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Preface

This thesis marks the end of my Master degree in Societal Safety. The learning curve has been steep and exciting, but it has not been effortless. There have been many nights and weekends when I would rather have been spending time with my boyfriend and our two daughters, the youngest of which was born during the course of these studies. Without the support and understanding of my boyfriend my journey would have been much more difficult. Thank you Ola.

Several other people deserve my gratitude. I would like to thank my supervisors at Safetec, Bjørnar Heide and Helge Stangeland. Your guidance, suggestions and positivism have been invaluable. I would like to thank my faculty supervisor Ove Njå for all your help and feedback, and for putting up with Susanne plus baby. I would like to extend my gratitude to my manager for giving me the flexibility and support I needed to complete my studies, and my employers diving manager for always making time for me and for providing me with a wealth of information. Thank you to all the respondents I interviewed - your answers are the backbone of this thesis.

Last, but not least, I would like to thank my fellow-students, and now close friends, Monica Helen Sirevåg and Lene Schibevaag – we have laughed and cried together and I have enjoyed every minute of it!

Abstract

The long-term health effects of petroleum related diving activities have been much debated in recent years. The case of the pioneer-divers has been well documented and as the use of divers continues to be a requirement in the petroleum industry, the issue of long-term health effects is currently on the agenda of the authorities, operators and diving entrepreneurs.

The aim of this study has been to assess how good the existing safety barriers are with regard to long-term health monitoring of offshore divers. The focus area was soft defences in the form of regulations, standards and procedures with regard to offshore saturation diving on the Norwegian Continental Shelf. The safety barriers specifically identified were the requirement for offshore health certificate, certificate for offshore divers, pre- and post-dive medical checks, and exposure assessment. In addition, two safety barriers where participation is voluntary were included, the 3-yearly medical examination and the annual health screening questionnaire.

A qualitative method was employed and key informants from the diving industry were interviewed. Representatives from the authorities, diving entrepreneurs, and divers were selected as key informants. The latter were selected based on a short set of criteria related to diving history, and the remainder were selected based on having in-depth knowledge regarding the subject matter. In addition, data was obtained through personal communication with operator and persons with expertise within diving medicine. Data was collected and analysed, and the results discussed in light of relevant theoretical framework.

The main findings from this study are that the effectiveness of the two voluntary safety barriers, which together with exposure assessment form part of a long-term health follow up program, is poor. Many divers are reluctant to participate due to factors such as suspicion, or no knowledge of its existence. Some divers reported that they have in fact not been invited to participate during a three-year period. Further, one diving entrepreneur´s organisation of the 3-yearly medical examination in particular, has much room for improvement. The medical examinations appear, at times, to be organised in an ad hoc manner, sometimes resulting in the contracted diving doctor being unable to accommodate the requests for these. As the effectiveness of both the 3-yearly medical examination and the annual health screening questionnaire relies first of all on divers actually participating in them, it goes without saying that the divers must then do just that, participate. In order to

participate, divers must first be invited to participate. With regard to the annual health-screening questionnaire, the authorities and diving entrepreneurs identified low response rate as a challenge. Research suggests that divers as a group have a different risk perception than other offshore workers and a different safety culture. It would seem pertinent for diving entrepreneurs, as well as authorities and operators, to establish a good rapport with the divers in order to build up trust and good communication in both directions. By communicating the risks involved in saturation diving, and by disproving their concerns or suspicions, divers can better make informed decisions related to the safeguarding of their own long-term health.

The originality of this study is that few, if any, have looked into the effectiveness of these safety barriers from a safety point of view. There exist layers of defences, but when looked at from an "organisational accident" perspective, it is argued that these layers are in fact based entirely on divers voluntary participation and to some extent coincidences.

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Abbreviations and translations

Abbreviation	English	Norwegian
	Activities regulations	Aktivitetsforskriften
	Directorate of Labour	Arbeidsdirektoratet
	Framework regulations	Rammeforskriften
	Management regulations	Styringsforskriften
	Norwegian White paper	Stortingsmelding
	Norwegian Board of Health Supervision	Statens Helsetilsyn
	Petroleum Act	Petroleumsloven
BCS	British Continental Shelf	Britisk kontinentalsokkel
COPD	Chronic obstructive pulmonary disease	KOLS
DCI	Decompression illness	
DOH	Directorate of Health	Helsedirektoratet
DSV	Diving Support Vessel	
ECG	Electrocardiography	
HSE	Health and Safety Executive	
HUH	Haukeland University Hospital	Haukeland Universitetssykehus
IRGC	International Risk Governance Council	
LIA	Labour Inspection Authority	Arbeidstilsynet
MOI	Ministry of Industry	Industridepartementet
MUO	Manned Underwater Operations	
NCS	Norwegian Continental Shelf	Norsk kontinentalsokkel
NIOH	National Institute of Occupational Health	Statens Arbeidsmiljøinstitutt
NOU	Official Norwegian Reports	Norges offentlige utredninger
NPD	Norwegian Petroleum Directorate	Oljedirektoratet
PSA	Petroleum Safety Authority	Petroleumstilsynet
PTSD	Post traumatic stress disorder	
RMT	National Union of Rail, Maritime, and Transport Workers	
SAFE	Union for workers in the energy sector	Sammenslutningen av Fagorganiserte in Energisektoren
WEA	Work Environment Act	Arbeidsmiljøloven
X-ray	Electromagnetic radiation	

1 Introduction

"There is evidence that changes in bone, the CNS and the lung can be demonstrated in some divers who have not experienced a diving accident or other established environmental hazard. The changes are in most cases minor and do not influence the diver's quality of life. However, the changes are of a nature that may influence the diver's future health. The scientific evidence is limited, and future research is required to obtain adequate answers to the questions of long-term health effects of diving."

(Hope et al. 1993, as cited in NOU 2003:133)

"The findings from this survey are consistent with the findings from the epidemiological surveys that was carried out on active divers in the latter half of the 1980s and are in line with the conclusions from the Godøysund conference. The changes in functionality that were detected and that correlated with cumulative diving exposure, was back then not regarded as having significance for the divers' quality of life. The changes are now more pronounced, yield more clinical symptoms, and implies a significant deterioration in quality of life in a large proportion of the divers."

(Haukeland University Hospital, 2004:7)

The working conditions and fate of the pioneer divers have been much discussed in the media during the course of the last decade. The pioneer period is defined as the years from 1965 to 1990, and the pioneer divers are those persons who carried out petroleum related diving activities during that period (St.meld. nr. 47 (2002-2003)). The Petroleum Safety Authority (PSA) (2011:130) reports that during the period between 1967 until 2010 the number of diver fatalities was 14, which constituted 5.2% of total petroleum-related fatalities on the Norwegian Continental Shelf. Between 1981 and 2010 diver fatalities constituted 11% of occupational accidents. Further, the PSA (2012) reports that in the period between 2009 until 2011, although the activity level was low, there were 11 personal injuries related to saturation diving, 8 injuries in 2011 alone. The PSA produces an annual report entitled "Trends in risk level in the petroleum activity" in which the number of diving incidents and near misses are reported together with the activity levels for diving. However, the report specifies that reported cases of work related illness are not included as they are not regarded as a suitable indicator of risk (PSA, 2011). A report from Haukeland University Hospital (HUH) (2004) concerning pioneer divers found evidence to

suggest that diving can be detrimental to long-term health, which is supported by St.meld. nr. 12 (2005-2006) (Norwegian White Paper), stating that diving can cause late onset health problems. In light of this one may wonder why diving-related health effects are not considered when assessing status and trends for risks in the petroleum industry.

The PSA (2012) reports that activity levels for saturation diving have been low on the NCS in recent years. However, representatives from the diving industry estimate that the activity level for offshore diving will be approximately 100 days per year, per diving entrepreneur during the next few years. This equates to approximately 40000-50000 hours of saturation diving. There are two main diving entrepreneurs operating in Norway. Activity levels on the British Continental Shelf (BCS) are much higher and this is due to the fact that there is more Diving Support Vessels (DSV) accepted for diving there. On the NCS the number of DSVs accepted for diving is very limited, and thus, the capacity for diving work is also limited. Diver safety is high on the agenda within the industry receiving focus not only from the PSA, but also unions and operators. The pressure is high on diving entrepreneurs to ensure sufficient risk management with regard to diver safety. In the Norwegian White paper no. 12 (2005-2006) it is emphasised that the current working conditions for divers in the Norwegian petroleum industry are safe. However, perhaps slightly contradictory to this, the same white paper refers to the conclusions from the international workshop ”Long-term health effects of diving. The Godøysund 1993 consensus conference revisited” held in Bergen, Norway in 2005 (as cited in Molvær 2005:9). The consensus from the workshop was as follows (own translation):

> “Findings suggest that changes in lung function, central nervous system, skeleton, and hearing/balance system can be found in some professional divers. The extent of these changes varies greatly and has the potential to affects divers´ quality of life. Exact knowledge of the mechanisms behind such changes is still limited and suggests further research is required. It is therefore necessary to implement preventative measures, including health monitoring in future diving.”

The PSA (2012) report would also seem to suggest that the working conditions of divers are not entirely safe.

1.1 Objective

The subject matter of long-term health monitoring of divers seems to be high on the agenda in the diving industry, and potential improvements or changes in long-term health monitoring and follow up of divers´ health are much discussed. There appears to exist a great deal of contradiction with regard to monitoring the long-term health of divers whilst at the same time operating within the existing legal boundaries. There also appears to exist some debate as to the usefulness of some of the safety measures. Whether these challenges can be attributed to the divers themselves, the diving entrepreneurs, operators or regulators is a much debated matter within the industry. This study aims to assess the effectiveness of safety measures that are in place to prevent or decrease long-term health risks to divers. The intent is to provide knowledge that can be used to improve the long-term health follow-up of offshore divers as well as further my own understanding of the subject matter. In order to achieve this the study attempts to answer to the following question:

How good are the safety barriers with regard to long-term health monitoring of offshore divers?

In the context of this study, long-term health monitoring refers to the use of measuring tools with the purpose of assessing the diver´s health. The outcome of these health assessments determines whether the diver is fit to dive, or if further medical attention/follow-up is required.

In order to address the research questions it is necessary to

- present relevant theories concerning risk management
- present relevant research literature concerning long-term health risks associated with diving
- examine the roles and responsibilities of the divers, employers, operators and regulators in relation to the identified barriers
- assess the effectiveness of the relevant laws, regulations and standards by examining to what degree they are implemented and complied with

For the purpose of this study any safety measures put in place by divers, diving entrepreneurs, operators and regulators to prevent or reduce long-term health risks to divers will be defined as safety barriers.

There are many different types of barriers, but this study will be limited to non-physical barriers and include the following regulations, standards and procedures:

- Offshore health certificate
- Health certificate for offshore divers
- Pre- and post-dive medical checks
- 3-yearly medical examination
- Annual health screening (questionnaire)
- Exposure assessment

Due to time- and geographical constraints, as well as own interests in the subject matter, the study will be limited to diving work performed in petroleum related activities (hereinafter referred to only as diving) on the NCS, specifically saturation diving, and the long-term health risks associated with this type of work. Further, due to data availability the study will to an extent be limited to diving work carried out under the management of diving entrepreneur 1 (hereinafter referred to as DE1). DE1 has 264 active saturation divers, of which 40 are permanently employed. Of the 264, 12 are Norwegian and the remainder British.

1.2 Background

This section will give a short description of what diving is and will include some definitions of diving terminology. Further, a short account of the history of petroleum related diving on the NCS will be provided, as well as the evolvement of the regulatory regime surrounding diving activities. To provide an insight into what possible long-term effects divers can experience and which the safety barriers should, in theory, prevent or decrease, a short description from selected research findings will be provided.

1.2.1 What is diving?

Diving is exposure to increased surrounding pressure compared to normal atmospheric pressure at a given location. This type of exposure is most commonly associated with activities under water, although they can also occur under dry conditions such as for example in a pressure chamber or welding habitat. All dives are characterised by three

phases: the compression phase, bottom time and the decompression phase. The compression phase is the time during which the pressure is adjusted according to the relevant depth. So for example if a diver is to work at a depth of 50 metres below the sea surface, the compression phase is the time it takes to adjust the atmospheric pressure to that depth. Bottom time is the duration spent by the diver at the relevant depth. The decompression phase is the time from leaving the working depth until reaching the surface, i.e. normal atmospheric pressure (HUH, 2004).

