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MASTER'S THESIS

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PREFACE

This master thesis represents the end of my master degree in Risk management at the University of Stavanger, and has been an individual assignment. The master thesis is done in one semester and is ¼ of the points in the whole master degree. Scope of thesis was formulated together with Atle Lileng in Subsea7.

I would like to express my thanks to several people. First I shall thank my supervisors in Subsea7 Atle Lileng and Frode Eskildsen, who have given me a lot of valuable information throughout the whole process. I would also like to give my thanks to Eirik Bjorheim Abrahamsen for guiding me in the right direction and advice and improve my thesis. Finally I would like to thank the rest of HSE department in Subsea7 for helpful information.

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Thor-Atle Kolberg

SUMMARY

The main safety technique used for Subsea7 work activities is hazard identification and risk assessment (HIRA). This process shows how the work activities are conducted, supervised and managed correctly, in accordance with approved practices. The biggest challenge is communicating the risk out to the people executing the work. Make them understand the risk tied to the work.

The goals with this master thesis were comparing different uncertainty factors and evaluate the different methods used in HIRA procedure. See what type of uncertainty tied to the procedures. What methods that are best in Subsea7 type of operations. Finally investigate the information received from the vessel.

Uncertainty tied to the HIRAs

The main purpose was to prove that Subsea7 had to take uncertainty into the calculation of risk. It shows that the risk description can be split into two parts, one covering events and consequences, and another that covers uncertainty. This acknowledges that risk cannot only be described and evaluated by referring to probabilities and evaluated consequences. It needs to be evaluated together with an uncertainty factor U. If Subsea7 implement factor U they will reduce the hazards from occurring.

Methods used to identify measure and communicate risk

Subsea7 HIRA contains parts of different risk identification methods and that is important for getting a better risk picture of the operation. The different techniques that are implemented are guidewords and task analysis. But it should also implement parts from SWIFT like “what if analysis”, this will question the procedures more. Also use FMECA on critical equipment so they don’t risk the whole operation stopping. That should give them better information about where the hazards are hidden. The best way of preparing the procedures is a combination of al the method evaluated, but that is time consuming.

The HIRAs are a good tool for finding the hazards and calculating the risk level, but it can be improved by more precise information about where danger is hidden. Subsea7 can try to upgrade the HIRAs with one or two columns. One with cause (cause of hazards) and split the corrective measures in proactive measures (actions that prevent hazards from occurring) and protective measures (measures that protect people, assets and environment from the hazards). That way the evaluated risk will be easier to communicate out to the people doing the work and they will understand the risk better.

The majority of employers who responded to the survey generally felt “safe” regarding offshore hazards and “satisfied” regarding safety measures on board their vessel. The respondents felt that the communication between the office and vessel could be better, and make the safety procedures user-friendlier. That could be something to focus on when management are making the new safety procedures for Subsea7.

TABLE OF CONTENTS

FIGUR AND TABLE LIST

1. INTRODUCTION

In today`s world the energy industry is in the focus of public interest. This was clearly shown in summer 2010 when the Macondo field had a blowout, lead to the largest oil spill in the history of the industry(Kolberg and Hummel 2010). After this accident people start to focus even more on safety. It is important to take into account different types of hazards given that is a chance of something happen. In a human life one are exposed to risk regularly, and risk forces people to take decisions. But how do we know if these decisions taken are correct. Good decisions will improve peoples understanding of the risk tied to the work in the office and at the worksite. If one can make people more aware of what causes an unwanted event, then that will reduce the probabilities for an unwanted event to occur.

Subsea 7 is a seabed –to-surface engineering, construction and service company to the offshore energy industry worldwide(2011). They concentrate on services that add value for clients throughout the lifecycle of their offshore energy fields. Their main risk tool for these operations is the hazard identification and risk assessment (HIRA) process. Their goal in each project is to reduce the risk as low as reasonable practicable (ALARP). Below is scope of tasks done in a HIRA process.

- It starts with identifying al the hazards, which are the potential causes of harm, associated with work being undertaken.
- Assessing the risk from the hazard.
- Identify suitable control measures that eliminate or reduce the hazard from occurring.
- Recording the HIRAs so it is easy to find them later on.
- Implement the control measures on the worksite.
- Control that the residual risk is ALARP. Residual risk is existing risk after control measures have been implemented.

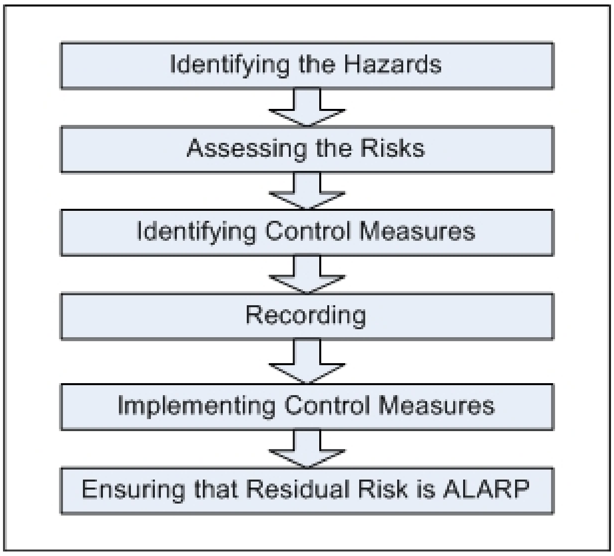

FIGURE 1-1 – HAZARD IDENTIFICATION AND RISK ASSESSMENT PROCESS

1.1 BACKGROUND

Subsea 7 uses a lot of recourses on reducing the risk to an acceptable level. And they want to know if the recourses used in the office is well spent. Are the risk communicated in a right way. Do the HIRAs go the whole way from office to the vessel? This is a procedure that gets completely overview over risk tied to different operations. This method is based on finding events that can make damages to people, equipment and environment. The analysis method starts with planning of operation on land, and revised/updated on on-board the vessel before start-up. This way the risk is sent forth to the people involved in the operation. The model defines activities and uncovers consequence with an unwanted event. Further it defines a risk picture (High, medium and low) before corrective measures are installed. In the end corrective measures shall be specified for preventing unwanted events and then the new risk picture is defined.

10 of January 2011 there was a fusion between Acergy and Subsea 7, the new company was named Subsea 7. The company became bigger and it presented some dilemma that they have double up with legacy Acergy on one hand and old legacy Subsea7 on the other. Now that they are making the new safety procedure, they want to know if they can use information from the old legacy Acergy procedure. How reliable is the legacy Acergy procedure? Is it possible to find something to improve from the old procedures? The legacy Acergy management system contains procedures of how management in Legacy Acergy is performing the operations in a safe manner. The HIRA procedure is one of the procedures in the legacy Acergy management system.

1.2 OBJECTIVE

The goal with this assignment is to use different methods to investigate opportunities of improving Subsea 7 HIRA procedure. Does HIRA procedure cover all aspect when it comes to risk exposure, and will it reduce the risk to a level that is ALARP? Also find out if the procedure can help people understand risk related to work better. A way of doing that is to find uncertainty factors in the HIRA procedure, that affect the procedure negatively. Factors that may not be in Subsea7 focus area. Find uncertainty that arises in the different stages of the HIRA procedure. Experience how the procedure works in practise and see where there is room for improvements. Investigate Subsea 7 risk view and see if the analyses used are covering all hazards. Make a questionnaire that shows how good the communication between office and vessel are and how well the procedures works on the vessel. Collect the important information and use it for discussion. In the end put the positive and negative factors against each other and see what we can improve on the procedure.

1.2.1 Evaluation of process

The first thing done in this thesis is evaluation of the HIRA process. The best way of doing that is taking part in as many risk assessments as possible, to get an good impression of how Subsea 7 perform a safe operation. A great thing with observing is the information one gets, making a better overview of how the procedure is done. But it can be difficult to collect valuable information, when taking part in meeting with many different enlists. The information one gets will not be as accurate as an interview or questionnaires.

The main focus area is on PHA, HIRA stage 1, HIRA stage 2 and Toolbox Talk. Theses are the main stages in the HIRA procedure. PHA is a qualitative method its purpose is identifying all hazards and operability problems in a project. HIRA is qualitative method used to find out how big the risk level is on a scale from high, medium and low. And implement actions that shall reduce the risk level to an acceptable level. Toolbox talk is a method for communicating the risk to the people that are performing the work.

The second thing done is making a questionnaire that is sent out to a vessel. It consists of questions with different types of alternatives. It uses alternatives or open-ended questions. Open-ended questions may often result as the most interesting questions where new information can be obtained, but are more time consuming. The information we get from the questionnaire is subjective and that is good when the intension is to improve the safety system. The figure 1-2 is illustration of how the thesis is structured: First evaluate the HIRA procedure taken from legacy Acergy. Find uncertainty factors in the HIRA procedure. Then evaluate the methods needed for doing HIRAs. In the end, find a solution that can improve the HIRAs.

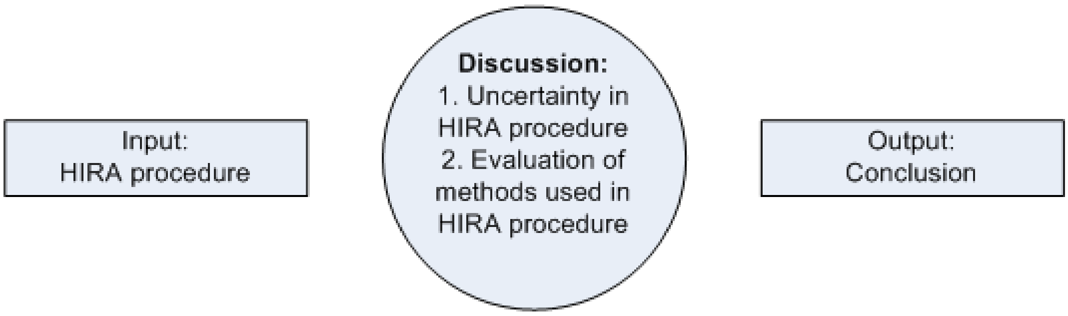

FIGURE 1-2 – EVALUATION STRUCTURE

1.3 TERMINOLOGY

Initials:	**Definition:**
ALARP	As low as is reasonable practicable
ASARP	As safe as is reasonable practicable
ETA	Event tree analysis
FMECA	Failure mode, effect and criticality analysis
FTA	Fault tree analysis
HAZID	Hazard identification
HAZOP	Hazard identification and operability study
HIRA	Hazard Identification and Risk Assessment
PHA	Preliminary Hazard Analyses
PPE	Personal protective equipment
SWIFT	Structured what if checklist technique
QRA	Quantitative risk assessment
HAZARD	Is anything with the potential to cause harm. This can be a dangerous substance, part of a machine, a form of energy or a method of carrying out work.
Lesson learned	A database containing experience from earlier projects. The project engineers use this early in the project for getting information from similar operations.
Risk	Is the measure of probability that harm from particular hazard will occur. In Subsea7 risk takes account of possible consequences and is expressed by loss probability rating of, Low – Medium – High.
Risk Analysis	When we are estimating risk from the basic activity

Risk Assessment	The process of analysing the level of risk, by considering those in danger, or what might be harmed. Then evaluating whether hazards are adequately controlled or can be controlled by putting control measures in place
Risk Management	Process of selecting the appropriate risk reduction measures and implementing them in the activity.
Safety management	A discipline producing frequency estimates of specific hazardous events.
Uncertainty management	A discipline producing prediction intervals based on probability distribution quantiles, in addition to mean values.

TABLE 1 - TERMINOLOGY

1.4 TYPICAL HAZARDS

Below is an example of guideword used in hazard identification. It is 32 hazards that will affect the operation negatively if not taken into consideration.

Slip/trip/fall hazards	Flammable materials
Chemicals/pollution/contaminants	Moving/swinging objects
Moving parts of machinery/vehicles	Voltage
Pressure/vacuum	Noise
Working at height/over side	Fumes/noxious gases
Dust	Manual handling
Position and entrapment	Low/high temperature
Lighting levels	Radiation
Low oxygen environment	Hydrocarbons
Restricted access/egress	Posture
Single point failures	Unstable objects
Weak structures	Explosives
Ship heave or roll	Weather conditions
Crane operations	Bacteria, virus, disease
Vibration	Dangerous
Sparks/material from welding/grinding	Task with repetitive injury potential

Table 2 – Typical hazards

2. PROJECT RISK MANAGEMENT

2.1 RISK DEFINITION

Subsea7 definition of risk is based on project risk. And that is conditions affecting the new or old projects. Risk is the measure of probability that harm from particular hazard will occur. In Subsea7 risk takes account of possible consequences and is expressed by loss probability rating of, Low – Medium – High.

In the table 3 we have first Subsea7 definition of risk and then we have (Aven 2008) definition of risk:

Risk	Definition
A	Expected hazard that may occur under the operation, that causes damages to personnel, environment or assets.
P	Evaluated probability for hazard occurring fund in Subsea7 probability guidelines.
C	Evaluated consequence of the hazard happening fund in Subsea7 severity guidelines.
K	Background knowledge of experts. Much of the experience is learned from Subsea7 database “Lesson learned”.

Table 3 – Subsea7 risk definition

Risk is related to future events A and their consequences (outcomes) C. Today we do not know if these events will occur or not, and if they occur, what the consequences will be. In other words, there is uncertainty U associated with both A and C. How likely it is that event A will occur and that specific consequences will result, can be expressed by means of probabilities P, based on our knowledge (background knowledge), K.

2.2 UNCERTAINTY

Subsea7 risk description is based on a gross risk analysis. With that we mean that they don’t spend much time on calculating the risk. The calculation of the risk analysis is done by the experience of the people executing the risk assessment. But there is uncertainty associated with the experience of the executers, this part is not considered in Subsea7 risk definition. Uncertainty U associated with probability for the hazard to occur and the consequence of the hazard. (Abrahamsen, Aven et al. 2009) Say that risk associated with an activity is to be understood as: “risk is uncertainty about and severity of the consequence (or outcome) of an activity with respect to something that humans value”. Severity can be referred to as intensity, size, extension, scope and other potential measures of magnitude, and affect something with a human value (injury’s, assets and environments). Severity are characterised as consequences. The risk perspective in (Abrahamsen, Aven et al. 2009) is “risk cannot be adequately described and evaluated by reference to probabilities and expected consequences only”. Subsea7 is calculating the risk by using qualitative methods. This is based on the background information from the experts. In the figure 2-1 we can see an illustration of the risk definition:

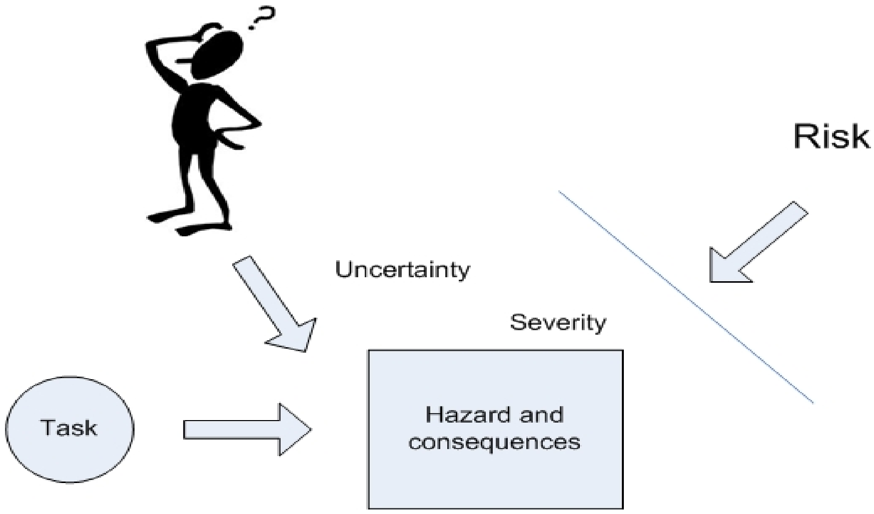

FIGURE 2-1 – UNCERTAINTY TIED TO CALCULATION OF HAZARDS AND CONSEQUENCES

2.3 PROJECT RISK MANAGEMENT FRAMEWORK

Project risk management is a systematic process of planning, identifying, analysing, responding, monitoring and control the project(Institute 2004). The objective of project risk management is decrease probability and impact of hazards on the project. In the figure 2-2 we can see framework of the project risk management:

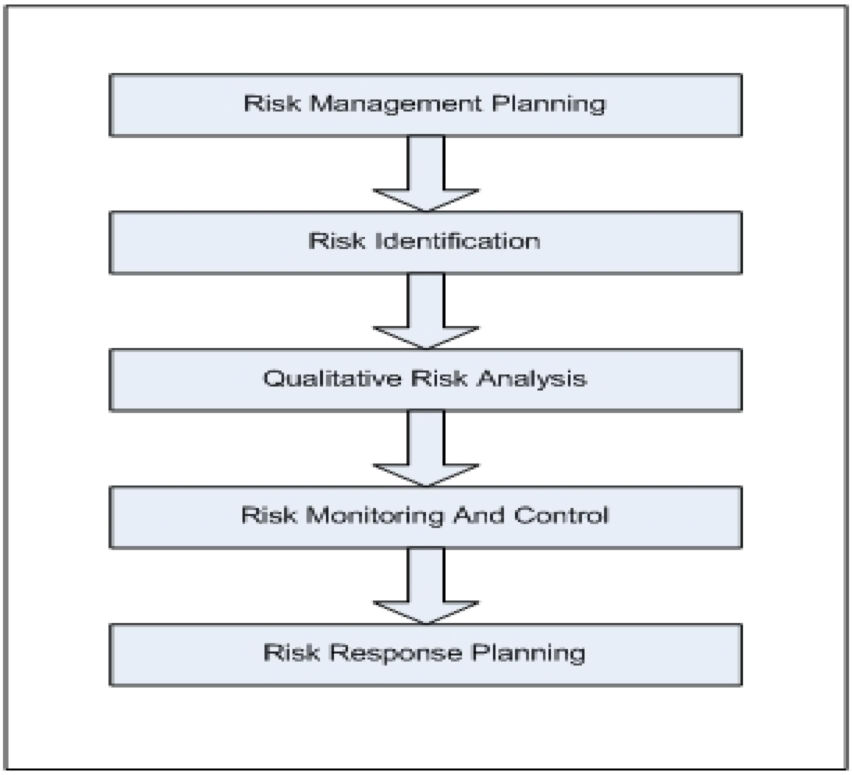

FIGURE 2-2 – PROJECT RISK MANAGEMENT FRAMEWORK

2.3.1 Risk management planning

Risk management planning is the process of deciding how to approach and conduct the management activities for a project. Planning is important tool for ensuring that the level, type, and visibility of risk management are communicated with both the risk and importance of the project to the organisation, to provide sufficient recourses and time for risk management activities, and for establish an agreed-upon basis for evaluating risk (Institute 2004).

