more hazardous jobs on offshore installations.

Incidents categorised according to their potential severity

Table 2.5 displays the frequency of incidents categorised according to the Severity Potential Index. Incidents which were analysed with the aid of WSFIs tended to be categorised most often as B2 Caution (22%), B1 Care (20%), A1 Care (20%) and C2 Caution (17%). This range was more diverse than for those incidents analysed without the aid of WSFIs where the majority were categorised as A1 Care (31%)and B2 Caution (21%).

Table 2.5 Frequency of Incidents grouped by potential severity

Severity Potential Index	WSF	no-WSF
A1 Care	20%	31%
A2 Caution	12%	5%
A3 Alert	2%	1%
B1 Care	20%	9%
B2 Caution	22%	21%
B3 Alert	2%	3%
B4 Alarm	-	1%
C1 Care	2%	7%
C2 Caution	17%	10%
C3 Alarm	-	3%
D2 Caution	2%	-
Missing	-	9%

Incidents classified according to their consequence severity

Table 2.6 indicates the percentage of incidents categorised according to the severity of their consequences. The majority of incidents were classified as property damage and near misses. The percentage values show that Medical Treatment Cases were more likely to be reported with WSFIs (with WSFI=20%, without WSFI=8%), whereas near-misses were less likely to be reported using WSFIs (with WSFI=22%, without WSFI=39%).

Table 2.6 Percentage of incidents categorised according to consequence severity

Severity Potential Index	WSF	no-WSF
Lost-day Work Case	17%	14%
Restricted Work Case	5%	1%
Medical Treatment Case	20%	8%
First Aid Case	7%	3%
Property Damage	22%	19%
Environmental	7%	16%
Near Miss	22%	39%

Level of detail in WSFIs

Tables 2.7 and 2.8 illustrate the frequency of incidents categorised according to the level of detail of the narrative descriptions (Table 2.7) and the remaining questions (Table 2.8). Using an informal and subjective method to evaluate the level of detail in the narrative descriptions, the findings indicate that the majority of narratives were either brief (39%) or 'comprehensive' (53%).

Table 2.7 Frequency of incidents categorised by level of detail of narrative.

Narrative Description	Frequency	Percentage
Detailed	4	5%
Comprehensive	48	53%
Brief	35	39%
Virtually Nothing	1	1%
Missing	2	2%
Total	*90*	*100*

Information in questions 2-11 of the WSFI was evaluated according to the following system: Respondents were given one point for each question answered and two points when the response was detailed. A maximum of 20 points could be obtained for the overall score. The majority of questions 2-11 were completed with 'very little' detail (61%). Twenty percent of the reports contained mainly "not applicable" statements.

Table 2.8 WSFI incidents categorised by level of detail of responses to remaining questions.

Questions 2-11		Frequency	Percentage
(16-20 points)	Detailed	1	1%
(11-15 points)	Comprehensive	9	10%
(6-10 points)	Brief	25	28%
(0-5 points)	Very Little	55	61%
	Total	*90*	*100*

Frequency of Immediate and Underlying Causes in WSFI and no-WSFI Reports

Table 2.9 displays the percentage of immediate causes in WSFI and non-WSFI reports coded by company investigators using the original reporting system. For both WSFI and no-WSFI reports around two thirds of the codes were unsafe acts and a third were unsafe conditions. The most frequently recorded immediate causes for reports using the WSFs were: 'using defective equipment', 'failure to make secure' and 'inattention'. The top three causes in reports using the WSFI were 'using defective equipment', 'taking unsafe position' and 'work environment'. Unsafe conditions were not reported as frequently as unsafe acts.

Table 2.9 Percentage of incidents categorised according to their Immediate Causes

Immediate Causes (n_{WSFI}=68; $n_{No\text{-}WSFI}$=127)					
Unsafe Acts	**No-WSF**	**WSF**	**Unsafe Conditions**	**No-WSF**	**WSF**
failure to make secure	11%	7%	inadequate guards and devices	3%	4%
failure to observe warning devices	4%	2%	inadequate warning systems	4%	3%
using defective/incorrect equip.	26%	18%	hazardous storage of materials	8%	6%
using equipment/tools unsafely	1%	7%	work environment	7%	9%
taking unsafe position	5%	13%	inadequate visual contact	4%	3%
failure to follow procedure	5%	4%	untidy site	2%	3%
improper physical effort/act	2%	4%	weather	3%	4%
inattention	11%	6%	inadequate PPE	-	3%
poor work practices	1%	-	inadequate isolation	1%	2%
failure to anticipate/ assess risks	2%	-			
Total	*68%*	*61%*	*Total*	*32%*	*37%*

Table 2.10 displays the frequency of underlying causes coded in the Original Report. The most frequently recorded underlying causes for reports using the WSFs were: inadequate engineering design, inadequate job instruction and inadequate procedures. The top three underlying causes in reports using the WSFI were inadequate engineering design, inadequate maintenance/ inspection, inadequate planning/ organisation.

Table 2.10 Percentage of incidents categorised according to their Underlying Causes

Underlying Causes	**No-WSF**	WSF
lack of competence	4%	3%
inadequate supervision	4%	9%
inadequate job instruction	4%	14%
inadequate physical/mental capacity	1%	2%
inadequate planning / organisation	18%	16%
improper motivation	5%	5%
inadequate maintenance / inspection	25%	10%
inadequate engineering / design	29%	21%
inadequate procedures	7%	14%
lack of appreciation/anticipation of situation	-	3%
inadequate communication	1%	3%
inadequate risk assessment	1%	-
inadequate materials	1%	-
Total	100%	100%

2.4.2 Differences between analyses of incidents using/not using WSFIs

Frequency of Immediate and Underlying Causes

Table 2.11 displays the number and percentage of immediate and underlying causes coded for WSFI and non-WSFI reports. A much higher percentage of non-WSFI reports contained no immediate or underlying causes (55%=immed, 56%=underlying) than the reports which used WSFIs (17%=immed, 20%=underlying). In addition, a greater percentage of WSFI reports contained one immediate or underlying cause (37%=immed, 59%=underlying) than the non-WSFI reports (25%=immed,

35%=underlying). Furthermore, more than double the percentage of WSFI reports (compared to non-WSFI reports) contained more than one immediate cause (46%=WSF, 20%=non-WSF) and more than double the percentage of WSFI reports (compared to non-WSFI reports) coded more than one underlying cause (21%=WSF, 9%-non=WSF).

Table 2.11 Percentage of incidents categorised according to their Underlying Causes

no. of immediate causes	Not using WSFI	Using WSFI
0	55%	17%
One	25%	37%
Two	13%	37%
Three	3%	5%
Four	3%	2%
Five	1%	-
Six	-	2%
no. of underlying causes		
0	56%	20%
One	35%	59%
Two	8%	12%
Three	1%	1%
Four	0	8%
Total	*77*	*41*

Table 2.12 displays the range and average frequencies of immediate and underlying causal codes found in the Original Report. T-tests indicated that significant differences between the reports using the WSFIs and non-WSFI reports were found regarding the number of immediate and underlying causes coded. Significantly more immediate causes (mean=1.49) were coded when the WSFI was used than when it was not used (mean=0.77; $t=2.95$, $p<.01$) and significantly more underlying causes (mean=1.14) were coded when the WSFI was used than when it was not used (mean=0.56; $t=3.19$, $p<.01$). It must be noted that these differences are only very small (between 0.77 and 1.49).

Table 2.12 Average Number and Range of Human Factors Causes using/not using the WSFI

	Not Using WSFI	Using WSFI
No. of Immediate Codes	0.77* (0-5)	1.49* (0-6)
No. of Underlying Codes	0.56* (0-3)	1.20* (0-4)

*average number of codes (range of number of codes in brackets)

Factors associated with frequency of causes

Correlation analysis using Kendall's Tau B was undertaken to investigate which factors affect the number of underlying codes recorded. Factors, such as the number of immediate causes, the potential severity of the incident, the consequence severity and the level of detail in the narrative and in the overall questionnaire were tested to see if they would correlate (be associated) with the number of underlying causes. Table 2.13 displays the significant and non-significant correlations.

Significant correlations were found between the number of underlying causes and:

(i) *the number of immediate causes*: indicating that as the number of immediate causes increases, so does the number of underlying causes

(ii) *the severity of the consequence*: indicating that as the severity of the incident increases (e.g. Lost-time Work Case) so does the number of underlying causes

The first correlation indicates that the number of underlying causes is related to how many immediate causes for the incident are found. It seems natural that behind every immediate cause there is an underlying reason for it occurring. The second correlation indicates that severity of the incident dictates the number of underlying causes that are found. This may have come about for one of two reasons: i. the more severe incidents were found to have more causes attached to them, or ii. the more severe incidents were analysed in more depth.

Table 2.13 Kendall's Tau B correlations.

	No. of underlying causes	No. of immediate causes
no. of immediate causes	0.33**	-
potential severity	0.11	-.018
consequence severity	0.36**	0.16
level of detail in narrative	0.07	-0.21*
level of detail in Questions 2-11	0.16	0.08

*significant at the .05 level of significance ** are the most significant differences at the .001 level of significance

In addition, a significant correlation (although less strong and in an unpredicted direction) was found between the number of immediate causes with:

(i) *the level of detail in the narrative description*: indicating that as the level of detail in the narrative description increased, the number of immediate causes recorded decreased. However, this finding was only significant at the 0.05 level indicating that it is not particularly robust.

Types of immediate and underlying causes

Table 2.14 displays the seven most commonly used immediate causes and the six most commonly used underlying causes. In addition, the number of times each cause was coded was divided by the total number of causes and multiplied by 100 to produce a percentage. For example, in the reports which did not use the WSFI, 24% of the immediate causes were coded as 'defective equipment', whereas only 13% of the immediate causes in the reports which used the WSFI were attributable as 'defective equipment'. This indicates that a higher proportion of non-WSFI incidents were due to defective equipment than WSFI incidents. The most commonly used immediate causes tended to be similar for WSFI reports and non-WSFI reports. However, a larger proportion of incidents that did not use WSFIs were coded as 'inattention' (11%) than those using WSFIs (6%). In addition, a larger proportion of incidents that used WSFIs were coded as 'taking unsafe position' (13% cf. 5%) and 'using equipment unsafely' (7% cf. 0.8%) than those which did not.

Table 2.14 Most commonly used immediate and underlying causes (percentages).

Reports Not Using WSFI (n=124)	%	Reports Using WSFI (n=47)	%
Immediate Causes:		Immediate Causes:	
using defective equipment	24	using defective equipment	13
failure to make secure	11	taking unsafe position	13
inattention	11	work environment	9
hazardous placement of materials	8	failure to make secure	7
work environment	7	using equipment unsafely	7
failure to follow procedures	6	hazardous placement of materials	6
taking unsafe position	5	inattention	6
Underlying Causes:		Underlying Causes:	
inadequate engineering/ design	29	inadequate engineering/ design	21
inadequate maintenance/ inspection	25	inadequate planning/ organisation	16
inadequate planning/ organisation	18	inadequate procedures	14
inadequate procedures	7	inadequate job instruction	14
improper motivation	5	inadequate maintenance/ inspection	10
inadequate job instruction	4	inadequate supervision	9

The most common underlying causes were similar for WSFI reports and non-WSFI reports (especially inadequate planning/ organisation (16%, 18% respectively) and improper motivation (both 5%). However, reports not using the WSFI reported more accidents than the WSFI reports due to: 'poor engineering/design' (29% cf. 21%) and 'poor maintenance/inspection' (25% cf. 10%). Furthermore, reports that used WSFIs reported more 'inadequate job instruction' (14% cf. 4%), 'inadequate procedures' (14% cf. 7%) and 'inadequate supervision' (9% cf. 4%) than the non-WSFI reports. Although this data is preliminary in terms of the number of reports, the results seem to suggest that the WSFI may be giving investigators more information to work with.

2.5 CONCLUSION

The aim of this study was to develop an incident reporting form which could be used to gather 'human factors' data from individuals involved in incidents on 5 installation. The specific problem that the participating company had with their accident reporting system was that the human factors causal data which were being extracted from their current reporting form was not providing the company with information that could be used to improve their systems. Therefore, the specific aim of this study was to improve the structure and content of the incident reporting form regarding the potential human factors causes of accidents and near misses. It should be noted that the technical causes of incidents are not considered in this project.

Original Report Form: The company's current reporting form does not contain a comprehensive range of possible causes, compared to some of the investigation systems reviewed in Chapter One. Thus its ability to collect detailed information is limited, where some important causes may be overlooked. In order to obtain more detailed and possibly more accurate data for accident investigations, it was

decided that the new form should involve those people who were witness to the event as well as supervisors, allowing them to describe it in their own words.

Witness Statement Form: The new reporting form, called the Witness Statement Form I (WSFI), was designed to be used in conjunction with the company's Original Reporting Form to collect details regarding the event. Individuals involved in an incident were required to describe the events leading up to the incident in their own words using the WSFI with the expectation that more detailed information would be collected. The WSFI contains 11 open questions covering the following topics: a narrative description of the activities engaged in before the event; job planning; tools and equipment; working conditions; procedures; how they were feeling at the time of the incident, others involved in the task, training; better ways to handle the situation; how well the situation was handled; other comments on how to prevent this type of incident.

Response Rates: In total, 90 WSFIs were returned from a sample of 47 incidents. Drillers and deck crew were the most likely occupations to complete the WSFIs. The majority of incidents were either A1 Care or B2 Caution on the Potential Severity Index and were either property damage, near miss or medical treatment cases on consequence severity.

Level of detail: The level of detail in the WSFIs was evaluated indicating that over half the respondents completed the narrative description comprehensively and the majority of the respondents completed the remainder of the WSFI (10 questions) in very little detail. The method of evaluation of the remaining 10 questions did not take into account the fact that many of the questions may not have been relevant to every incident. Furthermore, respondents may have felt that they gave sufficient information in the narrative description, and felt that they would have been repeating themselves if they had completed the form in more detail. Personnel may also feel that they have to fill in too many forms regarding the incident which is creating a 'paperwork overload'.

Frequency of Causes: Analysis of the frequency of causes reported when WSFIs were used was compared to causes reported when the WSFIs were not used. Incidents which were reported using WSFIs were found to produce significantly more immediate and underlying codes than were the reports which did not use WSFIs. However, it must be noted that the differences are only very small. This finding may suggest that investigators who have asked witnesses to complete WSFIs are more highly motivated (than those investigators who did not ask witnesses to complete forms) and these highly motivated investigators are therefore more likely to carry out in depth analyses of the incident. A relationship was also found between the number of underlying causes and the number of immediate causes for the incident. It seems natural that behind every immediate cause there is an underlying reason for it occurring. A second relationship was found between the number of underlying causes and the severity of the incident. This may have come about for one of two reasons: the more severe incidents were found to have more causes attached to them, or the more severe incidents were analysed in more depth.

Types of Codes: The most frequently used immediate codes in WSFI reports were unsafe acts: 'using defective equipment', 'failure to make secure' and 'taking unsafe position' which when compared to the non-WSFI reports, indicated that similar codes and their ranking orders were found. The most frequently used underlying codes (for WSFI reports) were: 'inadequate planning and organisation', 'inadequate supervision' and 'inadequate procedures' which when compared to the non-WSFI reports showed that the causes were similar, with only slightly different ranking orders.

In summary, the results illustrate that the WSFIs have helped increase the quantity of detail given in the analysis of the causes, however, there are still problems found with the form. The outcome of this examination of the Witness Statement Forms has shown that:

- Witness Statement Forms were not used after every incident
- The level of detail in the WSFIs was limited, especially in questions 2-11. Some of the reports only had very brief responses, such as: 'yes' or 'no'. Many respondents did not put much thought into answering the questions
- Personnel need some instruction and guidance on how to use the form, either in the form of: training; separate guidance notes with examples of what is meant by each question; or more guidance within the reporting form itself.

A second form has been proposed (WSFII, see Chapter 3) which will provide the respondent with more prompts within the reporting form.

3. The Development and Evaluation of the Witness Statement Form II

The following chapter describes the development of a second human factors accident coding form which is designed to analyse a comprehensive list of human factors causes of incidents. It is based on an accident causation model (see Figure 1.1) and is designed to be completed by persons involved in the incident or accident. The reasons for developing this form come partly from the findings of Chapter Two, where only a limited amount of data was being collected from the WSFI, and from Chapter One in which other industries' incident reporting systems are documented, indicating the need for a more comprehensive set of human factors codes for the UK offshore oil industry.

This chapter is divided into six sections: 3.2 describes the stages which should be undertaken to design a reporting form; 3.3 describes how the human factors topic areas of the form were selected; 3.4 describes how the items within each topic area were developed, 3.5 describes the pilot studies before the form was used offshore and 3.6 evaluates the form using ten offshore case studies.

3.1 Five stages in the development of reporting forms

Sinclair (1975) proposes five stages to plan, develop and test questionnaires. The researcher must define the (i) objectives, (ii) target population, (iii) sampling method, (iv) questionnaire structure, and (v) question wording. These have been adapted to apply to the planning and development of an incident reporting form.

3.1.1 Objectives

The first stage in the development of an incident reporting form is to define the objectives of the form. This includes an overall picture of what the results will show, the degree of accuracy and quality of the data, the quantity of data received and how the data will be linked with other accident data.

What are the results supposed to show?

The data from the incident reporting form are supposed to show what failures of people and systems led to the event. It should be a broad picture, where the behaviours of not only those involved directly in the incident are investigated, but also the actions of witnesses to the event, relevant supervisors, management as well as the systems involved, are included.

How accurate should the data be?

The more accurate the data, the better the understanding of the immediate and underlying causes of an incident. Personnel involved in the incident are required to complete the form, thus their openness and honesty is vital for the accuracy of the data. The form can only aid in the investigation of the causes of the incident, with the commitment of the company and employees. The accuracy (or 'reliability') of the form will be tested in section 3.6.

What quantity of data should be expected?

The more data that can be collected from a particular incident (from witnesses, supervisors etc), the greater the knowledge base that will be made available to the investigator. To every question asked, either a positive or negative response ('yes' or 'no') is required, thus in theory, the same number of responses will be returned by all individuals completing the form, only different number of positive and negative responses will be given. This provides the investigator with a huge amount of data to sift through. However, the data will be transferred onto a spreadsheet database which will allow for quick analysis of the data.

What additional data will be needed to link this survey with other work?

In order to link this accident data with other accident data, the human factors data from other industries and other similar accident investigation systems will be required. This will allow for a comparison to be made between different industries to see if similar human factors problems are found. This would test the construct validity of the accident reporting form. Construct validity is the testing of a instrument based on the determination of the degree to which the test items capture the hypothetical quality or trait (i.e. construct) it was designed to measure. It provides no quantitative or statistic measure of validity. The following types of questions are asked: What constructs (traits or qualities) actually characterise accident causation? Do the test items actually tap such constructs?

3.1.2 Sample Population

The second stage of questionnaire development is to define the sample population. This includes those people who will be completing the form, inputting the data, analysing & compiling the data, using and reading the findings and those who will benefit from the process.

Who completes the form?

The sample population completing this form will be those involved in accidents and incidents on UK offshore installations. From Chapter 2 it would seem that the sample tends to be deck crew, and therefore the structure, content and the level of sophistication of the questions need to be taken into consideration with this occupational group in mind. The questionnaire needs to be sufficiently generic to include other occupations.

Who inputs the data into the database?

The administration of the form into a database needs to be taken into consideration in the development stage of the form. A large amount of data is provided from one reporting form (up to 166 possible items) and thus a simple method is required by which to process the data. A reliable and quick way for data input is using a specially programmed scanner to read the forms. However, not all companies will have access to such facilities. The majority of the questions are answered with 'yes' 'no' responses, thus it will be fairly simple to input the data manually, where 'yes'=1 and 'no'=2. Where there are boxes (item fields) to be ticked, a master copy of the form will indicate the number associated with each item. For example:

Permit to Work..☐ (1) Work Order (Job Card)..☐ (2) Written instruction..☐ (3) Verbal Instruction..☐ (4)

In the draft stages of the form, the data will be inputted manually by the researcher. However, for future versions of the form, other methods of data input must be taken into consideration.

Who analyses the data and how is it reported?

Data from the form will initially be analysed using 'modelling' (see section 3.6 for details) and will be carried out by the researcher. It is hoped that in the future, the form would be analysed by the safety department and thus a software package would be required to analyse the data in a simplistic manner. The types of data analysis that will be undertaken will include:

- Description of the human factors causes found in the Original Report and from the WSFII
- Comparisons between the Original Report and the WSFII regarding the number of human factors causes
- Number of human factors causes addressed in the Original Report Remedial Actions

Who uses and reads the findings and who benefits from the reporting system and how?

Safety Management: This would be the first group to read the summary findings. The data would help them to present information to both senior management and the workforce in the form of graphical representations of the descriptive statistics. This would also allow both groups to become aware of the causes of accidents and incidents.

Senior Management: Summary data of the accident causes would allow senior management to obtain an overall picture the human and organisational factors affecting safety in their company. This in turn would help them to make strategic decisions regarding safety improvements.

3.1.3 Sampling Method

The third stage of accident reporting form development is to define the sampling method, to determine the types of incidents and accidents to be analysed and the personnel who are to complete the form:

Incident and Accident Types to be analysed

There will be some bias in the selection of the sample in preliminary versions of the form since the form will not be used for all accidents and incidents. Not only would this process be too detailed for some types of incidents, but it could also lead to an overload in the paperwork and information collected. This could eventually lead to a drop in the enthusiasm for this new process in the accident reporting system. Only those incidents reportable to the HSE and high potentials would be analysed using the form.

Personnel involved in the incident who will complete the form

Everyone involved in the incident (including the person directly involved, other personnel involved in the job, any witnesses outwith the group and the supervisor) will be asked to complete a form, thus providing the investigator with a range of different points of view.

3.1.4 Structure of Questions

The fourth stage regards the structure of the questions, and in particular describes the advantages and disadvantages of closed versus open questions.

Advantages.
they clarify the alternatives for the respondent
they reduce coding errors in analysis
they eliminate ineffectual answers

Disadvantages.
it is difficult to make the alternatives mutually exclusive
they must cover the total response range (exhaustive list)
they create forced-choice situation which rules out marginal or unexpected answers
all the alternatives must seem equally logical or attractive
in complex or difficult questions, subjects select the “safe” or “easy” option of the ‘don’t know’ category

An open question structure was used in the form described in Chapter Two and problems were found with this structure due to the reluctance of offshore personnel to give much detail. Thus the closed question structure will be used despite the disadvantages of it given above.

3.1.5 Questionnaire Wording

The wording of the questionnaire should ensure that the respondent is motivated to respond, they have the particular knowledge required, they understand the aim and meaning of the questions and

that they can produce an adequate response from their own knowledge. Guidelines and criteria have been set by researchers regarding form design (Adams (1977); Lawson (1991); Wright, (1975) which include the following items:

Respondents are motivated to complete the form

Accident reporting is often seen as a time-consuming ancillary activity with no intrinsic or extrinsic rewards (Adams, 1977). Often the foreman or supervisor is neither trained nor motivated to perform accident reporting, which is compounded by delays by the injured person to report the incident. In order that the respondent is motivated to complete the form, they must be informed of the purpose of completing the form (see Appendix B for the Guidance Notes). They also must feel comfortable completing the form, and therefore must be given time to complete the form in private or with the help of someone who was not involved in the incident (such as the installation medic). This person should be given specialist training in order not to bias respondents.

Respondent has the particular knowledge required to complete the form

Adams and Hartwell (1977) believed that the level of skill required is a function of the quality of information required and of the design of the report. They found that only a minority of those making reports possessed sufficient training and ability to make comprehensive reports and few plants had made provision for training. In the present study, key offshore personnel (safety personnel) will be targeted and given some brief training on the use of the form. In addition, only those personnel directly involved in the job will be asked to complete the form, thus hearsay remarks are avoided. Personnel completing the form will be asked to leave any questions they are unsure of.