Hyperbaric diving, which is the focus of this study,

> "…exposes man to ambient pressure at depth. On the surface, the human body is subject to a pressure of one atmosphere. When a diver descends in the water, the pressure on the body increases by one atmosphere per 10 metres depth. The body´s ability to absorb gas increases in proportion with the increase in pressure. This means that as the diver descends, the amount of gas his body will absorb will depend on how long he his down and how deep he goes. When the diver returns to the surface, his rate of return must be adapted to the time required to wash out the excess gas. If he returns too quickly, to a lower pressure, the excess gas will be liberated too quickly, and the diver will suffer from decompression sickness. Surplus gas must be transported to the lungs for ventilation."
>
> (Jacobsen et.al, 1984:13-14)

There are different types of hyperbaric diving, including bounce diving and saturation diving. Saturation diving involves the divers entering a chamber system (Figure 1), in which the atmospheric pressure is adjusted to that at the relevant working depth. The chamber systems may consist of several chambers in which the divers can live, and one or two chambers are connected to the diving bell (Figure 2) in a manner that allows the divers to move from the chamber to the diving bell (Figure 3), and vice versa, when they are at the same saturation level. A diving bell is a chamber for transporting divers between the decompression chamber and the workplace. When the divers are to enter the water to work, they first enter the diving bell. The saturation level in the chamber and the diving bell are isolated, and the bell is lowered into the sea down to the working depth. An umbilical is connected to the DSV and supplies the diving bell with gas, hot water, electrical power, communication, and control signal (NOU 2003:20-28).

Figure 1: Diving chambers (Walters, 2012)

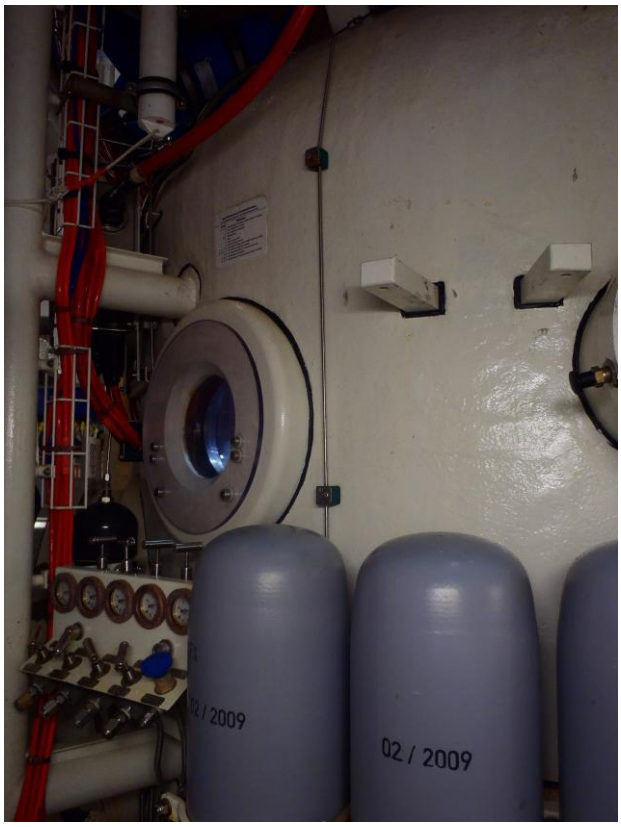

Figure 2: Diving bell (Walters, 2012)

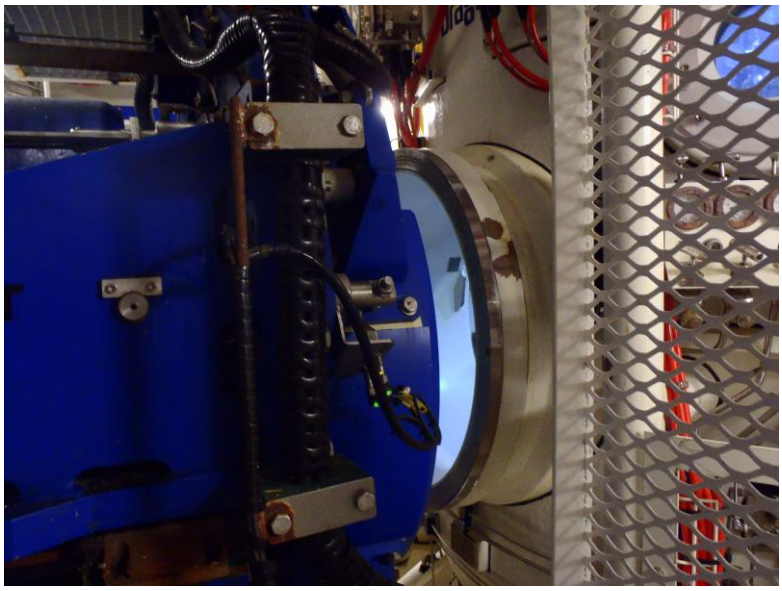

Figure 3: Connection between diving chamber and diving bell (Walters, 2012)

Once the pressure outside the diving bell is the same as the pressure inside the diving bell the bottom hatch can be opened and the divers enter the water. The divers are supplied with air from the surface, with a back-up air supply located in the diving bell (Figure 4). Once the dive is completed the divers are transferred to the saturation chambers at the surface. Here the divers can decompress (NOU 2003:28). Decompression means to return to the surface where the ambient pressure is one atmosphere at the end of a dive, or work period, from a given depth. As all gas pockets in the body will have the same pressure as the surroundings and therefore any pressure drop will result in the gas pockets expanding (NOU 2003:36). The time required to wash out surplus gas, the decompression time, depends on the depth and duration of the dive. However, after a certain length of time the body will become saturated with the gas being breathed, but the decompression time will not increase further (Jacobsen et al., 1984:13).

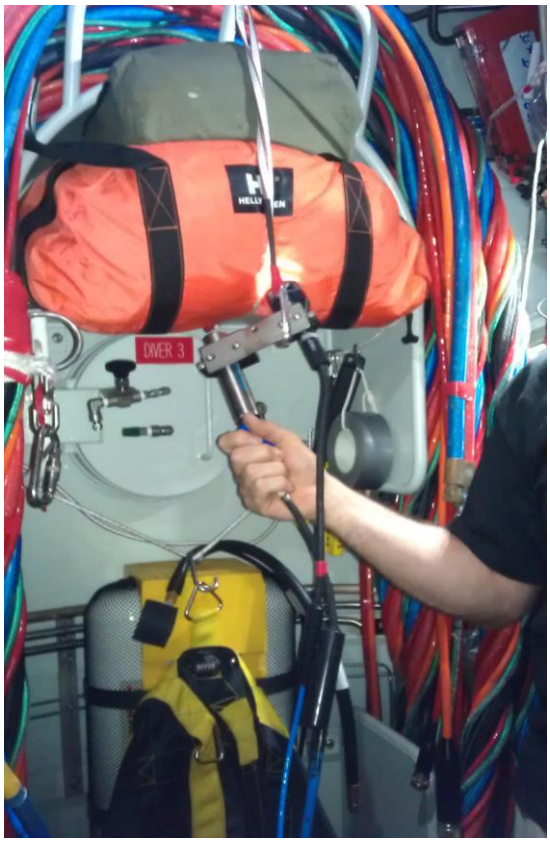

Figure 4: Diver´s seat inside diving bell with back-up air supply (Walters, 2012)

Bounce diving is usually carried out using a diving bell and decompression chamber at the surface. The dives are usually deep and relatively short in duration (NOU 2003:27).

1.2.2 Historic development of petroleum related diving on the NCS

When petroleum related diving started out in Norway in 1966 there were initially two types of diving being carried out. One was inshore, which was mainly related to the construction of platforms. The other was offshore in the North Sea, which was mainly related to exploration, pipe laying, trenching, field development and oil- and gas production. There were different types of diving methods being used including surface oriented diving, bounce diving, and saturation diving. In the 1970s diving bells were used and bounce- and saturation diving became the preferred diving methods due to the need for deeper dives, longer dives, and for reduced decompression time in the water in order to minimise the thermal strains on the diver. From the 1980s saturation diving became the main diving method with practically no bounce diving taking place. Practical knowledge regarding

deep diving was limited in Norway and so initially the main source of information came from foreign parties. The same applied to competence in diving medicine (NOU 2003:51).

Since the start of petroleum related diving on the NCS divers became overrepresented in the accident statistics, even after the oil industry as a whole experienced a significant improvement in safety. In the 1960s there did not exist any extensive training program for the coming offshore divers. Contracts were agreed based more on cost and speed of work rather than safety. Diving tables were used as a guideline for how quickly a diver could complete a job. Initially the diving tables of the US Navy were used, but later various diving companies developed their own, often secret, tables. Tables allowing for more diving time had a competitive advantage. The fast expansion of the industry resulted in young an inexperienced divers being sent to work without adequate training (Gjerde and Ryggvik 2009).

1.2.3 Pioneer divers – lack of regulations

Gjerde and Ryggvik (2009) state that the Norwegian authorities have been slow in establishing effective regulatory systems for the diving industry compared to other industries and professions. Immediately after World War II there were approximately 200-300 professional divers in Norway. No diving school existed and in practice anyone could undertake diving work (ibid).

Up until the 1950s the Navy´s diving regulations were used as a diving manual in Norway. The manual stated that a diver should be strong and a competent swimmer. Further it stated that if a diver became overweight he should be dismissed. In 1959 a royal Decree stated that divers should be between 21 and 40 years of age and have a certificate issued by the Labour Inspection Authority (LIA). However there were no requirements with regard to what knowledge a diver should have tin order to obtain such a certificate (ibid).

By 1960 the Navy had significantly improved the training of their divers. However, there did not exist any training for the new challenges the pioneer divers faced, nor had any significant medical research been carried out with regard to possible long-term health effects (ibid).

In 1967, safety regulations concerning oil operations in the North Sea were issued in the form of a royal Decree (Ryggvik & Smith-Solbakken 1997, as cited in Gjerde and Ryggvik 2009:126). However, diving was mentioned in only one paragraph:

> "The ministry or those it authorises, shall first be submitted for approval a plan for how diving shall be carried out, which equipment shall be used, including which safety measures will be implemented to protect the divers´ life and well-being. IF the person who shall carry out the diving is not in possession of a valid diving certificate, consent must be obtained from the ministry or those it authorises before diving can commence. Diving work shall be carried out in a proper manner and according to current regulations"
>
> (Statens Oljeråd, as cited in Gjerde and Ryggvik 2009:126, own translation)

Only five weeks later there was a fatal diving accident on Ocean Viking in 1967. After the accident a representative from the LIA recommended in a statement to the Ministry of Industry (MOI) that

> "for safety reasons the use of a diving bell when diving in open sea, from a standing point that is more than 3 metres above sea level, when the dive requires a decompression stop, should be imposed."
>
> (Smith-Sivertsen 1968, as cited in Gjerde and Ryggvik 2009:125, own translation)

After receiving this recommendation the MOI sent a letter to all oil companies working on the NCS where the recommendation was cited word for word and formulated as being mandatory (Dæhlin 1968, as cited in Gjerde and Ryggvik 2009:125). However, this provision was easy to work around, and no public inspections were carried out to ensure that the decision was complied with in practice. Up until 1971 there was hardly any follow-up of on-going diving activities by the authorities, and nothing was done to develop diving-specific safety regulations (Gjerde and Ryggvik 2009).

In March 1971, following one of two more diving accidents on Ocean Viking, the Directorate of Labour issued ten further provisions, mostly concerned with criteria that would indicate that a diver should not dive. However, the provisions did not indicate how one should ensure the sound health of divers, or who was responsible doing so. Subsequently to the two accidents on Ocean Viking in 1971, the WOI issued more strict

requirements with regard to who could issue health certificates for divers, and the MOI determined that no divers´ stay on the platforms should exceed one week, and was to be followed by one week´s leave onshore (Gjerde and Ryggvik 2009).

It was not until 1977, when the Work Environment Act (WEA) was implemented in Norway, that a decision was made that own diving regulations were to be developed. The WEA excluded floating rigs and supply vessels, and it was from these types of installations and special vessels that diving activities took place. It was decided that the Norwegian Petroleum Directorate (NPD) would take over the regulatory responsibility for diving and on the 1st of July 1978, twelve years since petroleum related diving started on the NCS, temporary diving regulations were implemented (Gjerde and Ryggvik 2009).

