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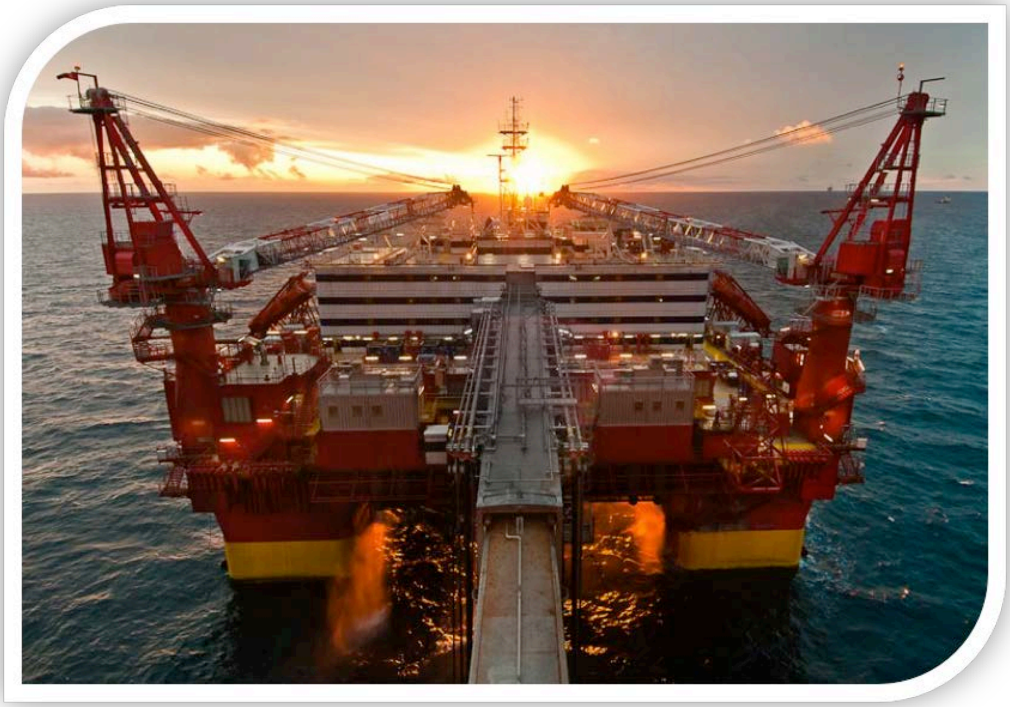

# A study of how accommodation vessel DP simulator training courses could be improved

## An analysis of Floatel International AB's DP-system training on critical elements during advanced marine operations

*Master's Thesis in the International Master's Programme Maritime Management*


BJÖRN JONSSON & CHRISTOFFER HOLMSTRÖM

Department of Shipping and Marine Technology

CHALMERS UNIVERSITY OF TECHNOLOGY
Göteborg, Sweden 2015



Master's thesis 2015:15/317

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ISSN 1652-8557
Department of Shipping and Marine Technology

Chalmers University of Technology
SE-412 96 Göteborg
Sweden
Telephone: + 46 (0)31-772 1000

Cover:
A photo of one of the company's accommodation vessels and its gangway during an advanced marine operation. A description of the Company fleet can be found under Section 1.1.1.

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ABSTRACT

The Thesis researches how accommodation specific dynamic positioning (DP) simulator courses can be developed. The purpose of the study was to identify critical elements during advanced marine DP operations and which to include in a simulator training course. The aim was to minimize risk and contribute to safer marine operations.

A mixed method approach has been used in order to reach the objectives. A survey was conducted on DP operators within Floatel Int. to identify critical elements and areas subjected for training. The results from the survey were concluded and later analysed in the interviews.

The results from the survey were discussed and verified by five in-depth interviews with DP operators. The survey identified: PMS, Sensors, PRS, Gangway system, Human Factors, Follow Target and Communication as critical elements. These categories have been arranged in a declining order. Respondents in the interviews then singled out the three most critical elements to include in an accommodation specific DP simulator course: Human Factors, PRS and Follow Target. An interview was arranged with a simulator trainer from the Swedish Maritime Administration in order to get an objective opinion of the results. The simulator trainer could relate to the findings except for Follow Target, this due to the limited knowledge of the element.

Key words: Accommodation vessels, advanced marine operations, critical elements, dynamic positioning, simulator training.

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# Preface

The Master Thesis was conducted as a concluding project for the Master's degree in Maritime Management at Chalmers University of Technology, Gothenburg, Sweden. The thesis is required to maintain a master degree and is equivalent to 30 ECTS. The thesis was conducted from January to June 2015. A close collaboration was established between the authors, the Department of Shipping and Marine Technology at the University and Floatel International AB.

The authors would like to acknowledge and thank our examiner, the Director of the Master's Programme Maritime Management Olle Lindmark and supervisor, instructor Christopher Anderberg. Their guidance and encouragement has contributed greatly to the completion of the thesis.

We would also like to recognize Floatel International's management for their support and trust throughout the project. Their operators made the study possible by showing interest in the subject chosen and willingness to participate was high.

The pilot and simulator trainer from The Swedish Maritime Administration participated as an external source. The source of information was highly valuable and increased the credibility of the study. We would like to thank the pilot and simulator trainer for his time and effort.

The opinions expressed herein are the two authors' and not necessarily those of Chalmers University of Technology or Floatel International.

Gothenburg, June 2015

Björn Jonsson & Christoffer Holmström

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# Abbreviations & acronyms

| | |
|---|---|
| ASOG | Activity Specific Operating Guidelines |
| AODC | Association of Offshore Diving Contractors |
| CBT | Computer based training |
| CCR | Centre Control Room |
| DHSA | Define Situation of Hazard and Accident |
| DNV | Det Norske Veritas |
| DP | Dynamic Positioning |
| DPO | Dynamic Positioning Officer |
| DPVOA | Dynamic Positioning Vessel Owners Association |
| ECTS | European Credit Transfer and Accumulation System |
| FIMS | Floatel International Management System |
| FMEA | Failure Mode Effect Analysis |
| FPSO | Floating Production, Storage & Offloading unit |
| GPS | Global Positioning System |
| HSE | The Health and Safety Executive |
| HTW | Human, element Training & Watchkeeping |
| IMCA | International Marine Contractors Association |
| IMO | International Maritime Organization |
| Int. | International |
| LSOG | Location Specific Operating Guidelines |
| MET | Maritime Education and Training |
| MSc | Master of Science |
| MSC | Maritime Safety Committee Circular |
| NGO | Non-Governmental Organization |
| NI | The Nautical Institute |
| NASA | National Aeronautics and Space Administration |

| | |
|---|---|
| NM | Nautical Miles |
| NMA | Norwegian Maritime Authority |
| OIM | Offshore Installation Manager |
| OPEC | Organization of the Petroleum Exporting Countries |
| POSMOOR | Position Mooring |
| PMS | Power Management System |
| PRS | Positioning Reference |
| SDPO | Senior Dynamic Positioning Officer |
| STCW | Standards of Training, Crew & Watchkeeping |
| TC | Transport Canada |
| TLP | Tension Leg Platform |
| TNA | Training Needs Analysis |
| WSOG | Well Specific Operating Guidelines |

# Definitions

| | |
|---|---|
| Accommodation vessel | A semi-submersible rig designed to function as living-quarters for offshore personnel within the oil and gas industry. The vessel offers the possibility to do repair work and other supplementary activities. |
| Advanced Marine Operations | Any radical procedure or manoeuvre out of the ordinary at sea which increases difficulty and burden for the on board operators, due to greater risks than during ordinary operation. |
| Ad hoc | Solutions that are designed for a specific issue, which are improvised or inadequately planned. |
| Brent Oil Index | A key trading classification of light crude oil that serves as a major benchmark price for purchases of oil worldwide. |
| Competency based training (CBT) | Training that is designed for a learner to demonstrate their ability. Tasks and knowledge shall be demonstrated in order to be certified. |
| Critical element | Any feature that has decisive or crucial importance in the success or failure of the advanced marine operation. |
| DP operators | The individuals who operates the DP system. By DP operator, the authors refer to the: DPO, SDPO, Chief Officer, Captain/OIM on board accommodation vessels. |
| Dynamic positioning (DP) system | A computer controlled system to automatically maintain a ship's position and heading by using her own propulsion system. |
| Floatel Int. | The company is active within the accommodation vessel segment. |

| | |
|---|---|
| | The HQ is located in Mölndal, Sweden. The company has been studied in this Thesis. |
| Floatel Int. Mangement System (FIMS) | A system containing Floatel International's official management documentation. |
| International Maritime Organization (IMO) | A specialized agency of the UN, with purpose to develop and maintain a comprehensive regulatory framework for the marine industry. Its responsibility includes safety, environmental issues, legal matters, technical co-operation, maritime security and efficiency of shipping. |
| Likert scale | An scale frequently used in questionnaires to measure attitudes or opinions. |
| Organic learning process | The concept emphasizes on a continuing development and learning processes. The process highlights the importance of learning in different educational environments. |
| Power Management System | The system, which controls the electrical and machinery system. |
| Positioning Reference System | The system, which gives reference input for the vessel to maintain its position. Example, GPS, Cyscan, Radius etc. |
| Standards of Training, Crew & Watchkeeping | An international convention that regulates training, crew and Watchkeeping in order to minimize accidents at sea. |
| STAR | Floatel International's online maintenance and documentation system (FIMS included). |
| The Health and Safety Executive (HSE) | The organisation accountable for the encouragement, regulation and implementation of workplace health, safety and welfare in the UK. |

# 1 INTRODUCTION

In 2014 the International Maritime Organization (IMO) documented an increase of 10% in fatalities caused by accidents at sea, compared to the previous year. According to the international governing body, 799 individuals lost their lives or went missing (IMO, 2015). The casualties from the shipping industry were noticeably higher compared to the commercial aviation industry where 641 losses were recorded the same year (IATA, 2015).

International education and training standards are in place, which necessitates seafarers to continually develop their knowledge and proficiency throughout their working careers. Although the international requirements exist, there are numerous accidents at sea each year, scribed to human error (Emad & Roth, 2008). Viewing the last ten years, almost 4,800 seafarers have lost their lives on transports at sea (IMO, 2015). The Human element, Training and Watchkeeping (HTW) issues are of particular importance due to the expected growth of the industry. The IMO suggests a growth between 35-70% by 2030 (IMO, 2015). Naturally, more transports by sea may lead to an increase in casualties unless the HTW issues are addressed.

One of the growing sectors is the offshore industry; a good example is the accommodation vessel segment which gross fleet capacity is anticipated to grow by 100% from 2014 to 2016 (Griggs, 2014). The Piper Alpha accident in 1988 is one example of how costly human element errors within the offshore industry may become. Another more recent occurrence but less destructive, was the Kvitebjørn incident were an accommodation vessel's operators experienced complications. More about these incidents can be read in Section 2.2.2.

This report investigates how training of operators within the offshore accommodation vessel segment can be developed. More specific, what should be included in the dynamic positioning (DP) system accommodation vessel specific simulator course has been researched. The concept of dynamic positioning is described in Section 2.3. The two authors have carried out a study on the offshore company Floatel International AB (from here on referred to as Floatel Int. or the Company) and their operators in order to fulfil the purpose of the Thesis.

## 1.1 Floatel Int.

Floatel Int. is a global enterprise with headquarter located in Mölndal, Sweden, with field-offices at operational markets. Previous executives from Consafe Offshore AB, a former offshore company delisted from Oslo Stock Exchange in 2006, and offshore investors formed Floatel International AB later the same year. The Company strives to operate the most modern accommodation fleet on the market. The aim is to offer greater support, service and living standards than any other competitor (Floatel Int., 2014 B).

The year of 2010 was eventful for the Company, with delivery of their two initial accommodation vessels, accompanied with being listed on the Oslo Stock Exchange. Floatel Int. was however delisted on the 9th of September 2011, when a set of shareholders along with the Company agreed to take the corporation private.

### 1.1.1 Fleet

The Company currently has four accommodation vessels, the Floatel Superior, the Floatel Reliance the Floatel Victory and Floatel Endurance in operation. One additional vessel, the Floatel Triumph is in the process of construction. All of the vessels are equipped with DP-systems and are of a semi-submersible character (Floatel Int., 2014 A).

Floatel Superior is the oldest vessel in the fleet with 440 single bed cabins on board. The vessel was ordered in July 2007 and delivered in 2010. It is equipped with a DP3-system and fulfils the rigid requirements for operating on the Norwegian Continental Shelf, all year around (Floatel Int., 2014 B). The Floatel Reliance was delivered the same year as the Superior but with a DP2-system. In other words, the vessel meets the requirement to operate worldwide, excepting the North Sea. Floatel Reliance has the capacity to accommodate 500 persons. The third vessel, the Floatel Victory was ordered in July 2011 and delivered in 2014. It has a DP3-system on board, which means it has the same operational capabilities as the Floatel Superior in terms of DP restrictions. It was built to house 500 persons, although reconstruction to increase capacity is planned. The Company’s fourth vessel, the Floatel Endurance was ordered in 2012 and delivered in mid-April 2015. The vessel is a DP3 classed vessel and is likewise the Superior designed to meet the demands set to operate on the Norwegian Continental Shelf. The regulations in the area are considered to be thorough. The Floatel Triumph, the most recent order was placed in 2013 and delivery is projected to the second quarter of 2016. All mentioned Floatel vessels have been or are being built at Keppel FELS Shipyard, Singapore (Floatel Int., 2014 A).

### 1.1.2 Current simulator course

Today Floatel Int. educates their DP operators in an accommodation vessel specific training course, which is set up at SimSea’s simulator centre in Haugesund, Norway. The simulator system consists of a DP-system designed by Kongsberg Maritime. The course duration is four days and the aim is to familiarize the operator with different scenarios inside the accommodation vessel simulator. The simulator features have been replicated from the Floatel Superior design. The course has a capacity to accommodate up to six participants at the time. The purpose of the simulator course is to practice situation reactions to diminish accidents at sea (Floatel Int., *no date*, p.2). Floatel’s intention is to train all bridge officers’ fleet wide in the accommodation specific simulator every other year. The aim of this Thesis is to improve the content of the DP course.