The risk management plan describes how risk management are structured and preformed on the project. The planning includes the following:

- Methodology defines how we do the work, tools used and data sources that may be used to perform risk management.
- Roles and responsibilities defines the leader of the project, who is supporting the project, and risk management team membership for each type of activity in the risk management plan, and assigned people roles and responsibility.
- Budgeting assigned resources and estimated cost for risk management.
- Timing defines when and how often the risk management process will be preformed throughout the project life cycle.
- Risk categories are structured to ensure a systematic process of identifying risk and contribute the effectiveness and quality of risk identifying. Companies often use a risk breakdown structure (RBS) for helping the identifying of the risk.
- Definition of risk probability and consequences are a way of making sure the quality and credibility of qualitative risk analysis process are good enough. A scale representing probability value from “very likely” to “almost certainty” can be used. And the consequences have to be defined as well, normally scale severity, injury, environment and assets.
- Probability and consequence matrix is a way of prioritizing hazards in a risk matrix. The combinations of probability and consequence will lead to the hazards being rated as “high,” “medium,” or “low”. One has to implement corrective action if the risk is too high.
- Reporting formats are very important, because the outcome of the risk management process are documented and communicated.
- Tracking documents are good ways of informing important factors in later projects.

2.3.2 Risk identification

Risk identification determines which hazards might affect the project and documents their characteristics. Participants in risk identification can include the following: project manager, project engineers, HSE advisor and experts from outside the project team. Experts can be customers, users, other project managers, stakeholders and risk management experts. Risk identification is an on going process as the project progresses through its life cycle. The involvement from project team and experts will vary from case to case trough project life cycle. But project team should be involved in the process so they can develop and maintain a sense of ownership of, and responsible for, hazards and corrective measures. The hazards are then saved in a risk register. It contains the outcome of risk management processes.

Recommended in a risk register: List of identified hazards contains root causes and uncertain project assumptions. Potential responses to a hazard may be identified during the risk identification. These responses are used to lowering the risk level. Find the root cause of the hazards. Sometimes it can occur new risk categories, which are useful when updating the process. Underneath there are some example of risk identification tools and techniques:

1. Documentation review: A structured review may be preformed of: project documentation, including plans, assumptions, prior project files, and other information.
2. Brainstorming is a good way of finding hazards. It is important that some of the project team has different expertise. Then it is easier to find ideas about project hazards.
3. Checklist analysis can be based on historical data and knowledge that has been accumulated in similar projects. The checklist should be reviewed during project closure to improve it for use on future projects.

2.3.3 Qualitative risk analysis

Qualitative risk analysis assesses the priority of identified hazards using their probability of occurring, and consequence on project objectives. It is important to have good definition of the levels of probability and consequences, and have experts with experience support in the risk analysis. Risk probability and consequences assessment investigates the likelihood that each specific hazard will occur, and what effect it will have on project objective. The level of probability for each hazard and its consequences on each object is evaluated during the meeting. It is important that the hazards are evaluated after project guidelines. Evaluation of each hazards importance, and priority for attention is typically conducted using look-up table or a probability and consequence matrix. Such matrix specifies combinations of probability and consequences that lead to rating of the risk as low, medium or high. It is vital that project guidelines are clearly and easy to use. Then project team can analyse the risk correct.

2.3.4 Risk response planning

Hazard response planning is the process of developing options, and determining corrective measures to enhance eliminate or reduce hazards on the project. It addresses the hazards by their priority, inserting recourses and activities into the budget, schedule, and project management plan as needed. Planned Hazard response must be appropriate to the significant of the hazard, cost effective in meeting the challenge, timely, realistic within the project context, agreed upon by all parties involved, and owned by reasonable person. Selecting the best hazard response from several options are often required. One strategy for accepting the hazard is establishing a contingency reserve, including amounts of time, money, or resources to handle correct.

Underneath we can see three strategies for hazards:

- Eliminating the hazard by conducting the work differently.
- Avoid hazard by changing the hazard management plan.
- Transfer hazards by shifting the negative consequences.
- Mitigate actions will reduce the probability for hazard occurring.

2.3.5 Risk monitoring and control

Hazard monitoring and control is process of identifying, analysing, and planning for arise hazards, and keeping track of identified hazards in the project life cycle. It can involve choosing strategies, executing contingency plans or fall back plans, taking corrective actions, and modifying the project management plan. Tool and techniques for doing it are hazard reassessment and hazard audits.

3. HAZARD IDENTIFICATION AND RISK ASSESSMENT PROCEDURE

3.1 INTRODUCTION

HIRA is a simple qualitative risk analysis methodology used to identify hazards that are associated with work assignments that is to be executed. This chapter is based on legacy Acergy`s procedure for safe operation. The identifying of the hazards is based on guidewords. There are two types off HIRAs in Subsea7, and that is project HIRAs and generic HIRAs. Project HIRAs are risk assessments done on every new task. Generic HIRAs are risk assessment done on tasks that are done regular. Generic HIRA can be something we do every day for example "walking in stairs". Project HIRA can be laying new pipelines on seabed from A to B, even if we have laid pipelines before. It is not under the same conditions, but we can use the old HIRA as starting point. Therefore all the HIRAs are saved in a database.

HIRA procedure is a formal process that must be completed before the activity has been carried out. This will ensure that people can carry out the work by using right methods, which are ASARP (as safe as reasonable practicable), to prevent injury or harm to themselves, the assets, or the environment. This procedure concentrates only on assessment of hazards, which may be present when caring out work activities not risk associated with general business or contractual issues. In the figure 3-1 it is shown how HIRAs are conducted. The main parts in the procedure are PHA, HIRA (stage 1 and 2) and Toolbox Talk.

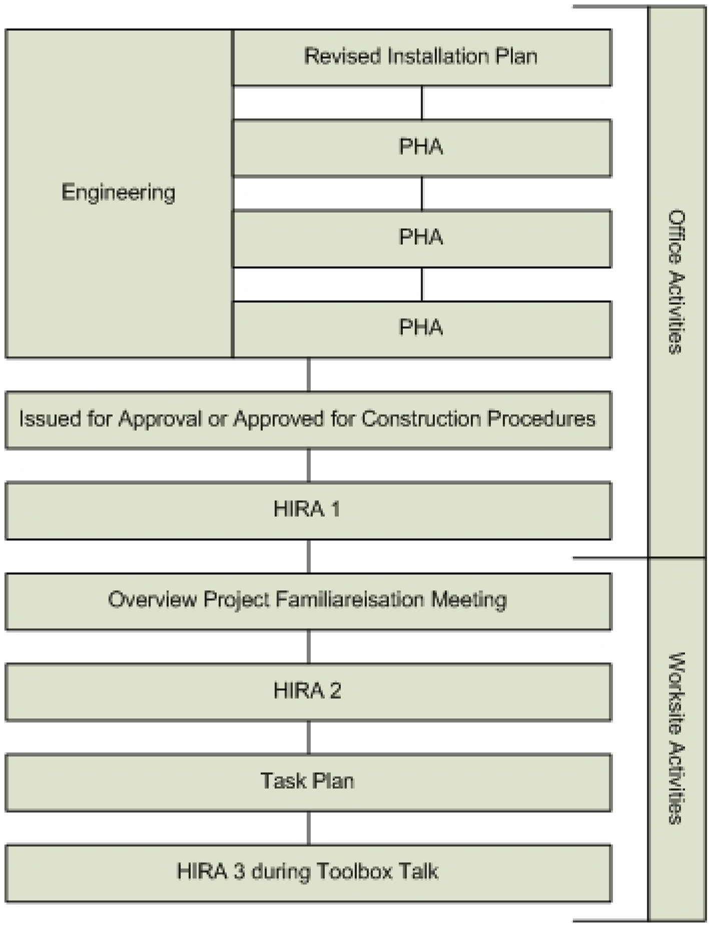

FIGURE 3-1 - HAZARD IDENTIFICATION AND RISK ASSESSMENT PROCEDURE

3.2 PHA

First thing done in HIRA process is different analysis called preliminary hazard analysis. PHA is often used to evaluate hazards early in the project being undertaken at the conceptual and front and engineering stage(Vinnem 2007). PHA is a set of different identifying processes, such as HAZID and HAZOP conducted at an early stage and throughout of the engineering phase. The engineering phase is when the engineers review and revise, as required for the installation plan. How many PHA there are depends on how big or complex the project is. The PHA assessment is conducted in an office environment, usually by HSEQ advisor, managers and people that have ownership in the project. PHA main goal is as mentioned in “the risk managing planning” and “risk identifying” to determine a risk methodology for Subsea 7 by finding and assessing solutions, and identify measures that provide the lowest risk for every operation. When the methodology is agreed it will be outlined in the installation plan.

3.2.1 HAZID - Hazard identification

HAZID is a method for evaluating hazard early in the projects (DNV-RP 2003). It is a useful technique to revel weaknesses in the design and the detailed procedures. The HAZID is normally conducted by a group of experts that have different expertise. HAZID should involve relevant personnel, including riggers, shift supervisors, operational and technical responsible engineers, and leaders. The HAZID leader should be a skilled independent person, with both operations and specific engineering experience. The process starts with presentation of the work scope and identifying all possible undesirable consequences that could occur and then to identify hazards, which would cause the consequence. It is usual to count all reasonable foreseeable hazards, whether each hazard poses a significant hazard to the activity in question. If a hazard is not significant like a vessel is hit by asteroid, the frequency for that to occur is very low. Once the hazard list is completed each hazard is reviewed to see whether it is significant and should be evaluated further. It is normal to use checklist and “lessons learned” from similar activities and previous HAZIDs for assistance when finding all hazards.

3.2.2 HAZOP - Hazard identification and operability study

The purpose of HAZOP is to ensure adequate functionality and back up of the project if operability problems occur.(ISO 2002) That means a systematic approach to identify problems in facilities, equipment, processes and assessing systems from multiple perspectives. We can split the unwanted occurrence in three different perspectives design, physical and operational environments and operational and procedural controls. In the design perspective one is assessing system design capability to meet user specifications and safety standards. Important thing with having a HAZOP is to have contingency plan for the critical part in the project. Timing of the HAZOP is important because one has to have time for correcting the design when discovering a fault in the project. The HAZOP is conducted by at team of experts that have different expertise. HAZOP start with presentation of work scope split in tasks, and then hazards that can affect the operation. The table 4 is categorising of the perspective in a HAZOP.(IEC 2001)

Design	Assessing system design capability to meet user specifications and safety standards Identify weaknesses in systems
Physical and operational environments	Assessing environment to ensure system is appropriately situated, supported, serviced, contained, etc.
Operational and procedural controls	Assessing engineered controls, sequences of operations, procedural controls, etc. Assessing different operational modes – start-up, standby, normal operation, steady & unsteady states, normal shutdown, emergency shutdown, etc.

Table 4 – Categorising of HAZOP perspectives

3.3 HIRA STAGE 1

HIRA Stage 1 is also conduced at an office environment, often by the same people that took part in the PHA. HIRA stage 1 is a method used to identify hazards, evaluate the risk, identify control measures and record the result. The risk assessment is carried out as we mentioned in “qualitative risk analysis” and “risk response planning” towards the end of the project, but well in advance of the work, to ensure that there is time, if there is something that needs to be adjusted. Then the procedure is sufficiently reviewed and checked and will either be issued for approval or approval for construction status. The main goals with HIRA Stage 1 is confirming the methodology that the risk is reduced to a acceptable level, and ensure all aspects of work have been assessed, including contingency methods; hazards identified; and control measures fully defined before going to the worksite. The assessment should also consider recovery situations when the work has to adapt to foreseen changing situations. Procedures for this kind of changes are “Management of Change process”.

3.4 HIRA STAGE 2

The people that are supervising the activities and reviewing the results of the HIRA Stage 1 normally carry out HIRA Stage 2 at the worksite. HIRA stage 2 is a method used to implement control measures on the worksite and ensuring that risk is ALARP. It is conducted well in advance of the actual work, but after project team have briefed the operation people on the overall work scope for the project. It is important that those how managing the work fully understands what has to be done and which control measures that need to be implemented. The HIRA stage 2 is on one hand a way of controlling the HIRA stage 1 and on the other hand informing the people how to execute the work safely. Like we mentioned in “risk monitoring and control” identifying, analysing, and planning for newly arisen hazards, and keeping track of identified hazards in the project life cycle.

3.5 HIRA STAGE 3

HIRA Stage 3 will be done during the Toolbox Talk. Toolbox Talk is also carried out at the worksite by supervisors, normally right before the activity takes place. It is vital that the risk is communicated in the Toolbox Talk. HIRA stage 3 can also be linked to “risk monitoring and control” as mentioned in HIRA stage 2. Under the toolbox talk supervisors explains scope of work, control measures, recovery or contingency measures, and how is responsible for executing them. It is important that every participant understands their work roles and what type of risk they are exposed for. And if the work starts to diverge from the main plan, it is important in this type of operations that people are aware of what has to be done. One should ask questions about these issues before activity start.

Shift handover or peripheral activities, which could have an impact on the work has to be taken into the toolbox talk. Relevant task plans and permit to work (PTW) must be covered in the toolbox talk.

If every enlist undertaking the task attended the shift briefing and discussed the job its not required to do both HIRA Stage 2 and HIRA Stage 3. But it's important that everyone involved in the job fully understands his responsibilities; accepts the risk; the control measures to be implemented; how to recover the situation; or which contingency activities to carry out if things do not follow the main plan. It is very important that they stop the activity if faults are discovered faults in the procedure that have not been agreed and risk assessed.

3.6 RISK MATRIX

Subsea 7 risk matrix is based on the International Code of Practice (IMCA) provides guidance in determining risk level from the probability or likelihood of occurrence, and risk severity or consequences if the hazard occur.