1.2.4 Long-term health effects

It is difficult to find one single report that states and verifies all possible long-term health effects associated with diving. With regard to many health effects there appears to be a lack of consensus. The state-designated commission of inquiry, who in 2002 concluded its investigation into the working conditions of pioneer divers in the North Sea, concluded that there did not exist reliable data with regard to whether or not diving can result in adverse neurological/cognitive long-term effects, or whether deep-diving that is carried out correctly can lead to long-lasting or permanent neurological and/or cognitive damages (NOU 2003:7). In 1998, after the Minister of Social Affairs offered all pioneer divers a medical assessment if it was suspected that there existed a diving-related illness or injury, Haukeland University Hospital (HUH) was requested to carry out a study to establish which type of diving injuries should qualify one for occupational injury compensation. The study, the findings of which were published in 2004, included lung-function examinations, neurological-, and neurophysiological examinations, hearing- and balance examinations, and neuropsychological examinations (HUH 2004:6). In addition, psychological stress reactions were assessed (HUH 2004:110). Although the HUH study concerned pioneer divers it will be used in this section to briefly present possible long-term effects of diving as identified by the results of the study.

Decompression illness (DCI)

With regard to the central nervous system it is especially decompression illness that can result in acute neurological defects with a risk of long-term effects. Diving causes decompression stress that can lead to the development of micro gas bubbles locally in tissue and in the venous blood circulation. Decompression illness is generally divided into two different types. Type I includes symptoms from the musculo-skeletal system, skin and lymph, where joint pain or skin bends is most common. Type II includes neurological, cardiovascular, audio-vestibular and/or respiratory symptoms (Francis and Mitchell, 2003 as cited in HUH 2004:51).

Reduced lung-function

The study showed that the frequency of symptoms for chronic obstructive pulmonary disease (COPD), in the form of chronic cough, breathlessness during physical exertion and wheezing in the chest, was higher amongst divers compared to the general Norwegian population (HUH 2004:48)

Neurophysiological effects

Neurological effects included self-perceived mental impairment, reduced capacity and energy, mental difficulties and neurological symptoms such as chronic pain. Neurological examinations of the divers exhibited signs of deterioration in the nervous system and the neurological symptoms were significantly higher amongst the divers compared to a control group (HUH 2004:69).

Reduced hearing and balance

As a group, the divers exhibited poorer hearing than expected based on their age. Results indicated hearing loss due to noise exposure, among other causes. Also, compared to a control group, the divers had poorer balance (HUH 2004:93).

Neuropsychological effects

The divers exhibited reduced attention, concentration, working memory, mental/psychomotor pace, and mental flexibility. They also exhibited more tremor and

mild to moderate impairment of tactile perception (HUH 2004:106).

Psychological stress reactions

The divers in the study exhibited significant mental health problems. Several had been exposed to traumatic diving-related events and exhibited mental stress reaction in relation to these. Also, several of the divers fulfilled the criteria for posttraumatic stress disorder (PTSD), commonly associated with increased suicidal tendencies (HUH 2004:116).

It should be noted the HUH study concerned pioneer divers that worked during a period of time when the regulation regime was considerably different from that of today. However, the long-term health effects outlined above appear to be relevant to those divers working today, and in fact, some of the divers working in the North Sea today were also active during the pioneer period.

Health related quality of life

In 2004, the Health and Safety Executive (HSE) released a similar research report in which the long-term health impact of diving was investigated (Macdiarmid et al. 2004). This study, which compared divers to a age matched Oil and Gas industry offshore workers, comprised of 1) an assessment of ”occupational history, general health complaints, diagnosed medical conditions and health related quality of life” through the use of a postal questionnaire survey; and 2) ”a detailed physiological and neuropsychological investigation (clinic study) of a sub-sample of the population who responded to the postal questionnaire survey” (Macdiarmid et al. 2004). Like the study carried out by HUH, this study also concerned pioneer divers. It was found that complaints of “forgetfulness or loss of concentration” was associated with significant impairment of health related quality of life. In the study by HUH (2004:6), a large proportion of the divers reported that they had a decreased quality of life and that health problems affected their ability to live a full life both in relation to their work and free time. Further, many reported that their health problems prevented their ability to socialize.

1.2.5 Previous research

There have been numerous studies carried out related to diving medicine. Already mentioned above are the two studies concerning the long-term health of pioneer divers (HUH 2005 and Macdiarmid et al. 2004). However, with regard to the safety barriers used in diving, specifically the non-physical safety barriers, there appears to be limited research published.

In 2010 the National Institute of Occupational Health (NIOH) published a report that presented the findings from an assessment of the annual health-screening questionnaire intended for saturation and air divers. The study was part of an agreement between the NIOH and PSA and concludes that the current health surveillance program, with the pre- and post-dive medical checks and the 3-yearly medical examination, "suggests that divers are well taken care of" (Skogstad et al. 2010:4). Further the report states the annual certificate controls are additional safety factors and that the annual health-screening questionnaire is not pertinent (ibid).

2 An organisational view on diving safety

This chapter will present theoretical contributions that will be used to evaluate and understand how diving risks are managed, and to assess how good the existing safety barriers are. Some of the terminology used in the following chapters, and not already covered in the introduction, will also be defined here.

Risks associated with diving are managed by organisations, be it regulators, diving entrepreneurs, or operators. As such, one possible way to assess how good the safety barriers are, with regard to preventing or reducing long-term health risks to divers, is to view the occurrence of long-term health effects as organisational accidents or failures. Much of modern theory regarding organisational accidents is centred on the fact that the cause of failure is often organisational rather than due to human error alone. One example of this type of thinking comes from James Reason (1997). Some of Reason´s theories will be presented in section *2.1 Organisational accidents.* Specifically applicable to this study is Reason´s "Swiss cheese" model, which will be used to illustrate safety barriers in relation to diving.

Section *2.2 Risk governance* will briefly present the concept of risk governance and the framework model for risk governance developed by the International Risk Governance Council (IRGC). In relation to this study, due in part to the limited scope of the study as well as time restrictions, only a few elements from the model have been selected as a theoretical framework to help analyse and understand how health related diving risks are managed. These include *concern assessment*; including *risk perceptions, social concerns,* and *socio-economic impacts*; and *communication.*

2.1 Organisational accidents

James Reason´s (1997) book "Managing the risks of organizational accidents" discusses causes of major accidents in high technology systems. This study will use some of the principles presented by Reason when examining the way in which the risks to divers are managed, in particular long-term health risks. In the context of this study risk is defined as the combination of uncertainty and consequence/outcome of a given activity (Aven et.al. 2004:37).

Between hazards and potential losses, lies protection, consisting of layers of safety barriers. Reason´s (1997:9) ”Swiss cheese” model of defences is a good illustration of how an accident trajectory passes through successive layers of safety barriers through *holes* caused by *active failures* or *latent conditions* (Figure 5).

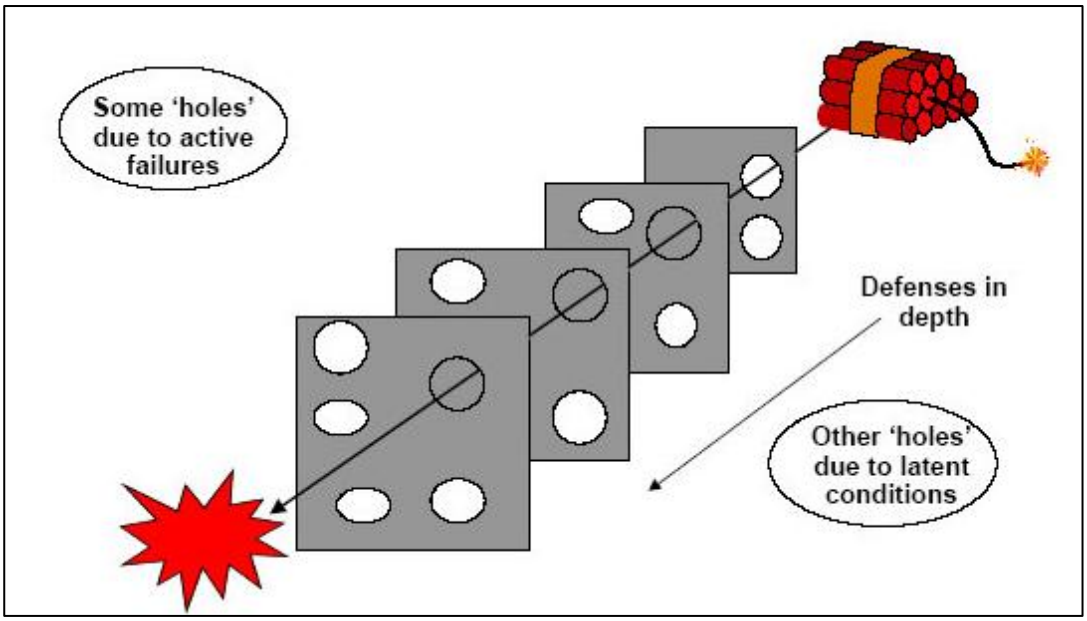

Figure 5: Reason´s (1997) Swiss cheese model

Reason (1997:7) states

> ”All defences are designed to have one or more of the following functions: to create understanding and awareness of the local hazards; to give clear guidance on how to operate safely; to provide alarms and warnings when danger is imminent; to restore the system to a safe state in an off-normal situation; to interpose safety barriers between the hazards and the potential losses; to contain and eliminate the hazards should they escape this barrier; to provide the means of escape and rescue should hazard containment fail”

As mentioned in section *1.1 Objective*, any safety measures put in place by divers, diving entrepreneurs, operators and regulators to prevent or reduce long-term health risks to divers will be defined as safety barriers.

Reason (1997:8) introduces the terms *hard* and *soft* defences. *Hard* defences include technical devices, physical barriers, alarms, and personal protective equipment. *Soft* defences include legislation, regulatory surveillance, procedures, licencing, training, and

front-line operators. In relation to diving this study will encompass *soft* defences including, but not limited to, laws and regulations related to diving and diver safety, any internal procedures that actors in the industry may have implemented, or any training or certificates required by divers. There can be no doubt that *hard defences* play a key role in protecting divers´ health, be it short- or long-term. However, it is the *soft defences* presented in section *1.1 Objective* that are currently high on the agenda in the diving industry and that will be focused on in this study.

Reason (1997:10) also introduces the terms *active failures* and *latent conditions*, which refer to the human contribution to organisational accidents. *Active failures* are unsafe acts committed by front-end operators such as for example pilots or maintenance personnel, whilst latent conditions are the reasons behind these unsafe acts. Unsafe acts can be seen as a consequence rather than a cause, a consequence of *latent conditions* (ibid:10). Whilst *front-end operators commit active failures*, *latent conditions* may originate from the upper levels of an organisation "and within related manufacturing, contracting, regulatory and governmental agencies" (ibid:11). In relation to diving, *active failures* could be related to for example maintenance of diving equipment such as the diving bell and umbilical, or the operation of such equipment. It will be argued later that the divers themselves can in fact commit active failures. *Latent conditions* could be related to for example decisions made by the management level in organisations such as the diving entrepreneurs, operators, regulators and even unions. The subject of whether there exists *active failures* and/or *latent conditions* as far as the long-term health risks to divers is concerned, will be revisited in chapter *5 Discussion*, after findings have been presented in chapter *4 Results.*

2.2 Risk governance

The IRGC (2005:22) state that risk governance "includes the totality of actors, rules, conventions, processes and mechanisms and is concerned with how relevant risk information is collected, analysed and communicated, and how management decisions are taken".

Neye and Donahue (2000) explain that on a national scale "governance describes structures and processes for collective decision making involving governmental and non-governmental actors" (as cited in Aven and Renn 2010:49).

The IRGC (2006:22) have developed a risk governance framework ”to help understand, analyse and manage important risk issues”.

Aven and Renn (2010:53) state that the three traditional categories of ”risk assessment, management and communication are not sufficient to analyse and improve the risk governance processes” and so the IRGCs framework (Figure 6) also includes a socio-cultural contexts as well as a risk categorisation component.