Respondent will easily understand the aim and meaning of the questions

The reporting form needs to takes into account the respondent's limitations and personal frame of reference, so he/she understands what is expected of them and understands the language. The *clarity* of the questions must be taken into consideration: Questions should be short (to clarify questionnaire designers thinking, remove superfluous words; reduce the chance of overloading respondents with too much information, reduce the chance of respondents forgetting the earlier parts of the question); use active voice, use affirmative rather than negative sentences; avoid double negatives and complex questions or vague phrases such as 'on the whole'; double-barrelled questions should be avoided: 'do you suffer from headaches or stomach pains'; avoid any ambiguities. *Familiar* words which the sample population can easily understand should be used; short rather than long words; and scientific or professional jargon should be avoided. Two versions of the form were provided one for those personnel carrying out the job and one slightly altered version for the supervisor.

Respondent produces an adequate answer from his/her own knowledge:

- It is important that the content of the form comprehensively covers the range of possible causes of accidents and incidents.

- In addition to this, *sufficient space* should be provided for the individual to describe other possible causes of the incident.

- *Leading questions* should be avoided, as these may influence the respondent's opinion.

- *Sensitive questions* should be placed some distance into the questionnaire and the whole tone of the questionnaire should be personal, relaxed and open. The use of euphemisms should be considered instead of blunt questions.

- It is thought that *hypothetical questions,* such as: 'In hindsight what would you have done differently?', generally do not yield very reliable results (Sinclair, 1975) since there is usually a difference between people's self-image in a particular set of circumstances and their actual behaviour. However, this question has been used in the following study (and in Chapter Two) with generally favourable responses. This may be because of the circumstances under which the questionnaire is completed. The respondents in this study are generally skilled in their job and therefore have a realistic view of the events.

- *Impersonal questions* lead to spurious answers because the respondent becomes disengaged from the subject matter and can lose interest in the questionnaire.

3.2 Development of Human Factor Topic Areas

The form (see Appendix C) was divided into 13 sections including a section for a narrative description of the event and an open section on how to prevent recurrence of the incident. The topic areas were chosen after a thorough examination of 4 accident reporting and/or investigation systems (see Chapter One) which included HPIP, IRS, ADAMS and a prototype reporting system developed by an offshore oil operating company. The structure of the human factors topic areas is based on Reason's accident causation model (also briefly described in Chapter One). It is important that an accident causation model is used in accident/ incident investigations since it guides the analyst's attention towards all the elements of the system that could have potentially caused or contributed to the event. It helps in understanding the event in its dynamic aspects and in clarifying the relations among minor events, major events and the final outcome (ADAMS, 1998).

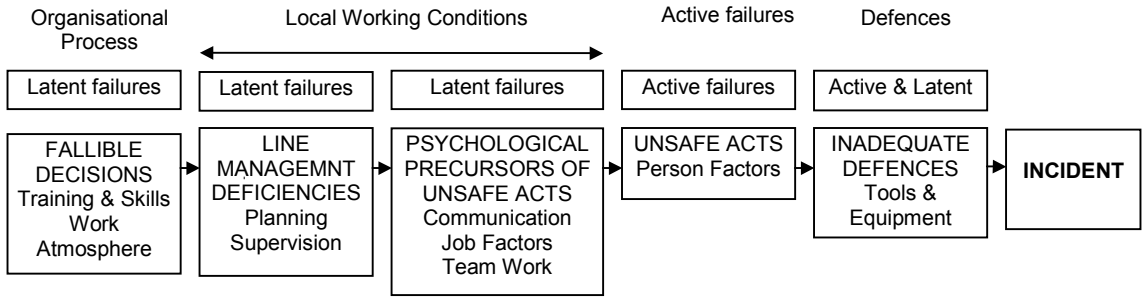


Figure 3.1. Based on Reason (1990)

Organisational Process: 'Fallible Decisions' are latent failures measured in Training & Skills and Work Atmosphere [In addition: Internal Business Process and Safety Culture as measured in the Benchmarking project].

Local Working Conditions: are divided into three types of latent failures: (i) 'Line Management Deficiencies' which is measured in the Planning and Supervision sections, (ii) 'Psychological Precursors' are measured in the Communication, Job Factors and Team Work sections and (iii) 'Local Working Conditions' is measured in the Work Environment, Written Work Practices and Workplace Atmosphere sections.

Unsafe Acts: are active failures and are measured in the Personal Factors section.

Defences, barriers and safeguards: 'Inadequate Defences' can be either active or latent failures and are measured in Tools & Equipment.

Each of these topic areas will be described in detail in the next section (3.4). Table 3.1 summarises where the items in each topic area have been taken from. In total there are 166 items of data which have come from 6 different sources: ADAMS, NEA, HPIP, Prototype 1, the Participating Company (P.Company) and Mearns et al (1998). The content of the reporting form has been divided into 11 sections plus the narrative description. The ordering of the sections was based on (i) temporal sequence (ii) familiar topic areas and (iii) more sensitive topic areas.

The narrative description of the event has been placed at the beginning of the form to jog the respondent's memory of the event, to encourage the respondent to express themselves, to bring up what they think were the main points to be learnt, and to know which incident they were involved in. 'Planning' is the second section, and has been placed as the first Topic Area in the form as this is normally the first stage of a job. It encourages respondents to recall the events in their time-sequence. The next four sections deal with the conditions at the workplace: 'Tools and Equipment', 'Work Environment', 'Written Work Practices' and 'Job Factors' which the worker is likely to come across next in that temporal order.

Person factors have been placed next in the form for two reasons. Firstly because the questions in this section are a continuation from the questions in the Job Factors section and secondly this section has been placed half way into the form because of the sensitivity of the questions (which tend to highlight the failures of the person directly involved in the incident). The respondent has

therefore had an introductory 'warm up' to questions about what happened during the event - so they realise that the questions are not there to incriminate them - that other factors may have been involved. 'Training & Skills' also related to the background of the person involved in the task and thus these sections are adjacent to each other.

Table 3.1 Summary of origin of items within the 13 topic areas

Topic Area	No. of Items	Origin of questions/items
Narrative Description	1	ADAMS & Mearns (1)
Planning	14	Prototype 1 (8); NEA (5), P. Company (1)
Tools and Equipment	7	Prototype 1 (4), P. Company (3)
Work Environment	39	ADAMS (35), NEA (1), P. Company (3)
Written Work Practices	18	Prototype 1 (7); ADAMS (6); Mearns (3); HPIP (2)
Job Factors	15	ADAMS (14), P. Company (1)
Person Factors	25	ADAMS (23); Prototype 1 (2)
Training and Skills	11	NEA (5); HPIP (3); Prototype 1 (2), P. Company (1)
Supervision	12	Prototype 1 (9); NEA (3)
Communication	7	HPIP (3); ADAMS (4)
Team Work	11	ADAMS (3); Prototype 1 (8)
Workplace Atmosphere	5	Mearns (5)
Preventing Recurrence	1	Prototype 1 (1)
TOTAL	166	ADAMS (85); Prototype 1 (41); NEA (14); Mearns (9); Participating Company (9); HPIP (8)

The final four Topic Areas focus on relationships between personnel working together on the job, which includes: 'Supervision', 'Communication', 'Team Work' and 'Workplace Atmosphere'. They describe the actions of the other people involved in the task such as how they: supervise, communicate with one another, work together and the general atmosphere on the installation. Finally, respondents are asked what they would do differently next time, if involved in a similar event. Although the use of this question has been discouraged by Sinclair (1975) because it does not tend to yield reliable answers, in the situation of incident analysis, it may be useful for investigators to involve respondents in this step.

3.3 Development of Items within each section

Each of the twelve topic areas consist of sections from other investigation systems. The following section describes which sections have been used and the reasons for their inclusion. Items were initially selected from various investigation techniques studied (HG65, MORT, MEDA, HPIP, IRS) on the basis of the following criteria:

i. relevance and suitability to the oil industry
ii. comprehensibility to offshore oil workers
iii. level of importance to offshore incidents

These criteria were initially based on the researcher's professional judgement and were later scrutinised by personnel who had worked offshore, as suitable subject areas.

3.3.0 Narrative

The data reported in the form would be almost meaningless without a narrative description, which highlights the temporal sequences and logical relations among the different events and factors involved in the incident. Comments may be written in this section irrespective of whether they are covered in the form. This section gives an opportunity for the reporter to explain the events in his/her own words. This section also enables the investigator to have a clearer picture of the human behaviour and of the technical and organisational environment in which the event occurred. In addition, it may contribute to a better understanding of the corrective remedial actions chosen by the investigation team to avoid recurrence of this or similar events.

The ADAMS investigation system places the narrative description at the end of the reporting form. This may be because the narrative, which is to be completed by the investigator (rather than the person involved in the incident), gives them the opportunity to include any further information not covered in the form, and to put the information into temporal order. The narrative description has been placed at the beginning of the current reporting form in order that personnel completing the form can arrange their thoughts in temporal order prior to the more detailed sections of the form.

Table 3.2 Content and Origin of Narrative Description

NARRATIVE DESCRIPTION	Origin
Briefly describe in your own words, the activities you were engaged in just before the event	ADAMS

3.3.1 Planning

This section contains 11 questions regarding the planning of the job such as: authorisation of the job, hazard assessments, Tool Box Talks, explanation of tasks, site visits and job 'walkthroughs'. Five of the questions were derived from an earlier prototype version of the reporting form designed for an oil operating company ('planning' section), one question was included after discussions with the participating oil company and the remaining five were from the Nuclear Energy Agency investigation form (IRS). The planning of the job was addressed by most of the investigation techniques studied (HG65, MORT, MEDA, HPIP, IRS) and many of the questions were similar for each investigation method, although this section was often placed within the 'Supervision' topic area.

Table 3.3 Content and Origin of Planning Topic Area

1. PLANNING	Origin
1. How was the work authorised? [Permit to Work; Work Order (Job Card); Written Instruction; Verbal Instruction]	Prototype 1
2. If work was authorised verbally, by whom? (e.g. foreman, supervisor, driller)	Prototype 1
3. Was a risk assessment carried out where required?	Prototype 1
4. Were the risk assessment results adequately communicated to you?	Prototype 1
5. Were any planning conflicts identified before the job was started?	IRS
6. Were the controls sufficient to reduce the risk to ALARP (as low as reasonably practicable)?	Participating Company
7. Did a tool box talk take place?	Prototype 1
8. Were the duties and tasks clearly explained to you?	IRS
9. Was a site visit used to help plan the job?	IRS
10. Was a job 'walkthrough' performed?	IRS
11. Did the work begin before all necessary materials & equipment were on the job site?	IRS

The majority of questions have been taken from the Prototype 1 reporting form developed jointly by the researcher and the operating company for use on their installations. The form, however, was not used due to changes taking place in the company at the time of implementation.

3.3.2 Tools & Equipment

This topic area examines how the tools and equipment may have influenced performance negatively and contributed to the error. The tools and equipment (including PPE) should be considered for how they were used at the time of the operations, with respect to their availability and condition. The questions asked regarding the 'tools and equipment' are not about any technical problems that may exist with the tools, rather the questions are about how people interact with the tools (e.g. using the tools and equipment correctly, choosing the wrong tools or the correct tools have not been available).

Table 3.4 Content and Origin of Tools & Equipment Topic Area

2. TOOLS AND EQUIPMENT	Origin
1. Were the necessary tools and equipment available for the job?	Prototype 1/IRS
2. Were they used?	Prototype 1/MEDA
3. Were they in good working order?	Prototype 1
4. Were personnel trained in their use?	Prototype 1
5. Was the appropriate PPE available?	P. Company
6. Was the appropriate PPE worn?	P. Company

The majority of questions (four out of six) were adapted from the Prototype 1 form. One item from MEDA was adapted for use in the current form (equipment/ tool/part is available but not used). A large amount of ergonomic detail is given in MEDA for the failure of tools and equipment and could possibly be included in a more comprehensive form.

3.3.3 Work Environment

This section covers the possible problems encountered in the working conditions such as weather, lighting, noise, access, ventilation, posture, manual handling and housekeeping. This section is based on the Environment section from ADAMS. The following additions were made: Ventilation (participating company), Manual Handling (HSE) and Housekeeping (IRS).

Table 3.5 Content and Origin of Work Environment Topic Area

3. WORK ENVIRONMENT	Origin
1. Weather: rain snow wind hail fog	ADAMS
2. Caused difficulty in: visibility touch movements	ADAMS
3. Slippery floor due to: wet oil ice snow	ADAMS
4. Uncomfortable degree of: heat cold humidity	ADAMS
5. Lighting & noise: insufficient light for task; glare hampers visibility; noise	ADAMS
6. Physical Access: fully obstructed; partially obstructed; congested work area confined space (tanks/vessels)	ADAMS
7. Visual Access fully obstructed partially obstructed	ADAMS
8. Ventilation: hazardous atmospheric conditions; area tested for noxious fumes & gases	Participating Company
9. Posture: task requires twisting, stooping, strenuous pushing/pulling, reaching outwards/upwards; repetitive handling; keeping the same position	ADAMS
10. Manual Handling: heavy, bulky awkward; unstable/unpredictable	HSE
11. Housekeeping: excellent; adequate; poor	IRS

3.3.4 Written Work Practices

This section asks questions regarding the written work practices, such as whether they were followed and reasons why they may not have been followed. This section was originally labelled 'Procedures' and was changed to 'Written Work Practices' as procedures govern the overall running of an operation, which would not necessarily be read by personnel carrying out the job. The written work practices, however, would be read by the person carrying out the job. Although the majority of reporting systems refer to the procedures, the meaning is slightly different in the offshore oil industry. The majority of the questions are based on the Prototype 1 Reporting Form.

Table 3.6 Content and Origin of Written Work Practices Topic Area

4. WRITTEN WORK PRACTICES	Origin
1. Were written work practices available for the job?	Prototype 1
2. Were written work practices used for the job?	Prototype 1
3. Should there have been written work practices in place, but wasn't?	HPIP
4. Were the written work practices correctly followed?	Prototype 1
5. Were the written work practices specific only to the job?	Prototype 1
6. Had you used the specific written work practices before?	Prototype 1
7. Did the written work practices describe the safest way of doing the job?	Mearns *et al*
8. Were the written work practices appropriate for the job?	Prototype 1
9. Were the written work practices difficult to follow?	Prototype 1
10. Were the instructions clear?	IRS & HPIP
11. Did you take any shortcuts which involved little or no risk?	Mearns *et al*
12. Did you ignore safety regulations to get the job done?	Mearns *et al*

3.3.5 Job Factors

This section investigates the aspects of the job which may have contributed to the incident, such as how familiar the task was to the person and the characteristics of the task, such as complicated or monotonous. It also records whether or not personnel were involved in more than one task, and if this contributed to the incident. It records the features of the task that negatively influenced the performance and contributed to the error. The job factors are those to do with the task and the majority are based on the ADAMS form.

Table 3.7 Content and Origin of Job Factors Topic Area

5. JOB FACTORS	Origin
1. How familiar were you with the task? Performed in/frequently	ADAMS
2. Was the task: complicated; lengthy; repetitive; boring; new/ changed	ADAMS
3. Complete the following section if you carryout more than one job:	ADAMS
a. I have no problems carrying out more than one job	P. Company
b. Combining my different jobs is difficult	ADAMS
c. My main activity is very demanding	ADAMS
d. I am often physically overloaded	P. Company
e. I am often mentally overloaded	ADAMS
f. Side activities are more demanding than the main one	ADAMS
g. Side activities are more interesting than the main one	ADAMS
4. Did any of the following cause pressure in the job?	
a. previous jobs delayed?	ADAMS
b. lack of staff?	ADAMS
c. not enough time allocated to task?	ADAMS
d. inefficient scheduling of tasks by planners?	ADAMS
e. inefficient organisation of work by supervisors?	ADAMS
f. financial incentives?	Mearns *et al*

3.3.6 Person Factors

In Section 6 of the WSFII, instances of poor information processing are measured. The questions in this section focus on the activities that took place immediately prior to the incident. Were there any problems in your concentration, perception, memory, interpretation, judgement of the task you were carrying out or did you assume something which in hindsight you should not have? These may be difficult for respondents to assess themselves without human factors training. It will involve them thinking back to how the events occurred. The first 16 questions are also used in the ADAMS system and are originally from Wickens' Information Processing Theory. The second section (questions 17-26 below) are from four different sources including ADAMS, NEA, Prototype 1 and ISRS.

Table 3.8 Content and Origin of Person Factors Topic Area

6. PERSON FACTORS	Origin
1. Was your attention distracted from your task?	ADAMS
2. Were you pre-occupied with your thoughts elsewhere?	ADAMS
3. Was your attention divided across many tasks?	ADAMS
4. Was your attention too focused on one aspect of the task?	ADAMS
5. Was anything you saw mistaken or misidentified?	ADAMS
6. Was any information misheard?	ADAMS
7. Did you fail to recognise information through touch?	ADAMS
8. Did you forget to do any stage of the task?	ADAMS
9. Did you fail to consider any other relevant factors?	ADAMS
10. Did you lose you place?	ADAMS
11. Did you see or hear information correctly, but misunderstood its meaning?	ADAMS
12. Did you choose/apply an incorrect solution	ADAMS
13. Did you choose/apply an inappropriate solution	ADAMS
14. Did you choose/apply part of a solution?	ADAMS
15. Did you think that you had the correct equipment/parts/procedures?	ADAMS
16. Did force of habit lead you to do a wrong action?	ADAMS
17. Were any of the following aspects a factor for you personally?	ADAMS
a. Physical fatigue	ADAMS
b. Mental fatigue	ADAMS
c. Low morale	ADAMS
d. Fear of failure	IRS
e. Lack of motivation	ISRS
f. Excessive work overload	IRS
g. Frustrated	ADAMS /Prototype 1
h. Worried about things at home	Prototype 1
i. Rushed	Prototype 1

3.3.7 Training & Skills

This section investigates the types of training that were lacking in each incident (e.g. training for special equipment). The items from this section were obtained from various sources including six from IRS, two from Prototype 1 and two from HPIP.

Table 3.9 Content and Origin of Training & Skills Topic Area

7. TRAINING & SKILLS	Origin
1. Were you provided with any training on how to perform the job?	IRS
2. If no, do you consider that training was required for the job?	Prototype 1
3. Did training prepare you for this situation?	HPIP
4. Were you provided with any training on how to use special equipment or tools?	IRS
5. Did you receive any training on the risk aspects of the job or situation?	IRS
6. Do you consider the training provided for the job was adequate?	Prototype 1
7. Were you evaluated upon completion of training to ensure you had the required skills?	IRS & HPIP
8. Had you practised the skills you learnt since the training?	HPIP
9. Was on-the-job training provided?	IRS
10. Have you had any refresher training ?	IRS
11. Do you think refresher training is needed?	P. Company

3.3.8 Supervision

This section investigates the level of supervision on the job, and the constitution of the supervisor (e.g. good motivator, sensitive to pressure). Most items in this section originate from Prototype 1, with three items from IRS.

Table 3.10 Content and Origin of Supervision Topic Area

8. SUPERVISION		Origin
1. Did the immediate supervisor provide adequate support during the work?		Prototype 1
2. What level of supervision was provided for the job?		Prototype 1
a. No supervision		Prototype 1
b. Direct supervision – present at worksite for whole/ part of the job		Prototype 1
c. Indirect supervision – present at job planning stage only		Prototype 1
d. Safety supervision only		Prototype 1
3. Was progress of the job adequately monitored?		IRS
4. Was the supervisor too involved in the job?		IRS
5. Was the job too complex?		IRS
6. Describe the supervision of the job		Prototype 1
a. Competent		Prototype 1
b. Gave good information	f. Not committed to safety	Prototype 1
c. Recognition of good work	g. Sensitive to pressure	Prototype 1
d. Good motivation	h. Fair with discipline	Prototype 1
e. Good man-management skills	i. Aggressive	Prototype 1

3.3.9 Communication

This section investigates problems in communication (e.g. was the message communicated in a timely manner) and between crew members, supervisors and other departments.

Table 3.11 Content and Origin of Communication Topic Area

9. COMMUNICATION	Origin
1. Was the message/briefing clear & concise, so you could understand it?	HPIP
2. Was the message communicated in a timely manner?	HPIP
3. Did you have the opportunity to ask questions?	P. Company
4. Was there poor communication:	ADAMS
a. within your team	ADAMS
b. between your supervisor and your team	ADAMS
c. between shift / rotation handovers	ADAMS
d. between related teams/departments	ADAM

3.3.10 Team Work

This section focuses on how team dynamics may have influenced the safety of the team (e.g. personnel are not familiar with each other; too few personnel are working on the job). Respondents were asked to describe the team they work with in terms of how well they know them, did they get on together and were there enough personnel to complete the job safely?

Table 3.12 Content and Origin of Team Work Topic Area

10. TEAM WORK	Origin
1. Has there been a change in your team members or leadership within the past 4 months?	P. Company
2. Were there enough workers allocated to the task?	ADAMS
3. In your opinion were the appropriate staff selected for the task?	ADAMS
4. Were any of the following a factor with your work group?	Prototype 1
a. Low morale	Prototype 1
b. Lack of motivation	Prototype 1
c. Poor communication	Prototype 1
d. Disagreements/hostility	Prototype 1
e. Unsafe working practices	Prototype 1
f. Discipline of crew	Prototype 1
g. Violations of practices	Prototype 1
h. Not willing to stand up to superiors	Prototype 1

3.3.11 Workplace Atmosphere

This section investigates respondents personal view of the safety culture on the installation at the time of the incident. These questions were included to get an impression of the atmosphere under which the incident took place.

Table 3.13 Content and Origin of Workplace Topic Area

11. WORKPLACE ATMOSPHERE	Origin
1. Do you feel that there is an open incident reporting culture at your place of work?	Mearns *et al* (1998)
2. Do you feel that people at your work place are punished for genuine slips or mistakes?	IRS
3. Are short cuts allowed/tolerated?	IRS
4. Would your company stop work due to safety concerns, even if it meant it would lose money?	Mearns *et al* (1998)
5. Are there recurrent violations of rules at your place of work?	IRS
6. Do employees believe other employees had been fired or not promoted because of expressing safety concerns?	HPIP

3.3.12 Preventing Recurrence

This section asks personnel to comment on what they would do differently to avoid the incident. This was taken from British Airways Human Factors Reporting Programme.

3.4 Pilot Studies

Prior to the WSFII being used on offshore installations, it was tested in three different ways to discover the fallacies and unnoticed assumptions in the designer's thinking and the respondent's understanding of the questions (Sinclair, 1975). All aspects of the questionnaire were tested: introductory passage, the questions, alternative answers and the form of the analysis. This was undertaken in three stages:

3.4.1 Individual criticism

A discussion of the form was undertaken with seven University colleagues who have experience of questionnaires. Comments generally covered issues regarding the content and layout. In addition, discussions with two personnel with offshore experience in the participating company added comments regarding the contents of the form.

3.4.2 In-depth interviewing

A small sample of respondents (n=30) was interviewed for their reactions toward the WSFII. Respondents were asked to read through an accident scenario and to complete the questionnaire as if they were one of the people involved in the incident. Each respondent was then questioned in

detail about the answers to the questions, to ascertain that the respondent understood the questions and the exact meaning of the responses given.

3.4.3 Larger sample

In order to detect whether any invalid or meaningless patterns of answers are occurring the form was sent offshore to be used with actual incidents. This will enable estimates of the reliability and validity of the questionnaire to be made. This stage should be repeated until the questionnaire appears to be error free. The results from this section are discussed in the following section.