A set up for the course was discussed and planned even before the incident at Kvitebjørn in July 2013, states Henrik Woodbridge, Floatel’s Country Manager, Norway during an interview. When Floatel Int. concluded their internal investigation report for the gangway incident at Kvitebjørn, lack of specific training for the bridge crew was established as one main contributing factor (more details from the investigation report is found under Section 2.2.2.2). The course was according to the Country Manager established in collaboration between Kongsberg, SimSea, Statoil and Floatel Int. The course has been held for Company operators since December 2013. He explains, “*the intention is to create as realistic situations as possible and to use internal documents such as, LSOG, DHSA and FIMS to customize the course*”. The documents are discussed further under Section 2.2.1. The course concludes with a theoretical and practical test, to measure the knowledge of the operator (SimSea, *No date,* p.2). The simulator model used during the DP course can be set to different environmental conditions (Kongsberg, 2013). Floatel Int. has invested in an accommodation specific model to create a more realistic environment during simulator training.

## 1.2 Purpose

The purpose of the study was to enhance the progression of accommodation vessel specific DP simulator training courses. Constructive development contributes to an increase in operator's knowledge and competence, which reduces the risk of accidents within the offshore industry.

The goal was to conduct a Training Needs Analysis (TNA) with intention to generate a well-defined indication of appropriate training needs for the niched DP courses. The purpose has been divided into two research questions in order to structure the research.

### 1.2.1 Research Questions

<u>Research Question 1</u>: Which are the critical dynamic positioning elements of accommodation vessel marine operations?

<u>Research Question 2</u>**:** Which of these elements should be included in the accommodation dynamic positioning course in order to meet new demands within offshore operations and maximize utility?

## 1.3 Limitations

The Master Thesis has been restricted with several limitations due to constraints in terms of resources and time. The report corresponds to 30 ECTS units, which means the authors have had 6 months to complete the Thesis. Restrictions allow the study to concentrate on a specific area and develop profound understanding, while other limitations act as constraints. Limitations have been discussed in the following paragraphs and had a direct impact on: the method chosen, the results and how generable the outcome can be considered.

Floatel Int. was the sole company studied in the report. This was decided upon restrictions in time and resources. Furthermore, complications would have risen if an additional accommodation vessel company were included in the research. The actors on the market are considered direct competitors, which would result in a delicate situation. Particularly since one of the authors was employed at Floatel Int. at the time of the report. Sharing delicate documents and information would not be in a competitor's interest.

The study was limited to advanced marine DP operational procedures within the accommodation vessel industry. The industry was chosen due to the need for research on the field and inquiry from Floatel Int. Including other DP vessels would have resulted in a scope too wide and the study would not have been feasible from a resource perspective. The DP operational procedures were chosen, since its considered the most critical action in terms of hazards and consequences at the occasion of an error. The type of operational procedure is currently the base in the Company's specific simulator course in Haugesund, Norway.

The purpose of the Thesis was not to analyse the certificate courses needed for the position on board (for example STCW or DP unlimited) or the current DP course in Haugesund, Norway. However, requirements for the DP certification have been mentioned as a background to create an understanding of today's situation. The current DP course was difficult to observe or analyse effectively since no Floatel Int. course was planned during the timespan of the Thesis. The objective of the report was instead to analyse what the DP operators currently needed to practice, in order to successfully encounter future demands and challenges.

The report focused on simulator training in terms of DP operations in association with oil and gas platforms. No consideration has been taken to the offshore wind production fields, the vessels could however be assigned to such fields. Although this has not been emphasized in this report, since the Company was not active on the particular market at the time.

On researching what should be included in the accommodation specific DP simulator courses, no restrictions in current simulator infrastructure or technology was considered. The aim was on identifying suitable course content. This was done by pinpointing which element required training and was an increasing risk. Because of limitations the authors divided the critical elements into categories. More regarding this is found under Section 3.5.3.1. Investigating all critical elements such as the specific reference systems, without categorising them was not feasible in terms of the time limit. If this were to be done, the focus would have shifted from the DP training to the reference system itself.

The financial aspect of efficient training on the critical elements identified was not studied. The respondents were however free to have it in mind or discuss it throughout the interviews. To decide whether or not the identified critical elements are economically viable to be included in the DP training course, is up to the management of the Company to decide. Majority of the qualitative interviews were carried out over phone. Travelling to Brazil, Singapore, Australia and the North Sea to carry out the interviews in-person was not possible, within the financial aspect.

The interviews with the DP operators were limited to five individuals. The number was set in regard to the number of respondents on the survey along with the time boundary. The number of interviews corresponded to more than 35% of the respondents in the survey. The authors sensed a degree of saturation in data collection at the end of the interviews.

## 1.4 Disposition of Master Thesis

An outline of the report and its Sections is presented to give an overview for the reader, see Figure 1. A more detailed list of topics and page numbers is found in the Table of Contents.

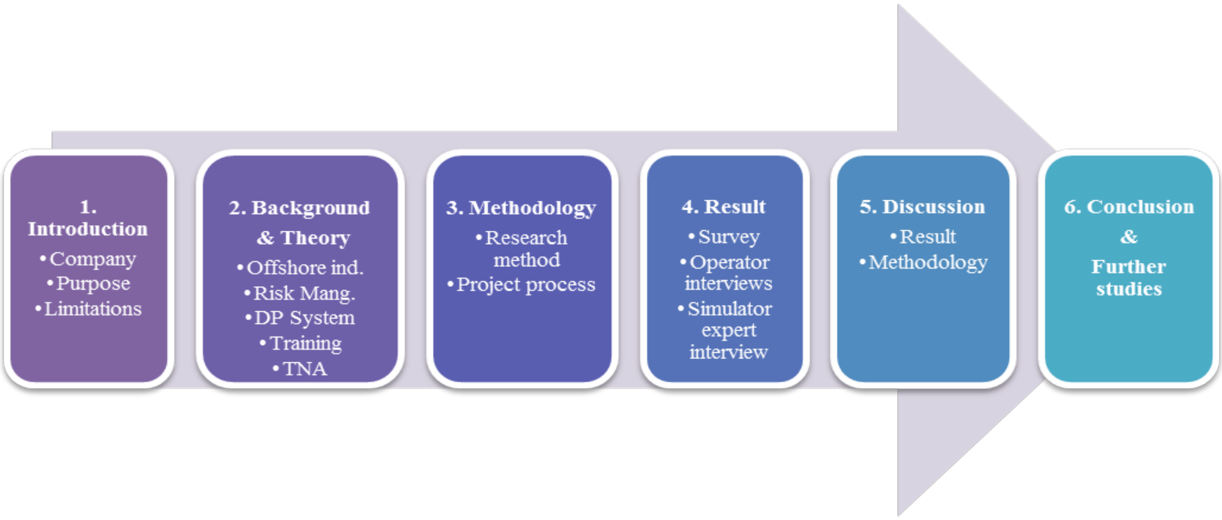


Figure 1: Thesis Outline

# 2 THEORY & BACKGROUND

This Section introduces the reader to the industry, risks and the concept of dynamic positioning. Later training, standards and the certification process of DP officers are described. The TNA approach towards training has been introduced in the end.

## 2.1 Offshore industry

In this report the term offshore industry refers to the extraction of oil and gas from the seabed for commercial purpose and it is closely correlating business. The extraction of oil at sea began in 1947 when oil was successfully drilled for approximately 17 kilometres outside the coast of Louisiana, United States at an depth of 5,5 meters (American Oil and Gas Historical Society, 2015). The rig began the era of extraction of oil and gas at sea, see Figure 2.

**Figure 2: The initial rig (American Oil and Gas Historical Society, 2015)**

Oil and gas fields have advanced further out from shore to deeper sea areas, much due to the development of the offshore drilling technology and equipment. Therefore, floating production rigs mainly carry out today's extraction at sea. Roughly 30 % of the global oil and gas production comes from offshore sources and the percentage is expected to increase in the coming years. There are about 240 operational floating production facilities and an additional 100 floating storage and offloading vessels, spread out across the world (MODEC, *no date*). The four standard types of floating production facilities are: Floating Production Storage and Offloading (FPSO) vessel, Tension Leg Platform (TLP), Spars and Production plus Semi-Submersibles, see Figure 3.

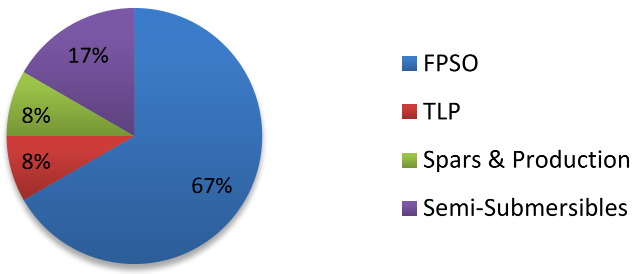


**Figure 3: Distribution of floating production facilities (MODEC, no date)**

The number of production facilities at sea is estimated to continue its growth, since orders at shipyards has increased noticeably the last decade. The incline is anticipated to resume, due to the growth in global energy consumption and continuous technological developments. This offers the ability to extract additional hydrocarbons in harsh surroundings (MODEC, *no date*).

## 2.1.1 The accommodation segment

Oil and gas fields have progressed to harsh un-exploited areas in search for new sources of oil and gas. Due to the remoteness, support-vessels offering housing of personnel and extra equipment is necessary. The resources required for transporting personnel and equipment back and forth from land on board vessels or aircrafts are not viable in terms of cost, environmental effect or time. Consequently, the long distance to shore and increase of project sizes have resulted in the emergence of the flotel and construction support vessel industry (Floatel Int., 2014 A). These vessels and rigs are hereafter referred to as accommodation vessels.

The accommodation vessels are normally positioned in connection with the production rig and the two are regularly united with a gangway. Personnel can then move between the units using the gangway even in harsh sea conditions. On board cranes are used in order to lift and transport equipment along with spare parts (O'Connell, 2012). These operations are possible due to the advanced DP system. By DP operators, the authors refer to the: DPO, SDPO, Chief Officer, Captain/OIM on board accommodation vessels. These are the individuals responsible for the vessels position keeping.

### 2.1.1.1 Market & main actors

The accommodation segment is growing, due to the expansion of the offshore industry. There are three main markets: the North Sea, Brazil and Gulf of Mexico, example of minor markets are West Africa and Southeast Asia. The major markets are considered to be stable; however analysts expect the daily rates to drop as much as 20-30%. The drop is projected since the increase in capacity is calculated to beat the estimated demand and there are several accommodation vessels in the shipyards' order book. The gross fleet capacity available in 2014 is projected to have increased with 100% by 2016. Relatively low barriers of entry are believed to be a part of the reason for the escalation in capacity. Costs for converting old semi-submersible vessels to accommodation vessels are at an all time low (Griggs, 2014). At the same time, the oil production demand has decreased. Frank Wolak, one of *Stanford News* economists commented on the drop:

> *"The drop in oil prices and demand reflects heightened energy production in North America, better technologies and the declining market power of the OPEC countries. The global oil price drop may last for the next couple decades (Parker, 2015)."*

One of the most regularly used standards for measuring the global oil price is the Crude Oil Brent index. The diagram displays the drop in global oil prices between mid-May 2014 to mid-May 2015, see Figure 4.

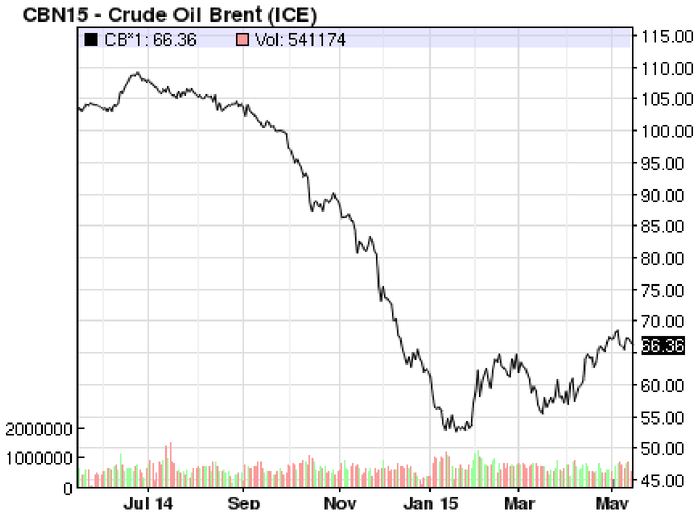


**Figure 4: Crude Brent oil price (NASDAQ, 2015)**

The Crude Oil Brent index has shifted significantly over the years, so has the scene on the accommodation vessel market. Prosafe was the lone dominant player on the offshore accommodation market until 2010, but dynamics are shifting. Today, there are three major actors; Prosafe, Floatel Int. and Axis offshore (Griggs, 2014). Although there has been a steady increase in competition and technical developments in training systems, there are still large risks.

## 2.2 Industry risks

The industry of oil and gas production out at sea is labelled as a hazardous since fire, toxic gases leakage and explosions are potential consequences of the extraction. Drilling rigs, platforms and accommodation vessels are exposed workplaces where emergency evacuation is challenging due to the surroundings. Characteristics of a harsh environment could for example consist of: demanding winds, waves, currents, depth or distance to shore. The operational risks have increased and effects of accidents in terms of human life, environmental impact and financial loss are immense (Sutton, 2012). The challenging conditions during advanced marine operations often require today's floating accommodation vessels to have sophisticated DP systems and rigorous barrier management to maintain a safe operation (Floatel Int., 2014 A).

### 2.2.1 Barrier management

Barrier management's purpose is to establish and maintain safety barriers and to manage whichever risk emerges at any given time (PSA, 2013, p.4). A barrier includes the process, the systems, the solutions and the measures to prevent accidents. To reduce the risk systematic usage of suitable studies and analyses are performed. This concept lies as a base for decision making of risks linked to an activity. An assessment must be made to establish the risk situation (PSA, 2013, p.4). Safety barriers are divided between barrier elements or barrier functions. A barrier element can be e.g. an operator, training, an instrument or an emergency response plan (mentioned in the following Section). Barrier elements act as a barrier within the barrier function. The function may consist of several elements. The LSOG and the DHSA are both barrier elements; together they act as a barrier function.