Hazard severity outcome				Probability				
Descriptive	Injury	Spill/ pollution	Damage of loss of production	Very Unlikely	Unlikely	Possible	Likely	Very Likely
Very Serious	Death or multiple serious long term injuries	> 100m3	US $ > 1 million	M	M	H	H	H
Serious	Day away from work case injury	100 ltr – 100m3	US $ 50,000 – 1 million	L	M	M	H	H
Moderate	Restricted work case injury	10 – 100 ltr	US $ 10,000 – 50,000	L	L	M	M	H
Slight	Medical treatment case injury	1 – 10 ltr	US $ < 10,000	L	L	L	M	M
Negligible	First aid case or no specific treatment	< 1 ltr	No Cost	L	L	L	L	M
				L		M		H

FIGURE 3-2 – SUBSEA7 RISK MATRIX

For finding the right risk level we have to look at Subsea 7 risk matrix (figure 3-2). Risk matrix is based on legacy Acergy probability- and severity guidelines. The probability guideline is appreciated on probability of occurrence is potentially subjective and open to personal interpretation. Subsea 7 has made the definition on probabilities in the table 5:

Definition	**Probability (%)**
Very unlikely	X < 0,001
Unlikely	0,01 < X < 0,001
Possible	0,1 < X <0,01
Likely	0.5 < X < 0,1
Very likely	X > 0,5

Table 5 – Definition of probabilities

The severity guideline is based on how big the consequences will be if hazard happens. Severity level is split in 5 steps; Negligible, Slight, Moderate, Serious and very serious.

Severity	**Definition**
Negligible	Minimal injury or health implications requiring no treatment or first aid treatment only. Virtually no damages to the environment, equipment or loss of function.
Slight	Minor injury requiring medical treatment. Some pollution impact to the environment. Damage to equipment requiring minor repair.
Moderate	Injury with no long-term disablement. Pollution incurring restitution costs. Damages to equipment requiring significant repair and loss of function.
Serious	A day away from work that stops any work duties. Pollution with short term localised implications incurring significant restitution cost. Damages to equipment resulting in major loss of operational capability and cost.
Very Serious	Fatality or multiple serious injuries. Extensive pollution with long term implication and a very high restitution costs. Damages with major long term implication for operational capability with extensive cost.

Table 6 – Definition of severity

Description of Subsea7 risk criteria:

Risk criteria:	
Low risk	Identified as “L” in the matrix. No additional immediate controls are required. Proceed with care.
Medium risk	Identified as “M” in the matrix. Activity must be investigated with a view to reducing the risk further. If a low risk solution cannot be found, the task can only proceed with appropriate management authorisation after consultation with specialist personnel.
Unacceptable risk	Identified as “H” in the matrix. Task must not be undertaken. It requires immediate action to avoid the hazard or substantially

	reduce the risk by additional/alternative control measures.

TABLE 7 – SUBSEA7 RISK CRITERIA

3.7 PRINCIPLES

Subsea 7 most important principle is that HIRAs and other types of risk assessment are conducted with the aim of reducing risk to a level that is ALARP.

They must performed HIRAs prior to any work commencing. Project teams, departments, or people on the worksite complete the HIRAs when the hazard has yet to be identified, or assessment are not fully covered.

It will be managed to focus on key issues, be kept short and simple and must be recorded either on the HIRA database or paper format.

People that take part in the HIRAs will be identified in the record.

HIRAs must be conducted in a systematic fashion covering the whole work scope using the key steps identified in the detailed procedures.

3.8 TIMING OF HIRA

All of Subsea 7 work is covered by risk assessment. Routine work covered by standard procedures and generic HIRAs may be referenced and reviewed prior to the work. But a specific HIRA must be carried out when:

- Performing any non-routine activity.
- Performing a new task.
- New categories of people are involved.
- Major changes to the work/ system are considered.

The specific HIRAs should be conducted suitably in advance of the work activity to allow the control measures to be correctly engineered, closed out and implemented. And it might involve reviewing previous generic or specific HIRAs from the HIRA database.

3.9 INVOLVEMENT

When Subsea 7 is conducting the different stages of HIRA, it is important that the people involved are appropriate and competent to assess the risk. They should be well aware of the operation that is to be undertaken, and have detailed information of the risk assessment, so no time is wasted. Example if the chairman cannot manage the people and the meeting effectively, then time will be dragged out and people will start to lose focus. Therefore it is important that the chairman have the possibility to move on quickly or park issues that are secondary, but he must not forget to focus on real issues which matter to the safety of the operation. It is the engineers that are responsible for preparation of scope of work before the different meetings.

The table 7 identifies who should participate in the HIRA processes. It is the chairman, in liaison with the project or department manager who are choosing who should be presented at the different meetings in the procedure. Example it is not necessary to include all engineers or specialists for the whole meeting if they have no particular involvement in a part of the work being assessed. It is important that the relevant operational people are included in all the discussions.

Owners of Job / Attendees Type of Assessment	Line Manager	Project Manager	Worksite Manager	Supervisor	Technical Manager	Engineers	Operations Manager	HSE Advisor	Marine Rep	Task Supervisor	Task Executer	Customer Rep	Third Party Rep	Subcontractor Rep	Consultant Expert	Safety Delegate
Preliminary Hazard Analysis		◆	1	1	◆	◆	1	◆	○					○		
HIRA Stage 1 Construction Project		◆	◆	1	◆	◆	◆	◆	1			◆	◆	◆	○	○
HIRA Stage 2 Construction Project			◆	◆		◆			◆	◆	○	○				○
Toolbox Talk Construction Project			○	○						◆	◆					○

◆ Denotes mandatory or designed nominee.

○ Denotes optional and (1) denotes optional but least one from the person categories identified in that row should be present.

Table 8 – Involvement in HIRAs

3.10 RESPONSIBILITIES

It is normally the project manager who is responsible and has authority for a particular task or piece of equipment in terms of production, safety, cost and quality. They are responsible for the technical quality of HIRAs and other forms of risk assessment. They must ensure that risk assessment on projects are completed and are ALARP, so the job/system/environment is safe for people and equipment.

3.11 MANAGEMENT OF CHANGE

What happens if something is discovered under the execution, the risk assessment does not cover all type of hazards? During the HIRAs we evaluate hazards and operability problems found in the project. Some of the risk proposed by the hazards have already been addressed or controlled. If the risk is low we don't need to do anything with it, but if it is discovered that the risk is not low we have to reduce the risk. The management of the vessel have to make a judgment whether the risk level is high, medium or low in terms of the risk of injury, damages to the assets or the environment. Subsea7 uses a management of change procedure on this type of judgment. This will give different cases:

Worst case is that the risk level is found to be high and the management or crew can't find measures to reduce the risk. Then the operation is stopped and the management have to alert the project manager in the office. A new risk assessment is done in the office and if it not possible to reduce the risk by doing the operation differently, if that is not possible the operation is stopped.

If the management on the vessel found the risk to be high, but have found risk reducing measures that reduces the risk level to medium. They have to communicate with the office project manager to see if he approves the reduction. They can continue the operation with care. This can be a difficult judgment that can go both ways, but the activity is highlighted so that will affect the execution in a positive way.

3.12 EXAMPLE OF HIRA PROCESS WHEN DOING A MOBILISATION OF A VESSEL

3.12.1 Scope

This example illustrates how Subsea7 conduct a HIRA. It has to be highlighted that the HIRA demands some preparation, it is not just the meeting described below. Subsea 7 has been requested to support a platform pipeline installation contractors on a project using a survey vessel. The work will be preformed in different stages pre-lay, lay support and post-lay campaigns, as described under, however changes may occur.

- Phase 1 of the pre-lay campaign involves; Installation of contracts (concrete elements that are making the pipe line stabile), and grout inflatable pipeline support base, removal of EEC (External End Cap)/TSU (Temporary Seal Unit), and pull-out of tag line.
- Phase 2 of the pre-lay campaign involves; Installation of pull-in ramp foundation plate, EEC removal and EEC/TSU recovery, recovery of feeder wire, and installation of Ø90mm pull-in wire and installation of guide posts, and temporary EEC

This is an operation that Subsea 7 cannot conduct with only one vessel, therefor they will use two vessels. The second vessel will support the lay activities such as; Temporary EEC recovery, ROV (Remote Operated Vehicle) support during pipeline pull-in, lay and lay-down, installation of a grout inflatable pipeline support pyramid, installation of the seal tube grout bung clamp, pipe lay buckle contingency operations.

- Post-lay support campaign involves; Counteract recovery, pull-in wire demobilisation from platform, assistance during pipe line de-watering, recovery of buoyancy elements, yoke and clamp half-shells.

The scope of this example is the mobilisation of the vessel when preparing Phase 2 of the pre-lay campaign. The tasks are described step-by-step in figure 3-3.

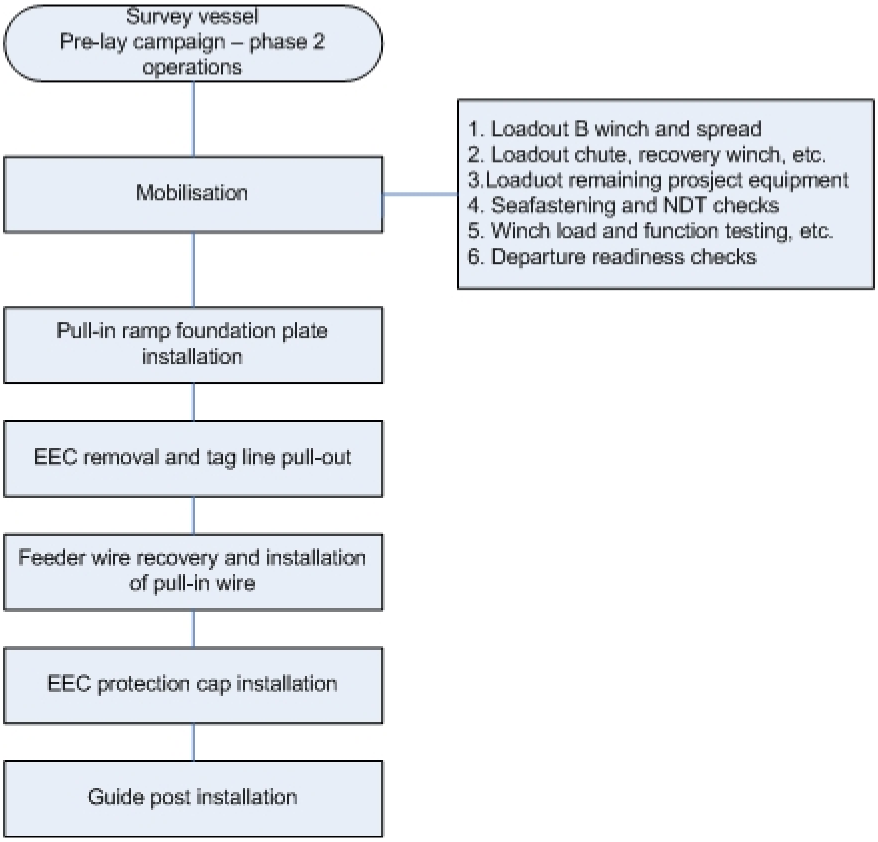

FIGURE 3-3 – SCOPE OF WORK IN EXAMPLE

3.12.2 Step 1 – HAZID

The HSE advisor invites the right experts to a HAZID meeting. In this project the experts are: 3 HSE advisor, student, 7 engineers, 6 managers, 2 supervisors, captain and 2 coordinators. The HAZID starts with HSE advisor present escape ways and how a HAZID is done. Project engineers present tasks that are going to be done in pre-lay campaign phase 2. After each task use a guidewords for identifying hazards in the task. Guidewords are used for covering all aspects of the tasks. In the table 9 you can see how the hazards found in the HAZID are evaluated. After the hazards are found we look at corrective actions for eliminating or reducing the hazard from occurring. Which company that has to do the corrective actions, and the deadline for doing it. After the changes have been done it is documented, and the person that is responsible for corrective action have to sign it out.

ID. No	Activity	Hazards/Actions/Info	Corrective Actions Performed	Follow-up resp.	Deadline	Doc. Ref.	Closed (initials)	Appr. (initials)
1	Activity 1 – Mobilisation	Captain concerned that difficult to control deployment from a marine / vessel point of view with chute and winch as shown going over the starboard side Aft. Re-evaluate position of winch and chute for stern 23xecution23.	DESIGN REVIEW MEETING was held to re-evaluate all possibilities. New deck layout was established to allow safe offshore 23xecution. Overboarding will be performed over the STBD (Starboard) side of the vessel.				Proj.Eng.	
2	Activity 1 – Mobilisation	Insufficient bearing capacity on quay for heavy lift. Bearing capacity of quay to be verified ahead of mob/demob.	Quays at base have a concentrated load limit at 70Te pr m^2, which is sufficient.				Proj.Eng.	
3	Activity 1 – Mobilisation	Consideration of interim demobilisation of empty winch to be made to ensure operational capabilities of vessel optimised (e.g. room for 2nd WROV & grouting spread while B winch is still on deck – demob winch /remob).	Optimised deck plans are made and available with Operational Procedures.				Proj.Eng.	
4	Activity 1 – Mobilisation	Heavy lift subcontractor to supply lift plan which will be checked and integrated to Acergy mobilisation plan	Lift plan according to Subsea7 guidelines will be issued /approved prior to operation.				Proj.Eng.	
5	Activity 1 – Mobilisation	Winch-base bolted connection (including documentation for supply of bolts) to be confirmed by Acergy engineering.	Sacrificial frame was designed and will be interfaced with the winch base to allow sufficient seafastening.				Proj.Eng.	

ID. No	Activity	Hazards/Actions/Info	Corrective Actions Performed	Follow-up resp.	Deadline	Doc. Ref.	Closed (initials)	Appr. (initials)
6	Activity 1 – Mobilisation	Angle brackets on at least two sides of the winch base to be pre-installed on deck to ease winch lifting/landing on its designated location during mobilisation	Not necessary since the position of the winch on deck has been changed and it is now easily achievable for precise landing.				Proj.Eng.	
7	Activity 1 – Mobilisation	Concern regarding vessel deck level during heavy lift. Vessel to be trimmed forward ahead of lift to ensure suitable level on deck during landing.	Deck Layout for mobilisation of the winch has been modified to allow controlled and safe load-out of the B winch.				Proj.Eng.	
8	Activity 1 – Mobilisation	Wire to be ensured secure on winch drum during mobilisation. Procedures to cover controlled release of wire ahead of overboarding.	Mobilisation and Installation is detailed in Operational Procedures.				Proj.Eng.	
9	Activity 1 – Mobilisation	Quay to be pre-marked for location of heavy lift crane and outriggers	Mobilisation Procedure				Proj.Eng.	
10	Activity 1 – Mobilisation	Lack of familiarity with winch for hook up and operation. B winch technicians to be available during mob and operation offshore.	B winch Personnel will be present at all times. Ref. Operational Procedures for details.				Proj.Eng.	
11	Activity 1 – Mobilisation	Difficulties with control of winch. Shareholder to ensure winch supplied with fixed and remote control systems.	Ref. B winch Operational Procedures – Manual – Only Authorised B winch personnel will be operation the winch at all times.				Proj.Eng.	
12	Activity 1 – Mobilisation	Concerns over noise and location of diesel generator. Investigating electrical power to B winch.	Diesel Powered hydraulic pump will be provided by B winch. Ref. Mobilisation Procedure				Proj.Eng.	

Table 9 – Record from hazard identification

3.12.3 Step 2 – HAZOP

In a HAZOP it is normal to use the same experts as in the HAZID. It starts the same way with HSE advisor presenting the escape ways and how a HAZOP is done, and then each task is presented by the project engineers. After each task guidewords are used to find hazard and operational improvement related to the work. After the hazards are found we look at corrective actions for eliminating or reducing the hazard from occurring. Which company that have too do the corrective actions, and the deadline for it. Document the change in the procedure and then close and approve it.

ID. No	Activity	Hazards/Actions/Info	Corrective Actions Performed	Follow-up resp.	Deadline	Doc. Ref.	Closed (initials)	Appr. (initials)
1	Activity – Mob	Pre-mob familiarisation to be arranged prior to mob date.	Arranged				Proj.Eng.	
2	Activity – Mob	All winches to be supplied with swivels or non-rotating wires.	Confirmed to be non-rotated wires.				Proj.Eng.	
3	Activity – Mob	Second fanbeam with multi-prism to be mobbed.	Radius system to be mobilised. Fanbeam to be used prior to this with fan/beam prisms onboard platform. To be agreed in next meeting.				Proj.Eng.	
4	Activity – Mob	Additional transponder for the platform. A referebce use to be procured and installed.	Done. Location for installation to determined on board vessel.				Proj.Eng.	