3.5 Data Collection

The WSFII was distributed to five offshore installations operated by one oil company. After an incident, involved personnel were asked by the Safety Advisor to complete a WSFII. The WSFIIs were sent onshore, along with the Original Report, for final comments by the onshore safety team. Over a period of 5 months (April-August, 1999), 52 incidents were reported. Copies of every incident report were made and given to the Aberdeen University researcher for analysis. This report will focus on only those incidents where personnel were asked to complete a WSFII. Out of the 52 incidents, 19 (37%) used the WSFII and a total of 28 WSFIIs were completed. Of these 19 incidents only 10 incidents could be used for analysis, due to either: (i) the forms only being completed partially (e.g. narrative descriptions only) or (ii) the incident was caused by a technical problem with no human interaction.

The 10 Original Reports and WSFIIs (n=18) were read thoroughly and models of the causal factors were drawn (see Appendix D). Information from the models was then summarised into individual Case Study diagrams (in section 3.7) and evaluations of whether or not the WSFII has added any useful information to the incident report have been described. The second section (3.8) summarises the findings from the WSFII and the original reports. The third section (3.9) takes each section of the WSFII in turn, briefly describes the results from the 10 incidents, their usefulness for providing human factors data, any problems with the section and finally possible analysis which could be undertaken. Finally conclusions of the assessment of the WSFII will be made (3.10).

3.6 Individual Case Studies

The aim of this section is to assess the WSFII in terms of its ability to generate further human factors data for incident investigation. The 10 incidents have been analysed as individual case studies and have been described in writing and displayed diagrammatically. Each case study includes the following information:

(i) Brief description of the event
(ii) Immediate and underlying causes from the original report
(iii) Remedial actions for the original report
(iv) Links between the original reports causes and remedial actions
(v) Findings from the WSFII (actions & influences)
(vi) Link between WSFII actions & influences and the remedial actions

3.6.1 Case Study One

The original report for this incident (*Classification*: Property Damage, *Potential Severity*: B3 Caution) found that *no unsafe act* and *no unsafe condition* contributed to the incident. The two underlying causes which were identified to have contributed to this incident were the poor *engineering/ design* and *inadequate maintenance/ inspection*. The WSFII found four additional human factors causes to the original report form. The results from the WSFII are summarised below:

1. The person involved in the incident reported that they had applied or chosen the wrong solution to a problem. Although it is not clear from the respondent's narrative description which wrong solution they applied, this piece of information may be important to the investigation and should be followed up to clarify the meaning.

2. Although many of the *planning* tasks were undertaken (risk assessment, site visit, job walkthrough) one of the respondents indicated that a tool box talk had not been undertaken.

3. A respondent indicated that the *job* was repetitive.

4. No refresher training was undertaken, although this was not thought to be necessary in the circumstances.

The remedial actions were found to address the two underlying causes found in the original report, however none of the causes found in the WSFII were addressed.

Case Study One Diagram.

INCIDENT DESCRIPTION:

During routine operation of vessel heading change, Turret turning gripper assembly failed allowing the gripper to fall from the rail, onto the deck approximately 2.5 cm below damaging A Turret bearing jack and small bore hydraulic tubing. Approximate combined weight of the ram and gripper is 6 tonnes

FINDINGS FROM ORIGINAL REPORT

UNSAFE ACTS	NONE
UNSAFE CONDITIONS	NONE
UNDERLYING CAUSES	ENGINEERING/ DESIGN
	MAINTENANCE/ INSPECTION

FINDINGS FROM WSF II

PERSON	CHOSE/ APPLIED WRONG SOLUTION
PLANNING	NO TOOL BOX TALK
JOB	TASK WAS REPETITIVE
TRAINING	NO REFRESHER TRAINING

REMEDIAL ACTIONS FROM ORIGINAL REPORT

A. TURRET BEARING AREA BELOW GRIPPER RAIL TO BE MADE A CONTROLLED AREA TO RESTRICT ACCESS

B. GVI OF GRIPPERS AND REDUCE OPERATING PRESSURE BY 50% TO 125 BARG PRIOR TO RECOMMISSIONING

C. INSPECTION OF ALL MAJOR MECHANICAL COMPONENTS OF TURRET TURNING & LOCKING SYSTEM

D. REVIEW OF SYSTEM OPERATION & LIMITATIONS

E. EXPEDITE REPLACEMENT/ REPAIR OF FAILED EQUIPMENT

LINKS BETWEEN WSFII FINDINGS, ORIGINAL REPORT FINDINGS AND REMEDIAL ACTIONS

PERSON (ACTION)
The wrong solution was applied/chosen because:
Planning. a tool box talk was not undertaken
Training. no refresher training
Job Factors. the task was repetitive, they felt familiar with it, and they took for granted that everything was going to work fine. The remedial actions did not address any person actions

PLANNING.
The original report did not identify planning as a contributing factor. However the WSFII found that there was no tool box talk undertaken. The remedial actions did not address any planning problems

JOB FACTORS.
The original report did not identify job factors as a problem. The WSFII found that the task was repetitive. However the job factor was not addressed in the remedial actions.

TRAINING.
The original report did not identify training as a contributing factor. The WSFII identified a lack of refresher training. Training was not addressed in the remedial actions.

LINKS BETWEEN ORIGINAL REPORT FINDINGS AND REMEDIAL ACTIONS

The remedial actions address the original report's underlying causes. Engineering/ Design, Maintenance and Inspection problems.

Action A does not relate to any of the causes in the original report, but addresses the work environment.

Actions B and D does not relate to any of the causes in the original report, but addresses changing the procedures

Actions C relates to Inspection

Action E relates to the Engineering/Design problems (failure of equipment) and Maintenance.

All the findings from the original report were addressed in the remedial actions.

3.6.2 Case Study Two

The original report for this incident (*Classification*: First Aid Case, *Potential Severity*: B3 Caution) found that the person involved in the incident *failed to follow the procedures* and *failed to wear the appropriate PPE*. The unsafe condition that contributed to this incident was *lack of suitable ventilation*. The two underlying causes that were identified to have contributed to this incident were the *inadequate risk assessment* and the *inadequate job instruction*. The WSFII found eight additional human factors causes to the original report form. The results from the WSFII are summarised below:

1. The people involved in the incident reported that their attention was divided across many tasks, their attention was too focused on one aspect of the task and that they failed to consider other relevant factors. Workers' may have failed to consider other relevant factors because their attention was divided across many tasks or because their attention was too focused on one aspect of the task. Poor planning, procedures, supervision or the job factors (see bullet points below) may also have contributed to the incident. Workers attention may have been divided across tasks or was too focused on one task because the job was performed infrequently and that it was a lengthy task. Further clarification of these points are needed which could be resolved with an additional interview with the respondents. One of the remedial actions in the original report (B) addressed the problem of workers failing to consider other relevant factors.
2. As found in the original report, *equipment* was not used properly. Personnel reported not wearing the appropriate PPE and that the extractor fan was not suitable for the job. Both issues were addressed in the remedial actions (D, A&B).
3. Although many of the *planning* tasks were undertaken (PTW, verbal instruction, tool box talk) both respondents indicated that a risk assessment had not been undertaken (as did the original report) nor a site visit or job walk through. These issues were addressed in one of the remedial actions (B).
4. Where the original report found that the *procedures* were not followed, the WSFII found that written work practices were not available (nor were they thought to be necessary by the respondents). This was addressed to some extent in one of the remedial actions (A), although the unavailability of the work practices was not addressed.
5. The WSFII found that the *supervisor* did not provide adequate support, which was also identified in the original where job instruction was not adequate. This issue was not addressed in the remedial actions.
6. Respondents indicated that the *job* was performed infrequently and was lengthy. These issues were not addressed in the remedial actions.
7. No training was undertaken, although this was not thought to be necessary by the respondents in the circumstances. One of the remedial actions addressed this issue (A).

Case Study Two Diagram.

INCIDENT DESCRIPTION:

Person used an angle grinder to remove excess foam buoyancy from a subsea bung after attempts to use handtools had failed. When changing cutting disc he realised that the workshop had filled with smoke given off by the foam. He then donned a protective mask, but had been breathing the fumes for 10-15 mins.

FINDINGS FROM ORIGINAL REPORT

UNSAFE ACTS	FAILURE TO FOLLOW PROCEDURES
	FAILURE TO USE APPROPRIATE PPE
UNSAFE CONDITIONS	VENTILATION
UNDERLYING CAUSES	RISK ASSESSMENT JOB INSTRUCTION

FINDINGS FROM WSF II

PERSON	ATTENTION DIVIDED ACROSS MANY TASKS; ATTENTION TOO FOCUSED ON ONE ASPECT; FAILED TO CONSIDER OTHER RELEVANT FACTORS
EQUIPMENT	WEARING UNSUITABLE PPE EXTRACTOR FAN NOT SUITABLE
PI ANNING	NO RISK ASSESSMENT UNDERTAKEN
PROCEDURES	WORK PRACTICES NOT AVAILABLE
SUPERVISION	SUPERVISOR DID NOT PROVIDE ADEQUATE SUPPORT
JOB	JOB PERFORMED INFREQUENTLY; LENGTHY TASK
TRAINING	TRAINING NOT PROVIDED

REMEDIAL ACTIONS FROM ORIGINAL REPORT

A. REVIEW PTW TRAINING REQUIREMENTS

B. REINFORCE THE NEED TO BE AWARE OF CHANGING CONDITIONS & REASSESSMENT OF TASKS AFTER CHANGE

C. VERIFY EFFECTIVENESS OF MECHANICAL WORKSHOP LOCAL EXHAUST VENTILATION

D. CONSIDER ISSUING A SAFETY ALERT REFERENCE OF THE HAZARDS BY HEATING CURED FOAM MATERIALS

LINKS BETWEEN THE WSFII & ORIGINAL REPORT

PERSON
The person's attention was divided across many tasks (Not addressed in the remedial actions), perhaps because:
Job performed infrequently and is a lengthy task
The person failed to consider the other relevant factors (Addressed in the remedial actions-Action B) because:
Person too focused on one aspect of the task
Planning there was no risk assessment
Procedures were not available for the job
Supervision did not provide adequate support
Job performed infrequently.

EQUIPMENT
The original report identified the equipment problems as the ventilation (unsafe condition) and wearing inappropriate PPE (unsafe act), which is also what the WSFII found. These issues were addressed in the remedial actions (Actions A&B- ventilation system; Action D: PPE).

PLANNING
The original report identified risk assessment as an underlying cause, which was also found in the WSFII. This issue, was addressed in Remedial Action B.

TRAINING
Although the original report did not identify training as a contributing factor (it was mentioned in the WSFII), it was addressed in Remedial Action A.

LINKS BETWEEN THE ORIGINAL REPORT FINDINGS AND THE REMEDIAL ACTIONS

The original report's remedial actions address some of the causes found in the original report and brings up some further issues:
Action A (review of PTW training requirements) is attempting to improve upon the unsafe act (failure to follow procedures)
Action B is attempting to take on the unsafe condition (ventilation) by encouraging personnel to be more aware of their environment (situational awareness). This action also emphasizes one of the underlying causes (no risk assessment) which is required when the tools and method of work is changed from the original plan.
Action C involves an inspection of the ventilation system, relating to the unsafe condition (ventilation).
Action D is being considered in order to inform personnel of the hazards of the specific job and perhaps ties in with unsafe act: failure to use appropriate PPE.

PROCEDURES
The original report identified that the procedures were not followed (unsafe act), whereas the WSFII found that the work practices were not available. Perhaps this is due to the job being performed infrequently. This issue was addressed to some degree in remedial action A, although the unavailability of the work practices was not addressed.

SUPERVISION
The original report identified an inadequacy in the Job Instructions (underlying cause), which was also picked up in the WSFII, where the supervisor did not provide adequate support. This issue was also not addressed in the remedial actions.

JOB
The original report did not identify job factors to be a cause of the incident. However, the WSFII mentioned that the job was performed infrequently & that it was lengthy. This issue was not addressed in the remedial actions (perhaps difficult to address).

3.6.3 Case Study Three

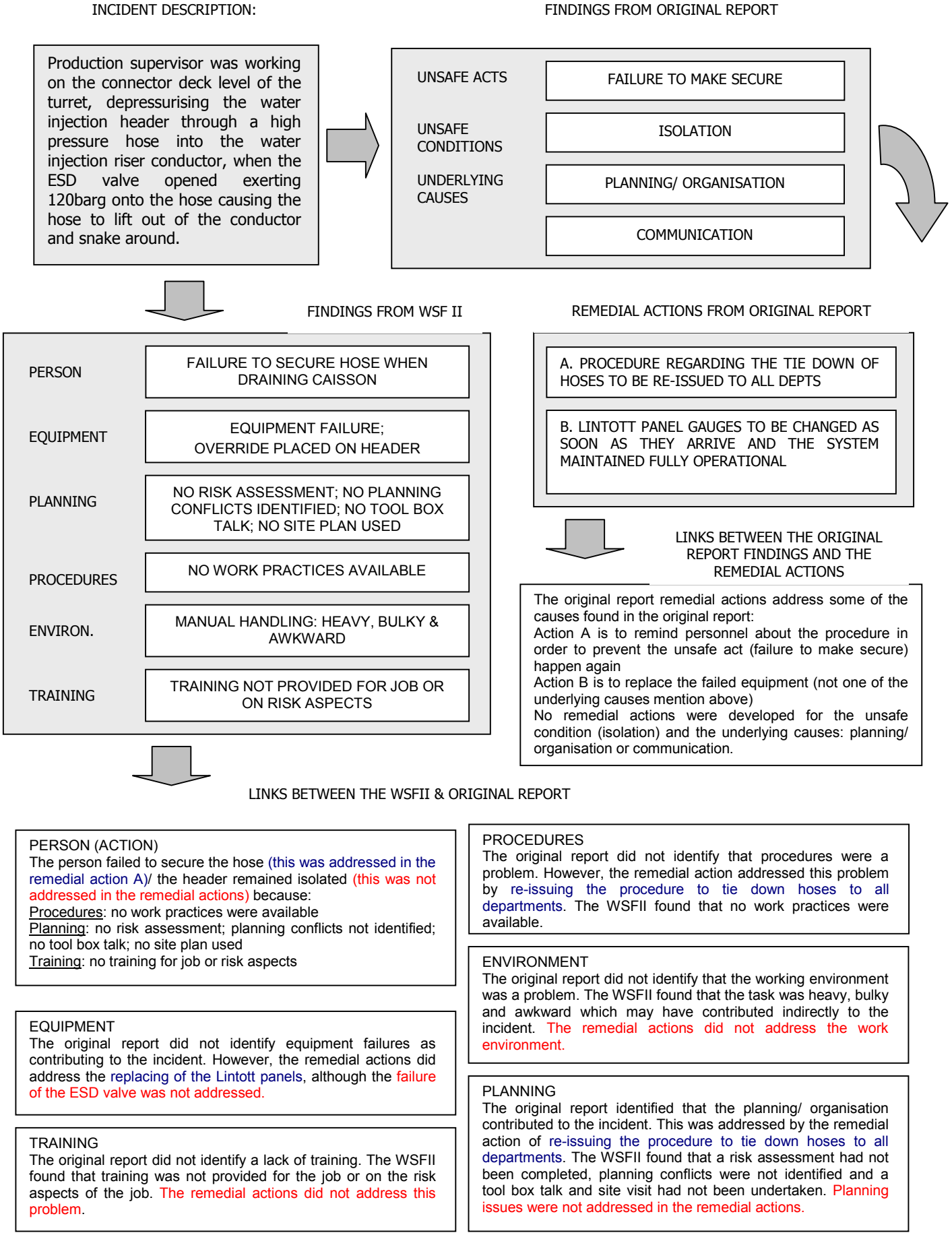
The original report for this incident (*Classification*: Near Miss, *Potential Severity*: B3 Caution) found that the person involved in the incident *failed to make the hose secure* and that the system was not *isolated* (unsafe condition). The two underlying causes which were identified as contributing to the incident were *poor planning/ organisation* and *communication*. The WSFII found 11 additional human factors causes than the original report form. The results from the WSFII are summarised below:

The people involved in the incident reported that they failed to secure hosing (from Narrative Description). This may have occurred because of inadequate planning, procedures or training (see bullet points below). One of the remedial actions addressed this issue (A). Personnel also mentioned that the hydraulics should have been isolated to prevent the opening of a valve, which was mentioned in the original report (as an unsafe condition), however it was not addressed in the remedial actions.

1. As found in the original report, *equipment* failure was found to contribute to the incident. Personnel reported failure of Lintott panel gauges and the ESD valve. The Lintott panel gauge issue was addressed in the remedial actions, however, the ESDV failure was not addressed.
2. As found in the original report, poor *planning* was found to contribute to the incident. The WSFII found that no risk assessment was carried out, no planning conflicts identified, no tool box talk and no site visit undertaken. These issues were not addressed in remedial actions.
3. The WSFII found that written work practices were not available, although a copy of how it was carried out the year before was held by the supervisor and was followed. This was addressed in one of the remedial actions (A).
4. The WSFII found that regarding the *work environment* the manual handling of the task was heavy, bulky and awkward. This issue was not addressed in the remedial actions.
5. No *training* was provided for the job, although this was not thought to be necessary by the respondents in the circumstances. However training for the risk aspects of the job was not provided but was thought to be required. The remedial actions did not address this issue.

Summary of the factors not addressed in remedial actions: planning (no risk assessment, planning conflicts not identified, no tool box talk & no site visit); manual handling (heavy, bulky & awkward) and training. The original report found poor communication as an underlying cause, which was not picked up in the WSFII.

Case Study Three Diagram.



3.6.4 Case Study Four

The original report for this incident (*Classification*: Property Damage, *Potential Severity*: B3 Caution) found that *no unsafe act* and *no unsafe condition* contributed to this incident. The two underlying causes which were identified as contributing to this incident were the *vibration leading to fracture* and *lack of bracing and support of line*. The WSFII found three additional human factors causes to the original report form about what happened after the equipment failure was realised, which could be used to investigate the nature of the incident's further underlying causes. The results from the WSFII are summarised below:

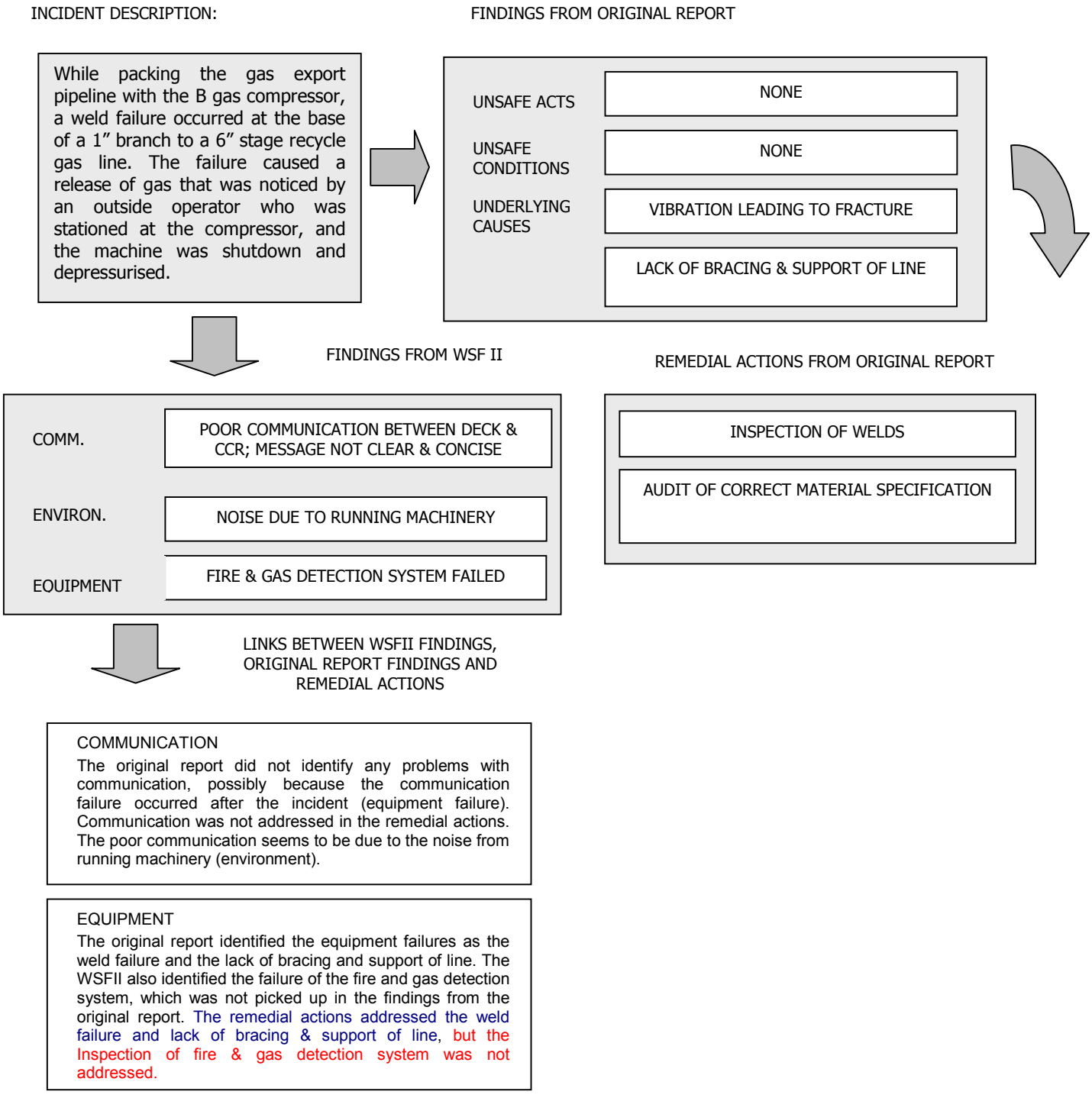
1. The person involved in the incident reported that *communication* between the deck and CCR was poor and that the message was not clear and concise (due to the noise of the running machinery). Communication was not addressed in the remedial actions, as it was not the cause of the incident, however, poor communication could have exacerbated the problem.

2. *Equipment* failure was found to contribute to the incident (weld failure and lack of bracing & support of line) which was identified in the original report addressed in one of the remedial actions. The WSFII identified the failure of the fire and gas detection system, however, this failure was not addressed in the remedial actions.

3. The WSFII found the *work environment* to be noisy. This issue was not addressed in the remedial actions. Information of this type could be used by planners and design engineers (see following sections for further discussion).

Summary of the factors not addressed in remedial actions: communication (message not clear & concise); and equipment (failure of fire & gas detection system).

Case Study Four Diagram.