#### 2.2.1.1 Location Specific Operating Guidelines (LSOG)

LOSG describes the operational, environmental and equipment performance limit in a table. The values in the table are evaluated for a safe DP operation. An example is displayed in Appendix A – Floatel Int. LSOG. Each location shall have a specific guideline set up prior to commencement of the operation. The table describes operator action, as limits are approached or exceeded (DNV, 2011, p.8). Values in the table must be considered before the operation. It is the Captain/OIM's responsibility to set up the scheme and appoint appropriate values. This is often done as a preparation in the pre-project execution with relevant personnel (DNV, 2011, p.15). Information to be considered when determining values are; DP FMEA, operational manuals and project specific procedures (DNV, 2011, p.16). The LSOG shall be signed by the Captain/OIM, SDPO and the Client prior to commencement of the operation (Floatel Int., 2014 D, p.25). Other similar operational guidelines to the LSOG are; Well Specific Operating Guidelines (WSOG) and Activity Specific Operating Guidelines (ASOG). In the Floatel Int. fleet the LSOG shall be posted on the bridge (Floatel Int., 2014 D, p.20). The LSOG consists of four levels; Normal (Green), Advisory (Yellow), Alarm & Gangway Lift (Red). Each level has required actions, which need to be performed. The LSOG is a governing document to ensure the vessel operates within limits and withholds the DP class.

#### 2.2.1.2 Defined Situations of Hazard and Accident (DSHA)

The DHSA is a selection of hazardous and accidental events that is a part of the emergency preparedness activity (Norsok, 2001, p.5). It describes the activities, which need to be performed on board during an emergency. The philosophy of the standard is to reduce the risk of accidents within the industry. How to develop the DSHA is described in detail in the Norsok standard Z-013. Each vessel within the Floatel Int. fleet has an emergency response plan. The response plan includes 13 different DHSA situations e.g. loss of position, loss of stability, helicopter accident, evacuation etc. (Floatel Int., 2014 E, p.6-43). The DHSA describes the duties of the Contingency Management and On Scene Management (CCR). Different scenarios for training is added into the maintenance program, STAR and performed accordingly.

### 2.2.2 Incident within the industry

One of the most acknowledged incidents within the offshore industry was the Piper Alpha catastrophe. The incident acts as an example in this Thesis of how destructive accidents and miscommunication within the industry may become. There has not been any critical accident such as the Piper Alpha in the accommodation segment, although there have been minor events such as the Kvitebjörn incidents.

#### 2.2.2.1 Piper Alpha

The offshore rig Piper Alpha was taken into service 1976 to export oil from Piper oilfield to the Flotta Terminal on the Orkney Islands, about 120 Nautical Miles (NM) north-east of Aberdeen, Scotland (NASA, 2013, p.1).

During a changeover between shifts on the 6$^{th}$ of July 1988 there was a miscommunication on board regarding the on-going maintenance work. One of the pressure relieve valves on the condensation pumps was removed for service and a flange was installed temporary at site. This resulted in pump A to be out of service (CCPS, 2005, p.2). Later the same evening there was blockages in pump B, causing the control room operator to change pump. Hydrocarbons started to leak out from the flange, until the rig exploded.

Fire pumps had been changed to manual control due to diving operations in the water, causing the deluge system to be unavailable (CCPS, 2005, p.3). The production at the two connected rigs was not stopped after the first emergency call. About 30 minutes later the gas line from the rigs burst, causing more gas to ignite (NASA, 2013, p.3). The rig slowly combusted and melted, the following day the rig had been torn up. This day the Piper Alpha had 226 persons on board. This incident caused the life of 167 personnel, leaving 61 survivors.

An official report was published in 1990 with 106 recommendations, which addressed insufficiencies within the industry. Recommendations were on the Health and Safety Executive (HSE), operators, the industry and the Standby Ship Owners Association. As a result of these findings the HSE adopted the Offshore Installation Regulation, Safety Case, which was taken into force 1992 (Oil & Gas UK, 2008, p.1-2) (HSE, 2005).

The incident occurred due to a chain of events transpiring from several different causes. NASA describes in *The Case for Safety* (NASA, 2013, p.1-4) the negligent culture for deactivation of the firefighting system, which was performed on board. The same study highlights the inadequate maintenance and safety procedures on board the Piper Alpha. NASA describes the incident on board the Piper Alpha as an "*…industry example of what happens when production, schedule and cost comes before investments in comprehensive system safety*" (NASA, 2013, p.4). Brian Appleton, Technical Adviser to the Enquiry on Piper Alpha, identified training and experience as another cause to the destruction. Experience of the permit process and inter-platform training or simulation was lacking (Appleton, 1988). Media such as the Daily Mail and Offshore Energy Today stated the Piper Alpha incidents as the worst oil disaster in time (Offshore Energy Today, 2013) (Daily Mail, 2008).

#### 2.2.2.2 Kvitebjørn Incident

The Floatel Superior was between May and October 2013 hired to lie as an accommodation vessel for Kvitebjørn, chartered for Statoil. Kvitebjørn is a seabed fixed platform and is located on the west coast of Norway, at block 34/11. The two rigs were connected through a gangway, which was used for transportation of personnel.

The gangway has a length of 38 meters and is equipped with a telescopic arm, with a stroke of ± 7,5 meter (Statoil, 2013, p.20). If the stroke exceeds ±4 meter the Captain/OIM and the Client representative shall be notified (advisory level), this according to Floatel Ints. LSOG. The LSOG is described under Section 2.2.1.1. Just after midnight the 29th of July the gangway stroke exceeded the 4-meter limit. The Captain/OIM and the client were notified, the Captain/OIM decided to start the thruster-assist (in the DP-system) and change set point (Floatel Int., 2013, p.21). The unexpected movements by waves about one hour later caused the gangway to auto-lift (Statoil, 2013, p.8). The Superior was then about 8 meters out of position, northwest. The gangway is programmed to auto-lift when the stroke exceeded 7 meter (Floatel Int., 2013, p.9). After the auto-lift initiation the gangway was following the movements of the Superior. The gangway then hit the landing platform on board Kvitebjørn two to three times. The gangway operator withdrew the gangway in manual mode a few minutes later. The operator made the evaluation to change from 'safe mode' to 'manual mode' since the gangway had not withdrawn sufficiently (Statoil, 2013, p26). The operator lifted up the gangway, causing the gangway to damage pipes and a ladder. The ladder with a weight of 146 kg fell down onto the landing area on Kvitebjørn. No personnel injuries occurred during these incidents (Floatel Int., 2013, p.4).

Investigation of the incident was done both by the Company and Statoil. Floatel Int. created the *Investigation Report ACC2013-0006* (Floatel Int., 2013) and Statoil formed the investigation report *Autoløft av gangvei mellom Floatel Superior og Kvitebjørn A* (Statoil, 2013). Statoil classified this incident internally as an Actual Red 2 for material injury and economic loss and possible Red 1 on personal injury (Statoil, 2013, p.9). The scale goes from Red 1 (most critical), to Red 2, Yellow 3, Green 4 to Not serious. A root cause analysis was made, Statoil proposed 8 different actions with barrier elements for improvements and Floatel Int. noted 17 different root causes. Root cause number 7 from Floatel Int. investigation report refers to "*Education, training and drills*" and one of the proposed actions was; "*Develop a training procedure for gangway operators and DPO's*" (Floatel Int., 2013, p.40). Under other proposed action Floatel Int. stated to *"develop a program for simulator and live training on board"* (Floatel Int., 2013, p.41). The other individual causes will not be described in detail since these are outside our scope for this essay.

## 2.3 Dynamic Positioning System (DP)

The offshore industry started out with mooring of rigs with the help of anchors and ropes. The industry moved forward and the development of the DP-system enhanced the possibility of conducting offshore operations further out from shore.

DP-systems allows a vessel to maintain its position and heading with its own propulsion system. The system compensates for natural forces such as wind, current and waves. Maintaining positioning is possible by integration of several systems and functions such as positioning reference sensors (PRS), wind sensors, motion sensors and gyrocompasses. The sensors and compasses, which collect data regarding level and direction of external forces, are connected to a computer system. The computer system is programmed to automatically calculate the drag of the vessel, required steering angle and thruster force, in order to maintain the position. Vessel categories that frequently use the DP technology are for example: vessels or rigs serving and operating the offshore industry. The DP-system can be positioned to a fixed point above the sea bottom, but also relative to a moving vessel or object underwater. The technology permits for procedures where conditions do not allow mooring, it could be because of deep water or congestion on the sea bottom in form of templates or pipelines (The Nautical Institute, no date). The system operates around six degrees of freedom: surge, sway, yaw, heave, roll and pitch, see Figure 5.

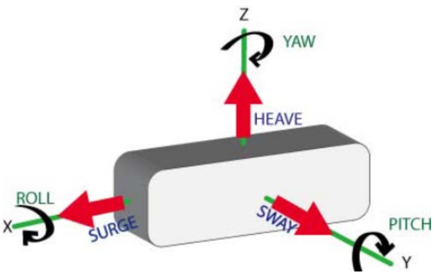


**Figure 5: Degrees of freedom (Bjørnseth et al., 2008, p.1)**

The operator could give input to the system by stipulating: surge, sway and/or yaw (Bjørnseth et al., 2008 p.1). The operator must monitor the system and take action if irregularities are observed. Any irregularities or potential hazards must be prevented by adjusting the DP settings.

### 2.3.1 DP classification

The purpose of the *MSC Circ. 645 – Guidelines for vessels with Dynamic Positioning Vessel* is to recommend standards for design criteria, equipment, operating requirements, improve the documentation system to reduce risk for personnel, the vessel, other vessels, structures or sub-sea installations and the environment (IMO, 1994, Circ. 645 p.3). It is the owner's responsibility to ensure the provisions included in MSC Circ. 645 are fulfilled. The circular's aim is to give guidance on DP equipment classification and redundancy requirements. The guidelines have been internationally accepted by authorities and organizations (IMCA, 2009, p.8).

MSC Circ. 645, serves as a platform for other guidelines within the industry. More details regarding guidelines for the design and operation of dynamically positioned vessels could be found in IMCA M 103 (replaced the DPVOA 103).

There are three different DP equipment classes, class 1, 2 and 3. The DP-classes are divided according to its redundancy capability and worst-case failure mode. The higher the equipment class, the more effective the system will be to withstand single failures (See Table 1).

**Table 1: DP equipment classes (IMO, 1994, p.6)**

| | |
|---|---|
| **Equipment class 1** | Loss of position may occur in the event of a single fault. |
| **Equipment class 2** | Loss of position is not to occur in the event of a single fault in any active component or system. Normally static components will not be considered to fail where adequate protection from damage is demonstrated and reliability is to the satisfaction of the administration.<br><br>Single failure criteria include; any active component or system (generators, thrusters, switchboards, remote controlled valves, etc.), and any normally static component (cables, pipes, manual valves, etc.), which is not properly documented with respect to protection and reliability. |
| **Equipment class 3** | For equipment class 3, a single failure includes: items listed above for class 2, and any normally static component is assumed to fail; all components in any one watertight compartment, from fire or flooding; all components in any one fire sub-division, from fire or flooding, including cables, where special provisions apply under Section 3.5 of MSC Circ.645. |
| In addition, for equipment classes 2 and 3, a single inadvertent act should be considered as a single fault if such an act is reasonably probable. | |

### 2.3.2 DPO/SDPO – Type A/B

The IMCA guideline *M 117 rev 1 - Training and experience of key DP personnel on board DP vessel*, recommends the Company to divide the competency on the bridge by type A and type B (IMCA, 2009, p.15). Type A to be the senior position, with experience of using the system both in manual and auto mode. Type B to be the junior position of type A. Type B should be able to operate the system during supervision by senior personnel and could by training be assigned to the Type A roll. Floatel Int. subjects these positions as DPO and SDPO. The training needed is described in Floatel Int. Crew Qualification (Floatel Int., 2014 C). All new DPO:s on board should be trained and familiarized to the specific vessel.

Time should be allocated by management for system specific courses and on board training (Floatel Int., 2014 D, p.18-19). On board training shall only be done without disturbing the ongoing operations or hamper the safety. Training should be liaised with the client, if no proper time could be given, time waiting on weather could be used (Floatel Int., 2014 D, p.19). Examples of trainings, which could be conducted, are: full or partial blackout, take-over between stations, change of DP-mode (between

Manual versus Auto) and reference system dropout. DP personnel should learn from previous incidents and lessons learned both on board and within the industry. A shared knowledge in the industry will increase the operating skills, capabilities, understanding and the safety awareness. Communication and interaction between operators are as important as situation training of the DP (IMCA, 2009, p.7). One way to share lessons learned and experience transfer is to report them through IMCA.

### 2.3.3 IMCA

During the 1980's consultants were working on developing a consistency within the industry and in 1990 the Dynamic Positioning Vessel Owners Association (DPVOA) was founded (Sean, 2009). The DPVOA together with the IMO collected data to develop new industry standards and in the beginning of June 1994 the IMO and DPVOA published the international *MSC Circ. 645*. The guideline is applicable for all DP vessels built after the 1st of July, 1994 (IMO, 1994, p.3). In 1995 the DPVOA and the Association of Offshore Diving Contractors (AODC) merged into IMCA. In 1995 IMCA had about a 100 members, today 20 years later, there are more than 1000 members (IMCA, 2015 A). DPVOA and IMCA have been assembling DP incident reports from members since 1991 and published them in their annual report (IMCA, 2009, p.42).

### 2.3.4 Safety Flash

IMCA sends out DP Safety Flashes on incidents, with information on the equipment failure or important lesson learned (IMCA, 2015 B). The flashes are sent in by operators within the industry. It is free for all DP operators to contribute with their incidents or lessons learned to IMCA. Forms to be used could be found on the IMCA webpage for Safety Flashes. The information given in the Safety Flash is anonymous and before released, the contributor must approve its content. Name, vessel and location will not be mentioned (IMCA, 2009, p.7). Under Section 3.2 in M 117, IMCA notes that one of the best tools for the owner is to use a comprehensive database for DP incidents.

IMCA realizes Safety Flashes not only for DP but also for general incidents, lessons learn and potential hazards. General Safety Flashes have been sent out to the industry since 1997, these could be found on the IMCA webpage (IMCA, 2015 B).