Table 10 – Record from hazard and operability identifying

3.12.4 Step 3 – HIRA stage 1

After HAZID and HAZOP are done we have to do a HIRA stage 1. Normally same participants as in HAZID and HAZOP. The HIRA stage 1 starts also with a short presentation of escape ways and then HSE advisor describe how the HIRA stage 1 is done. HSE advisor goes through the safety requirement that covers all the generic hazards. Project engineer presents the scope of work. Find every hazard with help from a checklist. After all the hazards are summarised, we have to do an evaluation of what the expected consequences can be. When all hazards and consequences are found for the task, the risk is evaluated. Risk matrix is used for quantifying the risk level (High, medium or low). The quantifying is done after legacy Acergy risk criteria. It is important that the chairman know how a risk assessment is done properly, if not we can end up with classifying the risk wrong. If the risk level is evaluated high, we need to eliminate or reduce it with implementing corrective measures. Each hazard is evaluated with the intention of lowering the risk level as much as possible. We look at the risk matrix after the corrective measures are implemented for lowering the risk level. If it's not achievable to reduce the risk level, we have to do the task differently. After the HIRA stage 1 is done the procedure is sufficiently reviewed and checked and will either be issued for approval or approval for construction status. On the next page is table 11 where you can se the result of the HIRA stage 1.

3.12.5 Step 4 – HIRA stage 2

Then the crew on the vessel can conduct the HIRA stage 2. It is normally done some days ahead of the operations by the supervisors and executers. The intensions of HIRA stage 2 are controlling the HIRA stage 1 and see if something is overlooked. This is a good way of doing the risk assessment because it reduces the uncertainty factors of the risk assessment, when one goes through the assessment two times. On the page after HIRA stage 1 you can se the result of the HIRA stage 2 in table 12.

3.12.6 Step 5 – Toolbox Talk

Right before the task is done there will be a Toolbox Talk that is the last step of the HIRA procedure. The supervisor does the Toolbox talk and this is where the risk is communicated out to the crew. The supervisor is gathering all the relevant crew to a short meeting. The toolbox talk can be complex so it is important that the supervisor prints out task plan, a checklist for toolbox talk and a copy of the HIRA stage 2 because it is impossible to remember everything that needs to be promoted. The list of corrective measures in the HIRA stage 2 is as one can see on the page after HIRA stage 1 long. Therefore it is important the supervisor communicate the most important measures first. Because it is a well-known phenomenon that people lose their focus when meeting are too long.

HAZARD IDENTIFICATION & RISK ASSESSMENT RECORD

ACTIVITY: HIRA stage 1	DATE :	PROJECT :
	LOCATION :	REF PROCEDURES:

Attendees:

Name	Job Role	Company	Name	Job Role	Company
	Senior HSE Advisor			Proj. Manager	
	Proj. Eng.			Technical Manager	
	Lead Proj. Eng.			OM	
	CR			Sen. Sup.	
	Survey			Lead Design	
	Ship Ops. Manager			Student	

Basic / General Safety Requirements		Project Specific	
1. APPROPRIATE PPE	8. POST BARRIERS / SIGNS	12. COMPETENT PERSON	16. Project HSE Plan
2. TASK SPECIFIC PROCEDURE	9. SUPERVISION	13. Ship's Generic HIRAs	17. Env Management Plan
4. RESTRICT WORK AREA ACCESS	10. CERTIFICATION	14. Ship's Generic Procs	18. Subcontractors Technicians
5. PERMIT TO WORK	11. TOOL BOX TALKS	15. Project Bridging Doc.	

Task / Activity Description	Hazard	Consequences to People, Equipment or the Environment	Quantify Risk	Recommended Corrective Actions / Control Measures	Residual Risk
Mobilisation / Demobilisation Of Pull-In Wire Installation Spread	Swinging load Rigging failure 3rd party personnel on quayside Working at height Heavy equipment Slips, trips and falls Awkward shapes / sharp edges	Injury to personnel Damage to equipment Damage to vessel Damage to quayside Damage to environment (oil spill)	E3 = H	ALL personnel to stay clear of moving loads Use of taglines as required Ensure all seafastening is removed prior to lifting off vessel SOPEP kit available Drip trays to be used Bridge to be informed prior to heavy lifting	C2 = M

	High pressure / high voltage Unfamiliar personell to vessel Moving lifts / vehicles Hot work/Fire Dropped objects Comms failure Vessel movement			Mobile crane operators to participate in toolbox talks Subsea 7 liftplans to be used for mobile crane lifts Good housekeeping Highlight trip hazards Avoid equipment to be mobilised on top scuppers (free access) if possible, block off both if required Mark sharp edges Vessel electrician to connect main power supply to all containers	
	Weather conditions Manual handling Working close to side of vessel SIMOPS Chute protruding from vessel			3rd party familiarisation Be aware of 3rd party traffic on quay Fire watch Monitor weather conditions during operation. Any person able to stop the work if see something unsafe. Bridge personnel to be aware of vessel traffic during lifting of B winch Port side of vessel towards quay during lifting of B winch Use of floating units if necessary Use of lifevests and safety harness when working close to side of vessel (rescue plan in place)	

Table 11 – HIRA stage 1

HAZARD IDENTIFICATION & RISK ASSESSMENT RECORD

ACTIVITY: **HIRA stage 2**	**DATE :**	**PROJECT :**
	LOCATION :	**REF PROCEDURES:**

Attendees:

Name	Job Role	Company	Name	Job Role	Company
	Proj. Eng.E			Medic	
	Rigger			Shift Supervisor	
	Rigger			Deck Foreman	
	Student			Client Rep.	
	Captain			Offshore Manager	
	HSEQ Advisor				

BASIC / GENERAL SAFETY REQUIREMENTS		**PROJECT SPECIFIC**	
1. APPROPRIATE PPE	8. POST BARRIERS / SIGNS	12. COMPETENT PERSON	16. Project HSE Plan
2. TASK SPECIFIC PROCEDURE	9. SUPERVISION	13. Ship's Generic HIRAs	17. Env Management Plan
4. RESTRICT WORK AREA ACCESS	10. CERTIFICATION	14. Ship's Generic Procs	18. Subcontractors Technicians
5. PERMIT TO WORK	11. TOOL BOX TALKS	15. Project Bridging Doc.	

Task / Activity Description	Hazard	Consequences to People, Equipment or the Environment	Quantify Risk	Recommended Corrective Actions / Control Measures	Residual Risk

Task / Activity Description	Hazard	Consequences to People, Equipment or the Environment	Quantify Risk	Recommended Corrective Actions / Control Measures	Residual Risk
Mobilisation / Demobilisation Of Pull-In Wire Installation Spread	1.Swinging load 2.Rigging failure 3.3rd party personnel on quayside 4.Working at height 5.Heavy equipment 6.Slips, trips and falls 7.Awkward shapes / sharp edges 8.High pressure / high voltage 9.Unfamiliar personnel to vessel 10.Moving lifts / vehicles	Injury to personnel Damage to equipment Damage to vessel Damage to quayside Damage to environment (oil spill)	E3 = H	1.ALL personnel to stay clear of moving loads Use of taglines as required Ensure all seafastening is removed prior to lifting off vessel 2.Use only certified rigging. 3,12. Area to be barried off prior to lifting. Bridge personnel to be aware of vessel traffic during lifting of B winch 4.Qualified personnel. 5.Subsea 7 liftplans to be used for mobile crane lifts Bridge to be informed prior to heavy lifting Mobile crane operators to participate in toolbox talks	C2 = L

Task / Activity Description	Hazard	Consequences to People, Equipment or the Environment	Quantify Risk	Recommended Corrective Actions / Control Measures	Residual Risk
	11.Hot work/Fire 12.Dropped objects 13.Comms failure 14.Vessel movement 15.Weather conditions 16.Manual handling 17.Working close to side of vessel 18.SIMOPS 19.Chute protruding from vessel 20. Incorrect use of rigging			Port side of vessel towards quay during lifting of B winch SOPEP kit available Drip trays to be used 6.Good housekeeping Highlight trip hazards 7.Mark sharp edges. Avoid equipment to be mobilised on top scuppers (free access) if possible, block off both if required 8.Vessel electrician to connect main power supply to all containers 9. 3party familiarisation 10.Be aware of 3rd party traffic on quay 11.Fire watch 12. Barrier off areas. 13. Line of sight during lift. Banksman / Crane OP. 14. Bridge to monitor vessel traffic. 15.Monitor weather conditions during operation. 16, 20. Work to be performed according to procedure. 17.Use of lifevests and safety harness when working close to side of vessel (rescue plan in place) 18. Bridge to monitor back deck activities. 18. Any non essential deck activities to be stopped during heavy lift Any person able to stop the work if see something unsafe. 19. Vessel with port side to quay 20. Check correctly installed rigging before commencing lifts	

Table 12 – HIRA stage 2

4. UNCERTAINTY IN HIRA PROCEDURE

4.1 RISK PICTURE OF THE PROCEDURE

In this chapter we look at uncertainty factors in the Subsea 7 HIRA procedure. It will always be uncertainty as to whether certain hazards will occur or not, what the immediate effects will be, and what the consequences for personnel, environment or assets may be. Insufficient information, available knowledge and the right communication are some important factors for reducing the uncertainty in the procedures. In this chapter we want to prove that Subsea7 must have an uncertainty factor U in there risk description. A way of doing that is to use fact from text (Abrahamsen, Aven et al. 2009). In the theory part we have described how Subsea7 risk description is today, and that it is missing uncertainty factor U. If we look at chapter 3 there is uncertainty associated with the HIRA process. Underneath we can see uncertainty areas found in the process.

4.1.1 Competence and experience

The competence and experience of participants is a vital part in the HIRA procedure. The vessel may be operated by young team with limited experience, and/or be managed by inexperienced leaders on the different shifts. This will affect the overall risk picture, especially if the operation is complex. Therefore it is important that staff is trained in strict procedures which must be followed. Another thing that is important is to remember saving the experience from project done. Subsea7 is doing that with saving “lesson learned”. This will reduce some of the uncertainty associated with competence and experience.

4.1.2 Following procedures

First thing is that managers have to make sure that the procedures are updated, and staffs are trained on a regular basis. And they need to have the relevant procedures available. Second thing is how HSE culture is on the vessel. Is it a culture for taking short cuts and not operating according to the established routines and procedures? Are the designer aware of “pressure situations”, is he assuming that operating people are following strict routines. With that we mean example subcontractors that sign Subsea7 HSE requirements and don’t follow them. Because they don’t understand what risk is. This creates uncertainty on following the procedures.

4.1.3 Involvement in the HIRA procedure.

In (Aven 2008) book he recommends that in a HIRA process (HAZID, HAZOP or risk assessment) there should be between 3-10 persons in the meetings. One uncertainty in the HIRA meetings is how many and how familiar the expert is with the project. The problems in Subsea7 meetings are there are normally too many experts on the meetings. Sometimes project owner wants to take part in that decision. Project owner is deciding that 4th wheel experts have to be in the meetings. And the meetings may not be that effective if there are too many in the meetings and if the expert is not familiar with the project. Then the meeting can be dragged out because the expert asks too many questions about how project is being executed. What is positive with that is we may discover more hazards. If you are going in this meeting you must be willing to contribute with something and be familiar with the project. And even better prepared with questions. But we don't want too few on the meetings either. In the table 8 you can see how many experts Subsea7 recommend. One thing that is important to remember is involving of operational people early in the project. Because it's easier for them with experience offshore to see problem areas in the procedures than experts from the office. If the chairman see that it is too many invited to the meeting. Then he should plan the meeting differently. He can split the scope into parts and coordinate experts in the meeting, so people with the correct experience are taking part where they can contribute this way we can reduce the uncertainty with having the correct experts on the meeting and the meetings will be more effective.

4.1.4 Risk analysis

Under the risk analysis we have to calculate the risks for describing how dangerous the different tasks are. The most usual risk analysis method of doing that is in a risk matrix. In this matrix you have both consequences and the probability for hazard occurring and there is uncertainty connected to the matrix. The higher the probability and consequences are the higher the risk will be. In Subsea7 we use probability guidelines and severity guidelines for evaluating the risk. The probability depends on such factors as the control measures in place, the frequency of exposure to the hazard and the category of person exposed to the hazards. The consequence will depend on the magnitude of the hazard (personnel, environment, assets). The guidelines intension is to help evaluating the correct risk level. One problem with the guidelines, they are not helping if the exerts have now background experience of the activity. The risk assessment matrix can have multiple outcomes. Like slippery deck, where the consequences can be in a range from nothing happens to a broken neck. This causes some uncertainty when calculating the risk. Therefore it can be difficult do decide the correct consequences for the risk calculation. Subsea7 choose the more pessimistic outcome and not the worst case like the more likely outcome. Therefore it is important to know the guidelines well, so that we can reduce the uncertainty in the risk analysis.

4.1.5 Communicating the risk

The last ting that is done before the execution of the task is the toolbox talk. The toolbox talk is a very important tool for communicating the risk out to the crew that are executing the work. If the supervisors having the toolbox talks cant communicate the risk, then there is now point in doing the HIRAs because that is the only way the risk can be communicated out to the crew. This gives the supervisor big responsibilities. The supervisors have to communicate: scope of work, control measures, recovery or contingency measures, and who is responsible for executing them. And if the scope of work is big and there are many control measures to communicate, as in a mobilisation then we have some issues. The main issue are crew and supervisor losing the focus, so Subsea7 should try to find an easier way of communicating the risk in the toolbox talk. One thing we can do for reducing the uncertainty in the communication of risk is having toolbox talk course for the supervisor.

4.2 PRESENTATION OF RESULT AND RISK EVALUATION

In the text over we have discussed some of the uncertainty factors in the HIRA procedure. We can conclude that uncertainty factor U should be implemented in

Subsea7 risk description. We can say that output from calculated probability P and evaluated consequence C depend on input from an uncertainty factor U. In Subsea7 the probability and consequences are based on background knowledge K, and they could produce poor predictions. Poor predictions can arise from inexperience experts, and that can cause surprises that we don't want to be overlooked. To get a better overview of the uncertainty tied to Subsea7 risk assessment we can implement (Abrahamsen, Aven et al. 2009) method. It describes that if we want to reflect the uncertainties to the management, it is recommended that the uncertainty factors should be classified within one of the three categories: high, medium, or low. In the table 12 there is shown categorization process that is based on some guidelines to ensure consistency:

Low uncertainty	All of the following condition are met: 1. The assumptions made in calculations of P and evaluated consequences C. 2. Reliable data are available. 3. Broad agreement among the experts.
High uncertainty	One or more of the following conations are met: 1. The assumptions made in calculations of P and evaluating of consequences C represent strong simplifications. 2. Data are not available or are unreliable. 3. Lack of agreement among the experts.
Medium uncertainty	Conditions are between those characterizing high and low uncertainty.

Table 13 – Categorization of uncertainty guidelines

The degree of uncertainty must be seen in context to effect/influence the uncertainty has on risk exposure. If we have high degree of uncertainty, combined with high effect/influence on the risk exposure, will lead to a conclusion that the uncertainty factor is "high". But if we have high degree of uncertainty, combined with little affect off the uncertainty we can sett it "low" or "medium".
The result from this evaluation of uncertainties in the HIRA is presented in the table 14. It is important that information about the factors (P, C, and U) is given to the decision makers. The two uncertainty factors that are considered to be most important are "Following procedure" and "Communicating the risk". Therefore crew have to be trained on regular basis, this will reduce the uncertainty factors.

Uncertainty factors			
Categories	High	Medium	Low
Competence and experience		X	
Following procedures	X		
Involvement in the procedures			X
Risk Assessment		X	
Communicating the risk	X		

Table 14 – Result from evaluation of uncertainties

4.3 CONCLUSION

The main purpose of this chapter is to prove that Subsea7 had to take uncertainty into the calculation of risk. It shows that the risk description can be split into two parts, one covering events and consequences, and another that covers uncertainty. This acknowledges that risk cannot only be described and evaluated by referring to probabilities and evaluated consequences. It needs to be evaluated together with an uncertainty factor U.

5. EVALUATION OF METHODS USED IN THE HIRA PROCEDURE

In this chapter we want to look at the opportunities of improving the HIRA procedure. One way of doing that is comparing different risk analysis methods that identifies and responds to hazards. Subsea7 is using a HIRA process to find and treat the hazards in a project. We can use many different methods for describing risk. The most common ones in projects are qualitative, semi-quantitative and quantitative methods. Qualitative approaches are easiest to apply because it demands least resources, requires least additional skill sets. But it gives us least degree of insight. The quantitative approaches are demanding on resources and skill sets, but they give us a detailed understanding and provide the best decision foundation. The semi-quantitative approaches is described in-between the two others methods. In the end it is the project teams that decide which methods that are used, although all are in principle equivalent. After the approach has been decided we have to choose method that fit to the approach we have decided. We will look at the methods strengths and weakness, and see which method that fits Subsea7.