3.6.5 Case Study Five

The original report for this incident (*Classification*: Near Miss, *Potential Severity*: B2) an unsafe condition (*equipment failure*) contributed to this incident (*no unsafe act* was found). The underlying cause which was identified to have contributed to this incident was poor *maintenance/ inspection*. The WSFII found nine additional human factors causes to the original report form. The results from the WSFII are summarised below:

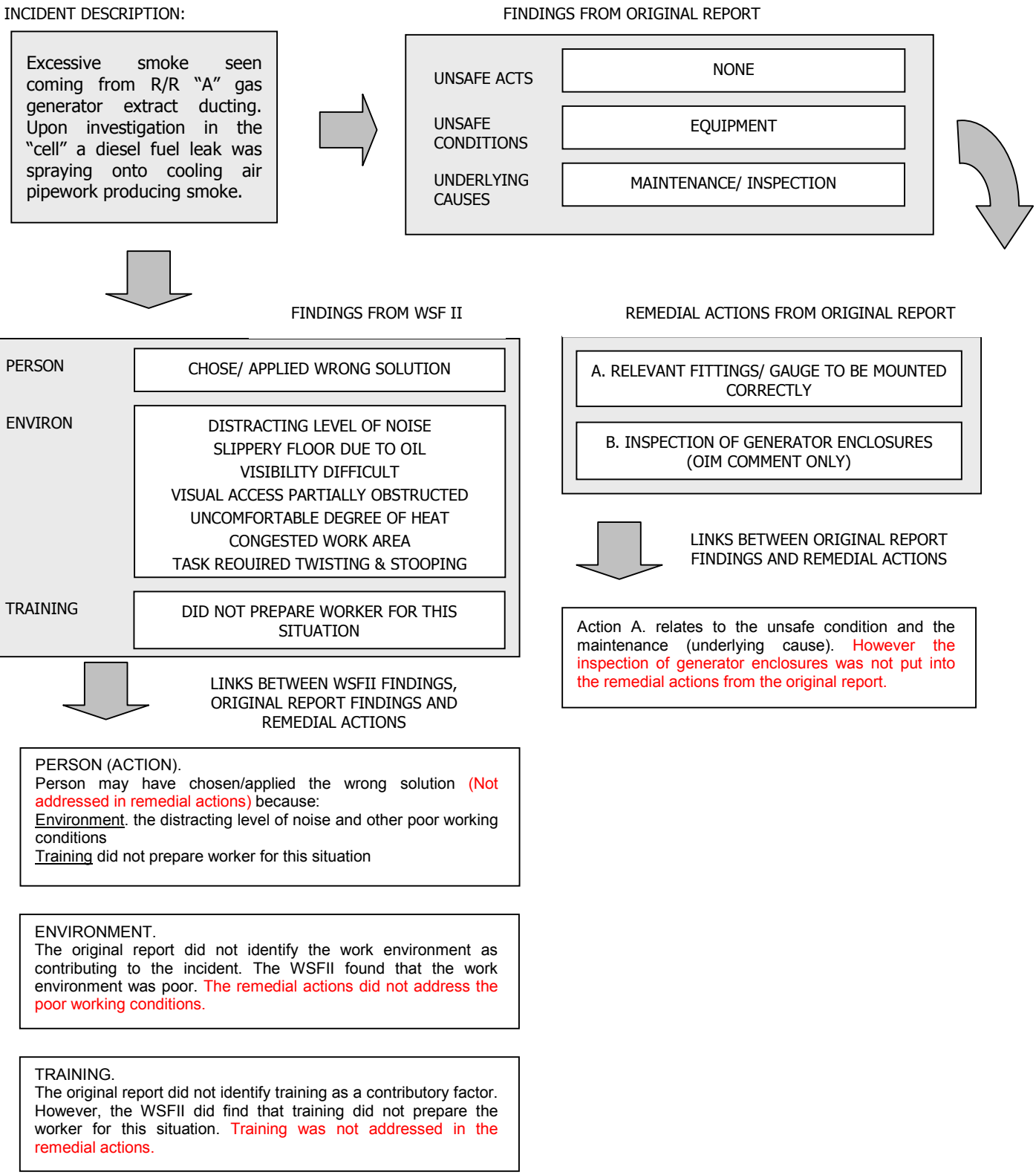
The person involved in the incident reported that they chose/applied the wrong solution to the problem. The poor work environment or lack of training (see bullet points below) may have contributed to this wrong decision being made. The remedial actions did not address this issue.

The person involved in the incident reported a poor *work environment*, where the level of noise was distracting, the floor was slippery due to oil, visibility was difficult, visual access was partially obstructed, there was an uncomfortable degree of heat, the work area was congested and the task required twisting and stooping. None of these issues were addressed in the remedial actions.

The WSFII found that training did not prepare the worker for this situation. The remedial actions did not address this issue.

Summary of the factors not addressed in remedial actions: chose/applied wrong solution, work environment (noise, slippery floor, poor visibility, heat, congested work area, task required twisting & stooping) and training.

Case Study Five Diagram.



3.6.6 Case Study Six

The original report for this incident (*Classification*: Environment, *Potential Severity*: A1) found that the person involved in the incident *failed to follow procedures* (unsafe act) and the unsafe condition (*vent line was not cleared of residual barite*) contributed to this incident. The underlying cause of the incident was identified as *poor procedures*. The WSFII found three additional human factors causes to the original report form. The results from the WSFII are summarised below:

The WSFII found that *planning* was inadequate, where no risk assessment was carried out, no planning conflicts identified and no tool box talk was undertaken. These issues were not addressed in remedial actions.

1. As found in the original report, the WSFII found that the *work environment* was not adequate (vent line not cleared), which was not addressed in the remedial actions.

2. The unsafe act (failure to follow procedures) and the underlying cause (inadequate procedures) which were identified in the original report were not picked up by the WSFII. This may be due to the person not willing to admit to violating the procedures. The remedial actions concentrated mainly on this issue.

Summary of the factors not addressed in remedial actions: planning (no risk assessment, planning conflicts not identified, no tool box talk); work environment (vent line not cleared).

Case Study Six Diagram.

INCIDENT DESCRIPTION:

A supply vessel was alongside an installation attached by bunkering hoses discharging diesel when drilling operations vented barite over the vessel.

FINDINGS FROM ORIGINAL REPORT

UNSAFE ACTS	FAILURE TO FOLLOW PROCEDURES
UNSAFE CONDITIONS	VENT LINE NOT CLEARED OF RESIDUAL BARITE
UNDERLYING CAUSES	PROCEDURES

FINDINGS FROM WSF II

PLANNING	PLANNING CONFLICTS NOT IDENTIFIED RISK ASSESSMENT NOT CARRIED OUT TOOL BOX TALK DID NOT TAKE PLACE
ENVIRON.	BARITE STILL IN DELIVERY LINE FROM PREVIOUS OPERATION

REMEDIAL ACTIONS FROM ORIGINAL REPORT

A. ALL SUPERVISORS TO READ AND UNDERSTAND WORK GUIDANCE PROCEDURE ON BULK TRANSFER PROCEDURE AND REITERATE TO ALL DRILLING CREW VIA TOOL BOX TALKS AND WEEKLY SAFETY MEETINGS.

B. PROCEDURE TO BE DISPLAYED PROMINENTLY IN GENERATOR ROOMS

C. WRITTEN WORK INSTRUCTION TO BECOME OTHER PLATFORMS WORK INSTRUCTION FOR USE BY CONTROL ROOM

LINKS BETWEEN WSFII FINDINGS, ORIGINAL REPORT FINDINGS AND REMEDIAL ACTIONS

PLANNING.
The original report did not address planning problems, however it did address the procedures (unsafe act: failure to follow procedures and underlying cause: procedures). A possible reason why the procedures were not followed were because the planning stage was brief: The WSFII identified the following planning problems: planning conflicts were not identified, a risk assessment was not undertaken, nor was a tool box talk. These planning issues were not addressed in the remedial actions.

ENVIRONMENT.
The original report identified the unsafe condition (vent line not cleared of residual barite), however, this work environment issue was not addressed in the remedial actions.

LINKS BETWEEN ORIGINAL REPORT FINDINGS AND REMEDIAL ACTIONS

The remedial actions in the original report address the unsafe act (failure to follow procedures), the unsafe condition (venting barite) and the underlying cause (procedures) found in the original report.
ACTIONS A, B and C are all about highlighting the procedures in different ways: at safety meetings, via tool box talks; on notice boards; and to other similar platforms.

3.6.7 Case Study Seven

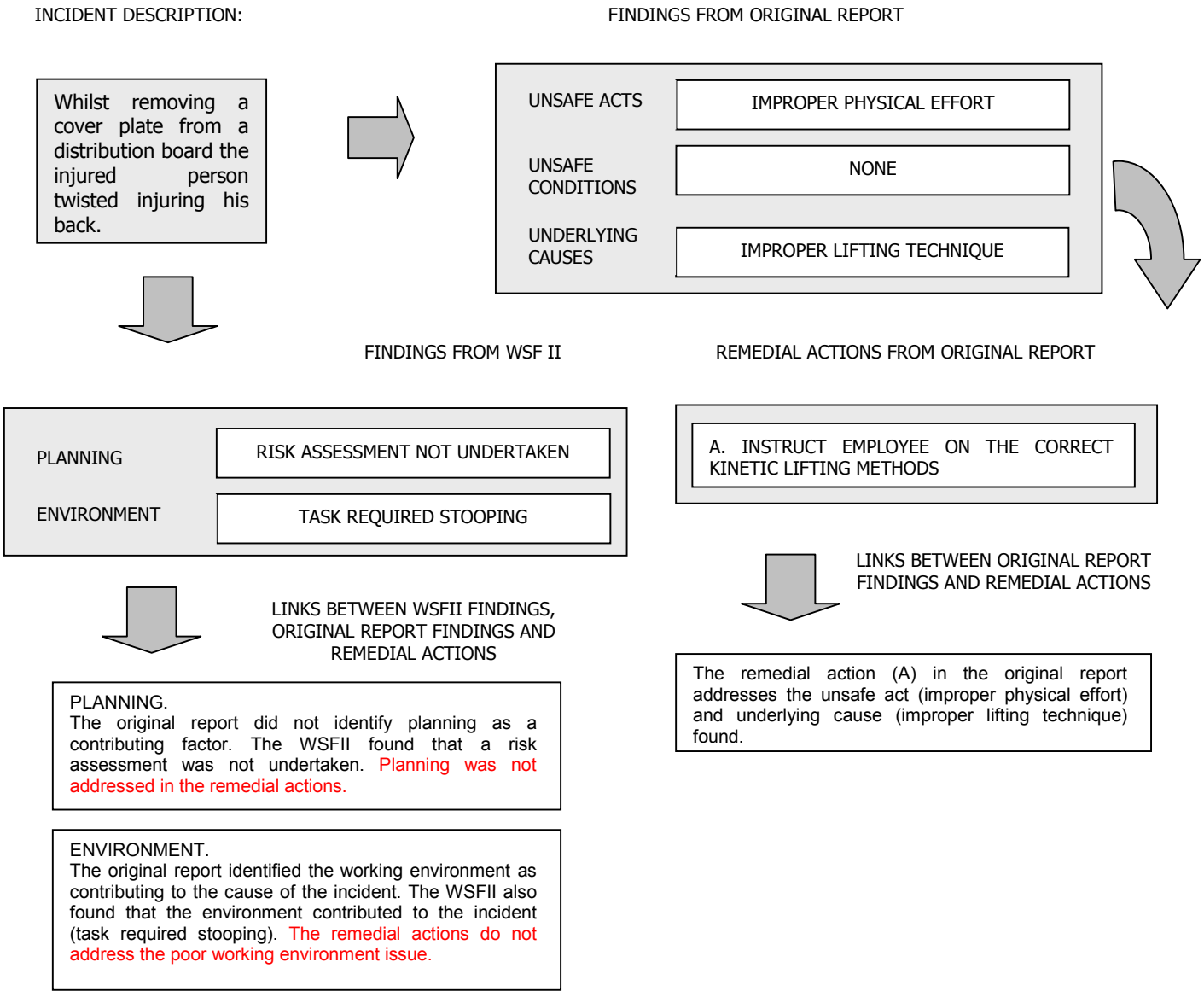
The original report for this incident (*Classification*: Restricted Work Case, *Potential Severity*: B1 Care) found that the person involved in the incident carried out an *improper physical effort* and used an *improper lifting technique* (underlying cause). The WSFII found two additional human factors causes to the original report form. The results from the WSFII are summarised below:

1. The WSFII found that *planning* was inadequate, where no risk assessment was carried out. This issue was not addressed in the remedial actions.

2. As found in the original report, the WSFII found that the *work environment* was not adequate, since the job required stooping. This issue was addressed in the remedial actions, where the person was counselled on the correct lifting method.

Summary of the factors not addressed in remedial actions: planning (no risk assessment)

Case Study Seven Diagram.



3.6.8 Case Study Eight

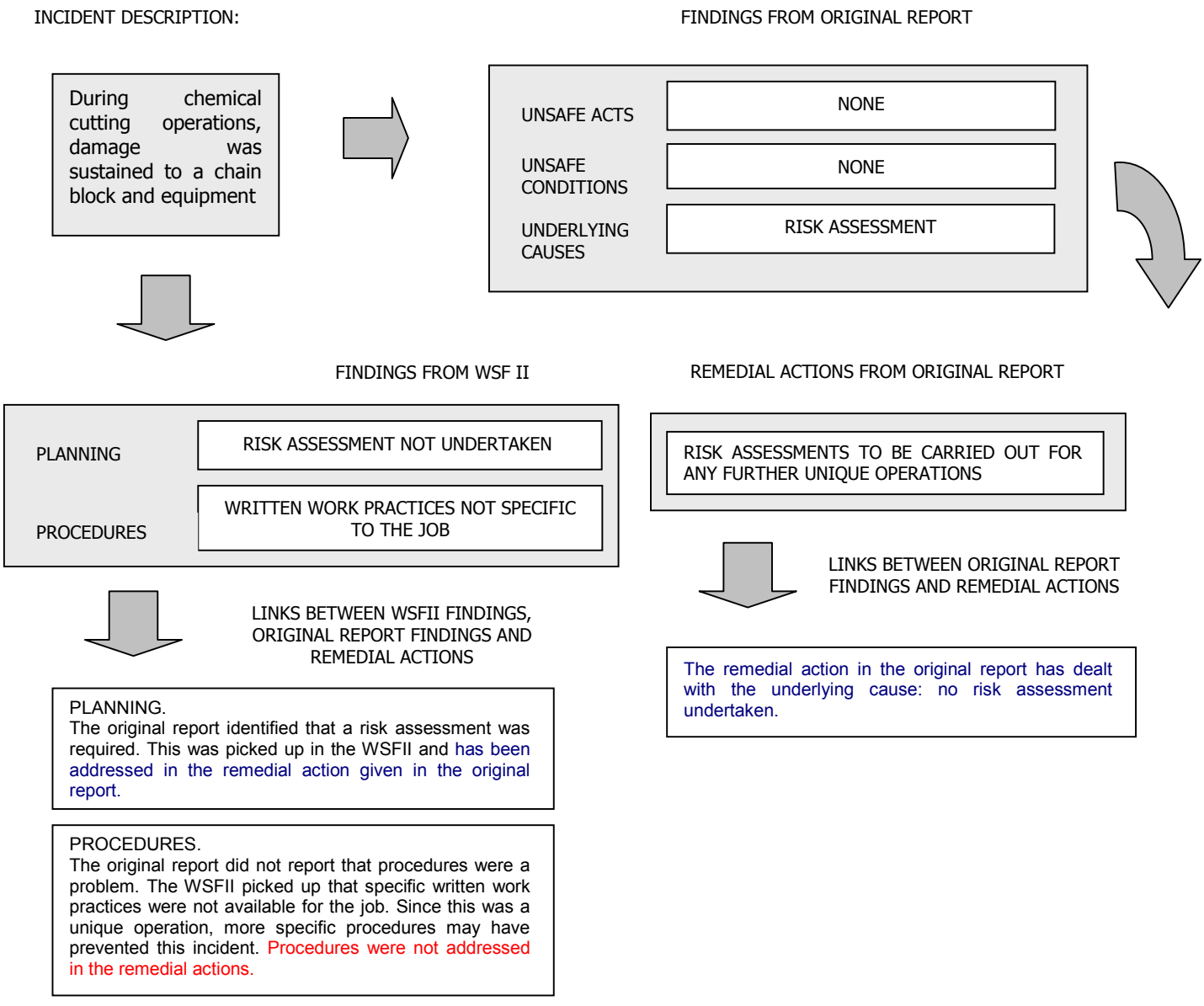
The original report for this incident (*Classification*: Property Damage, *Potential Severity*: A1 Care) found that there were *no unsafe acts or conditions* and the underlying cause was identified as *risk assessment*. The WSFII found an additional cause to the original report form. The results from the WSFII are summarised below:

1. As did the original report, the WSFII found that *planning* was inadequate, where no risk assessment was carried out. This issue was addressed in the remedial actions (A).

2. The WSFII found that written work practices were not specific to the job. This was not addressed in the remedial actions.

Summary of the factors not addressed in remedial actions: written work practices (not specific to the job).

Case Study Eight Diagram.



3.6.9 Case Study Nine

The original report for this incident (*Classification*: Environment, *Potential Severity*: A1) found that the person involved in the incident *failed to make the site secure* (unsafe act) and *failed to isolate the area* (unsafe condition). The two underlying causes which were identified were the inadequate *engineering/ design* and the *labelling misleading*. The WSFII found 10 additional human factors causes to the original report form. The results from the WSFII are summarised below:

1. Although many of the *planning* tasks were undertaken (PTW, tool box talk, duties & tasks clearly explained) the respondents indicated that a risk assessment had not been undertaken, planning conflicts were not identified before the work was started and controls were not sufficient to reduce the risk to ALARP. These issues were not addressed in the remedial actions.

2. The WSFII found that the *work environment* was not adequate, where the job required reaching upwards and keeping the same position, the work area was congested, physical access difficult, poor ventilation, visual access partially obstructed. These issues were not addressed in the remedial actions, where the person was counselled on the correct lifting method. A work environment issue which was picked up in the original report, but not in the WSFII was the mislabelling of the fire & gas panel. This was addressed in remedial actions (B & C).

3. The WSFII found that written work practices were not available. This was addressed to some extent in one of the remedial actions (A), although the unavailability of the work practices was not addressed.

4. Respondents indicated that the *job* was new or had changed. These issues were not addressed directly in the remedial actions, although remedial action A may train personnel who are not familiar with the job.

5. As found in the original report, failure of the *equipment* contributed to the incident, personnel reported (in the WSFII Narrative Description) that the fire & gas panel was inhibited, so that there was no change in the warning alarms or change in platform status lights. This issue was addressed in the remedial actions.

Summary of the factors not addressed in remedial actions: planning (no risk assessment, planning conflicts not identified); written work practices (not available), work environment (job requires reaching upwards / keeping the same position, congested work area, physical access difficult, poor ventilation, visual access partially obstructed) and job was new/changed.

Case Study Nine Diagram.

INCIDENT DESCRIPTION:

Halon 'A' was accidentally discharged in PT compartment whilst welding repairs were being carrying out.

FINDINGS FROM ORIGINAL REPORT

UNSAFE ACTS	FAILURE TO MAKE SECURE
UNSAFE CONDITIONS	ISOLATION
UNDERLYING CAUSES	ENGINEERING/ DESIGN
	LABELLING MISLEADING

FINDINGS FROM WSF II

PLANNING	RISK ASSESSMENT NOT UNDERTAKEN PLANNING CONFLICTS NOT IDENTIFIED CONTROLS NOT SUFFICIENT TO REDUCE RISK TO ALARP
PROCEDURES	NO WORK PRACTICES AVAILABLE OR USED FOR THE JOB
ENVIRONMENT	TASK REQUIRES REACHING UPWARDS & KEEPING SAME POSITION CONGESTED WORK AREA PHYSICAL ACCESS; VENTILATION VISUAL ACCESS PARTIALLY OBSTRUCTED
JOB	JOB NEW/ CHANGED
EQUIPMENT	FIRE CONTROL PANEL INHIBITED NO WARNING, ALARMS OR CHANGE IN PLATFORM STATUS LIGHTS

REMEDIAL ACTIONS FROM ORIGINAL REPORT

A. ALL RELEVANT PERSONNEL TO BE GIVEN REFRESHER TRAINING ON THE FIRE & GAS PANEL RELATING TO INHIBIT PROCEDURE

B. INHIBIT LISTING SHEET TO BE AMMENDED TO REFLECT CORRECT LABELLING

C. FIRE & GAS PANEL LABEL TO BE AMMENDED TO REFLECT ACTUAL PLATFORM AREA

D. SAFETY CHECK LIST TO REFLECT HALON LOCK OFF SWITCHES TO BE IMPLEMENTED WHEN PERSONNEL WORKING WITHIN COMPARTMENTS

LINKS BETWEEN ORIGINAL REPORT FINDINGS AND REMEDIAL ACTIONS

The remedial actions address all the findings from the original report:
Action A deals with both the unsafe act (failure to make secure) and the unsafe condition (isolation) by giving personnel refresher training.
Actions B & C deal with the underlying cause: labelling misleading.
Action D addresses the engineering/ design problem by implementing a safety checklist for people working within compartments.

LINKS BETWEEN WSFII FINDINGS, ORIGINAL REPORT FINDINGS AND REMEDIAL ACTIONS

PLANNING.
The original report did not identify planning as a problem. The WSFII found that in addition to other planning problems, a risk assessment was not carried out. The remedial actions did not address the planning of the job, unless the refresher training (Action A) will address this problem.

PROCEDURES.
The original report did not find that there was a problem with the procedures. The WSFII found that there were no work practices available or used for the job. The remedial actions did not address this procedure problem.

ENVIRONMENT.
The original report identified labelling as misleading as an underlying cause. This was addressed in the remedial actions B and C. The WSFII picked up some other work environment problems. These, however, were not addressed in the remedial actions.

JOB.
The original report did not identify the job as contributing to the incident. The WSFII found that the job was new or had changed. The remedial actions did not directly deal with this problem, however, the refresher training in Action A may address this problem.

EQUIPMENT.
The original report identified engineering/ design as an underlying cause. Remedial Actions C & D addressed this problem. The WSFII found these equipment problems as well

3.6.10 Case Study Ten

The original report for this incident (*Classification*: Medical Treatment Case, *Potential Severity*: B2 Care) found that an unsafe act (*inattention*) and an unsafe condition (inadequate *visual contact*) contributed to this incident. The two underlying causes which were identified to have contributed to this incident were *poor planning/ organisation* and *communication*. The WSFII found 10 additional human factors causes to the original report form. The results from the WSFII are summarised below:

The people involved in the incident reported that their attention was too focused on one aspect of the task. This may be because of lack of poor work environment, planning, job factors or training (see bullet points below). This factor was not addressed in the remedial actions.

1. As found in the original report, the WSFII found that regarding the *work environment* the manual handling of the task was bulky and awkward, unstable and unpredictable, physical access was partially obstructed and the task requires reaching up/outwards. These issues were not directly addressed in the remedial actions, although training [in methods of safeguarding against poor working conditions] was mentioned in the remedial actions.

2. As found in the original report, poor *planning* was identified as contributing to the incident. Although a risk assessment and a tool box talk were undertaken, the WSFII found that planning conflicts were not identified, no site visit or job walk through were performed. These issues were not addressed in the remedial actions.

3. Respondents indicated that the *job* was performed infrequently and was new or had changed. These issues were not addressed in the remedial actions.

4. Training did not prepare workers for this situation and no training with special tools was given. A remedial action addressed this issue (B).

Summary of the factors not addressed in remedial actions: attention was too focused on one aspect, planning (planning conflicts not identified, no site visit, no job walk-through); work environment (manual handling: bulky/awkward, unstable and unpredictable, physical access partially obstructed, task requires reaching upwards/outwards) and job was performed infrequently and was new/changed.

Case Study Ten Diagram.

INCIDENT DESCRIPTION:

Worker sustained a crush injury to thumb while installing/ guiding a coil tubing injector head assembly (4 ton) onto transit frame landing spigots.

FINDINGS FROM ORIGINAL REPORT

UNSAFE ACTS	INATTENTION
UNSAFE CONDITIONS	VISUAL CONTACT
UNDERLYING CAUSES	PLANNING/ ORGANISATION
	COMMUNICATION

FINDINGS FROM WSF II

PERSON	ATTENTION TOO FOCUSED ON ONE ASPECT OF THE TASK
ENVIRONMENT	MANUAL HANDLING: BULKY/ AWKWARD; UNSTABLE & UNPREDICTABLE; PHYSICAL ACCESS PARTIALLY OBSTRUCTED; TASK REQUIRES REACHING UP/OUTWARDS
PI ANNING	PLANNING CONFLICTS NOT IDENTIFIED SITE VISIT & JOB WALKTHROUGH NOT USED
JOB	JOB PERFORMED INFREQUENTLY; NEW/ CHANGED
TRAINING	TRAINING DID NOT PREPARE WORKERS FOR THIS SITUATION; NO TRAINING WITH SPECIAL TOOLS

LINKS BETWEEN WSFII FINDINGS, ORIGINAL REPORT FINDINGS AND REMEDIAL ACTIONS

REMEDIAL ACTIONS FROM ORIGINAL REPORT

A. EMPLOYEE TO BE COUNSELLED ON RETURN TO DUTY AS TO THE METHOD OF GUIDING LIFT

B. TRAINING REQUIREMENT TO BE IDENTIFIED, AGREED & CARRIED OUT

C. REMINDER OF USING TAG LINES FOR GUIDING LOAD TO BE GIVEN AT SAFETY MEETINGS

LINKS BETWEEN ORIGINAL REPORT FINDINGS AND REMEDIAL ACTIONS

The remedial actions from the original report address the findings:
Actions A & C deal with the unsafe act (inattention)
Action B addresses the unsafe act as well.
The causes which have not been addressed in the remedial actions include the unsafe condition (visual contact) and the underlying causes: planning/ organisation and communication.