### 2.3.5 Living documents

Documents such as operation manuals, procedures, checklists, Failure Mode Effect Analysis (FMEA) and training documentation are all considered to be living documents. These documents are to be updated continuously and revised with e.g. incidents or lessons learned (IMCA, 2009, p.7). Internal documents are revised and re-issued by Floatel Int. continuously; changes could be found in 1000-120-03 Floatel Int. Management System (FIMS) updates. The FMEA is a systematic investigation to establish the failure modes of the DP-system. The analysis can be used by the operator to learn the system and its limitations. Other documentation to be carried on board with relevance to the DP is being described in IMCA M 109 (IMCA, 2004). Training for operators is performed according to the training matrix 1000-221-02 A1/A2 and the 1000-221-00 Training Manual Offshore. These training documents are to be found in FIMS. The performance standard using simulator training could be described in the

STCW code Section A-I/12 and in IMCA C 014, this will not be described in details since this will be outside our scope.

## 2.4 Training & Standards

The mandatory Maritime Education and Training (MET) system leaves room for development, due to the fact that beyond 80 percent of the accidents at sea are ascribed to the human element on board vessels. Mariners often have several tasks and obligations that may vary in character, but each must be carried out properly in order to ensure safe and successful operation. Training and education is therefore required to minimize the hazard for failure derived from human error.

Previously individual ship-owners and government set local standards for training and certification, but there was no synchronized single standard of certification (Emad & Roth, 2008, p.260-261). Due to the lack of universal standards, the United Nations founded the Inter-Governmental Maritime Consultative Organization in 1948. The organization was renamed in 1982 to the International Maritime Organization (IMO). The organization’s initial purpose was to increase the safety within the maritime industry by refining technical aspects. In the 1970s statistics were presented that pointed out the human element as the main contributor to accidents at sea. Therefore, the organization created the *International Convention on Standards of Training, Certification and Watchkeeping for Seafarers 1978* (STCW78). The convention on training was an effort to reduce accidents at sea, signatory nations are required to meet or preferably exceed the demands of the convention. The STCW78 was however lacking in certain areas. Some standards were left for each government to interpret and the IMO had limited influence at the time. The lack of clear standards resulted in an ineffective convention that instead was revised. The new and amended STCW95 was taken into force the 1st of February 1997. It included highest practicable standards of competence and introduced the concept of Competency-Based Training (CBT). The method necessitates mariners to *“demonstrate their ability to perform the task for which they are going to be certified”* (Emad & Roth, 2008, p.260-262). In some cases competency-based training is known as ‘performance-based’, ‘outcome-based’ or ‘criterion-referenced’ education (Emad & Roth, 2008, p.2).

The CBT method emphasizes on unambiguous behavioural and outcome-based assertions, focus is put on everyday performance and exposes outcome instead of input (Emad & Roth, 2008, p.260-263). The revised convention has shown limited effectiveness in accomplishing its objectives. Some suggests the CBT method is not very beneficial for operators and that there are contradictions in the MET system (Emad & Roth, 2008, p.264).

### 2.4.1 Issues with IMOs CBT approach

In the article *Contradictions in the practices of training for and assessment of competency* written by Gholramreza Emad and Wolff Michael Roth (2008), training inconsistencies in the maritime industry are discussed. Proponents of the technique imply that it increases the resemblance between training and workplace necessities. Other less positive towards the CBT approach argues, that that method has been unsuccessful in incorporating learning and human action (Emad & Roth, 2008, p.263). Emad and Roth carried out an exploratory qualitative study in order to increase understanding of the inconsistencies, which are apparent in the current MET system that aims to improve operators' capabilities. Respondents in the study had recently attended a conditional course, held by Transport Canada in accordance with the international standards, for a 2nd level certificate of competency. Various respondents express criticism that the education is not of significant assistance for them. One representative example of which is a statement from one of the participants following certification "*Now I am qualified (air quoting) but really I didn't learn very much, learned a little bit*" (Emad & Roth, 2008, p.264). Quotes like this indicate that operator experience contradicts the intended aim of the MET system.

#### 2.4.1.1 Theoretical education

One of the objectives of the MET system is to enhance students theoretical knowledge required for navigating vessels at sea. However, the existing system is currently not achieving the objective. College is the main forum for maritime education, although attending college is not required for acquiring a certificate of competency. Students' primary demand is to successfully be prepared for certificatory examinations by a lecturer (Emad & Roth, 2008, p.265). It becomes frustrating for the lecturers, since the exams becomes an obstacle in the sense that time must be spent on preparing students with acceptable answers. Instead time should be spent teaching knowledge that can be transferred to on board situations. A course lecturer at one of the maritime colleges in Canada expressed his discontent:

> *"From here my students after they complete my course they go back to TC (Transport Canada, the administrator) to be examined and to me it is an obstacle. . I spend way too much getting students prepare to write examination as data (Emad & Roth, 2008, p.265)."*

The transference in target from gaining on board applicable knowledge and proficiency to succeeding in exams is a cause for the adverse circumstances for mariners participating in the educational CBT system.

#### 2.4.1.2 Practical training courses

Emad & Roth's (2008) study shows that participants are more positive when evaluating the practical training courses than the theoretical education. The hands-on nature of the courses along with the direct link between training and job-situations was an encouraging element for course participants. Respondents perceived the experience and skill received as transferable to future practice on board vessels. One good example of practical training courses are the ones carried out in simulators, which role is to replicate an environment as authentic as possible in order to maximize the user's learning experience (Emad & Roth, 2008, p.266).

Students are evaluated while performing various assignments. The participants are approved once the evaluator is persuaded that the student is capable of carrying out the assignment on board a vessel. The training courses are described as "*very close to competency-based criteria and provide the satisfactory result*" (Emad & Roth, 2008, p.266).

#### 2.4.1.3 On board training

The final part of the MET system demands a structured on-the-job experience, which permits for on board training and development of competency. This part of the MET system is vastly popular among students. However, the on board training function is deficient in regard of outcome and irregularity. The main issue is the deficiency in guidance on board (Emad & Roth, 2008, p.266-267). Communication and cooperation among governing bodies, training institutes, shipping companies and officers on board leaves room for improvement. The authors Emad & Roth (2008, p.267) described the issue in their article.

> "*There is no supervision of the training of mariners on board ships and there are no assurances that students actually obtain the required competencies, which comprises the effectiveness of the part of MET*".

There is an alternate way of fulfilling the MET criteria of on board experience. The second option is not as structured, no supervision or on board training is required. The time on board is however longer when choosing the less controlled alternative. The last part, on board training, is considered as one of the fundamental aspects of the MET system, but in the matter of fact results of the training method must be viewed as highly uncertain (Emad & Roth, 2008, p.266-267).

#### 2.4.1.4 Certification assessment

The purpose of evaluation in training systems is to measure whether the objective of developing required knowledge and proficiency among participants has been fulfilled. According to the article, studies indicate that assessments can infringe on accomplishing educational goals. The article *Contradictions in the practices of training for and assessment of competency* locates similar paradoxes in the MET system (Emad & Roth, 2008, p.266-267). Some features of the MET are converted into obstacles when attaining the objective of the CBT.

Students along with lecturers are sceptic towards the administrations certification assessments. A student found several questions as un-valid and the concrete implications of some of the question were distrusted. The lecturer recognizes the problem of out-dated exams as well; the exams were written nearly 40 years ago according to the lecturer. This forces institutes to teach their students out-of-date information rather than useful teachings of today, since their main task is to satisfy their clients whose primary goal is to pass the assessments required to be certified (Emad & Roth, 2008, p.267-268).

The design of the current assessment system does not fulfil the goal of evaluating knowledge and proficiency required by marine officers to effectively operate a vessel. Exam questions are selected from a question database, which means they can come up identically across various assessments. Knowing this, students with the help of lecturers' emphasizes on memorizing questions and answers, due to the fact the set of questions are largely known in advance. The administration (in this article: Transport Canada) has recently developed new questions in order to expand the question database. The solution is considered temporary, since students and institutes shortly will acknowledge the new questions prior to examination (Emad & Roth, 2008, p.268).

The inconsistency found in Emad and Roths' (2008) article does not suggest that accidents at sea are caused by low competency among officers, since human error occurs even among the utmost competent individuals. However, the certification of individuals without sufficient assessment of knowledge and skill results in the idea that officers are competent when very little evidence supports the idea (Emad & Roth, 2008, p.268-269).

In the concluding paragraph Emad & Roth (2008) call for the IMO and the test administrators to step up and develop the standards further.

> "*The IMO and the examination administrators have to do more than just prepare guidelines regarding CBT but they have to arrange a proper transition process to this training concept. The certification system has to be modified as it has direct effect on the way that the maritime institutions and workplace deliver and the students obtain the skills and knowledge required to be a competent seafarer (2008, p.270).*"

In order fulfil the purpose of proper CBT training the governing bodies must ensure that mariners demonstrate their competency by setting up clear industry standards. Proper demonstration and assessment of ability to successfully carry out on board tasks verifies that students are eligible for a certificate of competency.

### 2.4.2 Present simulator training

Today there are different offshore courses available on the market. The course aim is to improve the knowledge of the operator and to maintain safe operations at sea. Courses could be attended at several places. For Kongsberg courses, the centre must be approved before courses could be held. To verify competence Det Norske Veritas (DNV) is using the ISO standard 17024 (DNV GL, *no date*) as an assurance. Courses relating to the accommodation segment such as DP and Anchor Handling have a specific standard (DNV, 2013 A & B). These standards have been set together with a certification committee and contain: principles, acceptance criteria and practical information relating to the Society's consideration of objects, personnel, organisations, services and operation (DNV, 2013 A, p.2). The awareness of each requirement is to be divided into four levels: Knowledge, Understanding, Application and Integration (DNV, 2013 A, p.6). The DNV approach for how to obtain the DP certificate is described in detail under Section 2.4.4.2. Another course relating to the DP operation is the Posmoor course. The Posmoor course is a mode used in the DP-system in regards to anchor operation. Today there is no specific accommodation DP course required to function as a DP operator on board accommodation vessels. The course developed by Floatel and its partners exceeds obligatory standards.

### 2.4.3 DP Training

In 1996 IMO invited their members to notify parties about the IMCA guideline M 117, at their thirty-nine-Section meeting. 10 years later in 2006, during their eighty-first session meeting, the IMO verified the updates. No major changes had been performed, but the guideline was reissued as Rev.1 based on the updated documentation and the best practice used in the industry (IMCA, 2006, p.1).

DP training could be done both onshore and offshore. It is the owners' responsibility to ensure the competence of the personnel involved in the DP operations (IMCA, 2009, p.14). This applies to all personnel involved in the DP system. The operator should track their experience on board the intended vessel as described under the same Section and in Floatel Int.'s DP Manual (Floatel Int., 2014 D, p.17).

### 2.4.4 DP certification process

To become an authorized DPO the operator needs to have obtained a valid STCW deck officer certificate. The valid certificates is shown in Table 2. There are two recognized ways of obtaining a DP certificate, either through the training scheme from the Nautical Institute or from the DNV training scheme.

**Table 2: DP Operator Certificates (The Nautical Institute, 2014, p.7)**

| STCW | DEFINITION |
|---|---|
| II/1 Deck | Officers in charge of a navigational watch on ships of 500 GRT or more. |
| II/2 Deck | Master and chief mate on ships of 3,000 GRT or more. |
| II/3 Deck | Officers in charge of a navigational watch and of masters on ships of less than 500 GRT. |

#### 2.4.4.1 The Nautical Institute

The scheme to become a certified DPO was in 2013 reviewed and revised. The new scheme from the Nautical Institute (NI) was taken into force the 1st of January 2015. To serve as a DPO, the "…*minimum qualification is set at STCW Regulation II/1, II/2 or II/3…*" for deck officers (The Nautical Institute, 2015, p.7). Operators, who started their training assessment before The 1st of January 2015, will be assessed based on the old DP scheme rules.

The old DP scheme rules required a DP basic/induction course of 5-days (40 hours). After completion of the course the students should receive a DP familiarization training on board, for a minimum of 30 days. The days were to be logged into the logbook received after completion of the induction course. Following completion of the on board familiarization, the student could attend a 5-day advanced DP simulator course (40 hours). When completed the advanced DP simulator course, further DP watchkeeping on board is required. Depending on the DP-class of the vessel, the time needed to obtain a DP Limited or Unlimited Certificate can differ. Supplementary to the time, operators must receive a statement from the Captain/OIM to confirm the level of knowledge.

The new training scheme is applicable for operators who began their training after the 1st of January 2015. This scheme makes it possible to withhold a certificate at three different levels. The three different certificates are: Restricted to Unclassed vessel, Limited certificate and Unlimited certificate. These categories are divided depending on the DP class of the vessel. To receive the certificate the operator must go through seven phases, A-E (The Nautical Institute 2014, p.6-26) (IMCA, 2006). The first phase is the same as before: an introduction course accompanied by practical assessment on board, followed by an advanced course. Both the introduction course and the advanced course end with a theoretical assessment. In phase D it is possible for the student to attend another DP course to reduce the number of DP days on board by half. After the student has attended the courses and sufficient DP sea time is withheld, the Captain/OIM must issue a letter of suitability together with a letter of confirmation from the company.

Requirements regarding certificate validity and revalidation were revised and altered in the new training scheme. Until the 1st of January 2015 the DP certificate remained valid as long as the operator regularly uses the DP system. The requirement was to have a minimum of a 6-month DP watchkeeping experience on board for the last 5 years. The operator could also obtain the certificate by working as an instructor at a NI accredited training centre (The Nautical Institute 2014, p.27) (IMCA, 2006, p27). From the 1st of January 2015 the operator needs to revalidate their certificate differently. The operator has eight different alternatives for revalidation (IMCA, 2006, p.27-32). The eight alternatives will not be described here since it falls outside the scope of this essay, although the alternatives can be found on page 27-32 in *The training and Experience of Key DP personnel* guidelines provided by IMCA (2006).

#### 2.4.4.2 DNV

On the 6th of June 2012 the Norwegian Maritime Authority (NMA) recognized DNV's concept as equivalent to the international standards and is valid to be used as a certificate (Vikse & Waage, 2012). According to the DNV standard for certification *"…the DPO must be a STCW qualified deck officer*" and operator knowledge is to be equivalent to the standard (DNV, 2013 A, p.5). To receive a DNV approved DP certificate training course need to be completed.