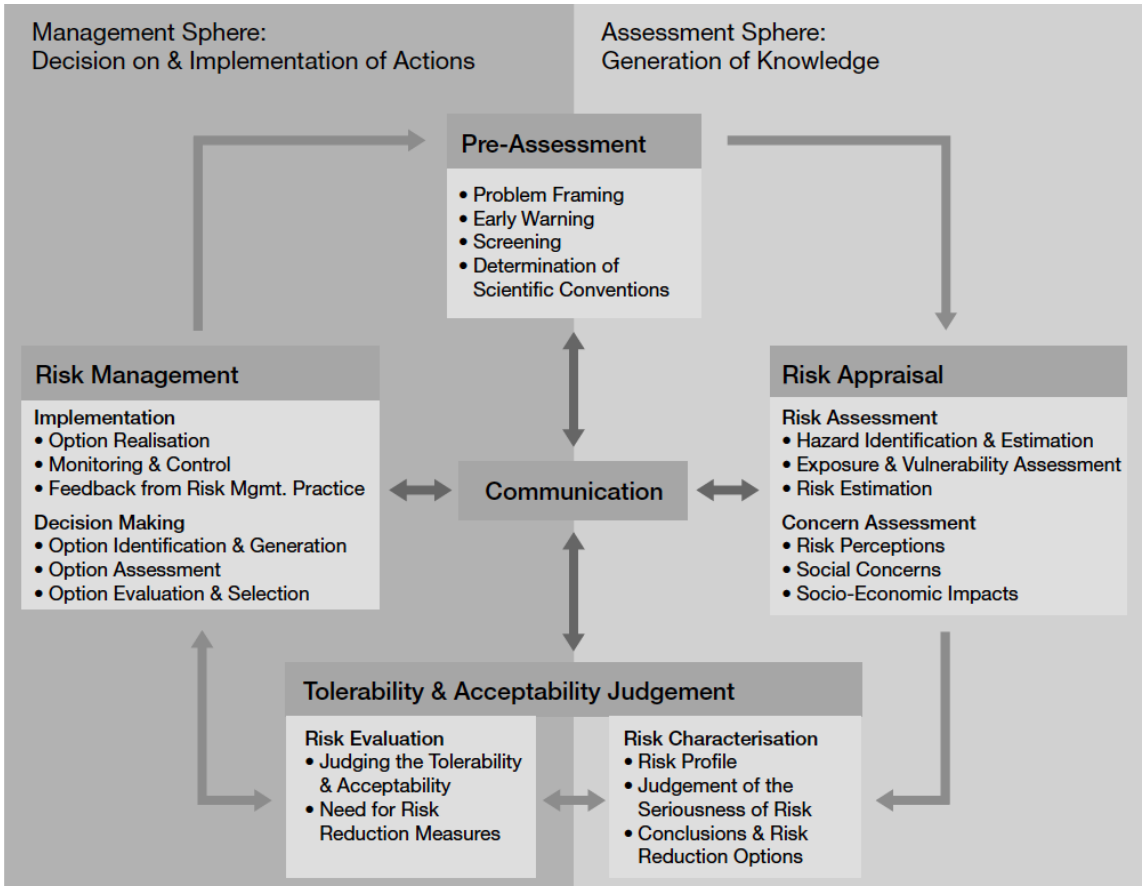

Figure 6: IRGC risk governance framework (Aven and Renn 2010:57)

Concern assessment

The history of the diving industry, with all its´ lack of regulation, injuries, fatalities and loss of quality of life for many divers, may not differ significantly from other groups in the offshore petroleum industry. Indeed, Smith-Solbakken (1997:119) investigated the workplace culture in the offshore oil industry from the 1960s to the 1980s and states that the labour culture in the early days of the offshore was grounded in American drilling culture where the mentality was to keep working until the job was done, no matter what the

cost. As with divers, the oil workers also operated with little or no regulations to protect them (ibid:167). However, all the media attention the diving industry has received during the last few years, suggests that *concern assessment* should be included in the governance of diving risks, especially related to long-term health effects, be they physical or psychological.

Social concerns

Aven and Renn (2010:93) state there exist many different classification schemes for socio-economic concerns and present a list with various categories of impacts developed by Vanclay (2002). These categories include "Indicative Health and Social Well-being Impacts" and "Indicative Family and Community Impacts". When seen in relation to what is known about diving today, these two categories appear to be very relevant. Potential negative health effects of diving affects not only the divers themselves, but also their families and friends. In the study of pioneer-divers´ health status conducted by HUH (2004:6), a large proportion of the divers reported that they had a decreased quality of life and that health problems affected their ability to live a full life both in relation to their work and free time. Further, many reported that their health problems prevented their ability to socialise.

Risk communication and risk perception

Aven and Renn (2010:159) state "good practices in risk communication are meant to help all affected parties to make informed choices about matters of concern to them". When dealing with uncertain or ambiguous risk problems, which are certainly how long-term health risks to divers can be described, it is important to consider data not only on physical consequences, but also data on secondary impacts (ibid:94). This can include social impacts and insights into risk perception (ibid). People´s perception of risk is subjective and related to how information concerning a risk source is communicated. Further, Aven and Renn (2010:159) state "risks pertaining to complex health threats (…) are difficult to communicate because they are usually effective only over a longer time period". Research on accident risk judgements among offshore workers has found that level of safety culture significantly influence the outcome (Adie et al. 2005:144). Divers have been found to

place less importance on good safety culture in reducing accident risk (ibid). Aven and Renn (2010:163) list "addressing different subcultures in society" as a major problem of risk communication and state that characterising the audience according to cultural beliefs is of great assistance. Divers´ risk perception may affect their willingness to undergo medical examination as well as the way they work, something that will be discussed further in chapter *5 Discussion.*

3 Research method

In order to answer the research question presented in section *1.1 Objective*, primary data was collected and analysed in light of relevant theory presented in chapter *2* Theory. This chapter will present information regarding research design, selection criteria, data collection method, method for analysis, and validity and reliability.

3.1 Research design

The research design was to a certain extent based on Blaikie´s (2009) core elements of a social research design. Figure 7 below illustrates how the research design incorporated Blaikie´s core elements, albeit it a simplified version.

Upon determining the research topic for this study a literature search was carried out in order to find previous research related to the same topic. Databases used for the literature search were *Scopus, Academic Search Elite* and *ScienceDirect.* Key words used included "diving", "health", "long-term", "barrier", "offshore", and "saturation". The searches yielded limited results for research in the same topic area, but some relevant sources were found within diving medicine, offshore safety culture, and barrier categorisations. These have been used throughout this thesis to support context and findings.

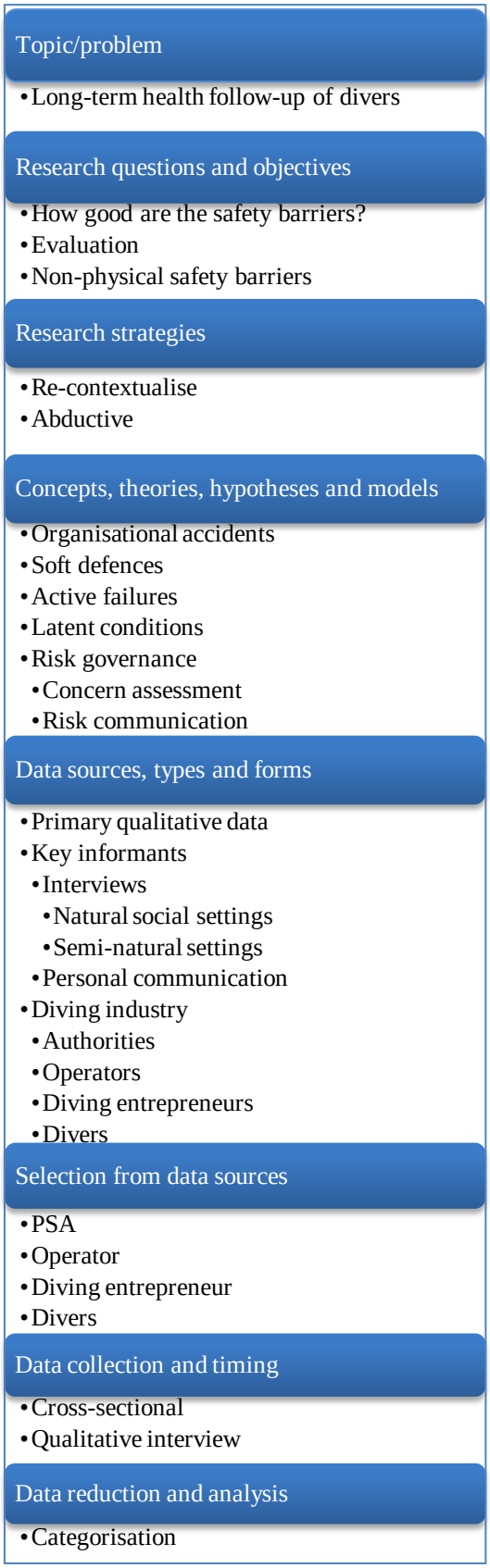

Figure 7: Research design, adapted from Blaikie (2009)

3.2 Selection criteria

In order to assess the effectiveness of the safety barriers listed in section *1.1 Objective* it was necessary to interview key persons from the industry (Appendix A). The interview candidates fell under the category *informants,* who, according to Jacobsen (2005:171) have good knowledge of the phenomenon being studied. The goal was to find out to what degree the said safety barriers are implemented and complied with, as well as identify any associated challenges.

The PSA is "the regulatory authority for technical and operational safety, including emergency preparedness, and for the working environment" (www.ptil.no), and so it seemed prudent to interview a representative from there. A representative from a group within the organisation that has in-depth knowledge about the subject area was available to be interviewed.

DE1 is a subsea entrepreneur that employs divers both in permanent and contract positions Key informants within the organisation´s health department and diving management department were identified and approached. One representative from each of these departments agreed to participate in interviews.

Interviews with divers were essential in order to ascertain how the safety barriers functioned in practice, and further to use this information in assessing their effectiveness. Contact information for divers registered in DE1´s database is restricted to specific personnel. The relevant employee was contacted with a request to send out emails on behalf of the author, requesting divers to participate in interviews (Appendix B). Divers who wished to participate responded to the author by email. The divers selected to participate had to meet all of the following criteria:

- Carried out diving work for DE1
- Carried out diving work post 2009
- Carried out diving work on the NCS

Selecting divers who had worked on the NCS post 2009 was based on the fact that the annual health-screening questionnaire was implemented in 2009. In total, eight divers were interviewed.

Relevant information was also obtained through personal communications with an approved diving doctor (approved by HA), as well as a representative from two of the largest operators on the NCS (hereinafter referred to as Operator 1 and Operator 2).

3.3 Data collection

Qualitative interviews with informants allow the researcher to "get close to the social actors´ meanings and interpretations, to their accounts of the social interaction in which they have been involved" (Blaikie 2009:207).

Some of the interviews were carried out in a specific order and interview questions were often based on information obtained in the preceding interview. The interviews were all individual, open interviews, which according to Jacobsen (2005:142) are best suited when relatively few units are being studied and when one is interested in what each individual says. After having identified and approached interview candidates, interviews were first held with key-informants from DE1 in order to ascertain to what extent they complied with the laws and regulations previously identified, as well as any major challenges they might be experiencing. The information obtained from these was followed up in interviews with key informants from the PSA. After having obtained information from the PSA and DE1, the divers were interviewed. Having identified specific challenges that related directly to the divers in the previous interviews, some of the questions posed to the divers were a direct result of this. Eight divers were interviewed, three of whom were employed, and five who were self-employed. The average age of the divers was 45 and the average number of years working as offshore saturation divers was 19 years.

The divers were interviewed regarding their participation, or non-participation, in the voluntary 3-yearly medical examination and the annual health-screening questionnaire. Reasons for participation or non-participation were also discussed, as well as their thoughts regarding the effectiveness, or usefulness, of existing barriers.

All interviews were prepared with Kvale´s (2009:26) "ethical questions at the start of an interview study" in mind. Having learned in the early stages of the research design that divers are often reluctant to participate in studies or surveys it was of significant importance that all communication was thought through and planned carefully. During the initial communication with divers that were potential interview candidates, the purpose of

the study was made very clear as well as the fact that anonymity was an option available to them. In being very open with the divers about the purpose of the study and informing them of the anonymity option it was hoped that the reliability of the information obtained would be strengthened. This is discussed further below in owa *3.6 Validity and reliability*.

All interviews, both of divers and other key informants from the industry, were of a semi-structured nature in line with Jacobsen´s (2005) definition of an open interview. That is to say, an interview guide was prepared beforehand with a few main questions, but follow-up questions were added ad hoc during the interview process. The interview guide was made available to those who wished it beforehand (Appendix C).

With regard to the diving doctor and the operators, information was not obtained via interviews, but rather through personal communication either via telephone, email, or both.