5.1 DECISION FRAMEWORK

In (DNV 2002) there are different ways of doing risk assessment and there is many different methods involved, and it is not always obvious which to select. We have to remember that there is no single correct approach for a specific activity, but there are approaches that are more suitable than others. A way of selecting the correct approach is having a decision framework. Underneath there are three way of deciding which approach that is used:

Lifecycle stage implies greater or less flexibility to change design elements, the knowledge of specific design and operational details, and the availability of historical records. The risk assessment in lifecycle stage is an on-going process throughout the lifecycle of the operation. In table 15 are the different stages in lifecycle stage:

Stages in lifecycle:	Methods:
Feasibility studies and concepts selection stage	Relative simple HAZID, SWIFT, Risk Matrix or QRA with generic FARs can be used.
Concept or front-end design	Based on previous design and “lessons learned” use SWIFT or Bow tie.
Detailed design	Sufficient information to do HAZOP, SWIFT, FMECA, FTA or QRA.
Operation	On-going risk assessment can be HAZOP, SWIFT or QRA.
Abandonment	Raise new issues of safety and environmental protection, suitable methods used are HAZID, SWIFT or ETA.

Table 15 – Different stages in lifecycle approach

Major hazard potential (Is not evaluated in this thesis)

Risk decision context – novelty/uncertainty/stakeholder concern. (UKOOA 1999) Has made a framework for risk related decision support. This framework gives us help on which methods we should use but we need to have some information about the complexity of the project. First thing that has to be done are identifying the context level, is done after the guidelines in table 16. After the level has been decided, we read horizontally across the framework. And read off the suggested balance of decision bases to be taken into account in the decision. Below we can se how the framework is structured: The framework takes the form of spectrum of decision basis, ranging from decisions dominated by engineers to those where company and societal values are the most relevant factors.

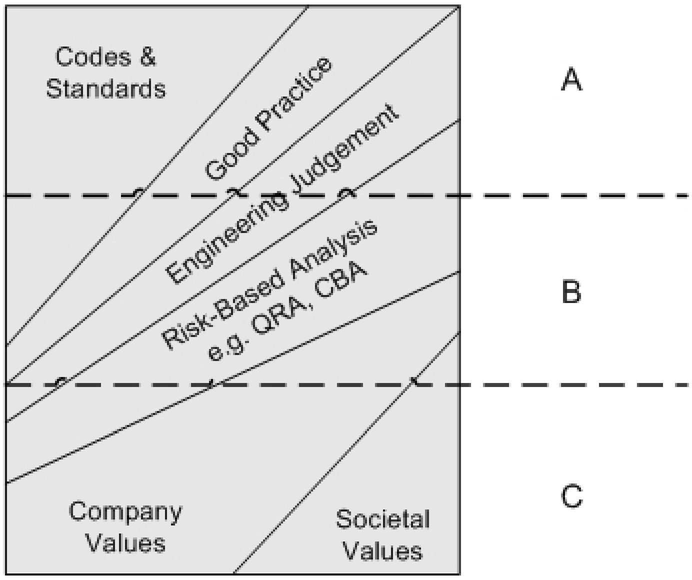

FIGURE 5-1 – RISK DECISION SUPPORT

In the figure 5-1 we can see approach showing that risk assessment has a major input to type B decisions, involving some uncertainty. A and C decisions, risk assessment are still relevant but is not that influencing on reaching the final decision.

Decision Context Type:	Guidelines:
A	Nothing new or unusual Well understood risk Established practice No major stakeholder implications
B	Lifecycle implications Some risk trade-offs/transfers Some uncertainty or deviation from standard or best practice Significant economic implications
C	Very novel or challenging Strong stakeholder views and perceptions Significant risk trade-offs or risk transfer Large uncertainties Perceived lowering of safety standards

Table 16 – Guidelines to risk decision context

5.1.1 Conclusion

In the energy industry project risk management is vital, because it makes clear that risk assessment plays an important role risk related decision, particular decision involving uncertainty. The decision framework from (UKOOA 1999) is a suitable basis for such decision-making. Today Subsea7 is using the lifecycle approach in their project. A problem with this approach is if we have little or now design or operability knowledge, will limit the approach to risk assessment to coarser method. The positive thing with the decision framework is that it is guidelines for methods that are best for the project. But Subsea7 have many operations that are similar to each another and it may be more time saved to use the lifecycle approach. Once we have selected approach, it is then feasible to select amongst the wide range of methods for risk assessment. These include:

- Hazards identification tools: HAZID, HAZOP, FMECA, SWIFT or FTA
- Risk Assessment approaches: HIRA (Risk matrix), Bow-tie (FTA and ETA)

5.2 HAZARDS IDENTIFICATION TOOLS

The first things done after an approach is decided are finding which methods that contain the necessary parts for finding all the project hazards. In this section we are looking at methods we can use for identifying hazards the best way possible. In the conclusion of "identifying hazards" we are looking at factors that are important when identifying the hazards. This is some of the important factors: gathering of information, identifying of hazards, team of experts, working in every operation. Below we can see the different methods that is evaluated in this thesis:

5.2.1 HAZID

Hazard identification done in Subsea7 is a qualitative exercise based on expert judgment. A team of experts with different background knowledge, early in the project, normally carries out the HAZID. This way we are more likely to not overlook serious hazards. In the figure 5-2 it is described how Subsea7 conduct HAZID.

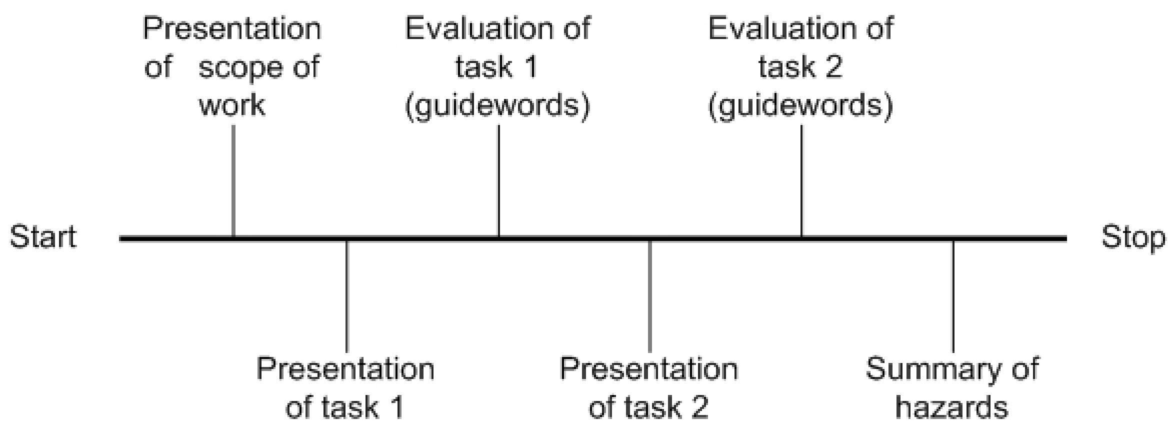

FIGURE 5-2 – HAZARD IDENTIFICATION PROCESS

If we look further into HAZID we can see that is should contain parts like (guidewords and task analysis), underneath we can see they contribute to the HAZID:

The experts involved in Subsea7 HAZID should be creative, encourage identification of hazard and not previously consideration. By that we mean not use older HAZID as insurance, rather than using more time on the new HAZID, and find hazards not discovered in the older procedure. They should ask questions that investigate the work procedure. After the meeting compare with old HAZID and see if something is overlooked. That way one can capture the "lesson learned" from previous HAZIDs.

Subsea7 are using a way of task analysis to avoid overlooks. Task analyses are splitting the scope of work in tasks, and obtain comprehensive coverage of relevant hazards without skipping less obvious problem areas. The less obvious problem areas can sometimes be the little extra that triggers the hazard.

Hazard guidewords is a very important tool for a HAZID, it gives use consideration of a full range of safety questions. The guidewords Subsea7 uses are design to ensure the HAZID team addresses key areas. They use the same guidewords from previous HIRAs. And that help preventing past accidents from recurring. Underneath we can see guidewords for HAZID and HAZOP:

Guideword	**Description**
Weather	Unclear weather restrictions or unexpected deterioration of weather. Weather forecasting
Impact	Impact between objects
Position	Object, grillage or barge not in correct position
Drop	Drop of objects from a higher level
Power	No power or insufficient power
Instruments	Malfunction or lack of instruments
Communication	Malfunction or lack of communication eguipment. Communication lines
Movement	Objects or vessels move in an uncontrolled way
Stability	Unstable conditions
Tolerances	Tolerances for postioning, grillage tolerances, barge tolerances etc.
Stuck	Movement cannot be performed
Rupture	Rupture of critical equipment
Access	Insufficient access
Not cut	No or insufficient cutting of items to be cut before an activity can start
Barriers	No or insufficient barriers
Tension	High tension in e.g. running wires or wire slings
Execution	A work task is executed in a wrong way
Procedures	Missing or unclear procedures
Environmental	Potential environmental pollution

Table 17 - Guidewords

5.2.2 HAZOP

HAZID and HAZOP are very alike in Subsea7. The main difference is that in the HAZOP the procedure for the work are nearly done and they focus more on the operability factors. Do they have contingency plans, if something does not function the way it is planed? That is very important because it cost a lot when the vessel is standing still and doing nothing. In the figure 5-3 we can see how the HAZOP is assessed. The only thing different in the methods are that HAZOP goes trough the contingency plans in the end.

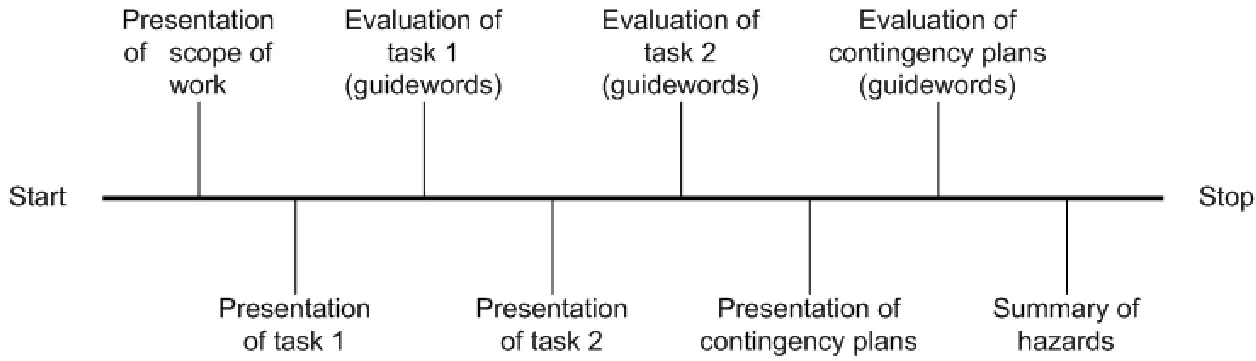

FIGURE 5-3 - HAZARD IDENTIFICATION AND OPERABILITY STUDY PROCESS

Example: Let say that Subsea7 is doing a survey operation, where they need to cut off a flange on a pipe. They need to use a ROV for this job because the pipe lays 400 meter under the surface. The ROV are equipped with a new type of steel cuter. What happens if the cuter breaks? Then they cannot complete the work on the pipe and have to sail back to the cay and repair the steel cuter, and that cost a lot of money. That's way Subsea7 have contingency plans, it is a type of insurance if something go wrong.

One problem with the guidewords in HAZID and HAZOP is that they can make the experts stop thinking, and that will give less insight into the nature of the hazards on the operation. Overall it is useful method in identifying hazard, but should not be the only identifying method.

5.2.3 FMECA

A failure mode, effects and criticality analysis is a systematic method of identifying failure modes of mechanical or electrical system, and evaluates the consequences as well (DNV 2002). It is a qualitative analysis technique, and Subsea7 are normally executing it in the system design phase. It starts with identifying possible "single point failures", risk to the system and cost of loss associated with such failures. Then it identifies if its possible to eliminate "single point failures", if that is not possible reduce the risk for it happening. In the end we identify contingency plans for "single point failures" that cannot be eliminated or reduced. Subsea7 uses the same matrix in the FMECA as in the HIRA refer to chapter 3.6, but the FMECA will focus more on cost associated with damages or loss of production. In the figure 5-4 is an example of how the FMECA is conducted.

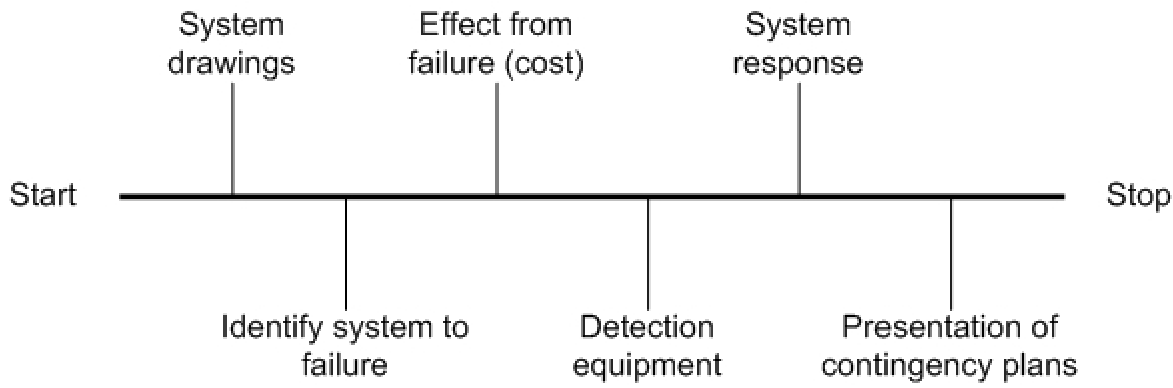

FIGURE 5-4 – FAILURE MODE, EFFECT AND CRITICALITY PROCESS

It is systematic and comprehensive method that helps identify al hazards associated with the electrical and mechanical parts in the system. Can be done by a single expert. It identifies critical equipment if a single failure would be vital for the whole system.

The FMECA can be very uncertain if the experts don't have experience with it. It requires good information about the system being analysed. Like good system drawings and that have to be develop before the analysis starts. It is just good with mechanical and electrical equipment and not procedure, process equipment and multiple human errors. Therefore it is best to use FMECA with other analysis like HAZID or HAZOP.

5.2.4 SWIFT

The structured what-if checklist technique is a method of identifying hazards based on the use of brainstorming (DNV 2002). It starts with a team of experts going through scope of work with a questioning attitude. The experts doing the analysis need to be familiar with the installation. It devied from the HAZID and HAZOP in some cases like: The discussion proceeds systematically through the installations modules or operation at the level of system or procedures rather than individual items or tasks. It relies on brainstorming and checklists to identify hazards. To start the discussions we need to begin with the words "what if", "how could" and "is it possible". The words should be prepared before the discussion. The figure 5-5 shows how a SWIFT can be conducted.

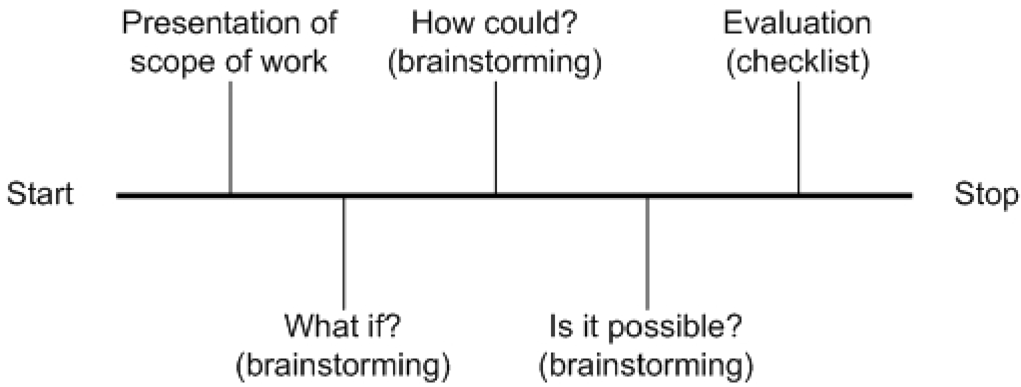

FIGURE 5-5 – THE STRUCTURE WHAT IF CHECKLIST TECHNIQUE PROCESS

This is a very flexible method of investigating any type of installation, operation and at any stage in the lifecycle of the project. It uses the experience of operating people in the meetings. This will give a better indication of the hazards. It moves on quick because it avoids considerations of deviations.