PERSON ACTION.
The person's attention was too focused on one aspect of the task, (not addressed in remedial actions) perhaps because:
Environment. it was a physically demanding job and was perhaps difficult to see another way of completing the task
Planning. a site visit and/or job walk through may have helped the person be more aware of the risks
Job. the job was new to the person or the job had changed and therefore they were not completely familiar with the risks involved
Training. the person did not have sufficient training in this area and were not familiar with special tools

ENVIRONMENT
The original report identified that visual contact was an unsafe condition. The WSFII found additional poor working conditions. In such working conditions, more rigorous planning and training is required. The poor working conditions were not addressed in the remedial actions.

JOB FACTOR.
The original report did not identify job factors as contributing factors. The WSFII found it to be a possible influencing factor The iob factors were not addressed in the remedial actions.

TRAINING.
The original report did not identify training as a contributing cause. The WSFII found that the training did not prepare workers for this situation and that no training with special tools was provided. Training was addressed in Action B.

PLANNING
The original report identified the underlying causes as planning/ organisation. The WSFII found that planning conflicts were not identified, site visits and job walk-throughs were not used. Planning was not addressed in the remedial actions.

3.7 Summary of Case Studies

The following section summarises the findings from the Case Studies in terms of their incident classification, potential severity and the human factors causes from the original report and the WSFII. [An overall summary of the case studies is displayed in Appendix E].

3.7.1 Classification and Potential Severity

Table 3.1 indicates that the classification of the case studies was fairly evenly spread, although three property damage incidents were examined and no Lost-time Work Cases (LWCs) were included. The potential severity of the case studies tended to be B3 Caution and A1 Care.

Table 3.1 Ten Case Studies summarised by Incident Classification and Severity Potential

Incident Classification	Frequency
Near miss	2
Environmental	2
Property Damage	3
First Aid Case	1
Medical Treatment Case	1
Restricted Work Case	1
Severity Potential	
A1 Care	3
B1 Care	1
B2 Care	2
B3 Caution	4

3.7.2 Immediate and Underlying Causes (Original Report)

Tables 3.2 and 3.3 indicate how the case studies were coded in terms of their immediate and underlying causes in the original report. In four of the case studies, unsafe acts did not contribute to the incident. Unsafe conditions did not contribute to five of the incidents. All of the unsafe acts and four out of the six unsafe conditions were addressed in the remedial actions.

Table 3.2 Ten Case Studies summarised by immediate causes (Original Report)

Unsafe Acts	Freq	In Remedial Actions	Unsafe Conditions	Freq	In Remedial Actions
No unsafe acts	4	-	No unsafe conditions	5	-
Failure to make secure	1	1	Work Environment	2	1
Failure to follow procedures	2	2	Failure of equipment	1	1
Improper physical effort/act	1	1	Inadequate visual contact	1	1
Inattention	1	1	Inadequate isolation	2	1
Failure to wear PPE	1	1			
Total	10	6	Total	11	4

The most common underlying cause was planning/ organisation. Of the 13 underlying causes, 8 (62%) were addressed in the remedial actions.

Table 3.3 Ten case studies summarised by underlying causes (Original Report)

Underlying Causes	Freq	In Remedial Actions
Inadequate job instruction	1	0
Inadequate planning/ organisation	2	0
Inadequate maintenance/ inspection	2	2
Inadequate engineering/ design	2	2
Inadequate procedures	1	1
Inadequate communication	2	0
Labelling misleading	1	1
Inadequate risk assessment	1	1
Improper lifting technique	1	1
Total	13	8

3.7.3 Person Actions & Influences

For each of the ten case studies, actions and influences were identified using the WSFII. Table 3.4 displays the distribution of the causes into actions (Person) and influences. The second column displays the number of times each action/influence contributed to an incident, column three displays the number of causes which were additional to the findings from the original report and the last column displays the frequency of causes which were not addressed in the remedial actions.

Table 3.4 Frequency of Actions/Influences identified in WSFII and not addressed in remedial actions.

Actions/ Influences	No. of causes in WSFII	No. of causes additional to the original report	No. of WSFII causes addressed in remedial actions
Person (Action)	7	5	2
Planning	19	10	4
Job	6	6	1
Training	7	7	4
Procedures	4	3	3
Equipment	6	2	6
Supervision	1	0	0
Environment	22	21	1
Communication	2	2	0
Total	74	56	21

In total, 74 actions/influences were identified, 56 (76%) of which were additional to the findings from the original reports. Less than a third (28%) of the causes found in the WSFII were either fully or partially addressed in the remedial actions. Although these are data from only a small sample, it does give an indication that the WSFII is adding to the findings from the original reports.

In addition, more than two thirds of the causes found in the WSFII were not addressed in the remedial actions. The influences which were addressed to some extent include: equipment (100% addressed in the remedial actions), procedures (74%) and training (57%). Those actions/influences which were not

often addressed in the remedial actions include: person actions (28% addressed in the remedial actions), planning (21%), job factors (16%), environment (4%), supervision (0%), communication (0%). Although some of these factors were not addressed in the remedial actions, many of the job and environmental factors are not easy to change. However, this information may provide useful information for engineers who are planning the time scale of a project or designers who need to be aware of physical environment problems. Furthermore, some of the problem factors highlighted by the WSFII may not necessarily have contributed directly to the incident, even though they were reported to be present at the time of the incident.

3.8 Actions and Influences

Each section of the WSFII will be evaluated in turn, by describing how often it was used, its usefulness, any problems with the section and possible analysis which could be undertaken with sufficient data.

3.8.1 Person (Action)

Case Study Results. In Section 6 of the WSFII, instances of poor information processing are measured (e.g. attention, memory, interpretation problems). It was not expected that many respondents would complete this section, since they may be reluctant to admit to making a mistake. However, out of the 10 case studies, respondents in four of the incidents reported that person actions contributed to the incident, with a total of 6 person actions reported.

- Chose/ applied wrong solution (x2)
- Attention divided across many tasks (x1)
- Attention too focused on one aspect of the task (x2)
- Failed to consider other factors (x1)

Usefulness. Although it may seem that this detailed information is only of use to accident researchers, this specific information can help companies understand the reasons behind why a person acted as they did. Many reporting systems classify actions using generalised categories, such as 'inattention', which are not always effective in getting to the root cause of the incident. The categories used in the WSFII (Person Actions) allow companies to direct resources toward specific causes. For example, "attention divided among many tasks" could alert management toward the planning of the job (i.e. was the person performing too many tasks at the same time?), the training of the person (i.e. was the person trained sufficiently?) or the procedures (i.e. were they unclear?).

Problems. The main problem with this section is that personnel may be hesitant to give out candid information in this section, since doing so may put them in a poor light in front of their superiors. In addition, this section may be difficult for offshore workers to complete, since it would usually be completed by trained human factors specialists, based on their knowledge of the incident and their training in information processing theory. However, since some of the questions (4 out of 16) have been responded to in these 10 case studies, this may indicate that at least some of the questions were understood. An additional problem with this section is that respondents did not complete the second part of this section: "Were any of the following aspects a factor for you?" e.g. physical fatigue, fear of

failure, frustrated, perhaps because they were of a very personal nature, and they were not willing to put this information in writing.

Further Analysis. With a greater number of incidents, it may be possible to carry out trend analysis of what types of person actions are linked with which Influencing factors.

3.8.2 Planning

Case Study Results. It was expected that this section of the WSFII would figure quite often as an influencing factor, since past accident analysis (see Mearns *et al*, 1998) has found poor job planning contributing to incidents. As expected, seven of the 10 case studies recorded poor planning as contributing to the incidents, with a total of 23 planning problems reported.

- No risk assessment (x4)
- Risk assessment not communicated (x4)
- Planning conflicts not identified (x4)
- Controls not sufficient to reduce risk to ALARP (x1)
- No tool box talk (x3)
- No site visit (x3)
- No job walk-through (x4)

Usefulness. Since planning seems to be a common underlying cause in offshore incidents, this section is useful for obtaining more detailed information about how the job was planned and what went wrong. The original reporting system classified planning problems as: 'planning/ organisation', which does not allow managers to focus on specific methods of planning which may need improvement.

Problems. One problem with this section is that when respondents indicate that a certain planning method was not used, it does not necessarily ascertain that use of the method could have prevented the incident. This section of the questionnaire could be reviewed, so that after each question regarding the planning method, a follow-up question would ask about whether or not this method would have been helpful in preventing the incident.

Further Analysis. A factor which may affect the job planning is the pressure to get the job done (measured in the Written Work Procedures section), which could be further investigated to see if there is a link between these influencing factors.

3.8.3 Tools & Equipment

Case Study Results. Although the aim of the WSFII is to focus on the contribution of human factors, a section on how personnel interact with the tools and equipment (e.g. were the necessary tools and equipment available for the job?) was thought to be of importance since human factors includes the study of man-machine interface (ergonomics). Although in the majority of cases, problems with the tools and equipment existed, this section was not used as often as expected. Out of the 10 case studies, only one incident reported a problem with the tools and equipment using the 'Equipment' section. An additional 6 equipment failures were instead reported in the narrative description section of the WSFII.

- Appropriate PPE not worn
- From Narrative Descriptions:
- Extractor fan not suitable for task
- Fire & gas detection system failed
- Fire control panel inhibited
- ESD valve failed
- Gauge failed

Usefulness. The purpose of this section is to investigate how personnel interact with the tools (e.g. choosing the correct equipment). By asking respondents to specify how the equipment failed, it allows the information to be categorised into the types of equipment failure.

Problems. One problem with this section is that it was not used very often by respondents, perhaps because it is too simplistic (only 7 questions) for respondents who are expert at describing technical causes of incidents. This could be amended by expanding this section to be more comprehensive (see example based on the ADAMS system) or it could be removed altogether since technical problems are likely to be investigated in detail in the main report which would also shorten the form.

Further Analysis. Since equipment failure is separate from the other human 'influencing' factors (along with work environment), further analysis of data from this section would not be undertaken.

3.8.4 Work Environment

Case Study Results. As with the 'Equipment' section described above, the 'Work Environment' section also measures ergonomic human factors issues. However, by asking respondents to describe the environment in which they work (e.g. physical access was partially obstructed), managers/investigators can better understand the conditions under which the person was working when the incident occurred. Out of the 10 case studies, work environment was thought to be less than ideal in seven, and a total of 19 environment problems were identified.

- Weather caused difficulty in: visibility
- Slippery floor due to: oil
- Uncomfortable degree of: heat
- Distracting levels of noise
- Physical access: congested work area
- Visual access: partially obstructed
- Ventilation: hazardous atmospheric conditions, area tested for noxious fumes and gases (x2)
- Manual Handling: twisting, stooping (x2), reaching up/outwards, repetitive handling, keeping the same position for a long time (x2), heavy, bulky & awkward (x2)

Usefulness. Although it is not always possible to change the work environment, data from this section of the form, could be collected as evidence for changing a specific part of the environment. For example, when a number of similar incidents occur because of the work environment, short term changes (e.g. improving the housekeeping) or long term changes (e.g. designing a new part of the installation to provide more space to work in) could be introduced. An example could be when a number of manual handling incidents occur, these could be prevented with training in the proper lifting techniques or by the introduction of mechanisation.

Problems. A problem with this section is that it is not specific to identifying human factors problems, making the form longer than perhaps necessary. In addition, many environment problems cannot be fixed readily, and therefore it is equivocal whether this section is of any real use for companies. Removal of this section would also shorten the questionnaire.

3.8.5 Written Work Procedures

Case Study Results. This section investigates the use of written work practices after an incident. It was expected that this section would be completed quite frequently, as it was found to be a common cause

of offshore incidents in Mearns *et al* (Mearns, 1998). Out of the 10 case studies, 4 reported problems with the written work practices, and a total of 8 problems were identified. Written work practices were not identified as a common problem within the 10 case studies.

- Written work practices not available (x3)
- Written work practices not used (x3)
- Written work practices specific only to the job (x2)

Usefulness. This section of the form is important for understanding why written work practices are not used, as it allows managers/investigators to pinpoint the specific trouble with the written work practices.

Problems. Since only a small number of the questions were answered in this section, this could either mean that the written work practices generally functioned well in these case studies or that personnel do not want to admit that they did not use the procedures correctly. Removal of the last two questions: Questions 11 and 12 (Did you take any shortcuts which involved little or no risk? Did you ignore safety regulations to get the job done?) would be reasonable since they do not add further information specifically to the incident and are unlikely to be answered honestly while their questionnaires are identifiable. The section on 'pressure in the job' was not completed by any of the respondents which may also be due to the respondents reluctance to complete such questions honestly when the questionnaires are identifiable. However, if the form is to be treated as confidential, this section would be worth retaining.

Further Analysis. This data could be used to see under what circumstances written work practices are not used (e.g. under pressure to get work done or training is poor/ supervision is poor).

3.8.6 Job Factors

Case Study Results. This section investigates the aspects of the job (e.g. complex or new task) which may have contributed to the incident. Out of the 10 case studies, job factors were found to contribute to 4 of them, and a total of 10 problems were identified.

- Job performed frequently (x5)
- Job performed infrequently (x2)
- Task was: lengthy, repetitive, new/changed

Usefulness. This section of the form describes to managers how the person was coping with their job (e.g. familiarity with job, the nature of the job e.g. lengthy and if they were overburdened with tasks). Although it may not always be possible to change the nature of the job, such as its length or complexity, it could be possible to improve the worker's skill or familiarity with the job, provide an extra worker or an additional tea break so that the work is carried out under the safest conditions.

Problems. The questions regarding the respondents familiarity with the job and the nature of the job were answered readily, whereas questions concerning carrying out more than one job were never answered negatively. This could mean that (i) they do not have a problem with multi-tasking, (ii) they did not understand the question properly or (iii) they did not want to admit that multi-tasking may have

been affecting their performance. These issues will need to be ascertained and remedied. Possibly with a larger number of incidents, potential problems with these questions would be highlighted.

Further Analysis. It would be interesting to investigate how job factors are linked with team working, communication and work pressure (written work practices), which would be possible with sufficient numbers of incidents.

3.8.7 Training & Skills

Case Study Results. This section investigates the types of training that were lacking in each incident (e.g. training for special equipment). Out of the 10 case studies, insufficient training was found to contribute to 4 of them, and a total of 28 problems were identified.

- No training to perform job (x2)
- Training did not prepare worker for this situation (x2)
- No training to use special equipment (x2)
- No training on the risk aspects (x3)
- Training provided for the job was not adequate (x6)
- Not evaluated upon completion of training
- Not practised the skills since training
- No on-the-job training provided
- No refresher training (x4)
- Refresher training not needed (x6)

Usefulness. This section can help managers/investigators focus attention/resources into the areas which require training, as viewed by the workers. The case studies indicate that although training is not always recorded as an underlying cause, it is one of the most commonly used remedial actions. This may indicate that companies are well rehearsed in terms of training requirements. However, this section still provides additional information of the specific training needs that may not always be apparent to management or investigators.

Problems. This section seems to be successful in capturing respondents' dissatisfaction with training, where all 10 questions were completed by respondents.

Further Analysis. A question which could be undertaken with the availability of a larger incident database, regards how training is related to workers familiarity with the job and their personal actions.

3.8.8 Supervision

Case Study Results. This section investigates the level of supervision on the job, and the constitution of the supervisor (e.g. good motivator, sensitive to pressure). Only one incident reported poor supervision as an influencing factor where the person who reported the inadequate supervision was the supervisor himself. Since no other incidents reported poor supervision, this may indicate that the workers are either satisfied with the supervision, or are reluctant to speak up about their supervisor as they may fear retribution.

- Immediate supervisor did not provide adequate support
- Level of supervision: none
- Level of supervision: indirect supervision

Usefulness. If workers feel at ease to report problems with supervision, this influencing factor could highlight to managers/investigators where possible improvement in supervisor training is required.

Problems. The main problem with this section is that workers may be reluctant to complete this section. If the form were treated as confidential, personnel may be more likely to report any problems with their supervisor.

Further Analysis. With the availability of a large incident database, investigation as to whether or not there is a link between lack of supervision and the planning of the job would be of interest.

3.8.9 Communication

Case Study Results. This section investigates problems in communication between workers (e.g. was the message communicated in a timely manner). Communication was reported in only one of the case studies, however, past accident analysis shows that poor communication is a relatively common contributor to incidents (Mearns *et al*, 1998). Poor communication was not the *cause* the current incident, although had it not been remedied by the people involved, it could have escalated into a worse problem.

- Message was not clear & concise
- Poor communication between related teams/departments

Usefulness. Workers in the remaining nine incidents felt that communication was good, however, this section is important for highlighting communication problems that may not always be obvious to the investigation team. Communication problems can be eradicated with training in human factors skills or better planning of the job. This information may also be of importance to designers and project planners who need to be aware of the areas on installations which are particularly prone to communication disruptions.

Problems. This section is limited in the number of questions it asks about communication. Possibly by expanding it to encompass a wider variety of communication problems, more instances would be highlighted. However, the results from the Benchmarking Project (see Volume I) indicate that offshore workers are generally very satisfied with communication.

Further Analysis. With the availability of a larger incident database, it would be of interest to investigate whether there is a link between communication failure and poor team work or poor supervision.

3.8.10 Team Work

Case Study Results. This section focuses on how team dynamics may have influenced the safety of the team (e.g. personnel are not familiar with each other; too few personnel are working on the job). None of the case studies reported team work as a possible influencing factor. In fact workers in the ten incidents felt that team work was good. Other research in the offshore oil industry has found good team work to be an important part of working safely (see Volume III) hence this section should be retained.

Usefulness. Information collected in this section could enable project planners to identify the necessary team composition (i.e. level of experience, number of workers) in order to create the most safe and productive crew.

Problems. One of the problems with this section is that this section comprises only a small number of questions, which may not be capturing all the possible problems that offshore crews face. This could be remedied by expanding this section to include more team working factors. Furthermore, workers may be reluctant to report any problems with their team for fear of retribution. If the form were treated as confidential, perhaps personnel would be more honest.

Further Analysis. As mentioned in the 'Communication' section above, it may be interesting to investigate whether there is a link between poor team work, communication failure and poor supervision, with adequate numbers of incidents.

3.8.11 Workplace Atmosphere

Case Study Results. This section investigates respondents' personal view of the safety culture on the installation at the time of the incident. Respondents only answered this section positively, therefore no differentiation between incidents is possible.

Usefulness. If it were answered honestly, this section would give investigators/managers a better understanding of the safety climate on the installation at the time of the incident, which would set the scene and help them understand the conditions under which the person was working.

Problems. However, these questions do not add any further information regarding the specific incident and therefore removal of this section is probable. Furthermore, respondents may have reported only positively to this section, because they fear retribution for answering negatively. If the form were treated as confidential, perhaps personnel would be more likely to report any problems in the safety climate.

3.8.12 Preventing Recurrence

Case Study Results. This section asks personnel to comment on what they would do differently to avoid the incident. Out of the 18 completed WSFIIs, 11 contained comments on how to prevent recurrence.

Usefulness. This section is important for managers/investigators to help formulate remedial actions to prevent similar incidents occurring.

Problems. Not everyone completed this section, perhaps because they are unsure of how the situation could have been prevented or because they were reluctant to speak their mind about possible safety problems.

Further Analysis. Comparisons between the respondents' comments and the remedial actions in the original report would be undertaken.

3.9 Conclusions

The evaluation of the WSFII was undertaken using only ten incidents, since access to the installations to test the form further was not obtained. The 10 incidents made up 19% of the original set of incidents that were reported during the 5 month period. The incidents were spread fairly evenly in terms of their classification (although no LTIs were in the sample), whereas the potential severity of the incidents tended toward B3 Caution.

A summary of the case studies indicated that there was an increase in the overall number of causes which were found to contribute to the incident. The original reports found only 25 immediate and underlying causes, whereas the WSFIIs found 74 actions/influences, a two-fold increase in the number. Much of the increase in information was from the Work Environment section, which respondents seemed at ease to complete. In addition, more details about the types of planning methods and training that were not carried out were included. Offshore workers probably understand work environment problems much better than human factors problems, since they are untrained in this area and are possibly unaware of how human factors problems can contribute to accidents.

Advantages

Each section of the WSFII was examined to investigate which sections are working well and which sections need to be reviewed or even removed. Overall, the examination of these case studies has shown that the form has helped to extract additional information than the company's original report. Although some of this information may not be directly relevant to the investigation, it sheds light on possible hazardous situations.

(i) The form gives more *specific information* about possible causes of the incidents than the original report. This is important for management in order for them to focus their time and resources in the appropriate areas. All of the section gave more specific information than the original report, however, the sections which gave the most detail were: person actions, planning, written work procedures and training & skills.

- ADVANTAGES
- More specific information
- Setting the scene
- Categorising & grouping information
- Involving personnel in investigation
- Easier to respond to in writing to sensitive/ personal questions
- Guiding which types of training should be introduced

(ii) Some of the sections were important for *setting the scene* and giving a broader picture of what happened, especially the Work Environment, Job Factors Tools & Equipment, Workplace atmosphere sections.

(iii) Some sections of the WSFII were particularly useful for *categorising information* which could be used for research purposes or for trend analysis, such as the Person Actions (information processing) and Tools & Equipment sections.

(iv) By *grouping information* from some of the sections, evidence could be collected in order to change pieces of equipment or parts of the working environment so that hazards are eliminated from the environment. For example, information about job factors could be used to inform project planners of possible work pressure problems. Designers could be informed about work environment problems and procurement could be informed of faulty/ unsafe equipment.

(v) By asking personnel involved in the incident to complete a form, it encourages them to think about the causes behind the incident. This could help the investigator learn more about the incident, encourage the person involved to be more aware of what went wrong and also reinforce their memory of it. By completing one of these forms, personnel may become more aware of the types of things that could go wrong.

(vi) Some sections of the form retrieve *sensitive and personal* information, such as person actions, supervision, communication and team work. Personnel may be less likely to give honest and open answers in a face-to-face interview, than when given the opportunity to describe what happened in their own time and in writing.

(vii) Information from some sections of the form could be used to plan work group composition (team work) or to plan the job (job factors).

(viii) Other sections could help highlight where *additional training* is required, such as supervision, training & skills, person actions, tools & equipment and communication.

Disadvantages

Although there is a lot of useful information coming out of the WSFII, there are problems with interpreting the data and obtaining honest answers from the respondents.

(i) Respondents may be hesitant to give honest answers to some of the more sensitive and personal sections since answering them negatively may put them in a poor light in front of their superiors and they may fear retribution. Respondents may be less willing to put into writing, information regarding their person actions, supervision, team work, work pressure (in written work practices) and workplace atmosphere.

(ii) Some sections of the form may be difficult for respondents to complete since accident analysis is normally completed by trained human factors experts/ or investigators. Since respondents had no training on how to use the form and no detailed instructions about the form, this task may have been more difficult than we thought, especially regarding person actions, where respondents have had no

training in information processing theory. However, out of the 16 questions that were asked, 4 were responded to.

(iii) Some of the questions may not have been answered as they were unclear or ambiguous to the respondent. The sections of the WSFII which were not completed were job factors (about carrying out more than job), work pressure and written work practices (only 3/10 of the items were used). These questions may not have been answered because they were irrelevant to the current incidents or because they were not understood properly. Larger numbers of incidents would be required to test this.