All interview candidates that participated in this study gave informed consent. Information regarding the background, design and intent of the study was given to the interviewees either verbally or via email prior to the interviews. Interviews were transcribed in their entirety and deleted upon completion of the thesis. Any requests for anonymity were respected.

3.4 Data analysis

Data was, as mentioned, obtained through interviews with informants as well as through personal communications to a small degree. The next step was to structure and simplify in order to get an overview of the findings. By compiling different interviews one can point out patterns or underlying causes (Jacobsen 2005:185). The purpose of a qualitative analysis is to point out the core details that can provide new insight into a situation or phenomena (ibid).

The data analysis phase followed the steps presented by Jacobsen (2005) as far as was possible. The first step was to *describe*. Most of the interviews were recorded, and for those that were not, extensive notes had been taken. The recorded interviews were transcribed in their entirety into electronic documents, as were those that were recorded by hand. The second step involved *systemising* and *categorising* the data (figure 8). The data was first categorised according to which safety barrier it related to, i.e. offshore health

certificate, health certificate for offshore divers, pre- and post-dive medical checks, 3-yearly medical examination, annual health screening questionnaire, and exposure assessment. This was followed by second level categories according interviewees, i.e. the authorities, the operator, the diving entrepreneur, and the divers.

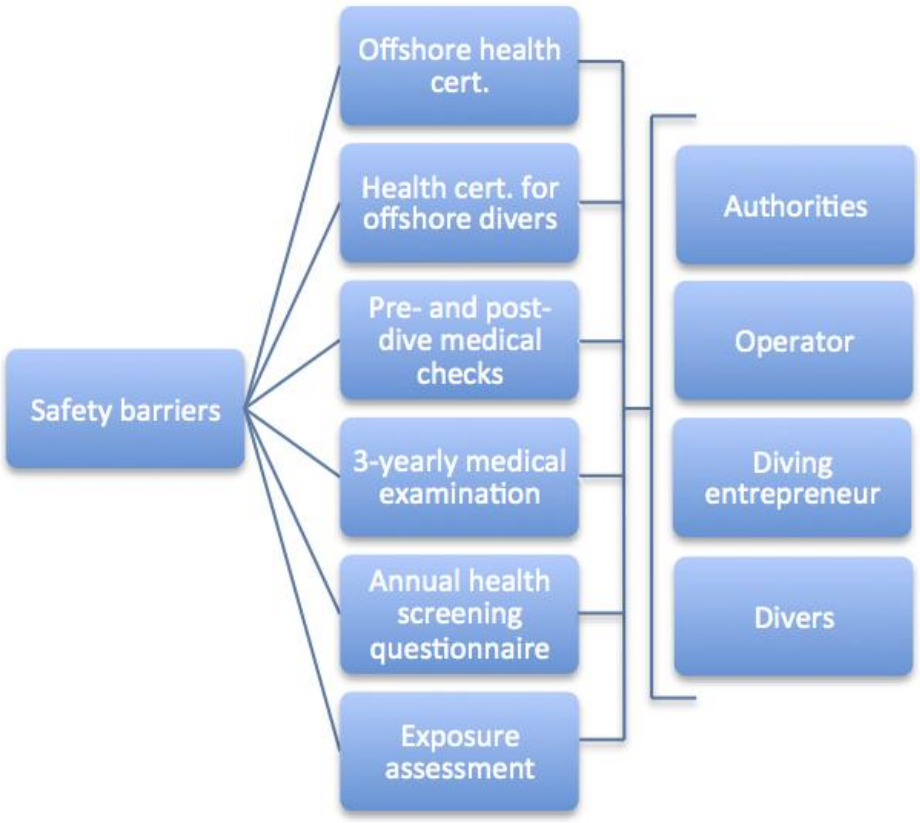

Figure 8: Systemisation and categorisation of data

Organising the data in this manner aided the process of identifying recurring themes, for example challenges with a particular safety barrier, and also identifying the various points of view on specific safety barriers. This was essential in order to make a qualitative assessment regarding the effectiveness of the safety barriers. As a third step these findings were then discussed using relevant theories and previous research as reference points.

3.5 Validity and reliability

As pointed out by Jacobsen (2005) the challenge with a qualitative approach is that it is resource-intensive. Interviews can be very time consuming, especially with regard to transcription and administration. Jacobsen (2005) explains that open individual interviews

are best suited when a) relatively few units are studied; b) when individual statements are of interest; c) and when individual´s interpretation of a certain phenomenon is of interest. One dilemma in this study was the choice between a closed interview with set answer alternatives in a set order, or even a questionnaire, versus an open interview where one can pose follow-up questions and really dig to get information. The latter type of interview, which was used in this study can give a wealth of information and can really get at the individual´s attitudes and perceptions, which was deemed very important with regard to the divers especially, and in order to address my main research question. However, the number of interviews that can be carried out becomes limited due to time restrictions, and with few respondents the validity of the results can come into question. Part of the challenge and reason for choosing open individual interviews was 1) sourcing divers that had worked on the NCS and/or the BCS since 2009, which is when the annual medical screening questionnaire was implemented in the industry; and 2) getting divers to participate in interviews. Jacobsen (2005:216)) states that one method of validating is to critically go through sources and information from sources. Here the purpose is to 1) assess whether the *correct* informants have been interviewed, and whether they have conveyed *truthful* information; and 2) to critically evaluate whether the categorisation in the analysis (discussion) phase reflects the data obtained and whether the context and explanations given reflect reality. The study was submitted to a health and safety advisor from DE1 with in depth knowledge about diving activities and diving health. This person's contribution was to test the validity of the findings in this study, and critical assessment according to Jacobsen´s method mentioned above.

The reliability of a qualitative study can be affected by interview technique. Jacobsen (2005:225-226) states that the researcher affects interviewees at the same time as the researcher is affected by the relationships that occur during the data collection phase. The person being interviewed is affected for example by the researcher´s body language, clothing, or the way he or she talks (ibid). The interview context can also affect the results. For example whether the location of the interview is artificial or natural can play an important part. The key concern with regard to obtaining reliable data in this study was in connection with the divers. As mentioned in section *3.3 Data collection,* communication with the divers was open and they were made fully aware that they could remain anonymous should they wish. This was emphasized in order that the information they gave should be truthful. Also, due to the geographical location of some of the divers, it was not

possible to interview all of them in person. In these cases interviews were conducted via telephone at a date and time that suited the divers. This allowed the divers to be in their natural settings, unaffected by many of the factors that may have played an adverse part had the interviews been conducted in person, what Jacobsen (2005:226) refers to an interviewer-effect. On the other hand, the divers who were interviewed in person may have been affected both by the interviewer and the settings, as these divers were interviewed in an office. That is to say they were interviewed in an unnatural setting. One diver was interviewed whilst inside a saturation chamber on board a DSV. The saturation chamber is under constant monitoring of diving support personnel and so it is not unlikely that this may have affected the diver´s willingness to speak freely when answering the interview questions.

4 Results

This chapter will present the main findings from the study. First, each barrier will be presented along with a short description of the regulatory framework and/or standard where applicable. Second, data obtained from primary sources, i.e. interviews with informants, is presented along with data obtained from secondary sources where relevant.

4.1 Safety barriers

4.1.1 Offshore health certificate

All potential offshore divers must undergo a health check before being allowed to commence diver training. Further, a yearly health check must be undertaken to confirm that the divers health is satisfactory.

Requirement	Regulation/standard	Reference
Offshore health certificate (valid for 2-year period)	FOR 2010-12-20 nr 1780: Health requirements for person working on offshore installations in the petroleum industry (regulations) (own translation)	www.lovdata.no (a)

Although not directly related to diving this regulation applies to anyone working on offshore installations. The regulations outlined health criteria that must be fulfilled in order to obtain a valid offshore health certificate. § 11 lists specific health requirements, and § 12 states that for persons who are to work under increased atmospheric pressure the health requirements outlined by the Directorate Of Health (DOH) also apply. Should a diver fail the required health criteria required to work on offshore installations it would naturally follow that the diver may not carry out offshore diving activities. The informants interviewed had no specific comments regarding the effectiveness of this barrier. However, the diving doctor (informant 13) states that the medical check required for the offshore health certificate is not designed to uncover long-term health effects from diving and as such is not an effective barrier for this.

4.1.2 Health certificate for offshore divers

Requirement	Regulation/standard	Reference
Health certificate for offshore divers	FOR 2010-12-20 nr 1780: Health requirements for person working on offshore installations in the petroleum industry (regulation) (own translation) § 11, § 12	www.lovdata.no (a)
	NORSOK U-100 §5.1.3	Standards Norway, 2009

The health certificate for offshore divers is pursuant to the same regulation as the offshore health certificate. The NORSOK U-100 is a standard that was developed by the Norwegian petroleum industry. Its purpose is to ensure an adequate level of safety, value adding and cost effectiveness for developments and operations in the industry. The standard states that divers must hold medical certificates as required by national regulations (Standards Norway, 2009).

Findings from informants were as follows:

Divers

Informant 5 (2012) states the medical examination is not particularly testing and is "easy to get through". Informant 11 states the medical examination is not very in-depth and that it used to be better some years ago when the examination included x-rays and electrocardiography (ECG). The informant further states that private healthcare offers a more thorough medical examination.

Informant 9 states "it is quite thorough and because you know you´ve got it each year you have to keep a level of fitness up so you can pass that medical". However, informant 9 states further that the quality, or thoroughness, of these medicals varies with different doctors.

Informant 10 states the HSE diving medicals are very good with regard to monitoring, particularly if the same doctor is used over a number of years. However, informant 10 also states that there is certain conditions a diver can hide from a medical examiner so as to not loose their health certificate.

4.1.3 Pre- and post dive medical checks

Requirement	Regulation/standard	Reference
Pre- and post-dive medical checks	LOV-2005-06-17-62 Work Environment Act § 3-1, § 10-11	www.lovdata.no (c)
	FOR-2010-04-29-613 Activities regulations § 6	www.lovdata.no (b)
	NORSOK U-100 § 5.1.4	Standards Norway, 2009

The requirement for pre- and post-dive medical checks is pursuant to the WEA § 3-1, which concerns the systematic HSE work and specifically states that employers shall survey hazards and problems, consider the risk factors within the organisation, and take measures to reduce risk. It is also stated that the employer shall ensure continued monitoring of the working environment and the health of employees when the risk factors warrants it. Further, § 10-11 in the WEA states that employers who mainly work at night shall be offered a health check before commencement and on a regular basis thereafter. The requirement is also pursuant to the Activities regulations § 6, which concerns monitoring of employees´ health. These regulations state that employers shall ensure employees are offered a health check before they commence work that may involve special health risks so that preventative measures can be taken. It is also stated that employers exposed to hazardous work environment shall be offered a health check if they are still employed so that any potential corrective measure may be taken. In addition, the requirement is in compliance with NORSOK U-100 § 5.1.4. This paragraph, concerning short and long-term health monitoring, states “pre- and post-dive medical checks, in accordance with procedures approved by the responsible diving doctor, shall be conducted routinely for all divers” (Standards Norway, 2009:17).

Findings from informants were as follows:

Divers

Informant 9 states the pre- and post-dive medical checks only check the minimum requirements for being able to dive, and does not believe these barriers do anything with regard to long-term health.

Contrary to this, informant 8 states

> "Certainly the pre-dive is fine because if there was a problem and the medic had picked that up and stopped you from going to sat then that´s an obvious barrier. (…) If there was something wrong on the post dive one, or marginally wrong, it wouldn´t preclude you from going home and self-medicating or going to a doctor yourself. So long as you pass the pre one for the next job then everything is back in place."

4.1.4 3-yearly medical examination

Voluntary (for diver)	**Regulation/standard**	**Reference**
3-yearly medical examination	LOV-2005-06-17-62 Work Environment Act § 3-1, § 10-11	www.lovdata.no (c)
	FOR-2010-04-29-613 Activities regulations § 6	www.lovdata.no (b)
	NORSOK U-100 § 5.1.4	Standards Norway, 2009

The WEA § 3-1 and § 10-11, and the Activities regulations § 6 both apply and are detailed under the pre- and post-dive medical checks above. Further, § 6 in the Activities regulations states that employers shall ensure that employees are offered regular health checks to uncover long-term effects of work environment factors. NORSOK U-100 § 5.1.4 specifies that "special attention shall be paid to long-term health monitoring of organ systems known to be affected by diving" (Standards Norway, 2009:17) and goes on to specify which organ system shall be monitored as a minimum.