Correct preparation of the checklist is very important, because if the checklist is not advanced enough it won't help find the hazards. The experience of the experts is also important because they are the one that are identifying the hazard.

5.2.5 Conclusion

Subsea7 uses different methods like HAZID and HAZOP for finding al the hazards on the projects. And that is recorded in a risk register database, so it is easy to track when evaluating the risk level. They contain parts of different risk identification methods and that is important for getting a better risk picture of the operation. The different techniques that are implemented are guidewords and task analysis. But they should also implement parts from SWIFT like “what if analysis”, this will question the procedures more. Also use FMECA on critical equipment so they don’t risk the whole operation stopping. That should give them better information about where the hazards are hidden. The best way of preparing the procedures is a combination of al the method evaluated.

5.3 RISK ASSESSMENT TECHNIQUES

When all the hazards are found we have to evaluate risk level, and see if it is acceptable. There is various ways of doing that and, the most common way in marine operation is using a risk matrix. Another way of deciding if the risk is acceptable is using a bowtie assessment.

5.3.1 Risk Matrix

Before the risk matrix is executed the project engineers prepare the new HIRA by implementing hazards found in PHA (HAZID and HAZOP) and finding similar old HIRAs and copy the hazards and consequences over to the new HIRA. After the hazards and consequences are recorded we calculate the risk from how likely it is for hazard occurring and the degree of severity, it is done after the legacy Acergy guidelines. The aim of risk matrix is to provide a basis for deciding whether a task is safe regarding assessing or not. It is the project owner and project management that decide if the risk is ALARP or not, and that gives them big responsibilities. This way of evaluating risk has both positive and negative factors.

A good thing with risk matrix is that it is easy to apply, if it has clear guidelines for how to evaluate the risk level. Some of the more complex methods needs detailed calculations but this method just need some basic experience from the experts. It is just a few of the experts that need to know how to evaluate the risk level.

It covers risk to the people, assets and environment, and that is making the risk decisions more correct. Then it is not just the people that are in focus.

But there are some negative factors with the matrix to. Many judgments are required on likelihood and consequences and if the judgments are not properly recorded the basis for risk decision will be lost. That’s way Subsea7 always record the result in a HIRA database. If hazard occur and causes big damages to the vessel, then they can track the HIRA done on the project in theirs database.

Another negative thing is manageability of the matrix. All of the prediction done in HIRA is based on background knowledge, and they could produce poor predictions. Surprises to the assigned probabilities may occur, when Subsea7 just evaluate probabilities and consequences grossly. As mentioned earlier one should implement an uncertainties factor in HIRAs.

5.3.2 Bow Tie Analysis

Bowtie analysis is another way of analysing the risk. Then we can use techniques drawn from quantified risk analysis, but we do not quantify the result (DNV 2002). This is a structured approach for risk analysis within safety cases where quantification is not possible or desirable. The idea is simple, to combine the cause and consequences analysis into a single diagram with the fault tree analysis plotted sideways on the left and the event tree analysis plotted to the right. We can find the frequency by using a fault tree analysis (FTA) and consequence analysed using a event tree analysis (ETA).

FTA

Fault tree analysis is a logical representation of the many events and component failures that may combine to cause one critical event (system failure). It uses "logic gates" mainly "AND or OR" to show how "basic events" may combine to cause the critical "top event". The top event would normally be major hazards such as "stop of operation". We use qualitative identification to find combination of basic events that are reason for the top event to happen. The FTA start with top event, and then it work towards the basic events. For each event, it is considers what conditions are necessary to produce the event, and represents these as events at the next level down. If any of several events may cause higher event, they are joined with an "OR" gate. If two or more events may occur in combination, they can be joined with "AND" gate. In the figure 5-6 a fault tree analysis is shown.

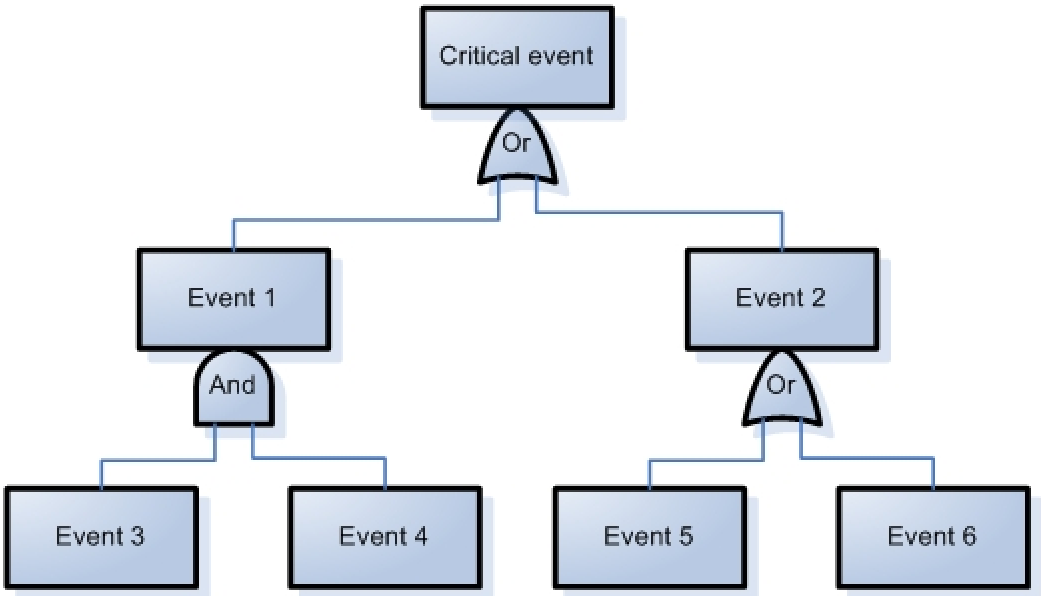

FIGURE 5-6 – FAULT TREE ANALYSIS

ETA

Event tree analysis (ETA) is a logical representation of the various events that may follow from an initiating event (component failure). It uses branches to show the various possibilities that may arise at each step. We can use it to relate a failure event to various consequences models, and it can also be used to quantify system failure probabilities, where several contributory causes can only arise sequentially in time. It starts with the initiating event and work through each branch in turn. A branch is defined in terms of question (B winch works). We answer it with either "yes" or "no". Each branch is conditional on the appropriate answers to the previous ones in the tree. Quantifying the event tree is relative simple, normally preformed on spread sheet by hand or computer. The decision can be based on probability or start or stop. In the figure 5-7 the decision is based on start or stops the operation.

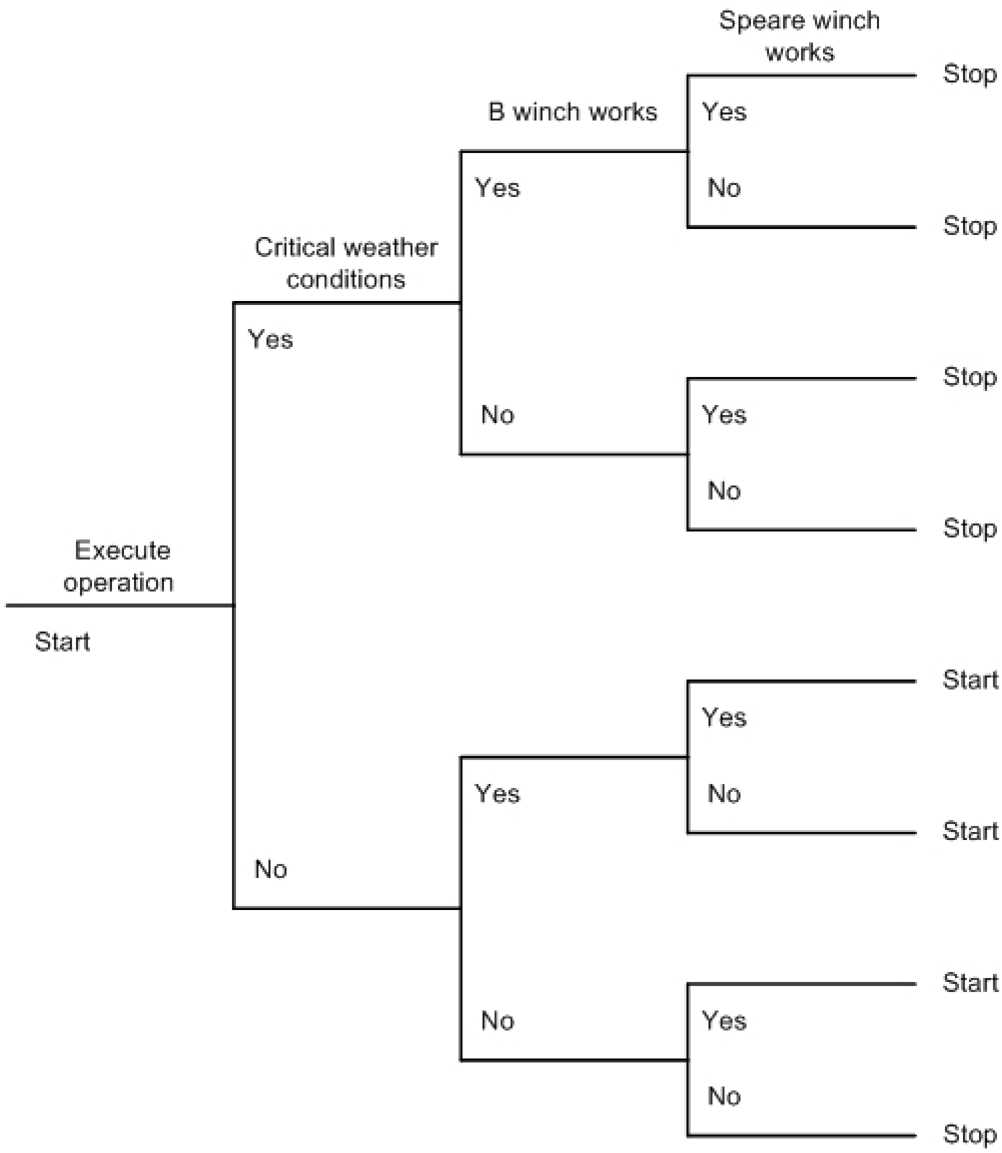

FIGURE 5-7 – EVENT TREE ANALYSIS

5.3.3 CONCLUSION

Risk matrix is the most common approach for risk assessment today, and that is because it is appropriate for people new to risk assessment. Because it`s straightforward to apply. The matrix has some negative sides to, like difficult to deal with multiple consequences that arise from the same hazard. The bowtie format is not overly complex and non-specialist can understand it. A positive thing with the bow tie is that events are described in FTA and consequences are described in ETA. It is shown clearly how the events and consequences affect each other. In HIRA records table (11-12) this is missing and that give us less information of how the risk can affect the operation. But it takes more time and work to do a bow tie compared to HIRAs, and time is money. Nevertheless it may be possible to do something in-between them. An approach that describes the risk connected to the operation differently then HIRAs records. More precise information about where danger is hidden. Subsea7 can try to upgrade the HIRAs with one or two Columns. One with cause (cause of hazards) and maybe split the corrective measures in proactive measures (actions that prevent hazards from occurring) and protective measures (measures that protect people, assets and environment from the hazards). That way the evaluated risk will be easier to communicate to the people doing the work and they will understand the risk better.

5.4 COMMUNICATING THE RISK

Today there has been a lot of effort put into minimising the risk of technological hazards in the offshore industry. However research shows that nowadays the, majority of incidents accident is caused by organisational and human factors(Mearns, Flin et al. 1997). The survey main goal is give information of organisational factors that affect the safety on the vessel. See if crew feels the HIRAs function the way it is supposed to do.

The survey that was used on vessel is based on (Mearns, Flin et al. 1997) offshore questionnaire. The survey was change a little so that it fit subsea7`s vessel better. The biggest challenge with this survey is information gathered can be thin compeer to an interview (Bang 1998). The information gathered form the survey is the respondent's expression, norms, opinion and values. The information gathered from the survey is quantified information analysed in a data worksheet. The probability for respondents gives the best answer because it is anonymous survey. It is an exemplar of the survey in appendix 1. Below is the structure of the survey:

- Work environment are based on a scale and are questions of measuring the social environments of different types of work setting. An example of "work pressure" is "there is constant time pressure, to get the job done". And work clarity is "the activities are well planned".
- Job communications are questions from a scale and are statements about level of communication in their job. Example of statement in the questionnaire is "There is good communication between the office and vessel".
- The safety behaviour was developed to measures respondents and self reports how they carry out potentially unsafe acts on a five-point scale.
- Experience of risk is a scale developed to measure personnel perception of how safe they felt from being injured by hazard on the vessel. Respondents where asked to rate "How safe do you feel from being injured by" each of the hazards "Fire".
- Experience of risk is a scale developed to measure personnel perception of how safe they felt "you preform a non-routine activity"
- Last question in the survey was open "what do you think about Subsea7 HSE (health, safety and environment) system?

5.4.1 Results information:

The result in the questionnaire may give different result from other surveys done on the vessel, because of different uncertain factors. The result from the survey is analysed on a worksheet in excel. It was 32 on board the vessel that answered questionnaire. The survey had 43 alternatives and one open question. Some of the questions where not answered. They where put in an own column N/A (not answered) in the analysis.

General information:

What is your job title?
Figure 5-8 shows what kind of job title the responder has.

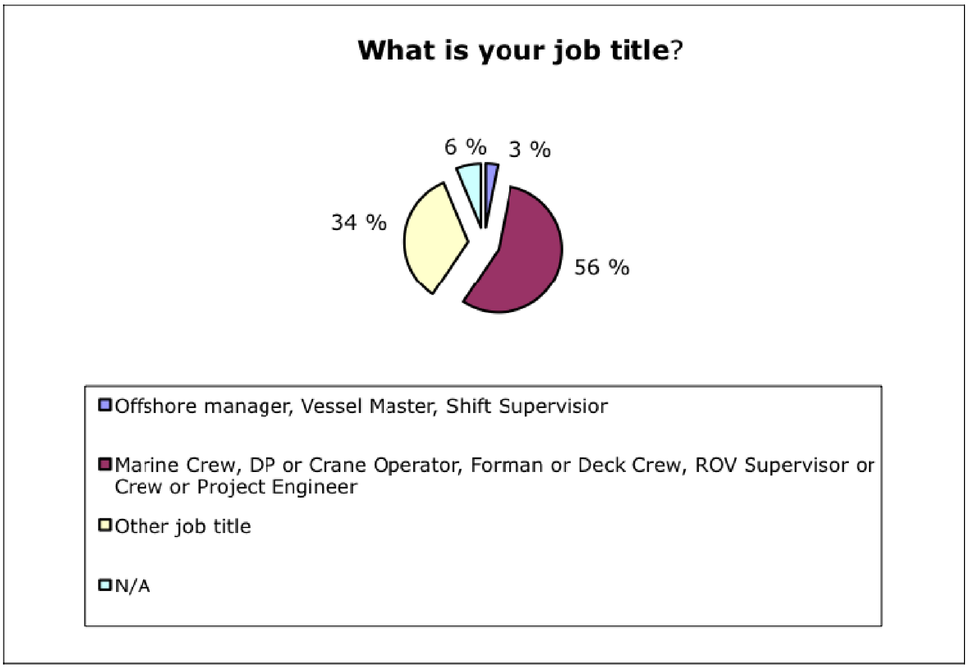

FIGURE 5-8 – RESULT FORM QUESTIONNAIRE "WHAT IS YOUR JOB TITLE?"

How long have you worked offshore?

Figure shows that 0 % has worked offshore less than a year. 31 % have worked offshore more than 10 years.