The course is divided into five levels. Starting at Level 0 with a computer based course (CBT) to Level 4 with both theoretical and practical assessment (DNV, 2013 A) (SMSC, 2014). Level 1 and 2 contain a familiarization course and on board training. Level 3 is more specialized on the intended work type e.g. Shuttle tanker, Rig etc. When all levels are completed the student must pass an assessment. The operator will receive the certificate once the assessment is completed.

The DP certificate is valid for 5 years, as long as the operator meets the STCW requirement. If the operator does not withhold a valid nautical certificate, the DP certificate will be invalid. After 5 years of service the operator need to take a practical examination at the course centre, if the operator passes, a new certificate will be issued (DNV, 2013 A, p.13 & 21-22)(SMSC, 2014, p10). The revalidation is a way to verify the knowledge of the operator.

## 2.5 Training Needs Analysis

Engineers within the human factor sector have been researching and developing solutions in order to decrease the risk of human errors. Due to the contribution, operator performance is enhanced because of the successful design changes of the operator interface. Nevertheless, it is essential that operators have been trained, in facing complicated high-risk situations where new advanced technology is being used

(Griffiths & Lees, 1995). Downsizing on staff results in enlarged burden on operators, who still frequently is the final safety barrier in the existing safety systems. Therefore it is imperative to train operators. The TNA is one organized method of how to allocate the gap between current competences and desired knowledge by the new equipment or designs. By using the TNA method, areas that shall be subject of training are identified (Griffiths & Lees, 1995).

The TNA approach towards training is uncommon, instead countless organisations structure their training on less methodical procedures founded on traditional practices, organizational policies along with other internal and/or external interests (Anderson, 1994, p.23). Organizational training plans are traditionally reactive and have an ad hoc approach. It means the training is designed after certain situations, which has occurred in the past (Grace, 2001). Further, training has previously been considered as a modest instructive procedure but the concept has been trending towards an organic learning process. The author Geoff Anderson (1994, p.23) described the shift in training technique in his article *A Proactive Approach towards Training Needs Analysis.*

> "*The idea that organizations must initiate and continue to foster transformative learning and that the role of the trainer will be increasingly to facilitate change is a common theme in recent literature.*"

TNA is considered as a proactive approach since the analysis identifies how individuals can gain new knowledge and develop present understanding, which ends in enhanced contribution to the organization by the individual (Anderson, 1994, p.24).

Another deficiency with the traditional training methods is the persistence of result orientation, which originates from prearranged behavioural targets. This disregards the option of spontaneous learning through functions such as personal comprehension and reflection, which may emerge throughout the process. The option is critical when training and preparing employees with proficiencies, which could potentially be required for future tasks. The primary aim of training should be to assist individuals to acquire knowledge and experience in pursuance of increased job competence (Anderson, 1994, p.23).

The traditional method is at times unsuccessful since it simply focuses on the employees' current work-task. The concept shall instead be extensive and designed to prepare the employees with new suitable skill required when facing new emerging issues. Further, training has previously been considered as a modest instructive procedure but the transformation towards an organic learning process.

> *"Training is an on-going process, one that is continually refreshed and renewed and where employees are encouraged to revisit training materials after the event. And naturally the content and style of materials should be tailored to the needs of the individuals undertaking the training (Denby, 2010. p.148)."*

From a TNA perspective training should be a regular part of employment in opposition to act as a singular isolated event or procedure (Anderson, 1994, p.23-25).

The TNA philosophy is in alignment with the belief of training as an on-going process.

The analysis generally studies the organization's needs, followed by department level and finally individual needs (Heery & Noon, 2008). The first step, identifying organizational needs could for example include identifying company objectives. The second level, studying department needs involves gathering information on skills and abilities of the personnel. The last and most detailed level, the individual necessities are fundamental for determining detailed employee training and requirements (Grace, 2001).

Training of employees has the potential to function, as a formidable and efficient investment by a company, however it must be applied in alignment and supplement to the organisation's prerequisites and objectives (Denby, 2010). One option of TNA organizational training is in-house courses with an educator were training can be adapted and taught with a clear purpose. This can be an advantage both in terms of finances and effectiveness. Due to the fact that individuals often attend external courses that they relish or are interested in, although they already are competent on the subject instead of being educated on areas required for accomplishing the organizational objectives (Grace, 2001). The company's strategic objectives are ordinarily set by top management and shall be communicated to everyone. This leads to a consensus among individuals what the organization is striving to achieve. The company aim guides the employees in terms of values and how to prioritize (Grace, 2001).

Grace (2001) discusses the importance of an appointed training co-ordinator and the role of top management in the *Training needs analysis* article. Training is easily neglected or inadequately planned without an assigned co-ordinator. Top management should preferably be committed, both in time and resources, but some involvement in the process is also necessary.

The next step contains gathering data and information of people's job requirements, existing abilities and knowledge required to meet future encounters. It is vital to anticipate change in regard of organizational and individual requirements. The last part includes analysis of the gathered data and establishing of gaps in knowledge. Gaps analysed are potential gap in knowledge or abilities and current requirements, followed by gap in knowledge or abilities and future assignments (Grace, 2001). TNA includes setback correction and discovering proficiency shortages, however the focus is not on previous insufficiencies but on upcoming effectiveness (Anderson, 1994, p.24).

The TNA concept is particularly useful in organizations where humans have a core function within organisations. The health and medical industry is one good example where the concept is highly useful and regularly used. The industry depends on the performance and skill of the employees. Health providers are faced with complex situations on a regular basis, human errors and mistakes come at high price. One example of an organization that effectively carried out a TNA on their health providers was Malta's Primary Health Department (Sammut et al, 2012).

# 3 METHODOLOGY

The Section begins with describing the methods applied by the authors, later the project process is portrayed. Important aspects such as ethics, data collection and research tools are presented as well.

The methodology chosen, see Figure 6, is considered by the authors to be the most suited technique for answering the academic research questions set in Section 1.2.1. An abductive approach towards the research has been applied since it fits the purpose of the Thesis.

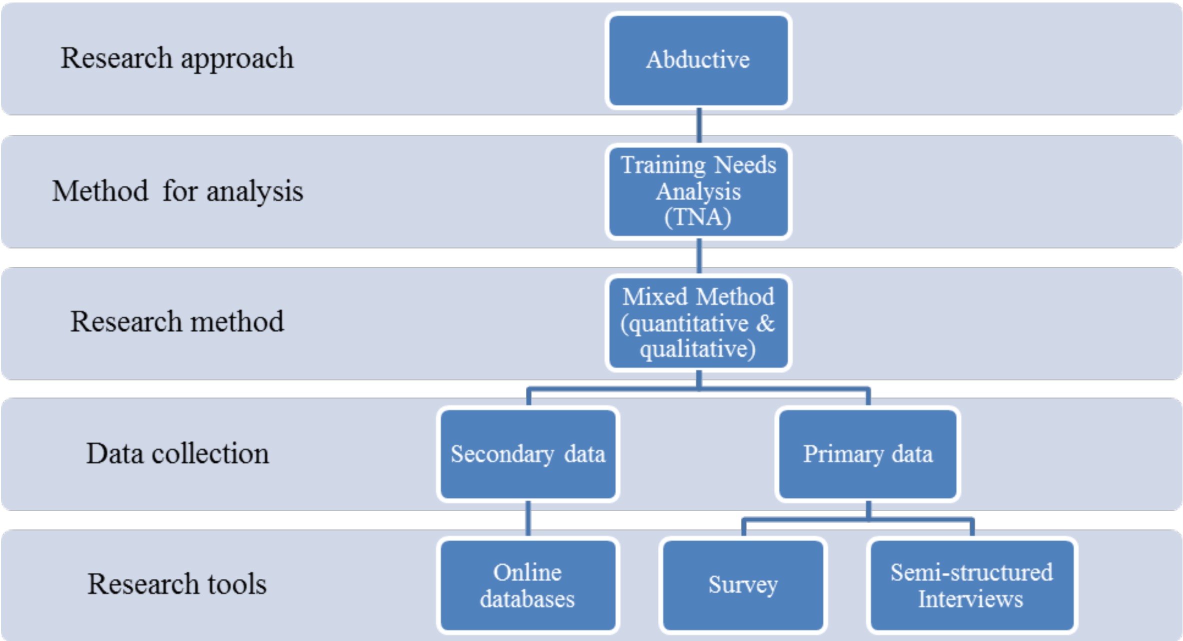


**Figure 6: Breakdown of Methodology used**

## 3.1 Research approach

Dubois and Gadde (2002) described abductive approach as useful during generation of "*new concepts and development of theoretical models, rather than confirmation of existing theory*". It would be challenging to reach the objective of the Thesis with a deductive approach, due to the lack of previous studies and data on the subject to formulate a hypothesis from.

## 3.2 Method for analysis

Heery and Noon (2008) defines Training Needs Analysis (TNA) as "*the technique of assessing the training required to fill the gap between what skills and knowledge are currently possessed by employees, and what ought to be possessed*". The process identifies areas for training in order to reach organizational and individual objectives (Grace, 2001).

The purpose of the TNA is to increase the internal knowledge within the organization and also develop available proficiencies. Improved employee proficiencies help maintaining personnel, since individuals consider themselves needed. This due to the willingness to invest in development and provide employees with knowledge to carry out requested tasks (Denby, 2010).

The TNA functions as an improvement tool for the organizations personnel, in order to fulfil the company's upcoming demands. The analysis can for example be completed using both quantitative and qualitative methods by gathering data through for example: observations, structured questionnaires and/or in-depth interviews (Anderson, 1994, p.23-24). Some background to the method of analysis and example of successful implementation was described in Section 2.5.

## 3.3 Research method

A Mixed Method has been chosen for the study. Quantitative methods are favoured when the aim of a study is to enhance available understanding in an area that formerly has been exploited. Floatel Int. does already provide their operators with a DP course, but available research on the area is lacking. In case of unexploited matters qualitative analysis methods are preferred. Furthermore, qualitative methods are beneficial when creating a deeper understanding of what purpose behaviour has for the respondents' (Clark-Carter, 2010 p.26). Since the aim of this Thesis lied within a rather unmapped area of the study, a mixed method was required.

Since each separate method has its boundaries it was decided a mixed method was appropriate. Additionally, each method can create understanding on different levels. Both closed- and open-ended questions have been used when gathering empirical data. A sequential approach has then been applied, where the result from one method (quantitative) has been elaborated using another method (qualitative approach) (Creswell, 2003, p.15-21).

## 3.4 Data collection & research tools

Empirical data is generally categorized into contradictions such as primary or secondary data. In this Thesis empirical data has been gathered through both primary and secondary sources. The two types of data have several differences, which affect the outcome of the study in terms of authenticity and quality (Eriksson & Wiedersheim-Paul, 2014 p.90). The credibility of this study is discussed further in Section 5.2.1.

Researchers generally gather primary data by interviewing respondents, observing participants or measuring etc. One advantage is the adaptability between research questions and data, the validity of the study. The main disadvantage however is the burden on resources in terms of time, capital and availability of sources (Eriksson & Wiedersheim-Paul, 2014 p.90).

The primary data in the Thesis derive from: a survey carried out on the company's DP operators, phone-interviews followed by an in-person interview with an external specialist on simulator training courses. Secondary data on the other hand is already gathered and available in for example: archives, registers or databases. This type of data is favourable from a resource perspective, although validity might be decreased due to the inability to adapt between the questions and data (Eriksson & Wiedersheim-Paul, 2014, p.90-91).

Secondary data has been collected throughout the Thesis by searching online databases and archives for relevant literature. Scientific articles and regulations that relates to the subject were found and discussed earlier under Section 2.

### 3.4.1 Ethics

The Thesis was of social scientific character and subjected towards improving the DP training for all accommodation vessel operators. All data gathered throughout the Thesis was collected in consent with respondents. No sensitive information of personal character was gathered, distributed or published.

Participation in the survey and interview was optional. The survey was anonymous for the operators, except for the individuals who volunteered for interviews via the questionnaire. The ones who volunteered could be identified via their email. These individuals and their statements were however confidential in the sense that no other person than the authors knew their identity. Operators at Floatel were introduced to the purpose of the study at an early stage of the Thesis. Permission to record the interviews was asked for and all respondents had a chance to edit or withdraw statements before they were included as quotes in the result. Both genders have been a part of the study. Detailed information of who was female/male was not mentioned, since it would be possible to single out certain individuals.

## 3.5 Project process

Hennink et al. qualitative research cycle has acted as a framework throughout the Thesis. The major cycle consists of three Sections, specifically: the *design cycle*, the *ethnographic cycle* and the *analytic cycle* (Hennink et al, 2011 p.4-5). An example of the framework is shown, see Figure 7.

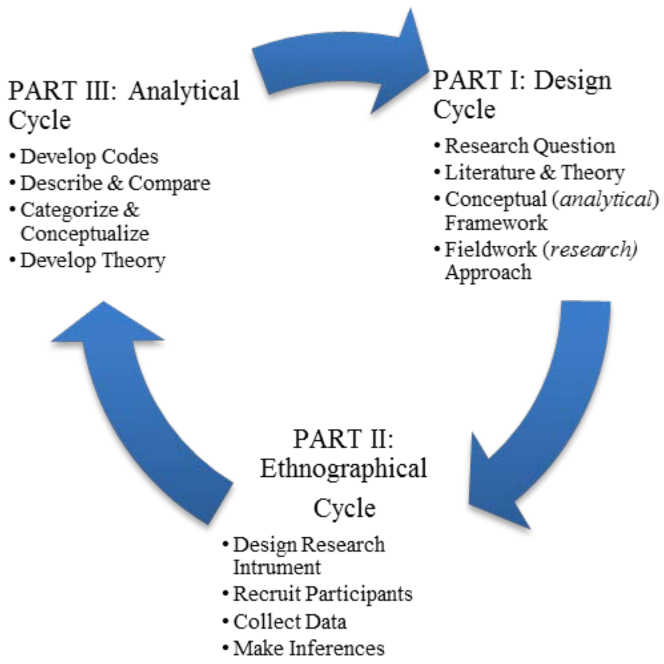


**Figure 7: Hennink et al. Qualitative Research Cycle**

### 3.5.1 Part I: Design cycle

The main tasks carried out in the first Section, the *design cycle* (*Part I*) were construction of research questions, reviewing research literature, and designing an analytical framework for the report followed by selecting an appropriate research approach.