Findings from informants were as follows:

PSA

The 3-yearly medical examination is offered to divers, but participation is voluntary. Informant 3 from the PSA states that although there exists a legal requirement to offer regular health checks pursuant to the regulations mentioned, the method employed is up to the employer.

Operators

Operator 1 has put forward a requirement to DE1 in relation to manned underwater operations (MUO) stating that they "will only accept divers participating in the established long-term health monitoring system" and that "results and trends from the long-term health monitoring system shall actively be used to prevent work related illnesses and injuries". Informant 15 from Operator 1 states the motivation for putting forth such a requirement is related to the fact that it is challenging for an operator to carry out long-term health follow up of divers over a long period of time due to the participation being voluntary and that many divers are not permanently employed. The contractual requirement incorporates both the 3-yearly medical examination and the annual health-screening certificate (presented in the next section). Operator 1 believes long-term health follow up is a positive safety factor for each individual diver (informant 15).

Operator 2 holds a frame contract with diving entrepreneur 2 (hereinafter referred to as DE2) for offshore diving services on the NCS. The contract includes statement of employment according to the WEA for diving personnel. It also requires that DE2 shall employ a sufficient amount of divers and surface personnel as a part of the company's contingency for pipeline repair (informant 12).

Diving entrepreneur

Informant 2 from DE1, states that the 3-yearly medical examination is offered to divers pursuant to the WEA. By offering a 3-yearly medical examination, the company is in compliance with NORSOK U-100 in addition to the regulatory requirements. Paragraph

5.1.4 of the standard states "examinations shall be repeated at regular interval not exceeding three years" (Standards Norway, 2009:17).

To date approximately 300 divers have participated in the 3-yearly medical examination, and some of these have been followed up for as long as 15 years. That is to say that some divers have participated in five 3-yearly medical examinations (Informant 2).

Divers

Of the eight divers interviewed, four had not participated.

Reasons for non-participation:

- Suspicion (informant 4)
- Not aware (informant 5)
- Not been offered (informant 9 and 11)

Based on the information from the divers reasons for non-participation was due to suspicion, not being aware of the program, and not having been invited to participate. According to the diving doctor used by DE1, these 3-yearly medicals occur on quite an ad hoc basis. That is, when the diving doctor receives a request from DE1 to carry out these medicals, he will either perform them himself or enlist one of his colleagues to do so. However, sometimes the requests are submitted with little notice and may not be carried out. Most of the 3-yearly medicals performed by the diving doctor and his colleagues to date have been in connection with mobilisations in Norway, and most often the medicals are conducted on board the vessel or at a location near by (Informant 13).

Informant 8 states that "there will be a lot of guys that will want to hide information" as a reason for divers not wanting to participate in voluntary monitoring programs. This statement is supported by informant 4 who states:

> "…the suspicion of health check-ups is that we´re self-employed (…) volunteering to do a health check-up can be beneficial for you, but it can be financially costly because if something does come up (…) your medical is taken away from you, and you´re out of work (…) people try to guard their medical very carefully (…) it has

been known for guys not to say certain things because they know that if they say that could be their medical gone for 6 months or permanently"

Reasons for participation:

- Proactive long-term health research is a good thing and worth participating in (informant 5)
- Long-term research has led to better understanding of long-term pressurisation effects (informant 6)
- Giving back the industry for the benefit of new divers (informant 8)
- Told to participate, no choice given (informant 10)

Informant 10 states that although he had participated in 3-yearly medicals whilst on board vessels in Norway, at the time there had not seemed to be a choice in the matter. The divers were simply told to go and see the Norwegian medic who came on board. He and others were of the impression that this was something they *had* to do. Informant 10 consequently received letters after the medical examination informing that the program was in fact voluntary, but states "…like a lot of these things, we´ve been told to get involved without much choice, we´ve just been told to go and do it".

4.1.5 Annual health screening (questionnaire)

Voluntary (for diver)	**Regulation/standard**	**Reference**
Annual health screening (questionnaire)	LOV-2005-06-17-62 Work Environment Act § 3-1, § 10-11	www.lovdata.no (c)
	FOR-2010-04-29-613 Activities regulations § 6	www.lovdata.no (b)
	NORSOK U-100 § 5.1.4	Standards Norway, 2009

The annual health-screening questionnaire is an additional method used to comply with the same regulations and standard as for the 3-yearly medical examination. Again, participation is optional.

Informant 2 states that the annual health-screening questionnaire for divers was implemented in diving entrepreneur 3 (hereinafter referred to as DE3) and diving entrepreneur 4 (hereinafter referred to as DE4) (pre merger in 2010, when the two companies became DE1) in 2009. The questionnaire is designed in a manner that the data collected can be split in two parts, one part containing the name and birth date of the diver, available only to the company health personnel, and a second part containing an individual diver reference number (Appendix D). The intended use of the latter is to be able to look for any trends that may warrant action on behalf of the divers as a whole, whilst the first part, containing the divers personal details, allows for individuals to be followed up as required with regard to any health risks (Informant 1).

Findings from informants were as follows:

PSA

Informant 3 states the process was initiated by NOPEF (previously Norwegian Oil and Petrochemical Union, later merged with Chemical Union and now known as Industri Energi) in 2002 and was originally geared towards employment terms. Permanent employment was the main goal, but the process led to other positive things. Informant 3 further states that the participation rate in the annual health-screening questionnaire is low due to distrust, which is in line with the attitude of the unions. The divers fear for their own job security and it is beneath them to participate until they can see some benefits to themselves in doing so. Informant 3 also states that, in his subjective opinion, the divers will avoid participation until it is no longer possible to do so. The divers think the information given in the questionnaires can be used against them and at the same time they are not interested in permanent employment. They don´t want to know until it is too late.

Diving entrepreneur

The questionnaire is sent out to divers every year and is the company´s way of maintaining long-term health follow-up including the 3-yearly medical examination (Informant 2).

Both informant 1 and 2 state that there is a low response rate to the questionnaires. In 2009 and 2010 DE3 obtained a response rate of 10% and 10.4% respectively. No questionnaires

were sent out in 2011. In 2010 and 2010 DE4 obtained a response rate of 23% and 11.6% respectively. No questionnaire was sent out in 2009 (ibid) Further, they attribute low response rate partly to trade unions, specifically SAFE and RMT, as well as sceptical divers. The RMT and divers are afraid that employers will use the information against them (informant 2). Informant 1 states the trade union SAFE is opposed to the health follow-up program. SAFE do not want their members to participate as they are of the opinion that such a program must be completely anonymous as they believe the information provided will be abused. Informant 1 argues that if the program were to be completely anonymous one would only be able to look for general trends and not be able to provide the individual follow-up that each individual diver is entitled to. Further, Informant 1 states the alternative is to offer each offshore employee, as SAFE represent not only divers, individual sessions with a doctor, something that would be extremely costly. Informant 1 also attributes the low response rate partly to the fact that divers are particularly "closed off" outside of work.

> "They spend up to 3 weeks in saturation, living and dealing almost only with 2 colleagues in saturation with them. When they exit saturation they want nothing to do with work and are hard to reach and communicate with on work matters."

(Informant 1)

Informant 2 states the system is voluntary, based on legislation, comes before any demands made by contractors, and that it is not possible to force divers to participate. Further, Informant 2 states demanding participation would not help and would only make it more difficult to get the right people for the job.

> "Divers will oppose if participation becomes a forced requirement rather than voluntary. With regard to the Operator 1´s contractual demand, we require 60 hyperbaric welders over the next three years. Three vessels will be working simultaneously and the welders are critical personnel that are difficult to find. We will train them and recommend that they participate in the yearly follow-up program. In fact, their employment contracts will require that they participate in the program. This is a bit on the "edge" according to the legislation and NORSOK U-100 §5.1.4".

(Informant 2)

Divers

Of the eight divers interviewed, four had not participated. Out of these four, only one had not participated in the 3-yearly medical examination. All divers, whether they had participated in the annual health screening questionnaire or not, were asked to comment on the low response rate.

Reasons for non-participation:

- Suspicion (informant 4 and 11)
- Apathy (informant 8)
- Not received questionnaire (informant 8 and 10)

> "[Suspicion] It is a strong word, but I have worked in the industry at times when people have not been open or friendly and we have been treated like shit. There is an ingrained suspicion, although probably unfounded now (…) if you´ve not given any information then it can´t be used against you"
>
> (Informant 4)

> "…are they trying to find something, and 20 years down the line, when you do put in a claim, they can turn around and show you that questionnaire that you filled out 20 years previous and they can use that against you?"
>
> (Informant 11)

4.1.6 Exposure assessment

Requirement	**Regulation/standard**	**Reference**
Exposure assessment	LOV-2005-06-17-62 Work Environment Act § 3-1	www.lovdata.no (c)
	FOR-2010-04-29-613 Activities regulations § 41	www.lovdata.no (b)
	NORSOK U-100 § 5.1.4	Standards Norway, 2009

The requirement for exposure assessment is pursuant to the WEA § 3-1 concerning surveying of hazards and problems, considering the risk factors within the organisation, and taking measures to reduce risk. The requirement is also pursuant to the Activities regulations § 41, which concerns risk information when performing work tasks. It states that it shall be ensured employees are given information about health risks and accident risks in relation to the work tasks that are to be performed. Further, it is stated "the results of assessments, analyses, measurements, surveys of causes for work related illnesses, accident investigations and events leading to accidents, and the significance of these results in relation to work tasks, shall be made available" (own translation). The requirement is also in compliance with NORSOK U-100 § 5.1.4, which states:

> "When following up the individual diver's health, diving exposure data is an important parameter. The contractor shall therefore maintain a system to collect and store such data in a manner enhancing a prompt retrieval of each individual diver's exposure data. The contractor shall further contractually require that the individual diver make available to the health service (in the form of a self-declaration) all diving exposure data, including data from diving taking place outside the confines of employment/appointment with the contractor."

Findings from informants were as follows:

Diving entrepreneur

In light of NORSOK-U100 § 5.1.4, the PSA wanted a firmer regime for the health follow-up of divers, a regime that included diving exposure data. DE3 has had such an exposure database for more than ten years. During a joint venture period (1995-2006), those diving activities that were carried out on DE3 vessels were recorded in their exposure database. Although DE4 has not previously had such a database, all diving logs have been kept/filed. Now that these two companies have merged (merged company is DE1), all diving activities will be logged in the DE3 exposure database. This type of data must be seen together with medical check ups in the shape of the health-screening questionnaire (informant 2).

4.2 Comments from diving doctor

A diving doctor (informant 13) was asked to comment on the effectiveness of the abovementioned barriers with regard to uncovering long-term health effects from diving, and in light of most recent research findings on the subject. The informant states as follows:

- The offshore health certificate and the health certificate for offshore divers are not designed to uncover long-term health effects from diving and as such are not an effective barrier for this.
- The pre-dive medical check is rated as an inefficient barrier as it is designed to uncover acute illnesses or injuries that can indicate the diver is not medically fit to dive rather than long-term health effects. Similarly the post-dive medical check is designed to uncover any health finding related to the relevant diving period.
- The 3-yearly medical examination is specifically designed to uncover long-term health effects and is therefore an effective barrier.
- The annual health-screening questionnaire can to some extent uncover long-term health effects, but most often with diving, a medical examination is required in conjunction with a self-declaration/health questionnaire in order to uncover both subjective complaints and objective findings.
- The exposure assessment is not relevant to uncover health effects, specifically organ function. However, it is necessary for long-term monitoring as on a group level as there is a correlation between exposure and health effects.

4.3 Comments concerning the safety barriers as a whole

- Well maintained health monitoring (informant 3)

Informant 3 states health monitoring of divers is well maintained overall. The challenge is the low response rate in the annual screening questionnaire. However, Informant 3 states that it is still at an early stage and needs time. The PSA are reasonably satisfied with the method.

According to Informant 3 the PSA see no reason to demand a change. However, with reference to RUG (risk exposed groups) reports, doctors maintain that it is difficult to

follow-up individual divers when they are not employed. It would be more purposeful if they all were employed, but there are no legal grounds to force permanent employment (ibid).

4.4 Potential improvements

Informant 1 states that by law, no employee can be forced to participate in the health follow-up program, but that if DE1 were more adamant and entered participation in the health follow-up program as a requirement in the diver contract, it would in the informant´s opinion work.