(iv) Some sections of the form gave rise to many negative responses (e.g. where many planning methods were not carried out). Negative responses to items which may not necessarily have been relevant in the given circumstances could give readers the wrong impression of what went wrong. It is important that the responses are qualified by investigators to ensure the answers reflect the respondent's point of view. Negative responses do not necessarily indicate a direct causal factor, although some indirect contribution can be implied. The sections which may need reviewing for this problem include: planning, work environment, job factors, refresher training and communication. This problem may imply that these questions are not worded specifically enough or that they require more instruction before the section.

- DISADVANTAGES
- Reluctant to give honest answers
- Difficulty completing some sections
- Ambiguities in the questions
- Not all responses are relevant to the incident
- Too simplistic
- Form is too long
- Not all findings can be dealt with
- Removal of some sections

(v) Two sections of the form may be too simplistic for capturing the details of incidents. The sections which could be expanded include: Tools & Equipment and Communication.

(vi) Some of the sections produce details about the background to the incident and cannot always be fixed (such as Work Environment and Job Factors), therefore it is equivocal whether this section would be useful for companies to improve safety.

(vii) Personnel may be more likely to complete the WSFII if it was shorter. At present it is 4 pages long but could be reduced by removing some of the sections that are not directly associated with human factors (such as Work Environment and Tools & Equipment) or are not specific to the incident (e.g. Workplace Atmosphere).

In conclusion, the evaluation of the form indicates that the WSFII provides investigators and management with additional information about incidents. In particular, more specific information about the causes of the incidents are identified which could be used to develop more focused remedial actions. In order to optimise the quality of the completed forms, it is recommended that the form be completed confidentially (sent directly to an independent third party) and therefore information obtained from the form is likely to be more open and honest.

4. DISCUSSION

The majority of accident investigation systems which focus on human factors causes, are often designed by human factors experts intended for the use of highly trained personnel in human factors. These systems are often complex and require intense resources to implement and to train relevant personnel to use them. When properly applied, many of these systems provide companies with a wealth of information regarding the human factors causes of incidents. However, the majority of accident reporting systems are vulnerable to underreporting, have incomplete recordings and do not necessarily provide a complete picture of the conditions under which accidents take place (Stoop, 1997). There are systems, however, that ask personnel involved in incidents to describe what happened in their own words and using prompting questions. The objective of these systems is to direct the witnesses' attention toward human factors problems rather than just the technical failures, which is what they tend to be expert at and feel more comfortable describing. The majority of these systems are confidential, thereby protecting the reporter from discipline or prosecution (e.g. HFRP, CIRAS and ASRS).

The main purpose of these systems is to allow companies to collect larger quantities of information and more detailed accounts of accidents and incidents. In addition, confidential reporting programmes allow incidents and hazardous situations to be picked up early on, so that alerting messages can be distributed to personnel on other installations. Furthermore, this information can strengthen the foundation of human factors safety research, which is particularly important since it is generally conceded that over two thirds of accidents and incidents have their roots in human and organisational factors.

The first Witness Statement Form was based on a confidential reporting system developed and employed by British Airways (HFRP). British Airways has found that this 'semi-structured' system of open questions worked well for pilots and provided them with large amounts of information about potential hazards. The system has, however, been changed due to pilots requesting an even less structured questionnaire, as they felt they could express themselves more freely with only a few prompting questions. This system works well with pilots, as they are possibly a more highly trained, educated and motivated group than the offshore personnel who are involved in accidents (drillers, floormen, deck crew and crane operators). Pilots are also primed in human factors issues as they are given mandatory training in Crew Resource Management (see Volume III). The system was not found to work as well with the offshore crews possibly because they are less able to express themselves in writing, especially regarding human factors issues, since they are generally not given any training in this area.

Despite the above mentioned shortcomings, the reports which used the WSFI did show an increase in the number of human factors causes coded. Feedback from the offshore safety personnel indicated that the WSFI was useful for them as a starting point for their interviews with the witnesses to the incidents. The safety personnel could review the forms prior to interviewing the witnesses and then ask them to

clarify or expand on certain sections. The additional information collected by the safety personnel was, however, not recorded (in order that they did not breach their trust with the worker) and thus their experiences were not being passed on to other personnel who might have benefited from it. Had this form been confidential, such information could have been recorded and passed on to the rest of the workforce as summarised information.

In a confidential reporting programme, personnel can report their error or safety concern to an independent 'safety broker'. This safety middleman assesses a report, draws it to the attention of the operator and safety authority where appropriate and over time, builds up a database which can be used to detect safety trends or to change training or procedures. Voluntary confidential incident reporting programmes promote the disclosure of human errors, provide the benefit of situations described with candid detail, and enable others to learn from mistakes made. Voluntary systems also produce a higher quality of reporting from individuals motivated by a desire to see an issue pursued. Companies who recognise and support such data collection systems accept that human beings do not like telling their superiors about their mistakes or those of their workmates.

The findings from the second Witness Statement Form (WSFII) indicated a very large increase in the number of human factors causes (66%). Naturally not all of these causes can be addressed in the remedial actions, however, such information can be used by the investigator to further investigate certain aspects of the circumstances under which the incident occurred. Although only a small number of incidents that used the WSFII were examined in this report, they do indicate that a wealth of information can be extracted from personnel involved. The two most important contributions made by the WSFII were the specificity of the information and the ability to categorise information for trend analysis. Specific information regarding the causes of the incident is important for designing remedial actions which will deal specifically with them. In addition, categorising incidents in broader terms (e.g. training, supervision) would enable companies to plot trends of human factors causal categories. This analysis could benefit companies by giving them an overall picture of the human factors problem areas as well as improvements over time. The findings from the case studies also suggest that despite improvements in the form to extract more human factors details, personnel are still not willing to give candid answers, as they suspect their superiors will have access to them. Discussions with offshore personnel who had been using the form during the 5 month period, indicated that they would not complete the form entirely openly because they could be identified. The majority did agree that if the form were confidential and was collated by an independent third party, they would be more candid in their responses.

Confidential Reporting Systems are now commonplace in the aviation industry since the ASRS (US FAA) system was developed. Aviation regulatory bodies in other countries, such as Britain (CHIRP), Australia (CAIR), New Zealand (ICARUS), Canada, Russia and South Africa (SAASCo) have followed suit. Other industries, such as the UK railway industry, has introduced a confidential reporting system (CIRAS) which is operated by the Centre for Applied Social Psychology at the University of Strathclyde. In addition, airline companies, such as British Airways, have implemented their own in-

house confidential reporting systems (e.g. HFRP and the Confidential Maintenance Reporting System) into their overall safety systems. Many of these confidential reporting systems have been reported to have a direct impact on changing the company's systems, such as introducing new training or re-designing equipment.

Although the two reporting forms described in this report have shown significant increases in the level of detail of human factors causes, the information still lacks complete openness from respondents. Further research is required to test whether or not a confidential reporting system would provide more candid details of incidents and enable others to learn from mistakes made.

5. References

ADAMS. (1998). *ADAMS WP4E Reporting Form and End-user Manual* (Brite-EURAM III BE95-1732). Ispra, Italy: EC Joint Research Centre.

Adams, N. L. a. H., N.M. (1977). Accident-reporting systems: A basic problem area in industry. *Journal of Occupational Psychology, 50*, 285-298.

Bird, F. E. a. G., G.L. (1989). *Practical Loss Control Leadership: The Conservation of People, Property, Process and Profits.*: Institute of Loss Control Industries Publishing.

Doran, J. A. v. d. G., G.C. (1996, 9-12 June). *Tripod-BETA: Incident investigation and analysis SPE 35971*. Paper presented at the International Conference on Health, Safety and Environment, New Orleans, Louisiana.

Fahlbruch, B., Wilpert, B. (1997). Event analysis as problem solving process. In A. Hale, Wilpert, B. and Freitag, M. (Ed.), *After the Event. From Accident to Organisational Learning.* (pp. 113-129). Oxford: Elsevier Science.

Hudson, P. T. W., Reason, J.T., Wagenaar, W.A., Bentley, P.D., Primrose, M. and Visser, J.P. (1994). Tripod Delta: Proactive approach to enhanced safety. *JPT, January, 1994*, 58-66.

Lawson, J. M. (1991, 1st-4th December). *Evaluation and development of an accident report form.* Paper presented at the Ergonomics and Human Environments. Proceedings of the 27th Annual Conference of the Ergonomics Society of Australia, Coolum, Australia.

Maurino, D. E., Reason, J., Johnston, N. and Lee, R.B. (1995). *Beyond Aviation Human Factors: Safety in High Technology Systems*. (1st ed.). Hants, England: Ashgate Publishing Ltd.

McDonald, N. (1998). *Human factors and aircraft dispatch and maintenance safety.* Paper presented at the Nouvelle Revue D'aeronautique et d'astronautique. 3 Aero Days Post-Conference Proceedings.

Mearns, K., Flin, R., Gordon, R. and Fleming, M. (1998). Measuring safety climate on offshore installations. *Work and Stress, 12*(3), 238-254.

NEA. (1998). *Improving Reporting and Coding of Human and Organisational Factors in Event Reports* (NEA/CSNI/R(97)15/PART1). Paris: Nuclear Energy Agency, Committee on the Safety of Nuclear Installations.

Norman, D. A. (1998). *The Design of Everyday Things*. London, England: The MIT Press.

O'Leary, M. (1999). *The British Airways Human Factors Reporting Programme.* Paper presented at the Human Error, Safety and System Development, Liege.

Paradies, M., Unger, L., Haas, P. and Terranova, M. (1993). *Development of the NRC's Human Performance Investigation Process (HPIP)* (NUREG/CR-5455 SI-92-101 Vol. 2). Washington DC: System Improvements, Inc and Concord Associates, Inc.

Rasmussen, J. (1987). Reasons, causes and human error. In K. D. a. J. L. J.Rasmussen (Ed.), *New Technology and Human Error* (pp. 293-301). London: John Wiley and Sons Ltd.

Reason, J. (1990). *Human Error*. Cambridge, UK: Cambridge University Press.

Shell. (1997). *Review of Tripod-DELTA* . Aberdeen: Shell Expro UK.

Sinclair, M. A. (1975). Questionnaire Design. *Applied Ergonomics, 6*(2), 73-80.

Stoop, J. (1997). Accident Scenarios as a tool for safety enhancement strategies in transportation systems. In B. W. a. M. F. A. Hale (Ed.), *After the Event: From Accident to Organisational Learning* (pp. 77-93). Oxford: Elsevier Science Ltd.

Wickens, C. D. (1992). *Engineering Psychology and Human Performance*. (2nd Edition ed.). New York: HarperCollins Publishers Inc.

Wiegmann, D. A. a. S., S.A. (1999, June 7-8). *Human factors analysis of aviation accident data: developing a needs-based, data-driven, safety program.* Paper presented at the Human Error, Safety and System Development, Liege, Belgium.

Wright, P. a. B., P. (1975). 'Just fill in this form' - A review for designers. *Applied Ergonomics, 6*(4), 213-220.

APPENDIX A: Witness Statement Form I

Company logo	Witness Statement Form	Reference No.

To be completed separately by: The injured person (if applicable)

All persons in the immediate vicinity at the time

The relevant Supervisor

The OIM

Please read the questions below and answer any you think are relevant. Any information you provide will help us to better understand the underlying causes of incidents and prevent them from occurring again.

It is important that you answer these questions honestly and accurately. We need your feedback about this incident, however irrelevant you may feel your information is, so that we can discover where there are deficiencies in the company's systems.

NAME: _____POSITION:_____Ref No._____

1. In your own words, describe the activities you were engaged in just before the event and then the event itself (Add additional pages as necessary)

2. Describe how the job was planned and your involvement in this process (e.g. toolbox talks, risk assessments etc)

3. Were there any deficiencies with the tools and equipment? If yes, what were they?

4. Was there anything about the working conditions which could have contributed to the incident? If yes, what were they?

5. Did all the procedures work well and did you have all the information you needed to do the job well? If no please specify what could have been improved

6. How were you feeling at the time of the incident?

7. Who else was there? How did they respond to the event?

8. Did your training prepare you for this situation? What training was particularly good and in which areas did you feel deficient?

9. With hindsight, if you think you could have handled the situation differently, what would you have done?

10. With regard to the way the situation was handled, was this done well or poorly? What do you think contributed to this?

11. Any other comments that could help prevent this type of incident happening again?

APPENDIX B: GUIDANCE NOTES FOR THE WSFII

A. PURPOSE OF THE FORM

The purpose of this form is to collect more detailed data on the causes of incidents and accidents than is being collected at present. The majority of accident reporting systems used in the UK oil industry only skim the surface when collecting data regarding the human and organisational factors.

By completing this form accurately and honestly, you will enable us to collect a larger amount of data on accident causes. This will eventually help us to understand how accidents happen and may lead us to ways of preventing them in the future.

B. COMPLETING THE FORM

This form is intended to be:

1. used to code the following types of incidents:
    - All HSE Recordable incidents
    - High Potential Incidents
2. used by personnel involved in the incident, who are either directly involved, or are witnesses to the event or supervisors of the job
3. completed as soon after the event as possible
4. completed in private (help can be given by the medic)
5. For more information about each of the 11 sections, please read the summary of each section (page 2).

C. ANALYSIS OF THE FORMS

1. WSFs will be sent back onshore (to the operating company) along with the rest of the incident report.
2. Aberdeen University will receive a copy of each WSF
3. Data from the WSFs will be inputted by Aberdeen University into a statistical computer package and analysed
4. Confidential summary data regarding individual incidents as well as collective incidents over a 6 month period will be written up as a confidential report.

D. SUMMARY OF EACH SECTION OF THE WSFII

Narrative Description

This section is provided for you to write your account of the events leading up to the accident or incident. Some of the questions in the remainder of the form may help you to remember other aspects of the incident.

1. Planning

This section asks questions regarding the planning of the job such as whether you read the Permit To Work Certificate and whether or not there was a Tool Box Talk. You may have to think back a while to when the job was first started to recall the whole event.

2. Tools and Equipment

This section asks questions about the availability and condition of the tools and equipment, including PPE.

3. Work Environment

This section covers the possible problems encountered in the working conditions such as weather, lighting, noise, access, ventilation, posture, manual handling and housekeeping.

4. Written Work Practices

This section asks questions regarding the written work practices, such as whether they were followed and reasons why they may not have been followed.

5. Job Factors

The questions in this section ask how much pressure you are under, such as how complicated demanding the job is.

6. Person Factors

The questions in this section focus on the activities that took place immediately prior to the incident. Were there any problems in your concentration, perception, memory, interpretation, judgement of the task you were carrying out or did you assume something which in hindsight you should not have?

7. Training and Skills

This sections asks questions regarding the training you have had to perform your job.

8. Supervision

Some questions regarding the supervision at the time of the incident are asked.

9. Communication

Describe the communication between your work mates, handovers, supervisor and yourself.

10. Team Work

This section asks you to describe the team you work with in terms of how well you know them, did you get on together and were there enough of you to complete the job safely?

11. Workplace Atmosphere

Five questions are asked regarding the safety culture (or atmosphere) on your installation at the time of the incident. These questions have been included in order to have a feeling for the atmosphere in which you were working when the incident took place.

12. Preventing Recurrence

A space is provided at the end of the form, for you to write down what you or others could have done to prevent the accident or incident.

APPENDIX C: WITNESS STATEMENT FORM II

Company Logo	Witness Incident Analysis Form	**Company Reference**

To be completed separately by: The injured person (if applicable)
All persons in the immediate vicinity at the time
The relevant supervisor

Please read the questions below and answer any you think are relevant. Any information you provide will help us to better understand the underlying causes of incidents and prevent them from occurring again.

It is important that you answer these questions honestly and accurately. We need your feedback about this incident, however irrelevant you may feel your information is, so that we can discover where there are deficiencies in the company's systems.

NAME: _____ POSITION:_____ Reference No_____

1. Briefly describe in your own words, the activities you were engaged in just before the event (add more pages as necessary)

1. PLANNING	
1. How was the work authorised? *(tick the boxes next to the statements you agree with)* Permit to Work ☐ Work Order (Job Card) ☐ Written instruction ☐ Verbal Instruction ☐	
2. If work was authorised verbally, by whom? (e.g. Foreman, supervisor, driller)_____	
3. Was a risk assessment carried out where required?…… *(circle your answer)*	Yes / No
4. Were the risk assessment results adequately communicated to you?……..	Yes / No
5. Were any planning conflicts identified before the job was started?……..	Yes / No
6. Were the controls sufficient to reduce the risk to ALARP (As Low As Reasonably Practicable)?	Yes / No
7. Did a tool box talk take place?.. ……..	Yes / No
8. Were the duties and tasks clearly explained to you? ……..……..	Yes / No
9. Was a site visit used to help plan the job? ……..……..	Yes / No
10. Was a job 'walkthrough' performed? ……..……..	Yes / No
11. Did the work begin before all necessary materials and equipment were on the job site? …..	Yes / No

2. TOOLS AND EQUIPMENT	*(circle your answer)*
1. Were the necessary tools and equipment available for the job? ……	Yes / No
2. Were they used? ……..……..	Yes / No
3. Were they in good working order? ……..……	Yes / No
4. Were personnel trained in their use?……..……..	Yes / No
5. Was the appropriate PPE available?……..……	Yes / No
6. Was the appropriate PPE worn? ……..……..	Yes / No
7. Was the quality of the PPE adequate?……..……	Yes / No

3.WORK ENVIRONMENT *(tick the boxes next to the statements you agree with)*

1. Weather:
   - ☐ rain
   - ☐ snow
   - ☐ wind
   - ☐ hail
   - ☐ fog
2. Caused difficulty in:
   - ☐ visibility
   - ☐ touch
   - ☐ movements
3. Slippery floor due to:
   - ☐ wet
   - ☐ oil
   - ☐ ice
   - ☐ snow
4. Uncomfortable degree of:
   - ☐ heat
   - ☐ cold
   - ☐ humidity
5. Lighting & noise:
   - ☐ insufficient light for task
   - ☐ glare hampers visibility
   - ☐ distracting levels of noise
6. Physical Access:
   - ☐ fully obstructed
   - ☐ partially obstructed
   - ☐ congested work area
   - ☐ confined space (tanks/vessels)
7. Visual Access
   - ☐ fully obstructed
   - ☐ partially obstructed
8. Ventilation
   - ☐ area tested for noxious fumes & gases
9. Task requires:
   - ☐ twisting
   - ☐ stooping
   - ☐ strenuous pushing/pulling
   - ☐ reaching upwards/outwards
   - ☐ repetitive handling
   - ☐ keeping the same position for a long time
10. Manual Handling:
    - ☐ heavy
    - ☐ bulky/awkward
    - ☐ unstable/unpredictable
11. Housekeeping:
    - ☐ excellent
    - ☐ adequate
    - ☐ poor

☐ There was no problem with the work environment

4. WRITTEN WORK PRACTICES *(circle your answer)*

1.	Were written work practices available for the job?	Yes / No
2.	Were written work practices used for the job?	Yes / No
3.	Should there have been written work practices in place, but weren't?	Yes / No
4.	Were the written work practices correctly followed?	Yes / No
5.	Were the written work practices specific only to the job?	Yes / No
6.	Had you used the specific written work practices before?	Yes / No
7.	Did the written work practices describe the safest way of doing the job?	Yes / No
8.	Were the written work practices appropriate for the job?	Yes / No
9.	Were the written work practices difficult to follow?	Yes / No
10.	Were the instructions clear?	Yes / No
11.	Did you take any shortcuts which involved little or no risk?	Yes / No
12.	Did you ignore safety regulations to get the job done?	Yes / No

Did any of the following cause pressure in the job? *(you may tick more than one box):*

- ☐ previous jobs delayed?
- ☐ lack of staff?
- ☐ not enough time allocated to task?
- ☐ inefficient scheduling of tasks by planners?
- ☐ inefficient organisation of work by supervisors?
- ☐ financial incentives?

5. JOB FACTORS *(tick the boxes next to the statements you agree with)*

1. How familiar were you with the task? performed frequently ☐ performed infrequently ☐
2. Was the task: complicated ☐ lengthy ☐ repetitive ☐ boring ☐ new/ changed ☐
3. Complete the following section if you carry out more than one job: *(tick the boxes next to the statements you agree with)*
   - ☐ Combining my different jobs is difficult
   - ☐ My main activity is very demanding
   - ☐ I am often: mentally overloaded
   - ☐ physically overloaded
   - ☐ Side activities are more demanding than the main one
   - ☐ Side activities are more interesting than the primary one
   - ☐ I have no problems carrying out more than one job

6. PERSON FACTORS *(tick the boxes next to the statements you agree with)*

1. Was your attention distracted from your task? ..... Yes / No
2. Were you pre-occupied with your thoughts elsewhere? ..... Yes / No
3. Was your attention divided across many tasks?..... Yes / No
4. Was your attention too focused on one aspect of the task?..... Yes / No
5. Was anything you saw mistaken or misidentified?..... Yes / No
6. Was any information misheard?..... Yes / No
7. Did you fail to recognise information through touch? ..... Yes / No
8. Did you forget to do any stage of the task? ..... Yes / No
9. Did you fail to consider other relevant factors?..... Yes / No
10. Did you lose your place?..... Yes / No
11. Did you see or hear information correctly, but misunderstood its meaning?..... Yes / No
12. Did you choose/apply an incorrect solution?..... Yes / No
13. Did you choose/apply an inappropriate solution?..... Yes / No
14. Did you choose/apply part of a solution?..... Yes / No

Were any of the following aspects a factor for you personally? *(you may tick more than one box):*

☐ Physical fatigue	☐ Fear of failure	☐ Frustrated
☐ Mental fatigue	☐ Lack of motivation	☐ Worried about things at home
☐ Low morale	☐ Excessive work overload	☐ Rushed

7. TRAINING & SKILLS *(circle your answer)*

1. Were you provided with any training on how to perform the job? ..... Yes / No
2. If no, do you consider that training was required for the job? ..... Yes / No
3. Did training prepare you for this situation? ..... Yes / No
4. Were you provided with training on how to use any special equipment or tools? ..... Yes / No
5. Did you receive any training on the risk aspects of the job or situation? ..... Yes / No
6. Do you consider the training provided for the job was adequate? ..... Yes / No
7. Were you evaluated upon completion of training to ensure you had the required skills? ..... Yes / No
8. Had you practised the skills you learnt since the training? ..... Yes / No
9. Was on-the-job training provided? ..... Yes / No
10. Have you had any refresher training?..... Yes / No
11. Do you think refresher training is needed?..... Yes / No

8. SUPERVISION

1. Did the immediate supervisor provide adequate support during the work? ..... Yes / No *(circle your answer)*
2. What level of supervision was provided for the job? *(tick one)*
   - ☐ No supervision
   - ☐ Direct supervision – present at worksite for whole / part of the job
   - ☐ Indirect supervision – present at job planning stage only
   - ☐ Safety supervision only
3. Was progress of the job adequately monitored? .....Yes / No *(circle your answer)*
4. Was the job over-supervised? .....Yes / No
5. Was the job too complex? .....Yes / No

Describe the supervision of the job *(you may tick more than one box):*

☐ Competent	☐ Good motivator	☐ Aggressive
☐ Gave adequate job instruction	☐ Good man-management skills	☐ Fair with discipline
☐ Good feedback	☐ Not committed to safety	☐ Sensitive to pressure

9. COMMUNICATION

(circle your answer)

1. Was the message/briefing clear and concise, so you could understand it?..... Yes / No
2. Was the message communicated in a timely manner? ..... Yes / No
3. Did you have the opportunity to ask questions? ..... Yes / No
4. Was there poor communication: *(tick the boxes next to the statements you agree with)*
   - ☐ within your team
   - ☐ between your supervisor and your team
   - ☐ between shift / rotation handovers *(circle as appropriate)*
   - ☐ between related teams/departments