Upon approach, the studied Company indicated that they were interested in developing their simulator training. The matter was then narrowed down; the authors, in collaboration with supervisor at Chalmers University of Technology, designed suitable research questions. The research questions were later accepted by Floatel Int. and finalized, the questions can be found in Section 1.2.1.

The aim of the study was to investigate how dynamic positioning simulator training on advanced marine accommodation vessel operations could be improved. Following discussion, it was decided that the most effective way to carry out the study in relation to available resources, was a study of Floatel Int. and their DP personnel. The Mixed Method approach was used when collecting and analysing data, even though majority of the data analysed was of qualitative character.

Relevant literature and material for the Theory & Background Section has primarily been gathered from online scientific databases and non-governmental organizations (NGO) webpages such as IMCA. Literature and articles of significance of composing a theory supporting the development of an effective DP simulator course specific for accommodation vessels are included in Section 2.

### 3.5.2 Part II: Ethnographical cycle

The second part began with designing research instruments; it was the tool used to collect data. The main instrument used in the Thesis consists of semi-structured interviews with DP operators and a simulator trainer. Additionally, with the purpose to act as a pre-study a survey was carried out. The intention was to prepare the authors for the planned interviews, the survey result acted as a foundation when constructing interview questions. All preparation prior to commencement was carried out in alignment with the TNA method. The method was introduced earlier in Section 2.5. How each research instrument was constructed is displayed in detail in the following Sections.

#### 3.5.2.1 Survey

It was decided to have a concise but qualitative online survey in favour of a high response rate. The online application Google Forms was used for designing and carrying out the survey. The option of having it distributed online was due to the demographic issues of intended participants and limited resources. The population of the study were spread out worldwide on board Floatel Int. accommodation vessels. However, the entire population had access to Internet during the scope of the survey.

Each question was assessed and discussed with all included parties (examiner, supervisor and representatives from the Company). Prior to commencement, a pilot study was carried out involving three individuals at Floatel Int. with previous experience from advanced marine operations. The pilot study was carried out on the

11th of February 2015, by in-person surveys. The aim was to ensure that the survey was comprehensible and that the respondents interpreted each question as the authors envisioned. The result in terms of function and logic of the survey was satisfactory since the respondents had no questions or concerns while answering. The average time for fulfilling the questionnaire was 4 minutes. No changes were required, which meant the questionnaire was considered finalized.

The online questionnaire along with a cover letter was sent out to all DP personnel on board the active vessels by the Vice President (VP) of Operations at Floatel Int. on the 25th of February 2015. The letter included the purpose of the study, estimated time for completion, incentives and an introduction to the individuals behind the survey. Later the confidentiality policy was described along with an explanation of how the result was used. Finally instructions with details of how respondents can contact the authors with questions or concerns were included in the cover letter followed by a link to the online survey.

Section 7, *Constructing Questionnaires* in De Vaus (2013) book *Surveys in Social Research* has been used when designing the questionnaire. The Section discusses the importance of balancing categories, alternatives exclusiveness, social desirability and exhaustiveness. The first half of the survey was of closed character and the open-ended questions were placed at the end, as recommended in the Section (De Vaus, 98-120).

The survey is attached at the end of this Thesis (See Appendix B – Online Survey). Each question used had a purpose and contributed to the result. Participants were asked to specify their positions on board and assigned vessel. This in order to identify any trends and to investigate if the simulator training shall be position or vessel specific. The available positions to choose from where the once regarded as key DP personnel.

Question 3 required respondents to specify their time at sea. The time at sea was relevant in terms of experience of critical situations, along with time passed since receiving the education. Individuals with *Less than 5 years* of experience can be assumed to have relatively modern training. Knowledge from school and simulator training could then be considered up-to-date. The next three alternatives are of intervals of 5 years. If the last option *More than 20 years* was selected, received education was considered to be out-of-date. This since the STCW regulations were amended and a major revision was conducted in 1995 (IMO, 2010), which influenced how training and education was conducted. The question allows the two authors to identify if correlation exists between experiences at sea and individual opinions regarding the DP simulator training. Potential differences between experienced and inexperienced operators may as well be discovered. The next questions asked respondents to specify their experience on board accommodation vessels.

Question 8 included a statement regarding the value of an accommodation specific DP simulator course in terms of increasing their proficiency as operators. The operators were asked to rate whether they agreed or disagreed using the Likert scale. The goal was to get an understanding of the operator's view of a DP specific simulator course, in terms of personal development.

The following set of questions investigated participants' previous experience from advanced marine operation simulator training and accommodation specific courses. They were also asked to specify by whom such courses had been carried out by. With a positive answer respondent confirms that they are familiar to practicing operations in such a milieu. It was of interest to recognize if respondents who participated in earlier courses had a different view of accommodation specific simulator training and what critical elements could be included in order for courses to be improved.

The next pair of questions was of open-ended character and allowed the respondent to generate his or her own answers. Open-ended questions were used since it would be difficult to provide respondents with a sufficient number of alternatives. Supplying a question with insufficient options would create a false result and could lead to an increase in non-responses (De Vaus, 2013, p.115-116). Researchers can formulate new knowledge statements instead of elaborate on existing hypotheses. By having the operators list the five most critical elements, answers could then be compared in a search for a consensus among the respondents. A clear consensus among operators could indicate that the element is of particular importance. Because an element is rated as critical does not automatically mean the operator wish to include it in the simulator training course. The operators may already master the element and would rather focus on practicing other more essential matters. The aim was to use the responses from these two questions regarding critical elements and elaborate further in the in-depth semi-structured interviews. Respondents could volunteer for the interviews by leaving their email addresses in the end of the survey.

A friendly reminder was sent out, half way through the research period (7$^{th}$ of March) in purpose of increasing the response rate, see Figure 8. The survey was available via the online link for 20 days before the results were downloaded and compiled on the 17$^{th}$ of March. On the same day the survey was concluded in an email including our and Floatel Int. appreciation.


**Figure 8: Timeline of Survey**

The population to which the study was distributed was estimated to approximately 20 operators. 14 responded to the survey under the 20 days, which results in a response rate of 70%. Off duty operators were not included in the survey.

#### 3.5.2.2 Semi-structured interviews

Semi-structured interviews have been conducted on the Company's DP operators and an external simulator trainer on the subject of marine simulator training courses. Separate interview guides were prepared for the two occasions. Both interviews were based on the result from previous data collection and carried out by the authors.

Five semi-structured interviews with DP operators at the Company were carried out over the phone on April 30th 2015. Prior to the interviews the survey results had been analysed. The result along with the research questions laid the foundation for the interviews. The authors created an interview-guide prior to the interviews with inspiration from the book *Den Kvalitativa Forskningsintervjun* by Brinkmann & Kvale (2009). The guide functioned as an overview of the topics to be covered with suggestions of suitable questions and follow up questions to ask. The authors used their judgement on questions to ask and direction to steer the interview. By this, previously discussed questions were not asked. The guide was gone through and approved by the supervisor and examiner at Chalmers University of Technology. Emphasis was to create short and clear qualitative questions, which allowed for receiving comprehensive answers. The quality of the guide and the interview itself is imperative in terms of the quality of answers (Brinkmann & Kvale, 2009 p.178-181).

Participants chosen for the interview were those who had volunteered throughout the survey. This meant a relationship between the authors study and the respondents already existed. The operators could then prepare themselves since they recently reflected over the subject and knew what was being researched. An e-mail was sent out prior to the interview informing the individuals of the date and time. Some information of the topics planned to be discussed was disclosed two days before the interview took place. Disclosing the purpose in advance is optional (Brinkmann & Kvale, 2009 p.140-147). The authors chose to unveil the topics in advance to permit respondents to reflect and prepare themselves for the interview. This along with a previous relationship allowed for well-thought of and comprehensive answers. Respondents were engaged throughout the conversations and showed interest towards the study. This was however expected since they volunteered to participate.

Each response was considered important and all answers within the scope of the Thesis were included. The interview setting was calm in the sense that the two interviewers were located in a closed calm room with access to a speakerphone. The majority of the respondents were on-duty on board the vessels when calling in to the phone interview. The surroundings were however peaceful and the respondents expressed no signs of stress. This meaning the respondents had time to elaborate and focus on the interview. The interviewers gave the respondents' time to elaborate and reflect throughout the interview, by talking slowly and applying short pauses at times. The interviewers had divided up various tasks prior to the interview. One focused on the conversation with the respondent while the other was in charge of taking notes and setting up equipment. Both individuals did however make sure all topics were covered. The results were discussed amongst the two authors after completion to ensure the answers were perceived the same way. Afterwards the audio files were used to verify notes taken throughout the interviews.

The interviews began with formal questions that confirmed that respondents were aware that the interviews were not anonymous but confidential. Meaning the authors knew who were participating in the interview, but no names or personal details were to be disclosed neither in the Thesis nor to the management at Floatel Int. The individuals were given aliases, referred to as Respondent A to E. This was decided in order for the respondents to feel free to express their opinions and personal beliefs. The risk for any negative feedback or sanctions for them personally was then eliminated. Afterwards, the respondents were asked if they approved of being recorded and quoted.

The next group of questions were more open for discussion and were about the seven elements considered critical in the survey. The respondents were asked if they considered the element critical. Following, each individual was asked to explain why the element was critical and if there was a need for training. Focus was on listening and asking relevant follow-up questions. The interviewers did also ask questions to cover viewpoints or subjects revealed by other respondents. The aim was then to compare the individuals and investigate to what degree they concurred or disagreed.

Later respondents were given the chance to rate the three most critical elements to include in the DP simulator course. Next, respondents were requested to add any supplementary critical element not covered in the discussion. Subsequently, a discussion took place regarding the elements increasing in criticality due to the development of the industry or technology. Towards the end the respondents elaborated on what they personally wish to gain from a DP specific simulator course. To conclude the interview, the respondents were asked if they had any other thoughts or comments they'd like to express. Time wise the interviews carried on for approximately 25-40 minutes.

A trainer on the area of marine simulator training was contacted in pursuance of an external opinion. The aim was to discuss and get a professional assessment and discuss the results from the interviews with the operators. Both management at Floatel Int. and the supervisor at Chalmers University of Technology recommended the individual. The interviewee works as a pilot and simulator trainer for *The Swedish Maritime Administration* (Sjöfartsverket) and functions as an educator in the administrations simulator facilities located in Gothenburg, Sweden.

The authors contacted the trainer via e-mail and proposed an interview. The purpose of the study and the Thesis was presented in the same e-mail. The interviewee was positive to the study and the interview. A date and time was set and the authors sent out topics that were going to be discussed prior to the interview. An interview guide similar to the one created for the DP operators were created. Although this time the interview was to focus on the results from the phone-interviews and not the survey. One goal was to get some input of critical elements that are believed to be increasing, but also an objective view of the training needs and simulator training.

The aim of the interview was to have an open discussion regarding how The Swedish Maritime Administration educates mariners in their simulators. The plan was to focus on simulator courses in general and how the future demand for training is projected to look like. Subjects as recent simulator development and a discussion regarding reactive versus proactive scenario based training took place. The interview was recorded in agreement with the respondent and took place at the Floatel Int. office in a conference rooms on the 4$^{th}$ of April.

In addition to the survey and interviews, on-going discussions between the authors and management within the Company along with the supervisors at Chalmers University of Technology have been carried out throughout the whole process.

### 3.5.3 Part III: Analytical cycle

The third component the *Analytical Cycle* includes the main parts of qualitative data analysis such as: developing codes, explaining and comparing, grouping data and finally development of theory. Findings from the *Ethnographic Cycle* have been studied under Section 4. The results have been linked to the original models, presented in Section 2, to compare the existing concepts in order to form new theories (Hennink et al, 2011 p.4-5).

#### 3.5.3.1 Survey

The data from the survey result has been analysed and presented mainly using charts. The raw data from the open-ended questions regarding critical elements were grouped into several categories. Categories with at least two answers were presented. Categories including single answers were not included in the pie charts, since the aim of the study was to research the viewpoint of the group as whole and not individual opinions.

#### 3.5.3.2 Semi-structured interviews

The results from the interviews with the operators were presented using aliases. The responses and opinions have been summarized in Section 4.1.1. The authors have been comparing the questions when analysing the data in search for possible trends and common denominators. The aim was to objectively present the interviewees' opinion and thoughts. Later the results were compared to data from the survey and theories mention in Section 2 in order to identify connections or distinctions. Audio files were used during the analysis of the interviews. The audio file acted as a reminder for the authors and allowed for using quotes in the result Section.

# 4 RESULT

Organisational objectives has been studied in order to identify required competency. The organizational requirements has then been analysed in order to identify individual needs. The individual needs were researched by a questionnaire and in-person interviews.

Grace (2001) describes how to act as an organisation to develop high individual competency and proficiency from a TNA perspective. When comparing Grace (2001) statements to Floatel Int. current training approach, both similarities and differences were identified. The TNA method highlights the importance of communicating organizational objectives. The Company vision is described in order to gain understanding of individual operator requirements throughout DP operations. Floatel Int. vision *"is to own and operate the most modern, safe and reliable floatel fleet in the world in order to meet the increased market demand"* (Floatel Int., 2014 A). Floatel Int. fulfils this by sharing company objectives and policies through their management system, STAR. STAR is accessible fleet and office wide. In order to meet the objectives employees must have the necessary knowledge to satisfy today's market but also to fulfil future demands.

Operating the utmost modern fleet incorporates the introduction of new systems, this means new proficiencies are required among operators carrying out the DP operation. The objective of a safe and reliable marine operation could be regarded as apparent; however the introduction of new systems and increased market demands enhance risk and burden on the operator. Therefore the organization could invest in operator DP training in order to acquire and maintain sufficient competence. The organization benefits from the customized course since enhanced operator competency results in increased safety awareness. The simulator course is supplementary to the DPO certificate courses, obtained from NI or DNV.

Floatel Int. has since December 2013 trained their DP operators in an accommodation specific simulator course. As mentioned in Section 4, the aim is to organize the course every other year. This demonstrates that the Company considers training as an on-going process, which is essential according to Grace (2001). The reoccurring courses allow for refresh and renewal of competency. There is no requirement of having a specific accommodation vessel course. The Company's own initiative is by the authors considered as proactive and a safe approach towards meeting future demands. The training course acts as a safety barrier to prevent incidents at sea.