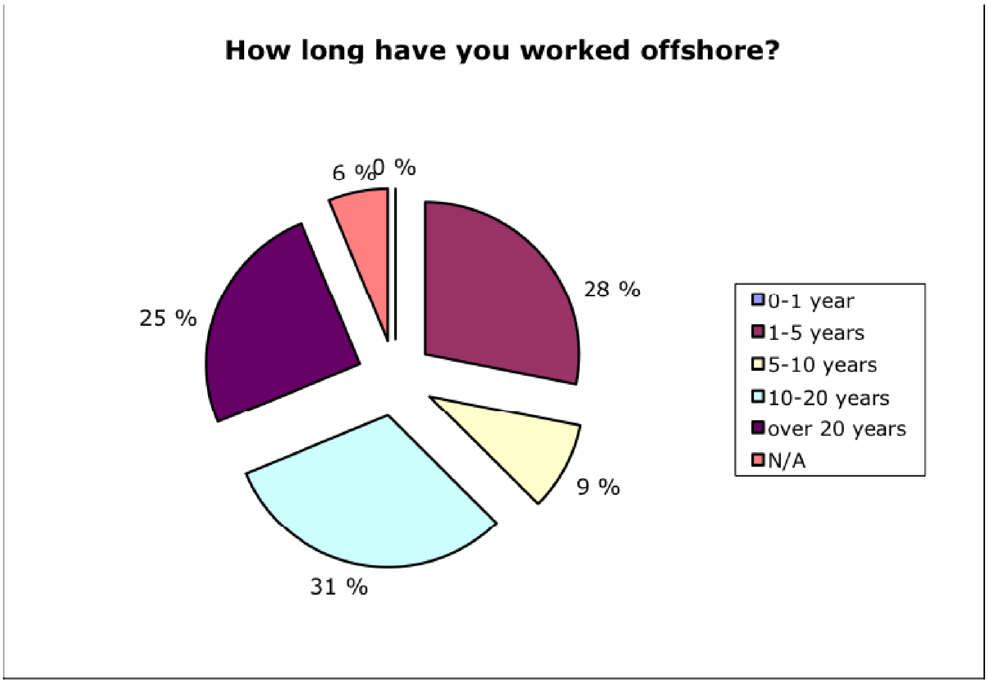

FIGURE 5-9 – RESULT FROM QUESTIONNAIRE "HOW LONG HAVE YOU WORKED OFFSHORE?"

Your job:

Your job gives details of how respondents perceived their job situation and work environment on board the vessel. The figure 5-10 describes how of respondent agrees with statements regarding their perception of work environment i.e. pressure at work and clarity in their work. 46 % are partially agreed, “there is constant time pressure, to get the job done”. 16 % are fully agreed, “The people in the office do not focus on the right safety problems”.

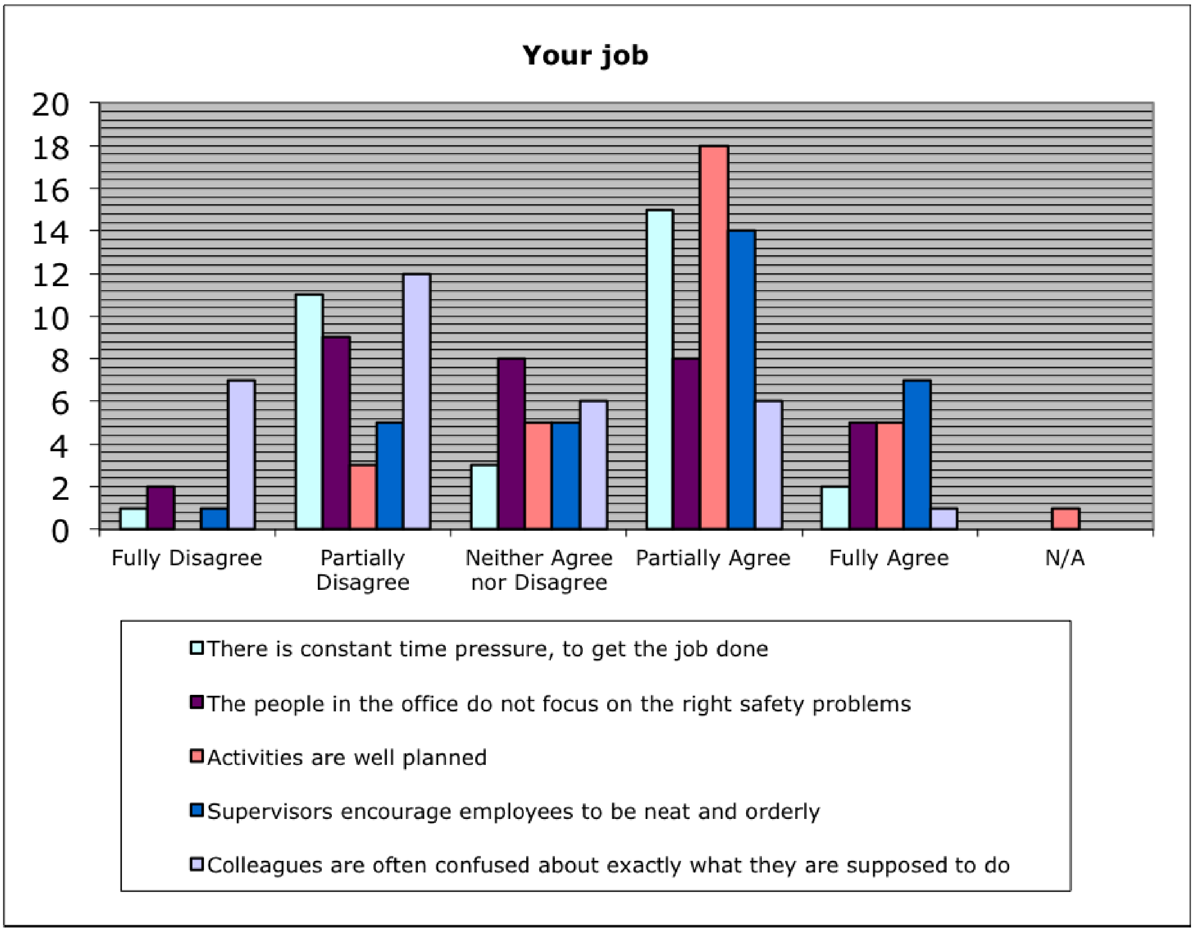

FIGURE 5-10 – RESULT FROM QUESTIONNAIRE “YOUR JOB”

Job communication:
Generally respondent’s appeared to be satisfied with the level of communication on the vessel. But the communication between office and the vessel could be better. 34 % feels that the “there is good communication between the office and vessel” is at minimal extent.

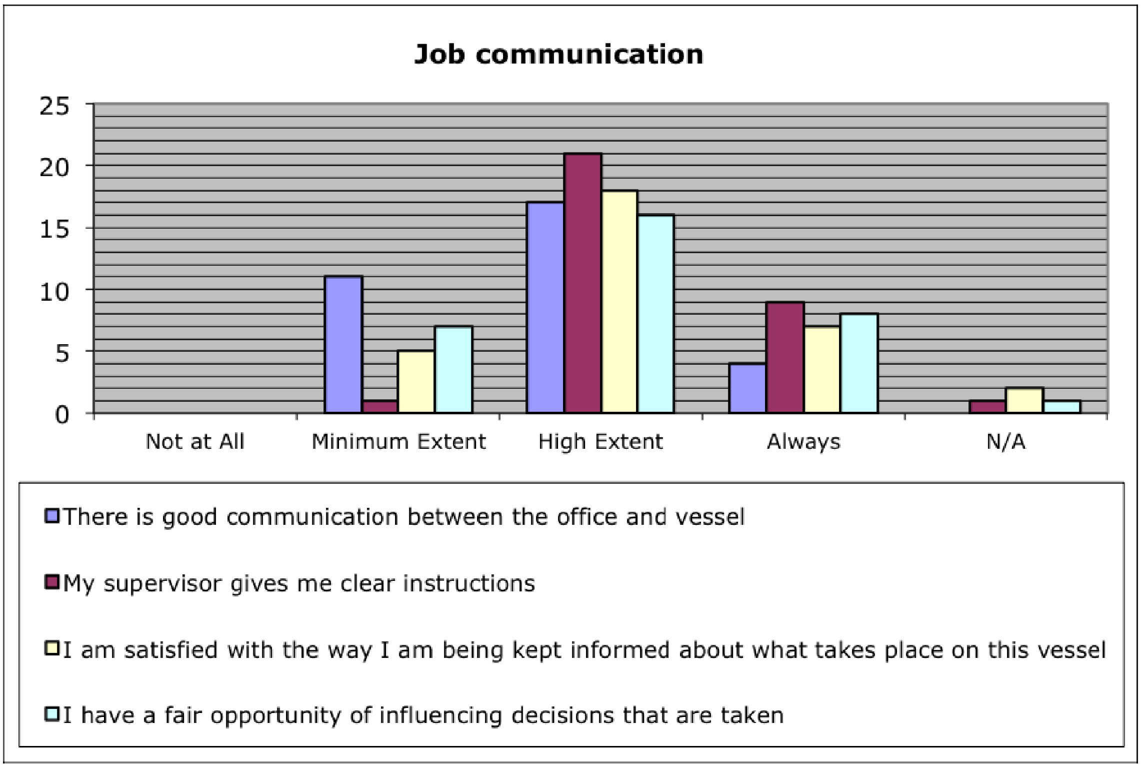

FIGURE 5-11 - RESULT FROM QUESTIONNAIRE "JOB COMMUNICATION"

Safety behaviour:
Figure 5-12 shows the proportion of respondents who admitted that they "never", "seldom/sometimes" or "often/very often carried out actions which could potentially compromise safety on the vessel. Most of the respondents "never" carried out activities which where forbidden, however 71 % of the respondents think seldom/sometimes that "I get the job done better by ignoring some rules".

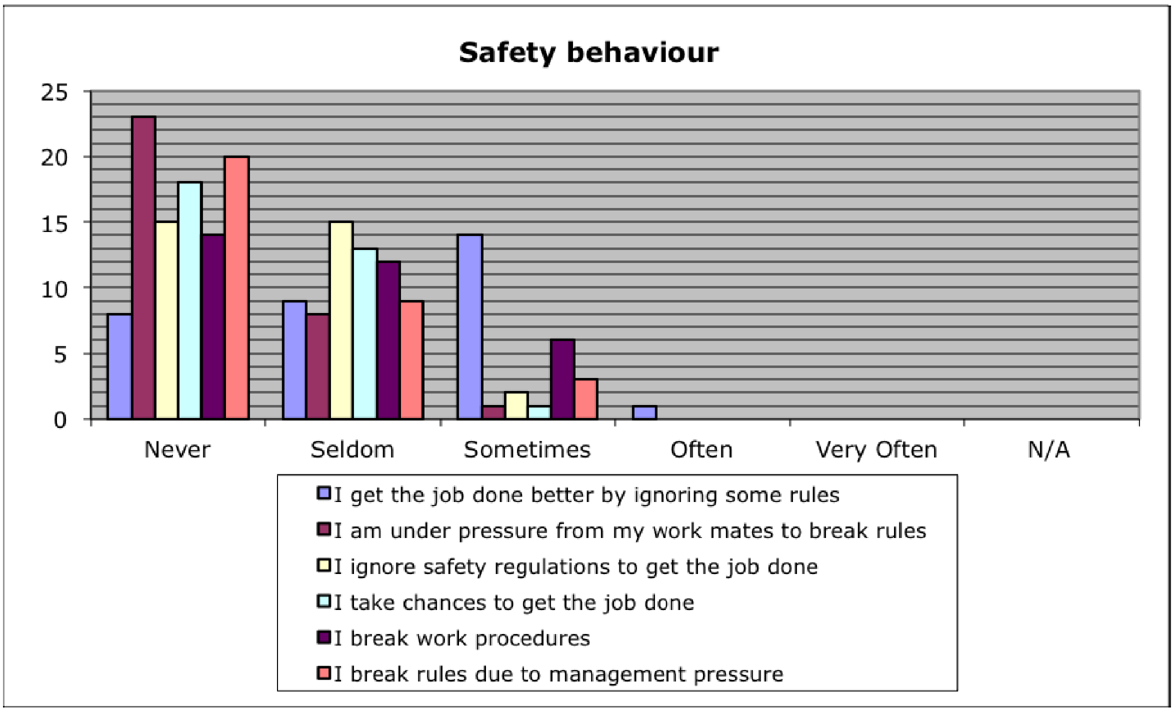

FIGURE 5-12 - RESULT FROM QUESTIONNAIRE "SAFETY BEHAVIOUR"

Risk perception on vessel:

The figures 5-13 to 5-15 shows the proportion of respondents who felt "safe" (combination of "vary safe" and "safe"), "neither safe" nor "unsafe" or "unsafe" (combination of "unsafe" and "very unsafe") with regard to the main hazards encountered offshore. Hazards like damages vessel, occupational hazards and work task hazards. The result from the figures 5-13 to 5-15 shows that the majority of respondent felt "safe" with regard to the hazards. But some felt neither "safe" nor "unsafe" in the work task hazards.

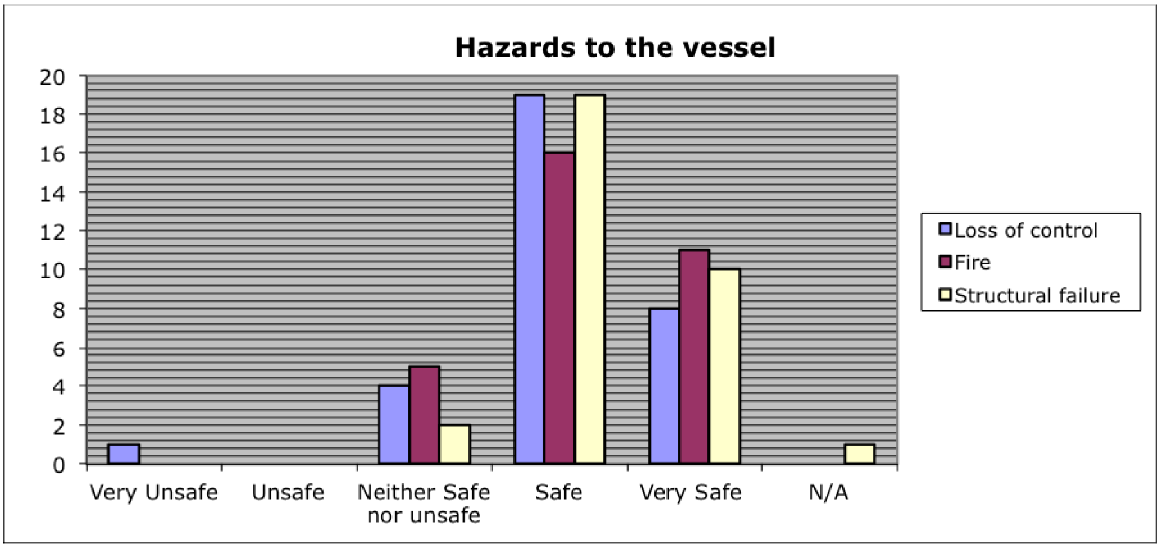

FIGURE 5-13 - RESULT FROM QUESTIONNAIRE "HAZARDS TO THE VESSEL"

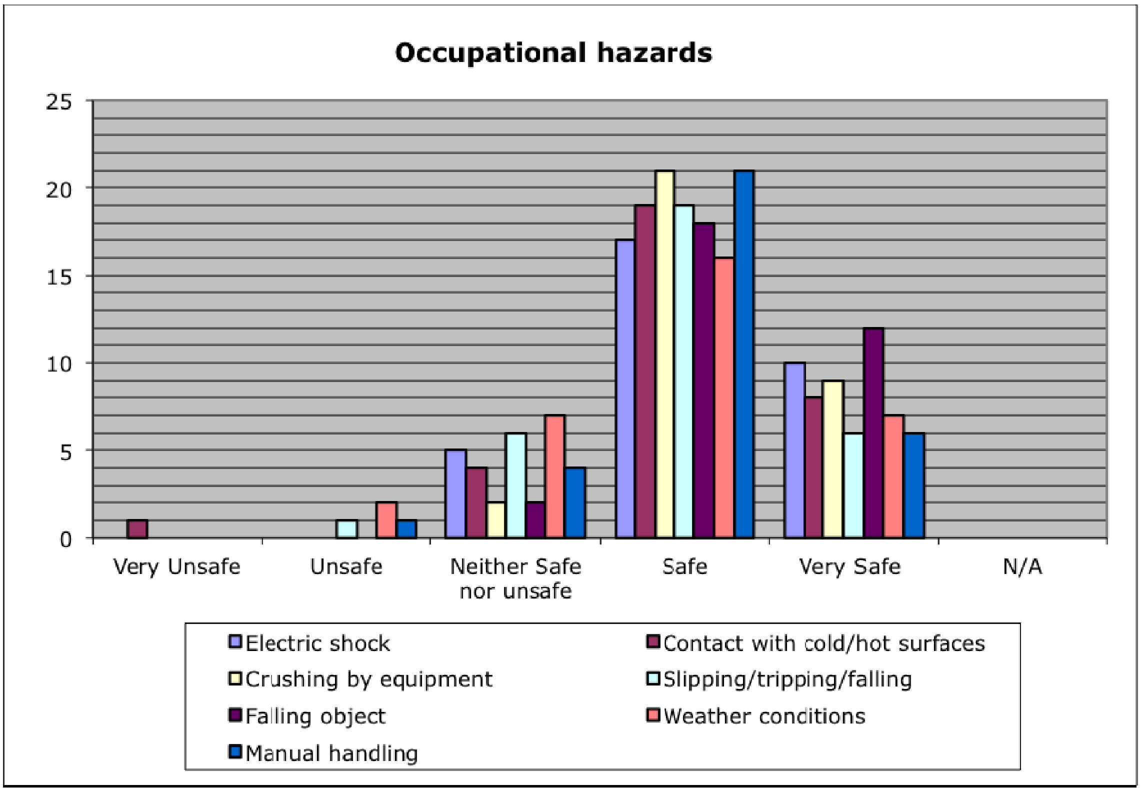

FIGURE 5-14 - RESULT FROM QUESTIONNAIRE "OCCUPATIONAL HAZARDS"