10. TEAM WORK

(circle your answer)

1. Have you worked with your team members before?..... Yes / No
2. Were there enough workers allocated to the task? ..... Yes / No
3. In your opinion were the appropriate staff selected for the task? ..... Yes / No
4. Were any of the following a factor with your work group? *(you may tick more than one box)*

☐ Low morale	☐ Unsafe working practices
☐ Lack of motivation	☐ Discipline of crew
☐ Poor communication	☐ Violations of procedures
☐ Disagreements/hostility	☐ Not willing to stand up to superiors

11. WORKPLACE ATMOSPHERE

(circle your answer)

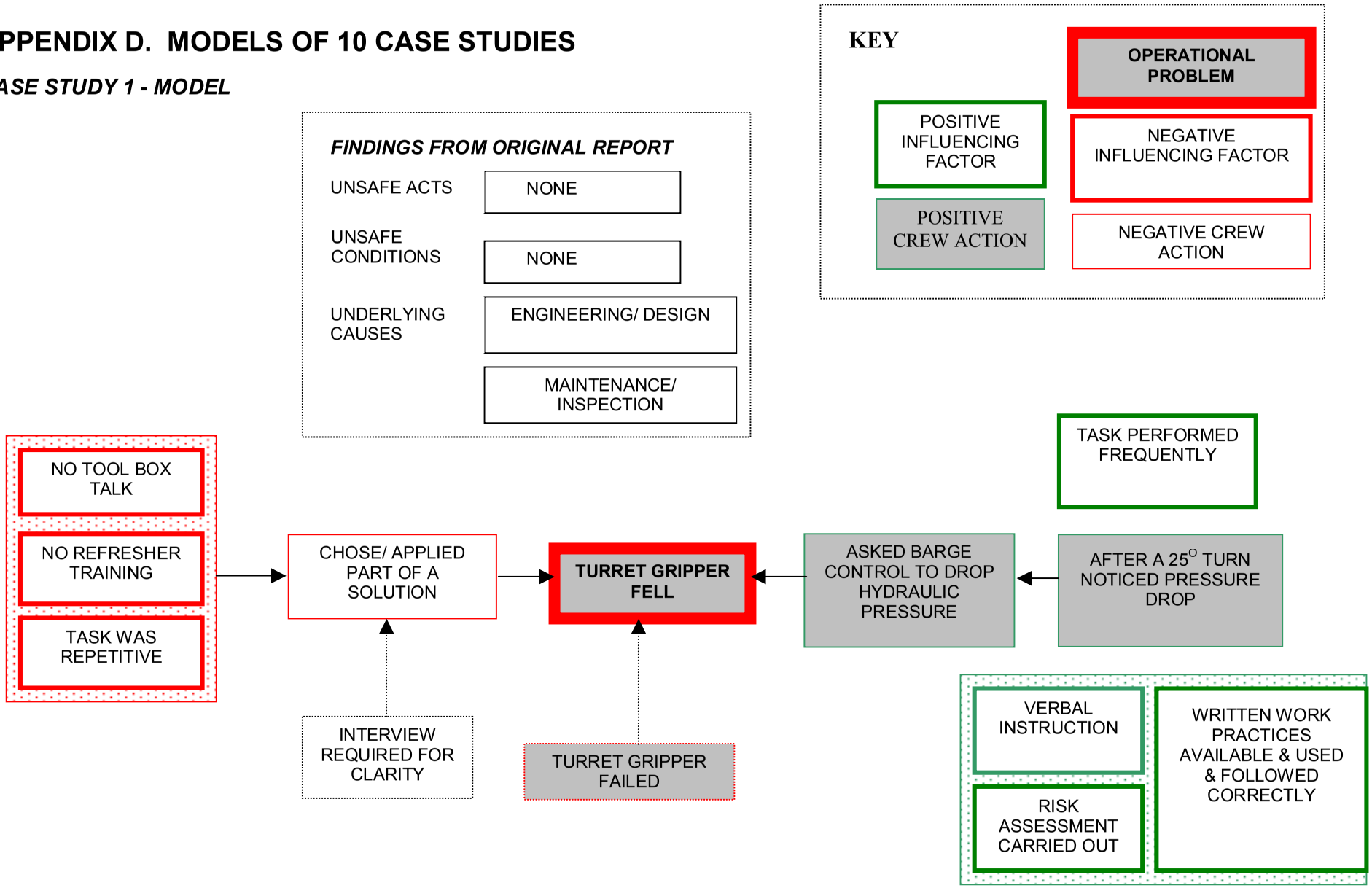
1. Do you feel that there is an open incident reporting culture at your place of work?..... Yes / No
2. Do you feel that people at your work place are punished for genuine slips or mistakes?..... Yes / No
3. Are short cuts allowed/tolerated? ..... Yes / No
4. Would your company stop work due to safety concerns, even if it meant losing money?..... Yes / No
5. Are there recurrent violations of rules at your place of work? ..... Yes / No

12. PREVENTING REOCCURRENCE

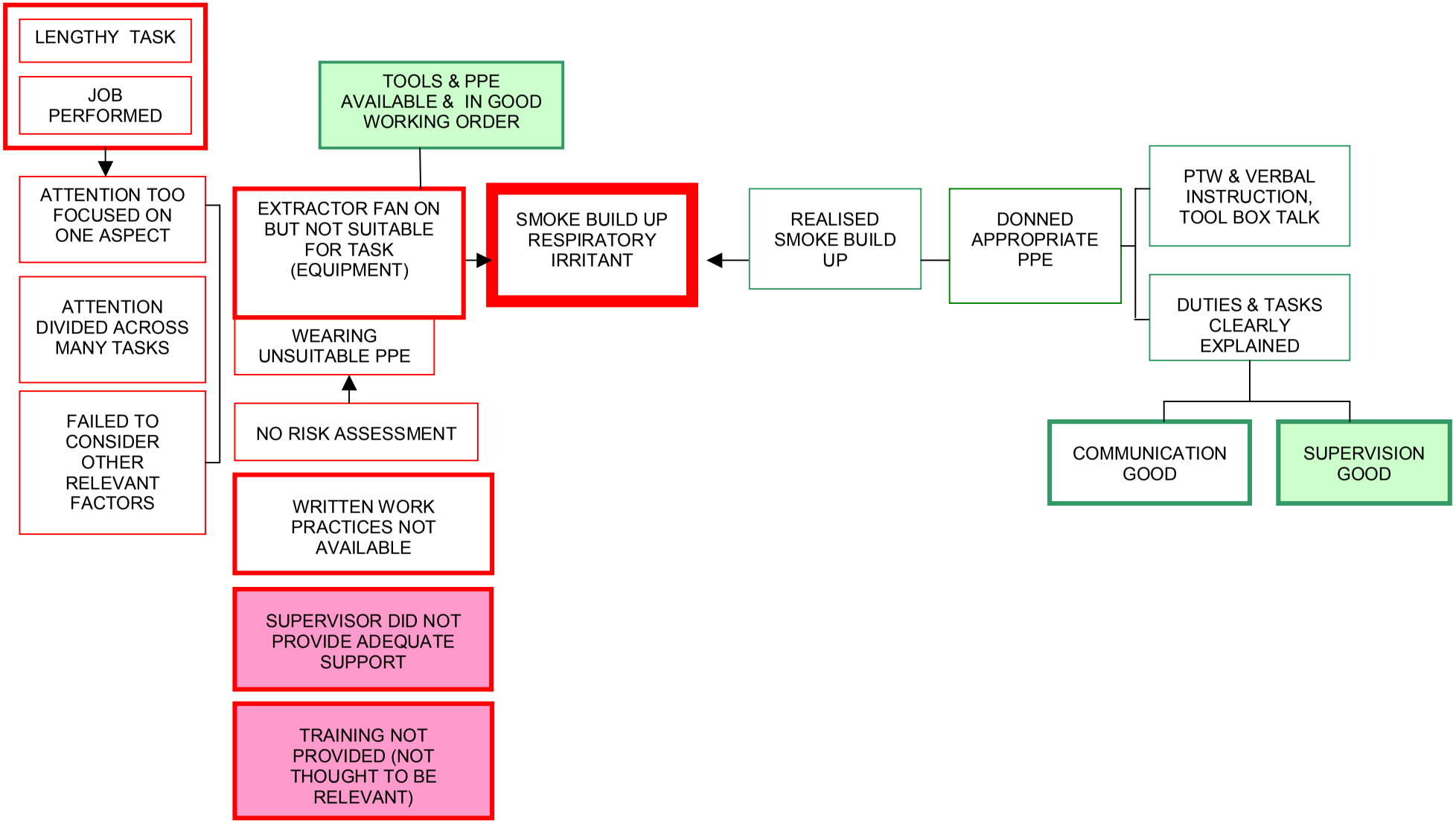
If you were to do this job again, what would you do differently to avoid the accident/incident?