By arranging specific accommodation simulator courses in collaboration with SimSea, content can be customized to the organisation. Grace (2001) supports the idea of in-house training since training can be adjusted to a clear purpose, which fits the specific organisation. Although in-house courses could negative from a financial aspect in a short-term perspective, but we believe the long-term aspects prevails the short-term financial loss. The long-term benefits are believed to arise from reduction in incidents due to enhanced competency. Grace (2001) encourages in-house training from a financial point of view since course relevance can be ensured.

The individual training needs has been investigated by a survey and in-depth interviews in order to analyse current knowledge and future requirements. The goal was to maximize effectiveness of the course. Focusing on critical elements and improving the course content will strengthen this barrier element.

## 4.1 Survey

The survey and the process were described earlier under Section 3.5.2.1. Responses were recorded from all three Floatel Int. accommodation vessels operational at the time of the survey. The raw data from the open questions (questions 9 and 10) has been processed and divided into categories. The categories have been formed in order to interpret the answers and identify potential trends.

Question 1 showed that majority of the participants came from Floatel Reliance, see Figure 9. Floatel Superior had the lowest number of participants in the study.

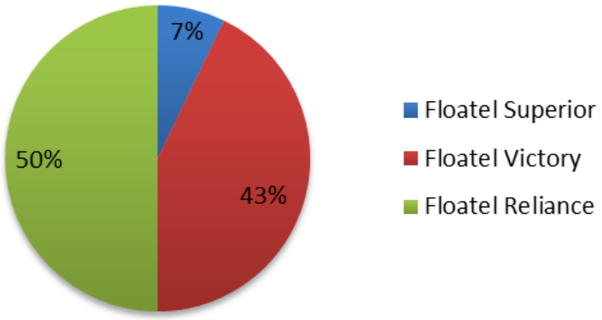


**Figure 9: Current rig of operation**

Question 2 divided respondents by their current position on board the vessels. All three bridge positions were represented in the study. The majority, 72% of the participants were DPO/SDPOs, see Figure 10. Reason for the high rate of representation from DPO/SDPOs is expected since the position is represented the most amongst the DP personnel on board. Four DPO/SDPOs are split up between two shifts, two on night and two on day shift. The Captain/OIM and the Chief Officer are on a normal basis on day shift, but are always available when needed.

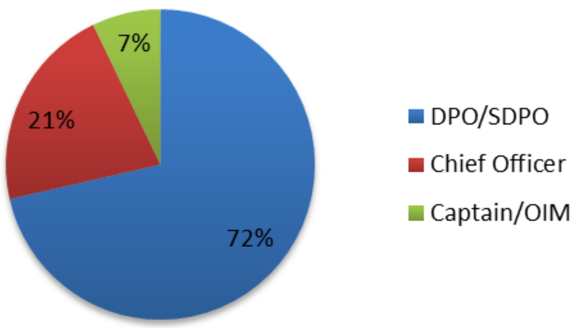


**Figure 10: Participants position**

Question 3 required the respondents to specify their experience at sea. There were five different time spans to choose from. The first four options had a span of 5-years, the last option was summarized as *More than 20 years.* The distribution of the participants was good. More than 29% of the participants had more than 20 years of experience and 21 % of the participants had between 16-21 years of experience. These two categories made up for 50% of all responses, see Figure 11.

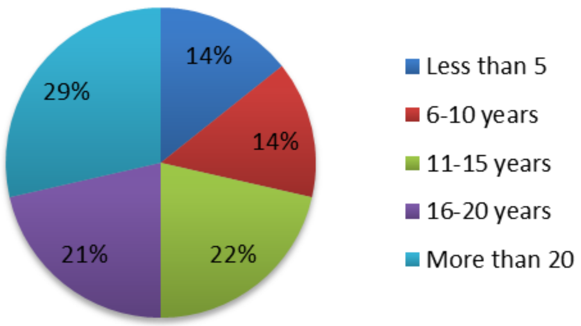


**Figure 11: Sea experience**

As a follow up to the previous question, the officers were asked in question 4 to specify the years of experience on board accommodation vessel(s). 50% of the respondents had less than 2 years of experience, see Figure 12; out of these were 86% DPO/SDPOs. Operators with *more than 6 years* of experience have experience from other companies. There was no correlation visible studying the other 3 categories of experience.

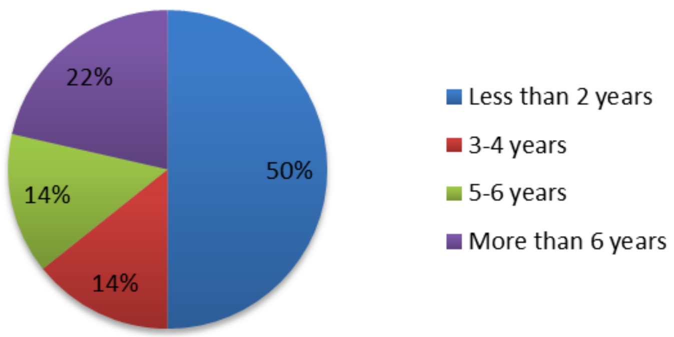


**Figure 12: Experience of operating accommodation vessel(s)**

In question 10 participants were asked if they participated in any type of advanced marine operation simulator training course. 14% had not any experience as such, see Figure 13. All of these proved to be DPO/SDPOs. The high ratio of previous simulator experience indicates that the majority of the operators were accustomed to this type of courses when training on advanced marine operations.

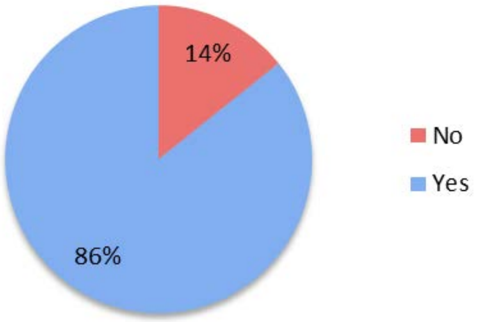


**Figure 13: Advanced marine operation simulator experience**

Subsequently participants were asked to specify if they have participated in a simulator training course, specific for accommodation vessels. As previous question 86% answered *Yes*, the remaining 14% were found to be DPO/SDPOs, see Figure 14. Later respondents were asked to specify where they attended the accommodation-training course.

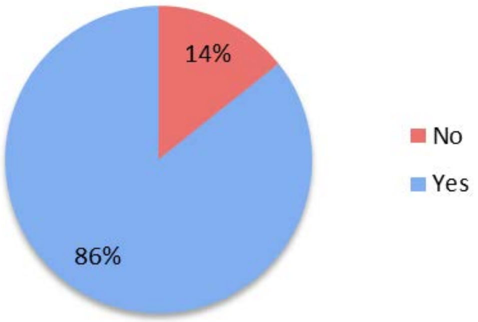


**Figure 14: Accommodation specific simulator experience**

Out of the 86% who had participated in a specific accommodation course; 83% attended a course arranged by Floatel Int., the other 16%[1] attended courses arranged by Prosafe or Kongsberg, see Figure 15. The participant who attended a Prosafe training course had more than 6 years of experience operating accommodation vessels. The participant who attended the Kongsberg's training course has less than 2 years of experience. The respondent could have misinterpreted the question, since Floatel Int. courses are held in a Kongsberg simulator centre. The two individuals who participated in courses arranged by other companies than Floatel Int. did not deviate from the others to define critical elements and training needs.

[1] Numbers have been rounded off to nearest whole number.

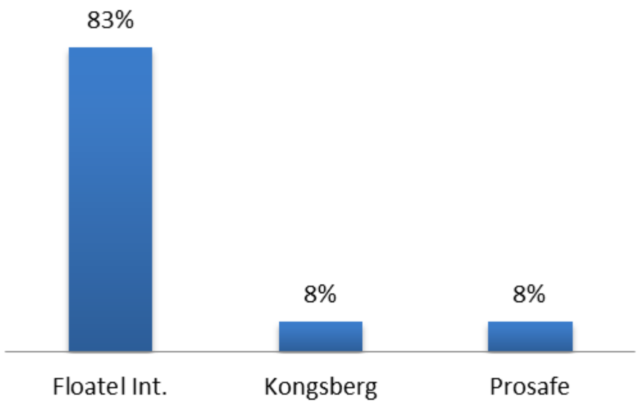


**Figure 15: Accommodation specific simulator courses attended**

In question 8 participants were asked if an accommodation specific DP simulator course would increase their proficiency as an operator. The scale was categorized from 1 to 5. The lowest option meant the respondent *Strongly disagreed* and choosing the highest option 5, meant the respondent *Strongly agreed.* The individual who *Disagreed* had *less than 2 years* of experience on board accommodation vessels. The respondent had previously participated in an accommodation specific simulator course and the low grade could be based upon a negative experience from previous training course. The authors did not see any correlation between the years of experience at sea or experience on board an accommodation vessel and the opinion of a specific DP simulator course. However, the mean value of the responses was calculated to 4,7. The result can be summarized between *Agrees* or *Strongly agrees*, see Figure 16.

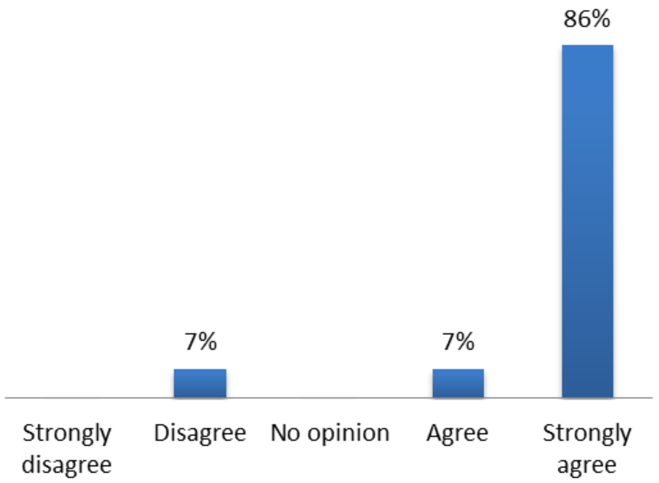


**Figure 16: Participants perception of simulator course effectiveness**

The raw data from the open questions (questions 9 and 10) has been processed and divided into categories. The categories have been formed in order to interpret the answers and identify potential trends. The categories with one or less responses, have been excluded from the result since the aim was to present the opinion of the group and not as individuals.

In question 9 respondents were asked to list the five most critical elements of a DP system. There were seven categories with two or more responses. The three most reoccurring critical elements fell under the *Power Management System* (*PRM*), *Position Reference System* (*PRS*) and the *Sensors* category, see Figure 17. A correlation between *Follow Target* as a critical element and assigned vessel was noticed. All individuals who mentioned the element were positioned on board the Floatel Reliance. No other clear correlation to the critical elements was identified in terms of vessel, position or experience.

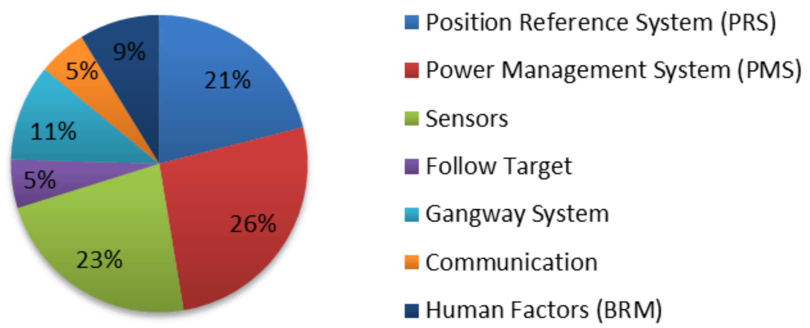


**Figure 17: Critical elements during advanced marine DP operations**

In question 10, participants were asked to specify which critical elements were necessary to include in a DP simulator course in order to enhance their competence as operators. Less critical elements were mentioned in question 10 compared to question 9. Operators stated that 65% of the critical elements mentioned in question 9 to be a part of the DP simulator course. However, a few of the respondents felt there was a need for training on all critical elements mentioned in the previous asked question. There were six categories with two or more responses recorded, see Figure 18. The two largest categories were *PMS* and *Sensors* which made up for about 50% of all the responses.

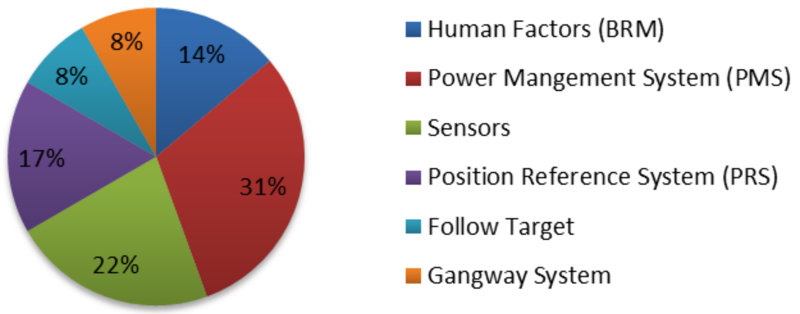


**Figure 18: Critical elements to include in a DP course**

The final question, number 11 allowed the respondents to volunteer for the planned in-depth interviews. Five responses were recorded and each individual was contacted. The results from the survey acted as guidelines when designing the in-depth interviews.

### 4.1.1 In-depth interviews with operators

There was a satisfactory dispersion between respondent's positions on board. Positions such as DPO(s), SDPO(s) and Chief officer(s) were represented in the five interviews. There was no position that was overrepresented in the interview. However, no Captain/OIM volunteered to participate. All participants approved being recorded; the audio-files were saved to be used when analysing the interviews. Participants were also asked in the beginning of the interview, if statements could be quoted in the report. All respondent agreed to this.

The experience on board accommodation vessels among respondents were mainly within the 0-2 years timespan. Majority of the respondents were close to 2 years of service, but there were also (a) representative(s) from the higher timespan of 5-6 years. Due to the spread of experience, variation in knowledge and DP proficiency has been included.

### 4.1.2 Critical elements

The main focus in the interviews was gaining knowledge in terms of which elements were most critical during advanced DP operations and which elements to include in an accommodation specific course.