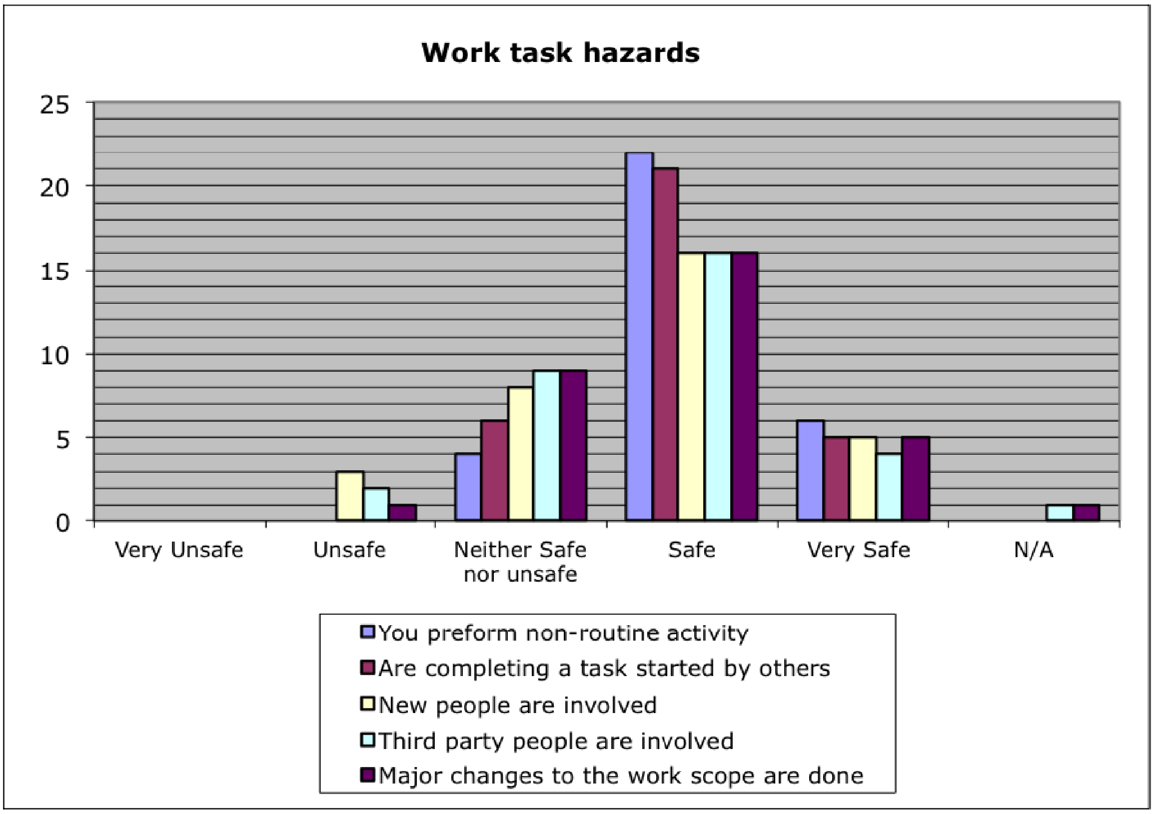

FIGURE 5-15 - RESULT FROM QUESTIONNAIRE "WORK TASK HAZARDS"

Assessment of safety

Figure 5-16 shows the number of responders who where "satisfied" (combination of "very satisfied" and "satisfied"), "dissatisfied" (combination of "very dissatisfied" and "dissatisfied") and "neither satisfied nor dissatisfied" with safety measures on and of board the vessel. The result in figure xxx show that respondents where satisfied with safety measures on-board the vessel.

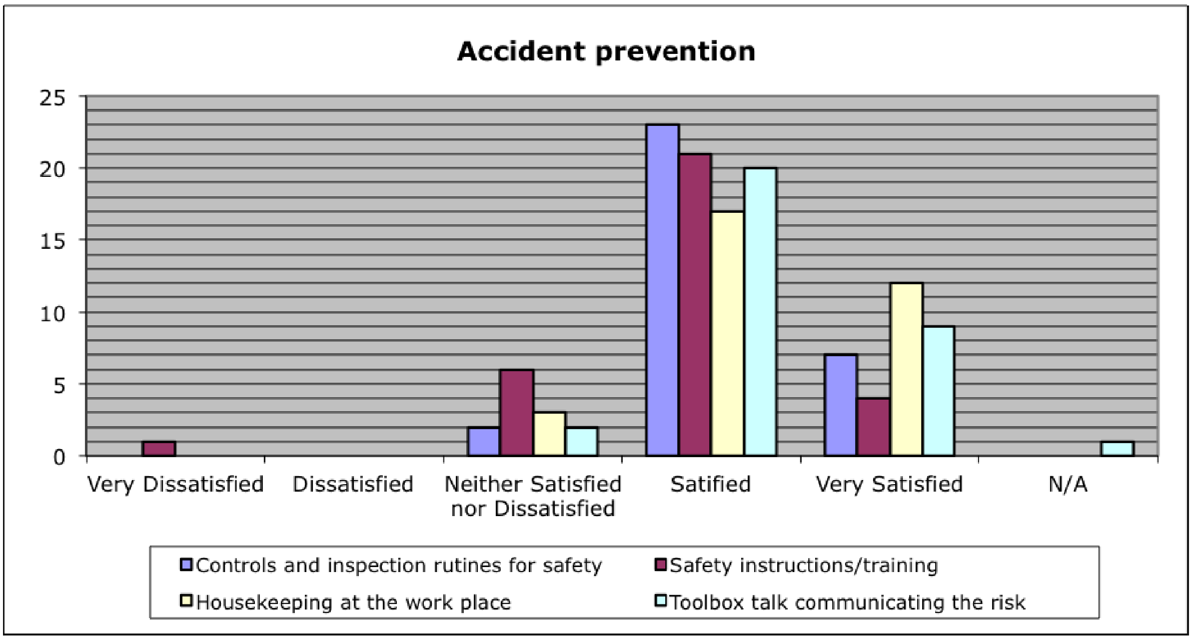

FIGURE 5-16 - RESULT FROM QUESTIONNAIRE "ACCIDENT PREVENTION"

Safety attitudes

Figure 5-17 show the result of respondents who "agree" (combination of "partially agree" and "fully agree"), "disagree" (combination of "fully disagree" and "partially agree") or "neither disagree nor agree" to the statement about safety and accident at work. 34 % of the respondents felt "the written safety rules and instruction are too complicated for people to follow" and 43 % felt "the procedures do not always describe the safest way of working.

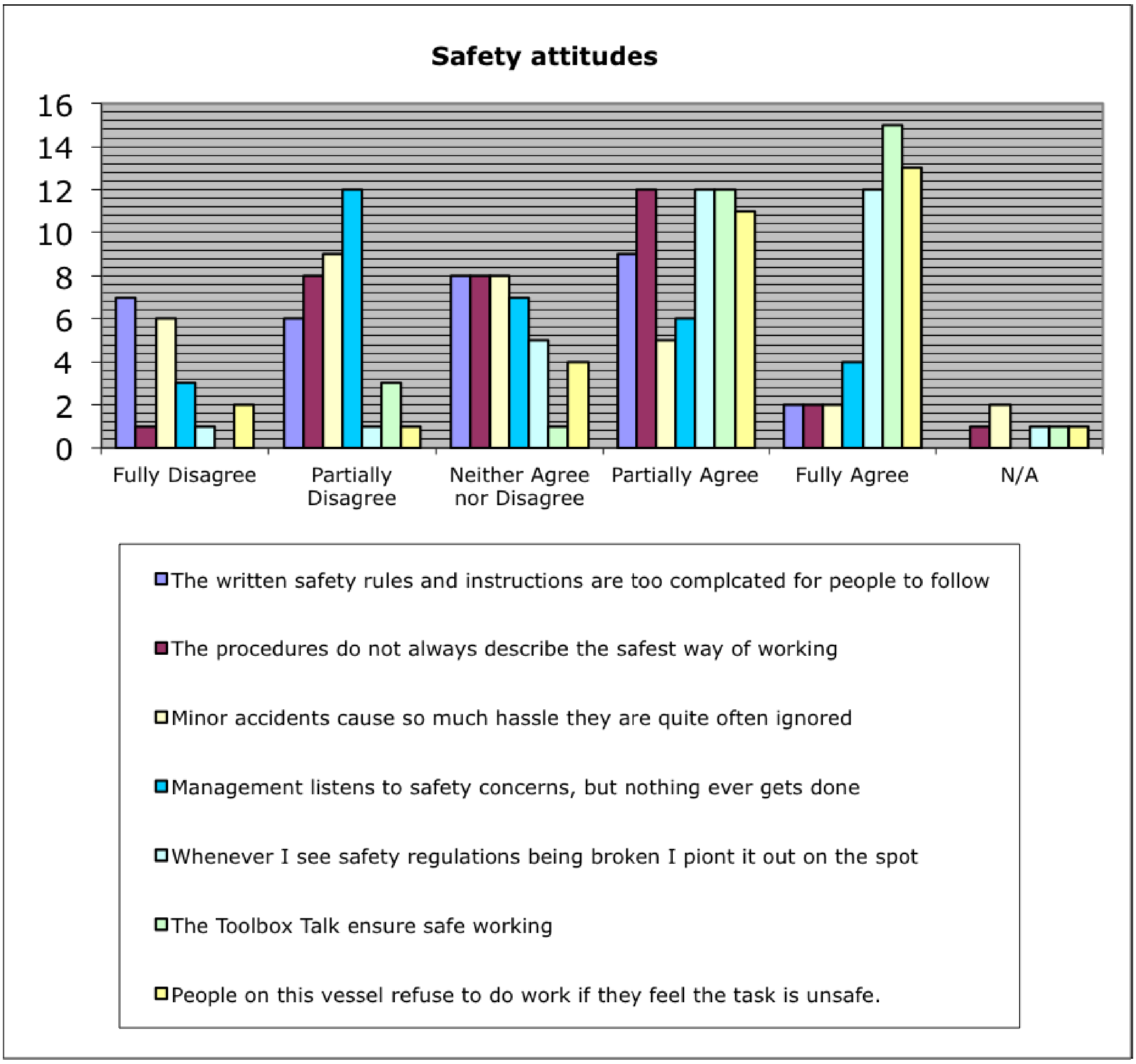

FIGURE 5-17 - RESULT FROM QUESTIONNAIRE "SAFETY ATTITUDES"

Result from the open question:

In the open question most of the comments where positive. But In the table 18 there is mentioned some of longer comments.

Negative factors:	**Positive factors:**
Very small incidents are reported to often. A lot of paper work, but a good system.	Focus on safety!
To complicated, have to be done in a easier way, cards, risk assessment etc.	
Slow progress on some safety issues.	Good encouragement for safety improvement.
Slightly complex, contractors not advised about where to assess Subsea7 HSE material.	Comprehensive system very good v/l walk around. Open door police to discuss issues.
Over complication of safety	

regulations implemented by onshore personnel unfamiliar with offshore condition`s. Safety campaigns rolled out before previous one`s finished resulting in excess complications.	
Too much safety is unsafe. Use common sense.	

Table 18 – Comments from open question

5.4.2 Conclusion

The majority of employers who responded to the survey generally felt “safe” regarding offshore hazards and “satisfied” regarding safety measures on board their vessel. They also reported that the communication between office and vessel could improve. The safety behaviour on the vessel was generally good, but one of the statement discovered that some respondent felt that they could execute the work better by ignoring some rules. The result from the open question showed that majority of the responders was satisfied with Subsea7 safety system, but some felt it could be user-friendlier.

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ATTACHMENT 1 - REFERENCE FORMS

Offshore Safety Questionnaire

This is a nameless questionnaire. Please just answer questions related to your job.
Complete the following questionnaire, by placing a CROSS in appropirate box.

Background Information	Offshore manager, Vessel Master, Shift Supervisior	Marine Crew, DP or Crane Operator, Forman or Deck Crew, ROV Supervisor or Crew or Project Engineer	Other job title
What is your job title?	☐	☐	☐

How long have you worked offshore?	0-1 year	1-5 years	5-10 years	10-20 years	Over 20 years
	☐	☐	☐	☐	☐

Work Enviroment	Fully Disagree	Partially Disagree	Neither Agree nor Disagree	Partially Agree	Fully Agree
The written safety rules and instructions are too complcated for people to follow	☐	☐	☐	☐	☐
The procedures do not always describe the safest way of working	☐	☐	☐	☐	☐
Minor accidents cause so much hassle they are quite often ignored	☐	☐	☐	☐	☐
There is constant time pressure, to get the job done	☐	☐	☐	☐	☐
The people in the office do not focus on the right safety problems	☐	☐	☐	☐	☐
Activities are well planned	☐	☐	☐	☐	☐
Supervisors encourage employees to be neat and orderly	☐	☐	☐	☐	☐
Colleagues are often confused about exactly what they are supposed to do	☐	☐	☐	☐	☐
Management listens to safety concerns, but nothing ever gets done	☐	☐	☐	☐	☐
Whenever I see safety regulations being broken I piont it out on the spot	☐	☐	☐	☐	☐
The Toolbox Talk ensure safe working	☐	☐	☐	☐	☐
People on this vessel refuse to do work if they feel the task is unsafe.	☐	☐	☐	☐	☐

Your Job	Not at All	Minimum Extent	High Extent	Always
There is good communication between the office and vessel	☐	☐	☐	☐
My supervisor gives me clear instructions	☐	☐	☐	☐
I am satisfied with the way I am being kept informed about what takes place on this vessel	☐	☐	☐	☐
I have a fair opportunity of influencing decisions that are taken	☐	☐	☐	☐

Your Job	Never	Seldom	Somtimes	Often	Very Often
I get the job done better by ignoring some rules	☐	☐	☐	☐	☐
I am under pressure from my work mates to break rules	☐	☐	☐	☐	☐
I ignore safety regulations to get the job done	☐	☐	☐	☐	☐
I take chances to get the job done	☐	☐	☐	☐	☐
I break work procedures	☐	☐	☐	☐	☐
I break rules due to management pressure	☐	☐	☐	☐	☐

How safe do you feel from being injured by the following hazards;	Very Unsafe	Unsafe	Neither Safe nor Unsafe	Safe	Very Safe
Loss of control	☐	☐	☐	☐	☐
Fire	☐	☐	☐	☐	☐
Structural failure	☐	☐	☐	☐	☐
Electric shock	☐	☐	☐	☐	☐
Contact with cold/hot surfaces	☐	☐	☐	☐	☐
Crushing by equipment	☐	☐	☐	☐	☐
Slipping/tripping/falling	☐	☐	☐	☐	☐
Falling object	☐	☐	☐	☐	☐
Weather conditions	☐	☐	☐	☐	☐
Manual handling	☐	☐	☐	☐	☐
How safe do you feel when;	Very Unsafe	Unsafe	Neither Safe nor Unsafe	Safe	Very Safe
You preform non-routine activity	☐	☐	☐	☐	☐
Are completing a task started by others	☐	☐	☐	☐	☐
New people are involved	☐	☐	☐	☐	☐
Third party people are involved	☐	☐	☐	☐	☐
Major changes to the work scope are done	☐	☐	☐	☐	☐
How satisfied do you feel with regard to;	Very Dissatisfied	Dissatisfied	Neither Satisfied nor Dissatisfied	Satified	Very Satisfied
Controls and inspection rutines for safety	☐	☐	☐	☐	☐
Safety instructions/training	☐	☐	☐	☐	☐
Housekeeping at the work place	☐	☐	☐	☐	☐
Toolbox talk communicating the risk	☐	☐	☐	☐	☐

What do you think about Subsea 7 HSE(Health,safety and environment) system?	
Negative	Positive
Thank you!	