APPENDIX D. MODELS OF 10 CASE STUDIES

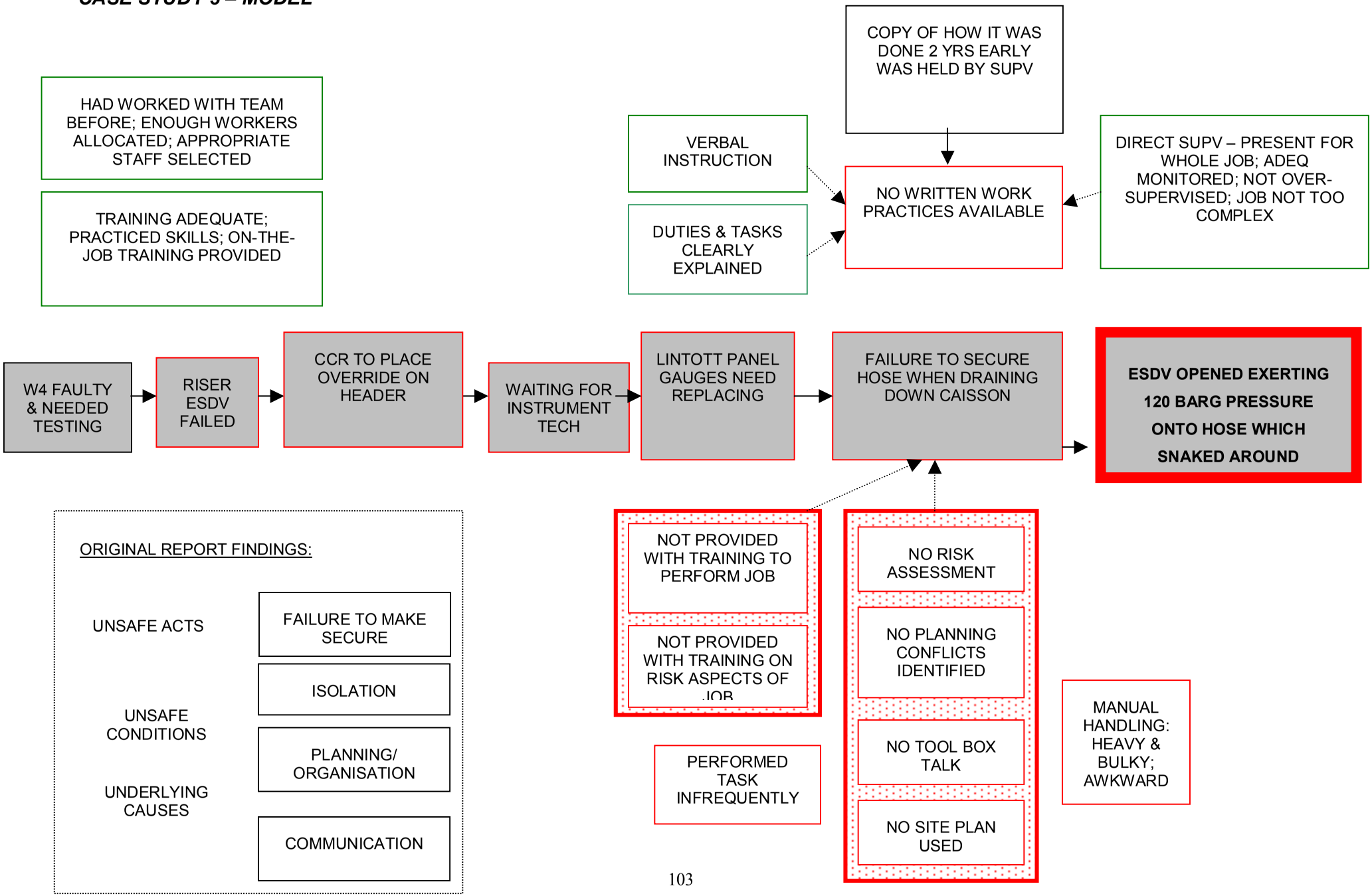
CASE STUDY 1 - MODEL



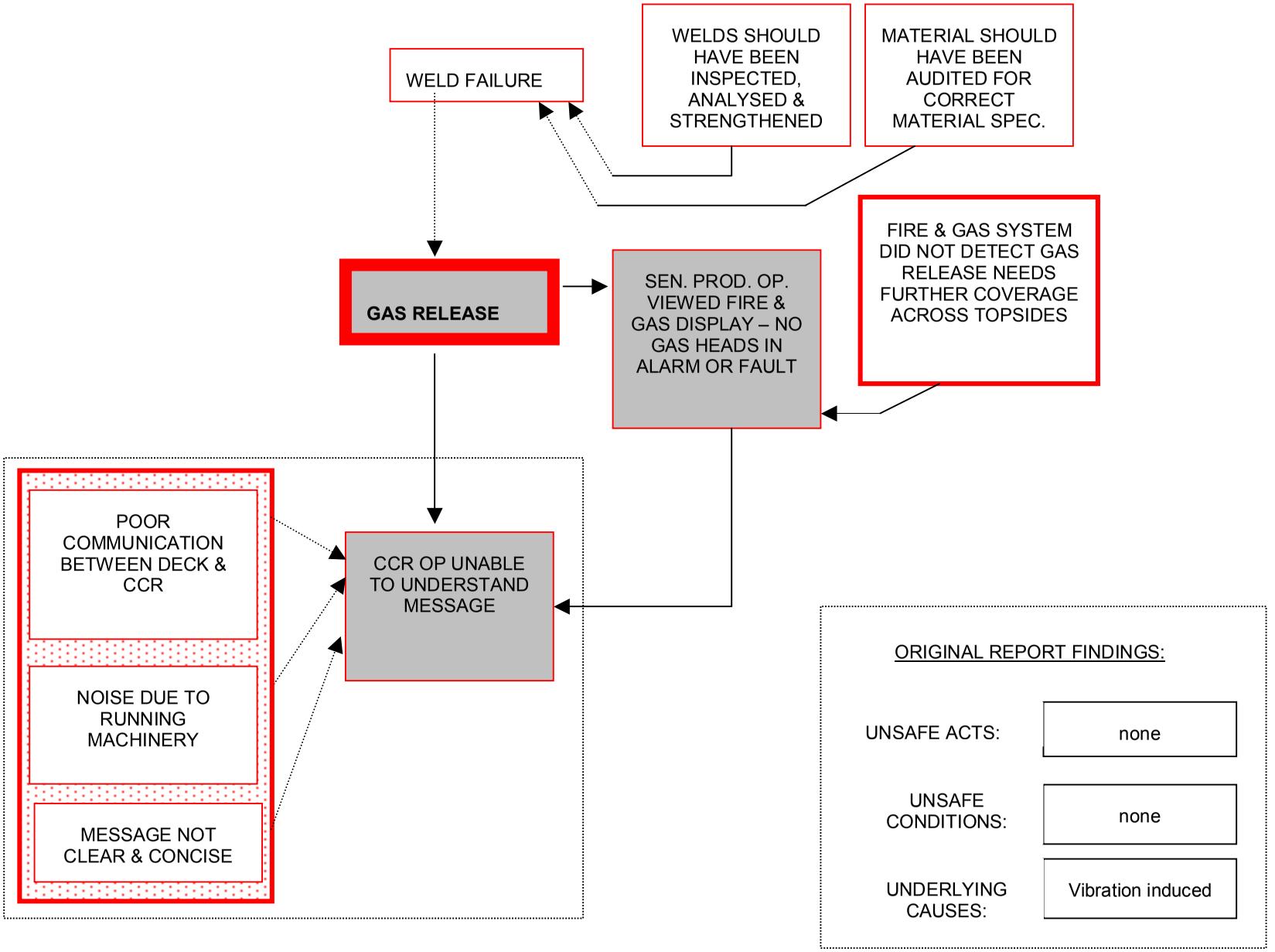
CASE STUDY 2 – MODEL



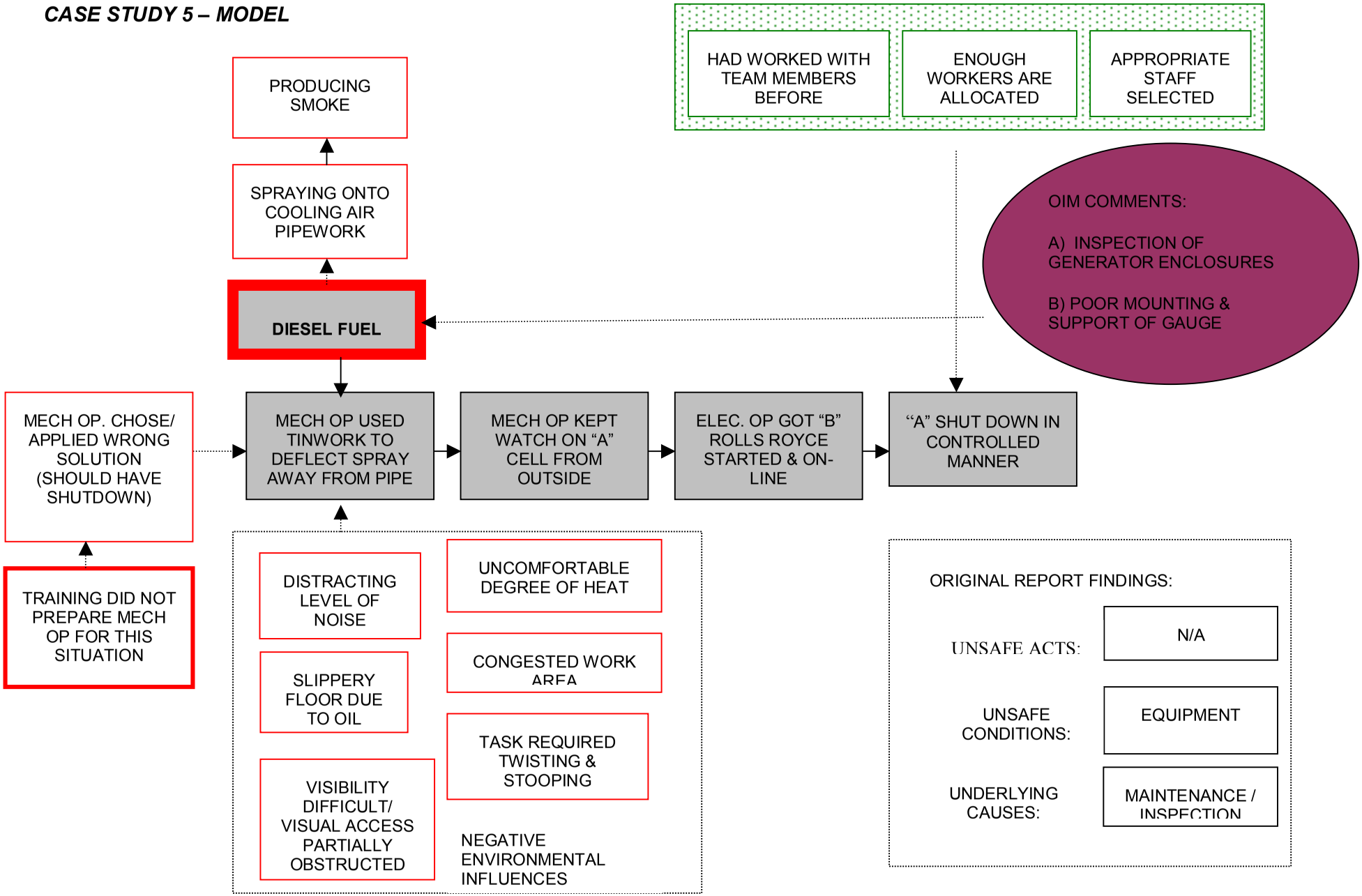
CASE STUDY 3 – MODEL



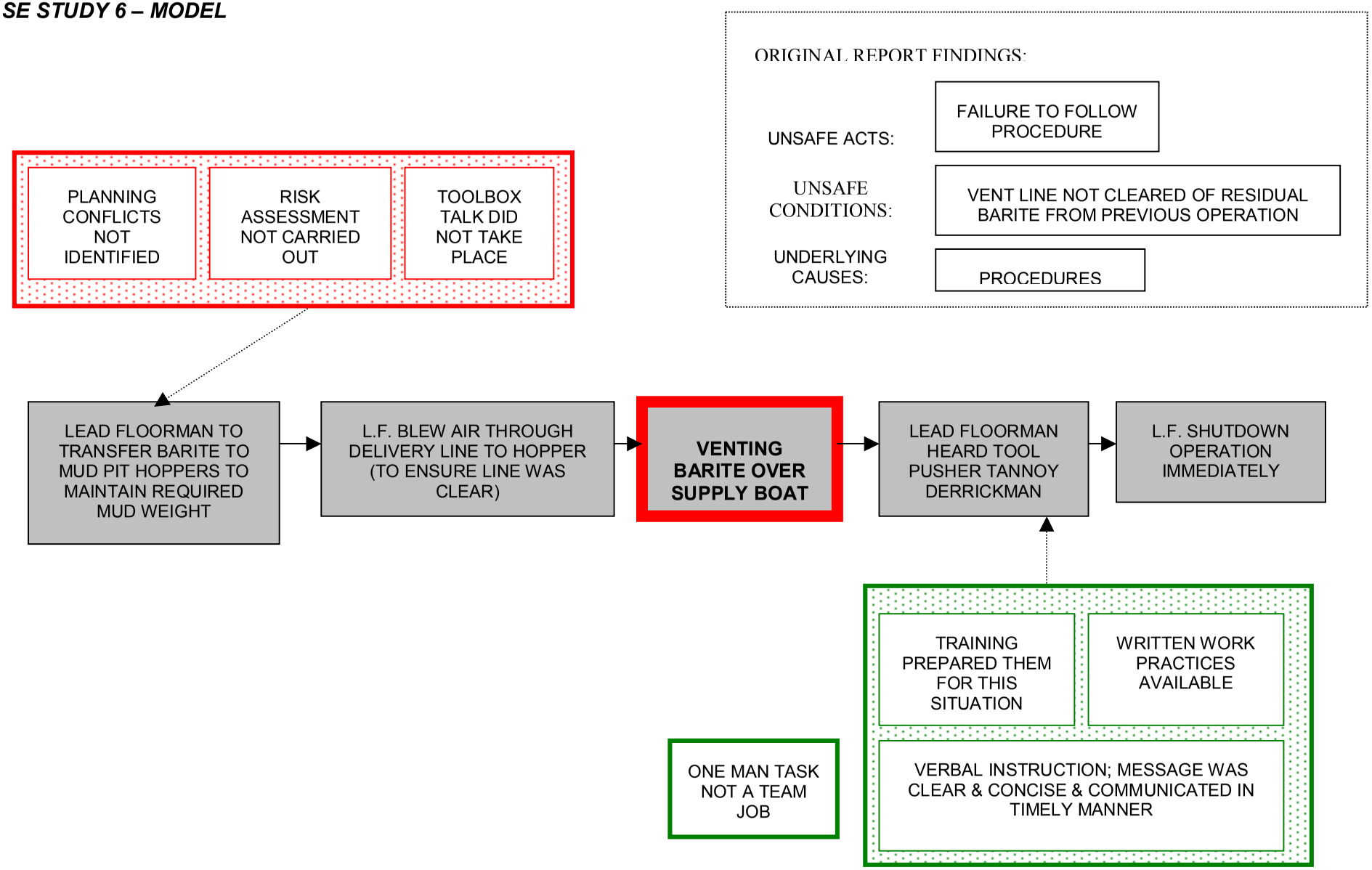
CASE STUDY 4 – MODEL



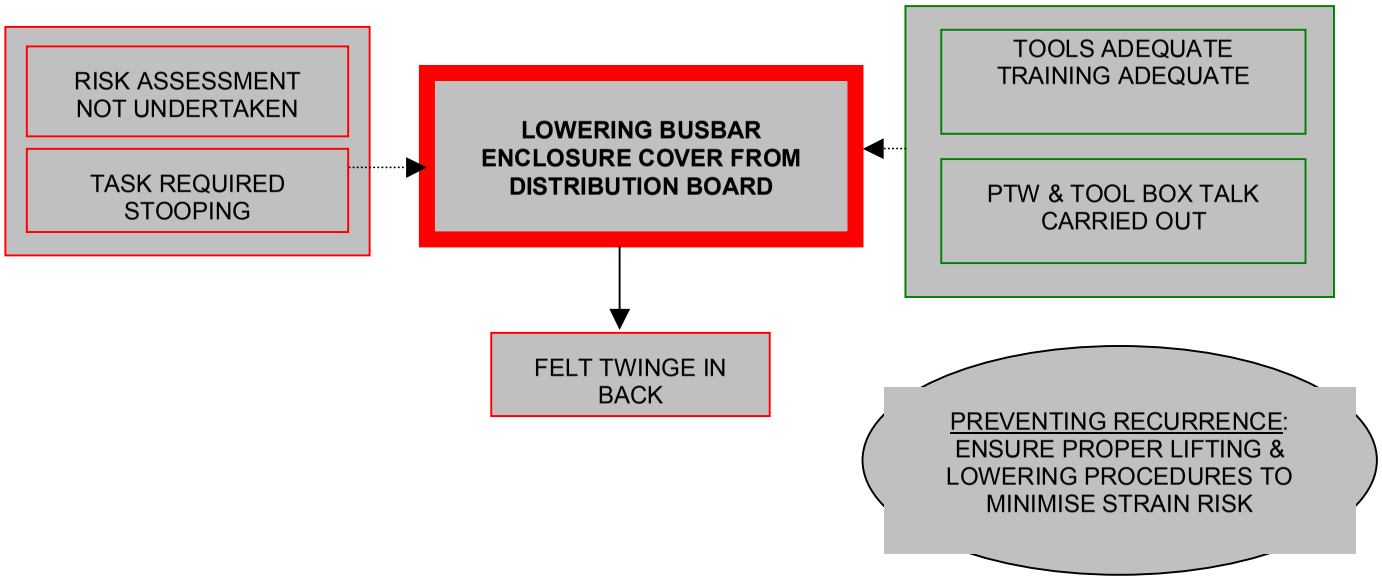
CASE STUDY 5 – MODEL



CASE STUDY 6 – MODEL



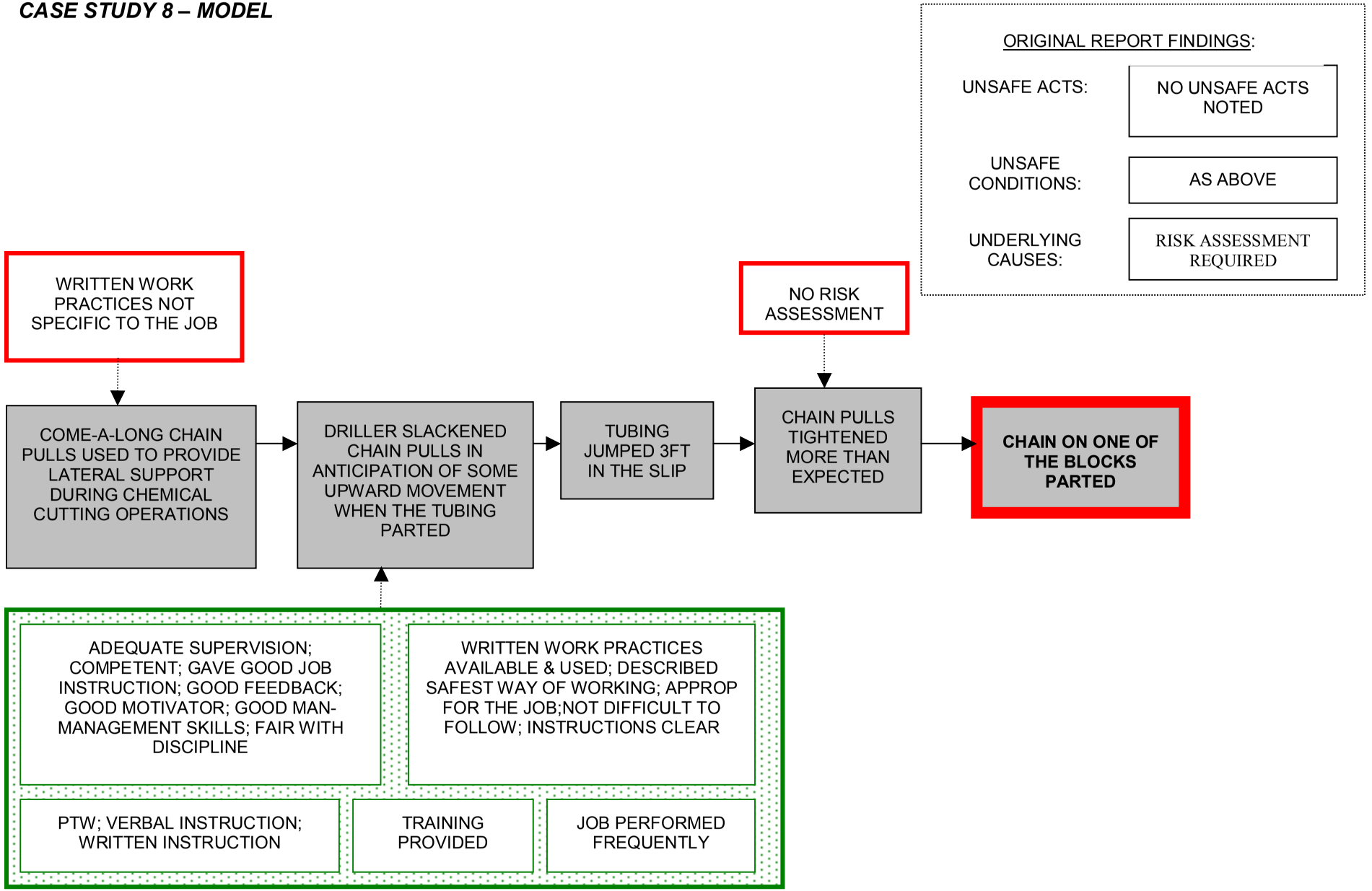
CASE STUDY 7 – MODEL



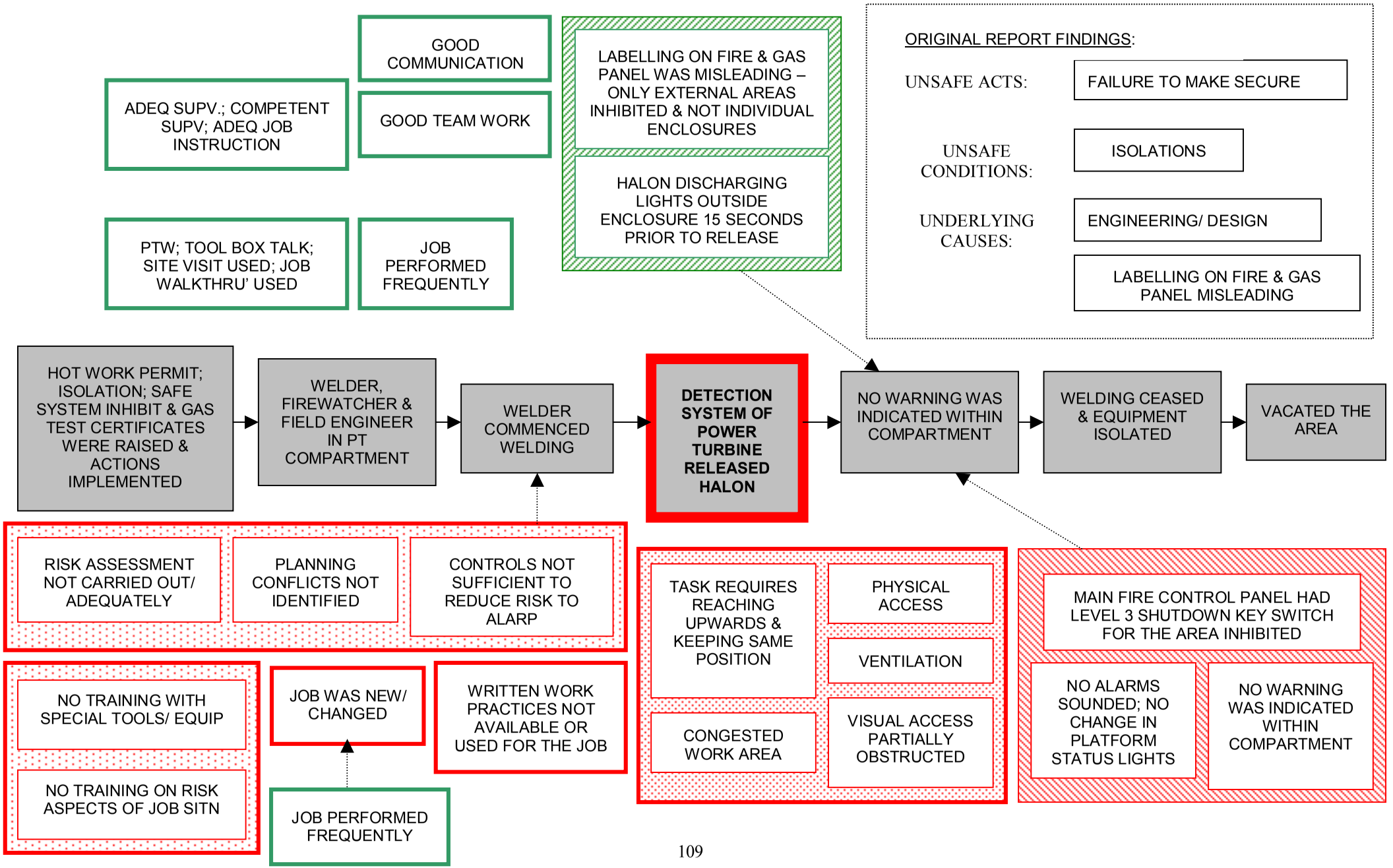
ORIGINAL REPORTS FINDINGS:

UNSAFE ACTS:	IMPROPER PHYSICAL EFFORT/ACT
UNSAFE CONDITIONS:	NONE NOTED
UNDERLYING CAUSES:	IMPROPER LIFTING TECHNIQUE

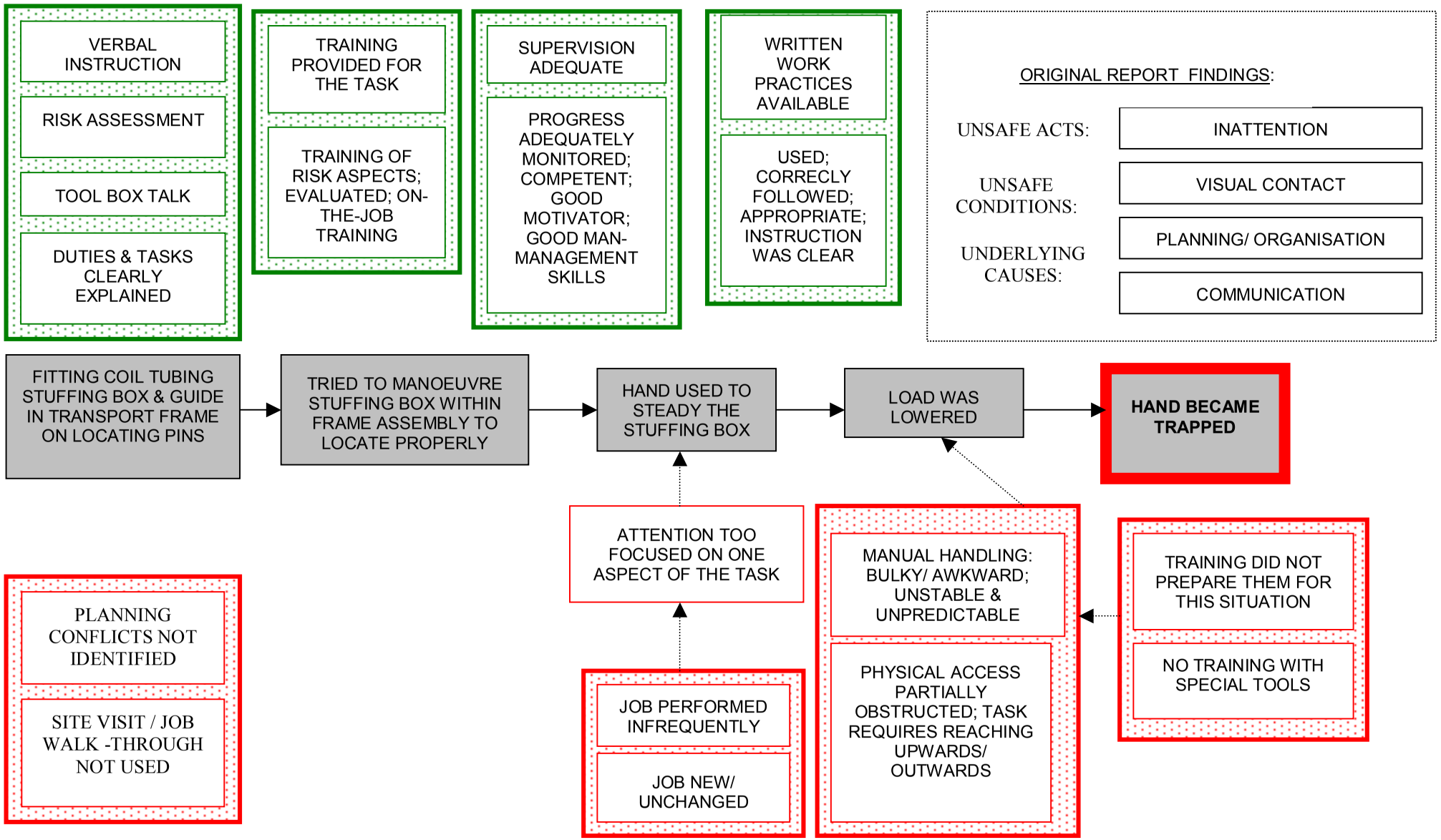
CASE STUDY 8 – MODEL



CASE STUDY 9 – MODEL



CASE STUDY 10 – MODEL



APPENDIX E. Details from 10 incidents: Findings from the Original Report and the WSFII.

	INCIDENT CLASSIF.	SEVERITY POTENTIAL		ORIGINAL REPORT CAUSES	IN REMEDIAL ACTIONS?	CAUSAL CAT	WSF II CAUSES	IN REMEDIAL ACTIONS?
1	PROPERTY DAMAGE	B3 CAUTION	UNSAFE ACTS	NONE	-	PERSON	CHOSE/APPLIED WRONG SOLUTION	✗
			UNSAFE CONDITIONS	NONE	-	PLANNING	NO TOOL BOX TALK	✗
			UNDERLYING	ENGINEERING/DESIGN		JOB	TASK WAS REPETITIVE	✗
				MAINTENANCE/INSPECTION		TRAINING	NO REFRESHER TRAINING	✗
2	FAC	B3 CAUTION	UNSAFE ACTS	FAILURE TO FOLLOW PROCEDURE	✓	PERSON	ATTENTION DIVIDED ACROSS MANY TASKS; FAILED TO CONSIDER OTHER RELEVANT FACTORS	✗
				FAILURE TO USE APPROPRIATE PPE	✓	EQUIPMENT	WEARING UNSUITABLE PPE; EXTRACTOR FAN NOT SUITABLE FOR TASK	✓
			UNSAFE CONDITIONS	VENTILATION?	✓	PROCEDURES	WRITTEN WORK PRACTICES NOT AVAILABLE; LENGTHY TASK	✓✗
			UNDERLYING	RISK ASSESSMENT	✓	TRAINING	TRAINING NOT PROVIDED	✓
				JOB INSTRUCTION	✗	PLANNING	NO RISK ASSESSMENT UNDERTAKEN	✗
						JOB	JOB PERFORMED INFREQUENTLY	✗
						SUPERVISION	SUPERVISOR DID NOT PROVIDE ADEQUATE SUPPORT	✗
3	NEAR MISS	B3 CAUTION	UNSAFE ACTS	FAILURE TO MAKE SECURE	✓	PERSON	FAILURE TO SECURE HOSE WHEN DRAINING CAISSON	✓
			UNSAFE CONDITIONS	ISOLATION	✗	EQUIPMENT	EQUIPMENT FAILURE (RISER ESDV FAILED; GAUGES FAILED); OVERRIDE PLACED ON HEADER	✓✗
			UNDERLYING CAUSES	PLANNING/ ORGANISATION	✗	PROCEDURES	NO WRITTEN WORK PRACTICES AVAILABLE	✓
				COMMUNICATION	✗	TRAINING	NONE PROVIDED FOR JOB OR RISK ASPECTS	✓
						PLANNING	NO RISK ASSESSMENT; NO PLANNING CONFLICTS IDENTIFIED; NO TOOL BOX TALK; NO SITE PLAN USED	✓✗
						ENVIRONMNT	MANUAL HANDLING: HEAVY, BULKY & AWKWARD	✗
4	PROPERTY DAMAGE	B3 CAUTION	UNSAFE ACTS	NONE	-	EQUIPMENT	FIRE & GAS DETECTION SYSTEM FAILED	?
			UNSAFE CONDITIONS	NONE	-	COMMUNICTN	POOR COMMUNICATION BETWEEN DECK & CCR; MESSAGE NOT CLEAR & CONCISE	?
			UNDERLYING CAUSES	VIBRATION LEADING TO FRACTURE	?	ENVIRONMNT	NOISE DUE TO RUNNING MACHINERY	?
				BRACING/ SUPPORT LINE	?	INSPECTION	INSPECTION OF WELDS; AUDIT OF CORRECT MATERIAL SPECIFICATION	?

	INCIDENT CLASSIF.	SEVERITY POTENTIAL	CAUSE TYPE	ORIGINAL REPORT CAUSES	IN REMEDIAL ACTIONS?	CAUSAL CAT	WSF II CAUSES	IN REMEDIAL ACTIONS?
5	NEAR MISS	B2	UNSAFE ACTS	N/A	-	PERSON	CHOSE/APPLIED WRONG SOLUTION	✗
			UNSAFE CONDITIONS	EQUIPMENT	✓	ENVIRONMNT	DISTRACTING LEVEL OF NOISE; SLIPPERY FLOOR DUE TO OIL; VISIBILITY DIFFICULT; VISUAL ACCESS PARTIALLY OBSTRUCTED; UNCOMFORTABLE DEGREE OF HEAT; CONGESTED WORK AREA; TASK REQUIRED TWISTING & STOOPING	✗
			UNDERLYING CAUSES	MAINTENANCE/ INSPECTION	✓	TRAINING	DID NOT PREPARE WORKER FOR THIS SITUATION	✗
6	ENVIRON.	A1	UNSAFE ACTS	FAILURE TO FOLLOW PROCEDURES	✓	ENVIRONMNT	BARITE STILL IN DELIVERY LINE FROM PREVIOUS OPERATION	✗
			UNSAFE CONDITIONS	VENT LINE NOT CLEARED OF RESIDUAL BARITE	✗	PLANNING	PLANNING CONFLICTS NOT IDENTIFIED; RISK ASSESSMENT NOT CARRIED OUT; TOOL BOX TALK DID NOT TAKE PLACE	✗
			UNDERLYING	PROCEDURES	✓			
7	RWC	B1 CARE	UNSAFE ACTS	IMPROPER PHYSICAL EFFORT	✓	ENVIRONMET	TASK REQUIRED STOOPING	✓✗
			UNSAFE CONDITIONS	NONE	-	PLANNING	RISK ASSESSMENT NOT UNDERTAKEN	✗
			UNDERLYING	IMPROPER LIFTING TECHNIQ.	✓			
8	PROPERTY DAMAGE	A1 CARE	UNSAFE ACTS	NONE	-	PROCEDURES	WRITTEN WORK PRACTICES NOT SPECIFIC TO THE JOB; NO RISK ASSESSMENT	✗
			UNSAFE CONDITIONS	NONE	-			
			UNDERLYING	RISK ASSESSMENT	✓			
9	ENVIRON.	A1	UNSAFE ACTS	NONE	-	EQUIPMENT	FIRE CONTROL PANEL INHIBITED; NO WARNING: NO ALARMS OR CHANGE IN PLATFORM STATUS LIGHTS	✓
			UNSAFE CONDITIONS	ISOLATIONS	✓	JOB	JOB NEW/CHANGED	✗✓
			UNDERLYING	ENGINEERING/ DESIGN	✓	PLANNING	CONTROLS NOT SUFFICIENT TO REDUCE RISK TO ALARP PLANNING: RISK ASSESSMENT NOT UNDERTAKEN; PLANNING CONFLICTS NOT IDENTIFIED;	✗✓
				LABELLING MISLEADING	✓	ENVIRONMT	TASK REQUIRES REACHING UPWARDS & KEEPING SAME POSITION; CONGESTED WORK AREA; PHYSICAL ACCESS; VENTILATION; VISUAL ACCESS PARTIALLY OBSTRUCTED	✗✓
						PROCEDURES	WRITTEN WORK PRACTICES NOT AVAILABLE OR USED FOR THE JOB	✗
10	MTC	B2 CARE	UNSAFE ACTS	INATTENTION	✓	PERSON	ATTENTION TOO FOCUSED ON ONE ASPECT OF THE TASK	✗✓
			UNSAFE CONDITIONS	VISUAL CONTACT	✓	ENVIRONMNT	MANUAL HANDLING: BULKY/ AWKWARD; UNSTABLE & UNPREDICTABLE; PHYSICAL ACCESS PARTIALLY OBSTRUCTED; TASK REQUIRES REACHING UP/OUTWARDS	✗
			UNDERLYING	PLANNING/ ORGANISATION	✗	PLANNING	PLANNING CONFLICTS NOT IDENTIFIED; SITE VISIT & JOB WALKTHROUGH NOT USED	✗
				COMMUNICATION	✗	JOB	JOB PERFORMED INFREQUENTLY; JOB NEW/ CHANGED	✗
						TRAINING	TRAINING DID NOT PREPARE WORKERS FOR THIS SITUATION; NO TRAINING WITH SPECIAL TOOLS	✓

Printed and published by the Health and Safety Executive
C1.25 03/03

MAIL ORDER
HSE priced and free
publications are
available from:
HSE Books
PO Box 1999
Sudbury
Suffolk CO10 2WA
Tel: 01787 881165
Fax: 01787 313995
Website: www.hsebooks.co.uk

RETAIL
HSE priced publications
are available from booksellers

HEALTH AND SAFETY INFORMATION
HSE Infoline
Tel: 08701 545500
Fax: 02920 859260
e-mail: hseinformationservices@natbrit.com
or write to:
HSE Information Services
Caerphilly Business Park
Caerphilly CF83 3GG

HSE website: www.hse.gov.uk

RR 060

£30.00

ISBN 0-7176-2695-4

9 780717 626953

Factoring the human into safety: Translating research into practice **Volume 2 (of 3)**

The development and evaluation of a human factors accident and near miss reporting form for the offshore oil industry

HSE BOOKS