Informant 2 talks of another approach for increasing the response rate to the annual health screening questionnaire and states that it must be explained to the unions and divers why the annual health screening program has been implemented. "We have to build up trust and confidence with the divers, convince them that it is only the company health department that will use the data and only for the good of the divers" (ibid, own translation). Informant 2 further states "adult" education is required; "we have to explain the background for doing this" (own translation).

4.5 Further measures taken by divers

- Regular exercise (informant 4, 5, 6, 7, 8, 9 and 11)
- Own water supply during bell-run (informant 4 and 9)

Informant 4 stated that British regulation is not as good as the Norwegian legislation and that most divers would like to go along with the Norwegian legislation due to it being more strict. This was illustrated with an example:

> "Normally you do a 6-hour bell run. In Norway you have to have a break after 3 hours to have a drink and food as well if you like. In the UK you can have a break, but no one asks to go for a break, nobody wants to be noticed for not being as productive as everyone else. (…) I received information about diving and dehydration (…) and it is very detrimental to your health to be dehydrated. Many divers who have worked in Norway were surprised at the difference having a drinking break makes. You feel much better." (Informant 4)

4.6 Additional noteworthy findings

“If people thought there was life after diving it would make a difference in taking part in the surveys” (informant 4. Many divers have no other qualifications/education other than the diver training (Informant 4), and so have nothing to “fall back” on should their diving career come to an end.

Many of the divers commented that the regulations encompassing diving were more stringent on the NCS compared to the BCS. There were two god examples of this. The first concerns a bell run, which is the duration of time from going from the diving chamber into the diving bell, being lowered down to a certain depth in order to carry out work, and finally being raised back up and going from the diving bell into the diving chamber. On both the NCS and the BCS the maximum bell-run is six hours. However, Norwegian regulations state that there shall be a mandatory water break after 3 hours, whereas UK regulations state that there shall be an optional break after three hours. When working on the BCS divers rarely request this optional break because “nobody wants to be noticed for not being as productive as everyone else” (informant 4). The second example concerns the “blow-down” speed. This is the rate at which the divers are compressed to the atmospheric pressure at which they will be working. On the NCS the maximum compression rate is one metre per minutes (in a main chamber), whereas on the BCS the rate can be as fast as 18 metres per minute (in a diving bell or entry lock) “which is far too fast because if you´re going over 100 metres you don´t just feel it physically, you feel it mentally as well” (informant 6).

5 Discussion

In this chapter the results from the study will be discussed using the theoretical framework presented in chapter *2 Theory*. The results obtained through interviews with key informants will be discussed with focus on the effectiveness of barriers. In light of the results obtained it is specifically the optional 3-yearly medical examination and the annual health-screening questionnaire that will be discussed. Some of the compulsory regulatory requirements will be included to a certain extent. In total eight divers were interviewed and therefore the results cannot be generalised as such. However, it is safe to assume that many divers will be able to relate to various opinions and statements presented.

The discussion will as far as possible be presented using the same thematic order as chapter *4 Results*. Initially, a short summary of the main findings will be presented and discussed in light of relevant theory.

5.1 The safety barriers

In short, the only barriers specifically concerned with long-term health monitoring of divers are, according to informant 13, the

- 3-yearly medical examination;
- annual health screening questionnaire;
- and the exposure assessment

Only with the latter is participation obligatory, regulated by law. By using this information and applying it to Reason´s (1997:9) "Swiss cheese" model, it can be seen that the effectiveness of these three safety barriers is dependent upon the participation of the divers:

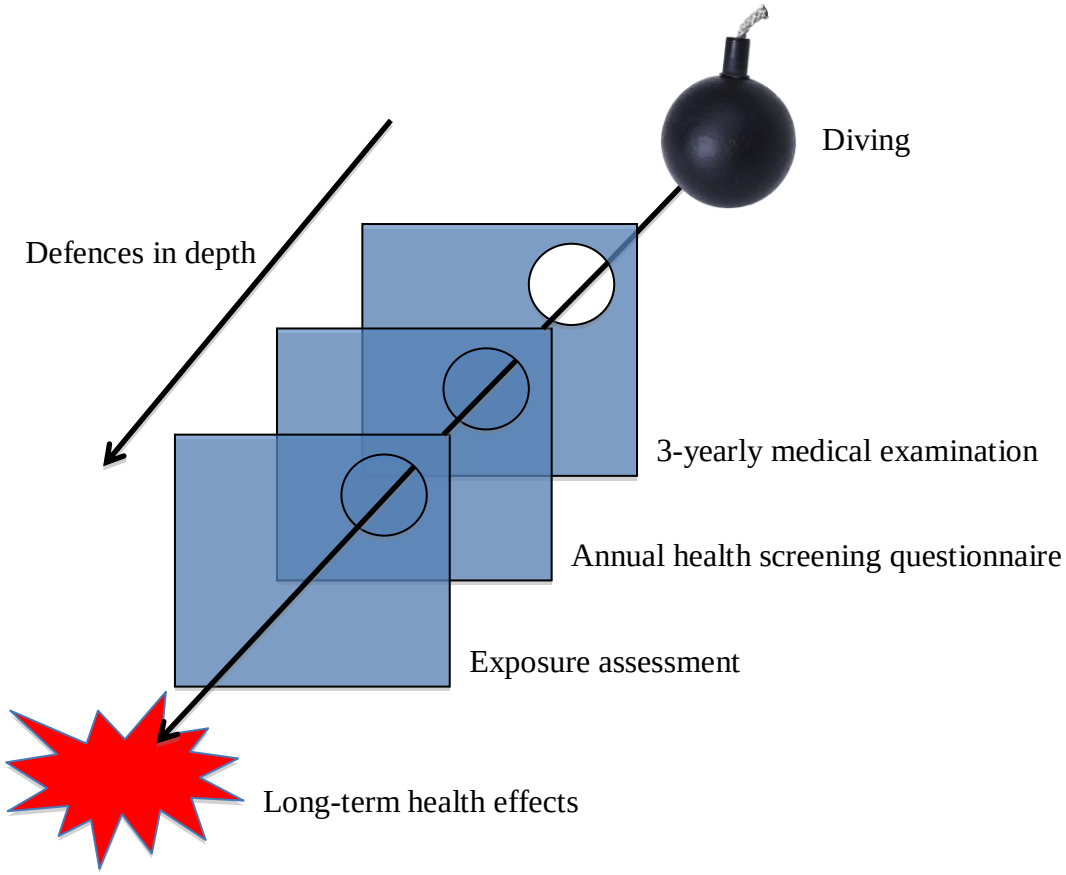

Figure 9: Safety barriers for long-term health monitoring

Figure 9 illustrates the three layers of defences an accident trajectory would have to pass through to results in an undesired incident, which in this case would be long-term health effects to the diver. However, as the 3-yearly medical examination and the health-screening questionnaire are both voluntary, i.e. divers may choose not to participate, the model could in fact look very different:

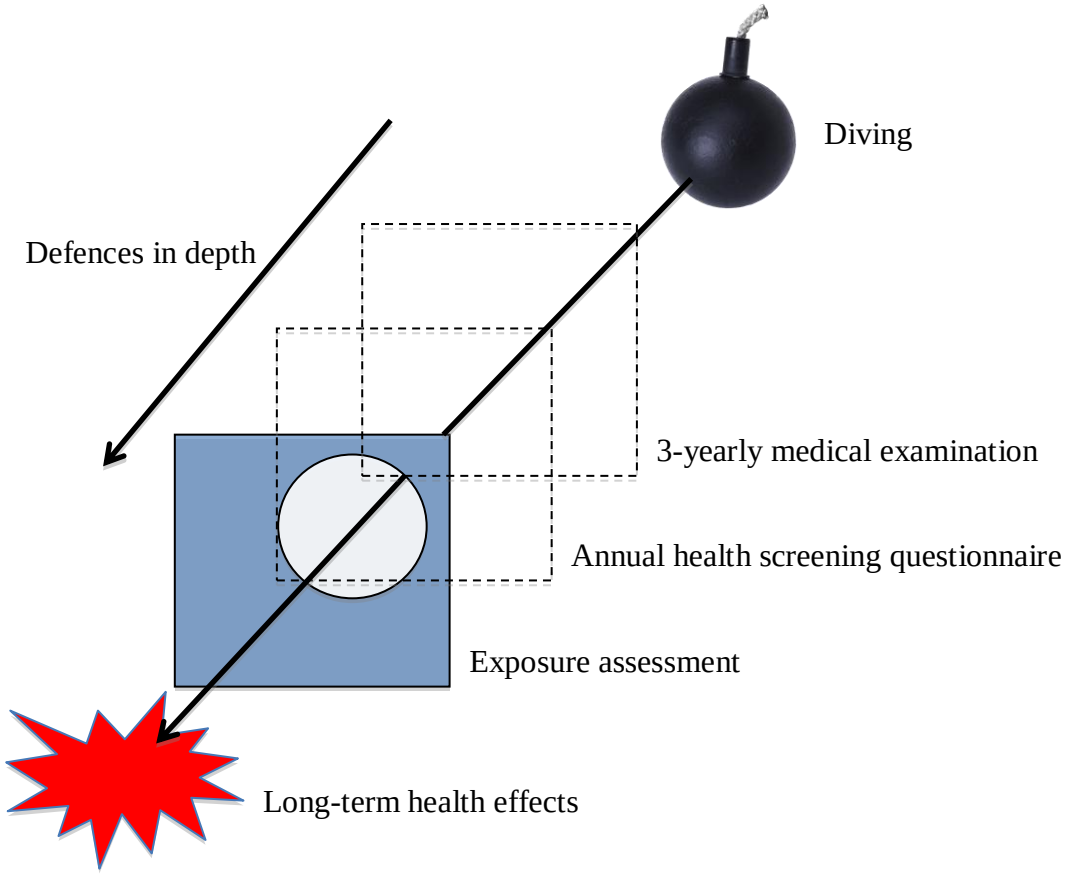

Figure 10: Compulsory safety barriers for long-term health monitoring

In figure 10 it can be seen that the two voluntary safety barriers, the 3-yearly medical examination and the annual health screening questionnaire, have been removed. This is, in effect, how the accident trajectory would look should a diver choose not to participate. In fact, according to informant 13, the exposure assessment safety barrier does not uncover health effects, but rather it is necessary for long-term monitoring on a group level due to the correlation between exposure and health effects. This leaves us with an alarming picture: Is the long-term health monitoring of a diver solely dependent on voluntary participation and coincidences?

5.2 3-yearly medical examination

As NORSOK U-100 § 5.1.4 (Standards Norway 2009) specifies

> "Special attention shall be paid to long-term health monitoring of organ systems known to be affected by diving (…) Examinations shall be repeated at regular

intervals not exceeding three years, using accepted methods".

Informant 2 states divers working for the company are offered 3-yearly medical examinations and that the organisation is in compliance with WEA and NORSOK U-100 Standard. However, informant 13 states that these medical examinations take place on quite an ad hoc basis and sometimes with little notice. There has been no system in place to ensure that each individual diver is offered the examination at least every three years (informant 1). The absence of such a system, as well as the lack of coordination and/or organisation around booking a diving doctor to carry out the examinations, both fall under the category of what Reason (1997) terms *latent conditions*.

Divers´ lack of participation in the voluntary examination falls under the category of what Reason (1997) terms *active failures*. It may be argued that a diver who does not participate, or who does not provide full disclosure in with regard to own heath, is in fact committing an unsafe act. However, as Reason argues, unsafe acts can be seen as a consequence of *latent conditions*. Informant 2 states that DE1 must build up trust and confidence with the divers, and that adult education is required. Shortcomings within these areas may also be identified as *latent conditions*.

So how does an organisation overcome *latent conditions* such as these? Aven and Renn (2010) state that good risk communication can help affected parties in reaching informed decisions. The results indicate that within DE1 there is a lack of communication concerning

- the existence of the 3-yearly medical examinations
- the reason for the program
- the benefits of participating in the program
- the choice of whether or not to participate in the program

Also, some divers have simply not been offered to undergo the medical examination (informant 9 and 11). This supports comments from informant 13 and informant 1 concerning the ad hoc way in which these are organised and the lack of a system for ensuring all divers receive an offer at least every three years.

For those divers that are aware of the 3-yearly medical examinations, but choose not to participate because they are suspicious, good risk communication could make a difference to their decision, or at the very least, contribute to a more informed decision being made.

So what can be said with regard to the effectiveness of this barrier? As pointed out by informant 13 it is specifically designed to uncover long-term health effects. Further, the same informant rates it as an effective safety barrier. However, as it is voluntary, it only works if the diver chooses to participate. So in this case, Reason´s (1997) ”Swiss cheese” model will not contain successive layers of holes through which an accident trajectory may pass. Alarmingly, a whole layer of defence will be removed, making it very easy for an accident trajectory to pass through the remaining layer(s), as illustrated in figure 10 above. This leads to the inevitable conclusion that this particular safety barrier is not effective at all, or at least it is not constant.

5.3 Annual health screening questionnaire

Informants 1 and 2 from DE1 state that one of the challenges with the annual health-screening questionnaire is the low response rate. The results indicate that one of the main reasons for non-participating is suspicion. It should be noted that the majority of the divers interviewed were British. As mentioned previously, only 12 of the 264 saturation divers registered with DE1 are Norwegian, the remainder are British. Although these divers work on the NCS, this does not necessarily mean that their attitudes towards trust and safety are the same as what may be found among Norwegian divers. A study by Tharaldsen (2011:94) found there existed differences in safety culture between UK and Norway respondents within an international drilling company operating on both the NCS and the BCS. Specifically, the results of the study indicated that UK workers exhibited “a more rule-based trust with regard to safety and between UK workers and managers”, whilst Norwegian workers “were characterised by equality and a common identity” (ibid). Communication with- and adult education of divers have been highlighted as important for improving the response rate to the questionnaire (informant 2). It may be argued that whether or not the response rate is low is relative. With regard to low response rate informant 12 (Operator 2) argues that the response rate is in fact not low when compared to similar screening questionnaires in the industry. Informant 3 (PSA) states low response rate is a challenge with the safety barrier, but attributes this to the short time span since its´

implementation. Based on these statements there appears to be a lack of consensus within the industry as to what is an acceptable response rate. However, participation in the health-screening questionnaire by the divers is voluntary. So, for the safety barrier to serve its purpose, divers must participate. As mentioned previously, DE3 and DE4 have had response rates ranging from 10% to 23% in the 2 years they have sent out the questionnaires since the implementation of the scheme in 2009. It can be argued then that in the case of the divers who did not participate the safety barrier has been non-functional. Again, as with the 3-yearly medical examination, it can therefore be argued that this is a weak barrier.

These findings may be supported by Hollnagell (2008:228) who states symbolic barrier systems, such as soft defences, are "inexpensive and can be put in place rather quickly", but are inefficient "since people can choose simply to ignore them". It would seem imperative then; to communicate to the divers the benefits of participating in a long-term health follow up program. This might reduce the likely hood of the safety barrier being ignored. By communicating to the divers the known and documented long-term health risks associated with diving, even if the information is ambiguous, the divers will be able to make more informed decisions. These decisions concern a profession that may not only damage their health, but may also have an impact on their families and friends (Aven and Renn 2010:93).

5.4 Health certificate for offshore divers

The divers interviewed had mixed opinions with regard to the effectiveness of the health certificate for offshore divers. Notably, it was commented that the medical examination required to obtain this certificate was easy to pass (informant 5), and that it is possible to hide, or not disclose, medical information related to own health (informant 10). It was also stated that the quality or thoroughness of these medical examinations varies with different doctors (informant 9). These findings may be supported by Simpson and Roomes (1999), who conducted a survey "to assess variability of opinion regarding fitness to dive among doctors currently doing diving medical examinations". The results indicated a lack of consensus with regard to what constitutes fitness to dive (ibid). Although that study concerned SCUBA divers, it may to some extent be related to medical examinations of offshore divers as the 81 doctors who participated in the survey were all members of a

underwater medical society. In Norway, as in the UK, there exist guidelines for use by diving doctors performing medical examinations on occupational divers (Norwegian Board of Health Supervision, 2000). Perhaps an audit, similar to that carried out by Sames et al. (2009), could contribute to ensuring that diving doctors are thorough and consistent in performing these medical examinations. Sames et al. (2009:765) found that five-yearly medical examinations of occupational divers (in New Zealand) have a low detection rate for health problems and also reported inconsistent decision-making between different practitioners as a challenge. In light of the findings above, it might be useful to conduct a similar survey both on the NCS and the BCS.

5.5 Additional noteworthy findings

As a concluding part to this chapter, some results from section *4.6 Additional noteworthy findings* will be briefly discussed.

5.5.1 Employment conditions

Similarly to communicating the known risks associated with diving, communicating the details of the long-term follow up program to the divers would also contribute to the divers´ ability to make informed decisions. Results indicate that loss of earning potential, i.e. not being able to continue a career as a diver, is a concern among divers. Again, this may be related to trust issues. In reports concerning risk exposed groups, doctors have maintained that long-term health follow up of individual divers is difficult when they are not employed (informant 3). Scandpower Risk Management AS (hereinafter referred to as Scandpower) carried out an analysis of risk in manned underwater operations at the request of Statoil, Norsk Hydro and Esso. The report suggests employment conditions of divers are an important consideration, as well as planning for ending diving career and re-education (Scandpower 2005:127). As pointed out by informant 15 from Operator 1, it is difficult to follow-up the health of divers that are not employed. Therefore, by operators requiring contractually that divers participate in the follow-up program, the effectiveness of the barriers is improved. Results indicate that there exists some ambiguity about the legality of making such requirements, however, due to the apparent flaws of the barriers, one may wonder if this is in fact a good way to manage this.

6 Conclusion

This study shows that the effectiveness of the three safety barriers specifically intended to manage the long-term health risks to divers, the 3-yearly medical examination, the health certificate for offshore divers, and the exposure assessment, depends on divers voluntarily participating and to a certain extent also on coincidences. Here, the word *coincidence* refers to the ad hoc organisation of the 3-yearly medical examinations, which appears to leave some divers on the outside of the long-term follow up program.

Reasons why divers do not participate in the long-term health follow up program include suspicion, career concerns, and also lack of information.

Further, divers report that the thoroughness and consistency of the medical examinations carried out in connection with the health certificate for offshore divers is varied.

These findings suggest that a combination of *latent conditions* and *active failures* leave the long-term health of divers in a vulnerable position. In light of these findings it is argued that the said safety barriers leave room for improvement with regard to their effectiveness.

The long-term health of a diver should not be dependant on voluntary participation and coincidences. A diver´s health should be protected and followed up through a regulatory framework with no room for ambiguity or misinterpretation, and through sound risk management.

6.1 Further research

Due to the time constraints of this study a limited number of divers were interviewed. A further study, encompassing as many offshore divers registered on the Norwegian and British shelves as possible, could greatly enhance our insight into what is required to improve the effectiveness of the safety barriers. Further, the effectiveness of the said barriers from a medical stance could be beneficial to the diving industry. During the latter part of this study it came to attention that *Helse Bergen HF*, in connection with an assignment for the PSA, is evaluating the need for improving the health and fitness requirement for occupational divers. The report is expected to be released in 2012.

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Appendices

Appendix A: Informants

Informant 1: Health department, Diving entrepreneur 1

Informant 2: Diving management, Diving entrepreneur 1

Informant 3: Senior personnel, Petroleum Safety Authoríty

Informant 4: Anonymous

Position: Diver, self-employed

Experience: 20+ years as diver; diving work carried out post 2009 on NCS for DE1

Informant 5: Anonymous

Position: Diver, employed by DE1

Experience: 20+ years as diver; diving work carried out post 2009 on NCS for DE1

Informant 6: Anonymous

Position: Diver, employed by DE1

Experience: 15+ years as diver, diving work carried out post 2009 on NCS for DE1

Informant 7: Anonymous

Position: Diver, employed by DE1

Experience: 5+ years as diver, diving work carried out post 2009 on NCS for DE1

Informant 8: Anonymous

Position: Diver, self-employed

Experience: 20+ years as diver, diving work carried out post 2009 on NCS for DE1

Informant 9: Anonymous

Position: Diver, self-employed

Experience: 15+ years as diver, diving work carried out post 2009 on NCS for DE1

Informant 10: Anonymous

Position: Diver, self-employed

Experience: 20+ years as diver, diving work carried out post 2009 on NCS for DE1

Informant 11: Anonymous

Position: Diver, self-employed

Experience: 10+ years as diver, diving work carried out post 2009 on NCS for DE1

Informant 12: Anonymous, Advisor Diving, Operator 2

Informant 13: Diving doctor

Informant 14: Anonymous, Advisor Diving, Operator 1

Appendix B: Request to interview divers

Hello

My name is Susanne and I am currently writing my masters thesis in Risk Management and Societal Safety. I have chosen to write about what safety barriers exist to prevent or decrease long-term health risks to divers, and will try to assess the effectiveness of these barriers (barriers in the form of law, regulation, standards, internal procedures, etc.).

I have worked for DE1 Norway since 2006 and transferred to the HSE department in 2010. I know little about diving and even less about the health risks, which is partly my motivation for writing about this topic.

Jane has kindly agreed to forward this email. I would very much like to interview you. It would only be a brief interview regarding whether or not you participate in the voluntary 3-yearly medical examination and/or the annual health screening questionnaire and the reasons for this. Any information you give me will be strictly anonymous, which is to say that I will write down your answers but not your name or any other information that can be linked to you. We can put this in writing if you like. If you prefer I can also send you my questions in advance so that you can prepare your thoughts.

Please let me know if you are available for an interview. Your participation would be greatly appreciated and would essentially be the central part of my study.

I hope to hear from you.

Regards,

Susanne Walters

Appendix C: Interview guides

Interview with Health Department representative, DE1

Please tell me about the long-term health follow-up of divers in DE1.

What challenges exist with regard to the health-monitoring program?

Interview with diving management representative, DE1

With regard to the legislation about the health follow-up of divers, including NORSOK U-100 §5.1.4, the Activities regulations §4 and 41, the WEA §3.1 and 10.11, how has DE1 complied with these?

What are the major challenges with the long-term health follow-up, if any?

What improvements, if any, is DE1 looking to make with regard to the follow-up program?

In your opinion, is the legislation appropriate as a safety barrier to reduce or prevent long-term health risks to divers?

Interview with PSA

With regard to long-term health follow-up of divers, how did the annual health questionnaires come about?

What, in your opinion, are the challenges with the long-term health follow-up of divers?

If we regard the laws and regulations as a safety barrier (soft defence as defined by Reason), how effective is it in your opinion?

It has come to my attention that some operators demand, in their contracts with entrepreneurs, that divers who work in their projects must participate in the long-term health follow-up program. Are they legally allowed to make such demands?

With regard to exposure data as per regulatory requirements and NORSOK U-100, it has been stated that some divers operate with more than one logbook, one for each entrepreneur they work for, e.g. one for DE1 and one for DE2. Further it has been stated that the divers don´t necessarily declare all work carried out in between jobs, they may only show one logbook. Is the PSA aware of this and if yes, how can it be avoided?

Interview with divers

Age
Nationality
Worked as diver in petroleum industry since
Date (year) of last diving job on Norwegian Continental Shelf
Date (year) of last diving job on British Continental Shelf
Employed/self-employed (if employed please also name employer)?
Employed since?
Member of union?
If yes, which?

Prevention or reduction of long-term health risks to divers

With regard to minimizing long-term health risks to divers I have been made aware that there exists both compulsory and voluntary health monitoring programs/procedures such as for example the pre- and post-dive medical checks, 3-yearly medical examination, and annual health screenings (questionnaire). This interview will focus mainly on the voluntary programs.

Have you ever participated in the 3-yearly medical examination?

If yes, why?

If no, why?

Since 2009 a health screening questionnaire has been sent to divers. The questionnaire is confidential and personal information may only be viewed by the occupational health service.

Have you ever responded to this questionnaire?

If yes, why?

If no, why?

The response rate to the annual health screening questionnaire has been very low. Do you have any thoughts on why this may be? Please elaborate.

Compulsory requirements such as

- Offshore health certificate
- Health certificate for offshore divers
- Pre- and post-dive medical checks
- Exposure data (self declaration)

and voluntary programs such as

- 3-yearly medical examination
- Annual health screening questionnaire

can all be regarded as “soft” defences or safety barriers that are there to prevent or minimise health risks to divers.

In your opinion, how effective are these safety barriers?

Do you take any other measures, not identified above, to protect yourself against diving related health risks?

Anything else you would like to add/comment?

Thank you for your time.

Appendix D: Annual health-screening questionnaire