#### 4.1.2.1 Power management system (PMS)

PMS was considered as a critical element during advanced marine DP operations. Respondents mentioned operations could not be carried out without proper power supply. Respondent A elaborated: "*the power supply will need to be evaluated in regards to each scenario to avoid blackouts*". However, two of the respondents mentioned the PMS as critical only during significant failures in the systems. The system is described as complex and emphasizes the importance of knowledge in terms of the system as whole. Both respondent A and B considered it fundamental to have partial understanding of how the system intervenes.

Three individuals with the least experience expressed the need for training to increase the understanding of the system. One example was to improve the usage of the FMEA on board. The respondent mentioned that the FMEA results should not only be read in its content, the operators should also have an understanding of why the results occurred as well. Respondent B believed the system should be subject for training. Although the PMS was included in the DP training the individual believed further training on how to calculate and evaluate the expected power demand is necessary. Two respondents proposed too not only practice on pro-active scenarios but also reactive such as procedures following partial blackouts. Respondents D and E did not agree with the need for PMS training at a simulator centre. This training could instead be carried out as a table top exercise on board.

#### 4.1.2.2 Position reference system (PRS)

All respondents considered the PRS system as a critical element. Two respondents mentioned the importance of understanding the system and its limitations. One individual gave an example "*the operator should be able to evaluate system values as realistic or not*".

Respondents were unanimous that there is a need for training within the PRS systems. PRS systems mentioned to be in use were for example: Global Positioning System (GPS), Radius, Cyscan and Gangway. Respondent A expressed a need to increase education on the various systems limitations and behaviours.

#### 4.1.2.3 Sensors

The respondents shared the opinion of sensors as a critical element, although some sensors were considered more important than others. Respondent C mentioned that there is a redundancy in the system, which allows the operation to proceed even if a sensor is not functioning. Available sensors on board the vessels differ depending on vessel design. Examples of mentioned sensors were gyro and wind.

Two out of the five respondents believed knowledge gained from current training is sufficient. The other three expressed a wish to include sensor dropout in existing DP course. One individual suggested situation adapted training in order to enhance understanding of system and operator behaviour. Respondent A mentioned, *"wrong input on one sensor could result in secondary failure on other sensors"*.

#### 4.1.2.4 Gangway system

All respondents considered the gangway system as critical. Person A explained, *"the gangway is critical, that is what we make our living on"*. Later respondent C elaborated on the matter *"all operations when connected to another platform are considered critical"*.

Several of the respondents highlight the complexity of the system and the importance of proper training. Respondents C and E requests a separate gangway course to increase operator proficiency. If a separate course is not feasible it was suggested to be the main focus of the existing operator course. The experience from previous training among the respondents varied.

#### 4.1.2.5 Follow target

Each operator considered the element as critical. All respondents showed signs of knowledge within the element; it was assumed that all personnel had experience of this type of operation.

Four out of the five had participated in a specific follow target course. However, two respondents consider there is a need for training within the upcoming new software. Thruster dropout, load reductions and fallbacks are mentioned as realistic scenarios to practice.

#### 4.1.2.6 Human factors

All respondent agreed upon human factors being a critical element. Four out of five respondents found the element to be the most critical of all during advanced marine DP operations. Human factor was a reoccurring element throughout majority of the questions. One example was respondent B who included human factors when answering all questions regarding critical elements.

Training such as Bridge Resource Management (BRM) and Maritime Resource Management (MRM) was considered needed. Two of the individuals with high rank on board expressed the importance of having a specific DP human factor course. Respondent E explained, *"my OIM and I actually discussed the issue yesterday… there is no existing BRM course for DP operations available"*.

The importance of sharing knowledge between operators is mentioned several times. Respondent B described, *"it is important to enhance ones colleagues in order to increase group proficiency, it exceeds the value of individuals knowledge"*. Respondent C described the same issue. Organisational culture in terms of open mindedness and constructive criticism are two important factors. The mix of nationalities and cultural differences could be factors contributing to insufficient sharing of knowledge.

Two respondents suggested to include the pilot and co-pilot system used on board regular vessels, to be adapted to the daily accommodation operations. The system suggested by senior ranks had stricter guidelines for bridge management during operations.

#### 4.1.2.7 Communication

The respondents considered the element critical, although several individuals mentioned it could be included in the human factor course. During the communication element discussions, the pilot and co-pilot system was mentioned once again by senior rank respondents. The issue of cultural differences was also stated.

Several respondents expressed that there are room for improvements in terms of communication on the bridge during advanced marine DP operations. Respondent D emphasized the importance of clear and easily accessed communication, both internally and externally.

#### 4.1.2.8 Three most important elements to include in a DP course

The five respondents were asked to list the three most important critical elements to include in a DP course, see Figure 19. Human factors were considered to be the most crucial element to include. Respondent C highlighted the importance of the element by answering *"human factors, human factors, human factors"* when asked to list the elements. The respondent had to adjust the answer to three different elements.

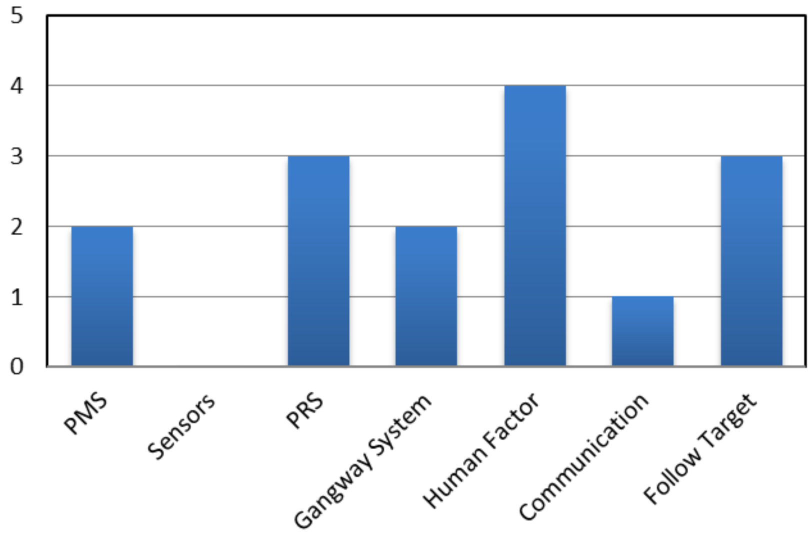


**Figure 19: Critical elements to include in DP course**

The two other critical elements to include were PRS and Follow Target. Under Section 4.1.2.5 the respondents mentions participating in a Follow Target course. No previous participation of a PRS specific course was mentioned throughout the interviews. Four out of five requested a course focused on PRS.

A noticeable need for training is the gangway system. The element is considered critical and respondent C sees it as an increasing critical element within today's industry. The need for training was discussed under Section 4.1.2.4.

### 4.1.3 Thoughts on training and DP course

The majority of the respondents said that it would be most beneficial with a vessel specific course. Respondent A states, *"this usually gives the best results"*. A module-based course where predefined systems have been divided during a week's time could be used to increase the knowledge of the operators', states respondent B. It was suggested that operators could participate days when desired systems were scheduled. The same operator expressed the need for both theoretical and practical sessions. Another respondent would like to see more individually based training plans. However, it was also mentioned during the interviews that from a pure financial aspect, courses could be done together with operators from other vessels. No individual mentioned the need for a position specific course.

Training together with other vessels would increase the chance for sharing lessons learned and experience transfer amongst operators. During the interviews the majority mentioned that there is a shortage of experience transfer and lesson learned today.

One respondent mentioned a previous incident, but was unsure if the lessoned learned had been communicated out to the other vessels. Operator C also describes the cost benefits of a well-functioning system of sharing experience and lessons learned.

It was requested by respondents to have individually adapted training arrangements, since each operator differs in competence and experience. The learning curve when transferring from ordinary/offshore vessels to accommodation vessels is according to Respondent A steep. Respondent E would like a DP training station on board for training purpose. The station could then be used for training on realistic and probable scenarios. These types of scenarios are requested to be used when training at onshore training centres. One example given from a Respondent was the setup of Follow Target from approach to connection. The Company aims to create as realistic scenario as possible by using LSOG, DHSA and FIMS documents.

A large number of the respondents described the importance of both proactive and reactive training. Proactive training is used to avoid incidents, but the need to receive reactive training was highlighted as well. Respondents C and D request training in terms of DP emergency situations, in order to practice operator actions after for example position dropout, partial blackout or total blackout. An example given of a preventive approach *"would be to attend a course specific for the operation in advance, instead of during the project"*, Respondent C. This would then minimize the learning as you go, which are common within the shipping industry according to two of the respondents.

Respondents A, B and C emphasizes the importance of theoretical and practical competence. Operator B elaborates, *"the aim should be to minimize decision making based on opinions and instead base decisions on facts"*. In order to manage the above mentioned training needs, Respondent B suggests appointing a Training Manager within the Company. The manager *"should be familiarized with existing STCW requirements and work to ensure high competence among the operators"*. The same respondent stated a need for appointed assessors and trainers on board the vessels. These individuals would need to have specific proficiency in how to teach and assess new operators. Operators should be appointed to these tasks in regard to their competence and ability to assess other operators.

Numerous of the previous training courses for Floatel Int. operators have been arranged by Kongsberg Maritime. All of the respondents expressed the high quality and their satisfaction in regards to the attended courses. The respondents were asked if any critical elements were found to be missing during the interview, however respondents were pleased with the elements discussed. Respondents found the study to be *"well set up and professional"* (Respondent C) and *"comprehensive"* (Respondent A and E).

## 4.2 Interview with external simulator trainer

The interview with pilot and simulator trainer at Swedish Maritime Administration (Sjöfartsverket) confirmed parts of the results from the previous studies. Certain features such as Follow Target could however not be confirmed due to the trainer's limited experience from the offshore industry. The pilot and simulator trainer were not surprised by the fact that Human Factors had been identified as the main critical element, which required training. However, he mentioned the complexity of educating this as a standalone element. This since it is difficult to focus only on the human factor element; instead he recommended including it in all types of training. The training would then focus on not solely the Human Factor element but also the correlation to the system. A correlation between the elements is vital for gaining an understanding of the systems and how they interact.

The Swedish Maritime Administration claims it is more beneficial to conduct regular training courses with less training days then courses with a long interval and a long agenda. The pilot and simulator trainer preferred courses to be conducted with an interval of about 1 to 2 years instead of the STCW requirement of 5 years. This to keep the knowledge fresh and up-to-date.

To conduct a qualitative course it is important for the course participants to use the same simulator infrastructure as on board, according to the interviewee. This to keep the scenarios as realistic as possible. The pilot and simulator trainer has noticed a remarkable increase the last three years in simulator usage within the Swedish Maritime Administration. Scenarios which are not often experienced on board could be practiced in the simulator. The interviewee mentioned that all Swedish pilots need to navigate their routes at least once in heavy fog. Proactive training is preferred compared to the reactive training. This since it will prepare the pilot for different scenarios and challenges. The interviewee argues *"to give the operator several failing variables to handle is not suitable out of an educational perspective"*. If the operator cannot successfully handle the failures the operator are likely to leave the course with a negative impression and a low self-esteem. But an even more devastating scenario would be if the operator handles the failures successfully without following the procedures. Then the operator is likely to solve the failures using the same approach on board without knowing the risks. To avoid incorrect learning the Swedish Maritime Administration educates their pilots using phases in the simulator training. The phases will be stepped up in complexity upon completion. The scenario and how to handle the situation are first explained and shown to the course participant. The participants will then be given the chance to practice the scenario on their own. Each scenario will increase in difficulty and complexity. By the end of the course the course participants could be given a simple reactive scenario to handle. The reactive training is to ensure knowledge of participants. The reactive scenario are kept simple in order for participants to leave the course with a positive self-esteem.

# 5 DISCUSSION

The following Section discusses the results from the survey and interviews and compares the result to articles and theories presented in Section 2, and also the method used in the Thesis. The Section includes the two author's own assumptions and theories.

## 5.1 Result

The survey identified a number of personnel with less than two years of experience on board accommodation vessels. The author's believe this could be connected to the fact that Floatel Int. is a recently founded company. Another reason could be the rapid development of the segment, which has resulted in an increased demand for DP operators.

To identify relevant course content the survey and interviews singled out certain critical elements during advanced marine DP operations. Seven main elements were identified in the survey; these elements were confirmed in the interviews to be accurate. During the survey the PMS, PRS and sensors were the three most commonly mentioned critical elements. The three most critical elements to include in a DP training course correspond to the three elements mentioned as critical. In the interview however, Human Factor, Follow Target and PRS were considered as the three most critical elements to include. We believe the Human Factor category increased after the respondents discussed and had time to reflect on the various elements. Several respondents stated that the Human Factor element is interrelated to all the other elements, which is most likely contributed to why it was considered the most vital element to include in the training. The Follow Target element increased as well, it could be due to several of the respondents operates or has operated on board vessels using the Follow Target mode.

By focusing on the most critical elements, training efficiency can be increased. The authors believe this can lead to an improved return on investments. This since increased proficiency will most likely result in a decrease of incidents and unexpected costs. Additionally, a decrease of incidents is favourable environmental perspective. An increase of the number of incidents could be expected due to the growth of the accommodation vessel industry. A proactive approach to prevent incidents would be to use lessons learnt and experience transfer from previous incidents such as Kvitebjørn and Piper Alpha into the simulator training. By foreseeing future demands, we recommend for senior crew to be introduced and educated on their work task well in advance. One way of educating the crew could be to participate in an accommodation specific DP course. Industry demand along with equipment developments forces training content to be updated. As mentioned by the Swedish Maritime Administration's own simulator trainer and Andersson (1994), training shall be considered as an on-going process and should be maintained frequently. The same individuals mention the significance of assisting students throughout the training process. Focus shall be on gaining knowledge and understanding rather than the results. This is in alignment with the Swedish Maritime Administrations view of how simulator training shall be carried out.

During one of the interviews a respondent suggested appointing a Training Manager. Grace (2001) mentions the importance of having a training co-ordinator. Floatel Int. currently uses their HR co-ordinator to follow up the training needs for the intended crew. Although, if a Training Manager was appointed, this would unburden the existing HR co-ordinator. An appointed Training Manager could focus on the fleet's training needs, along with assigning assessors and trainers for on board education. Emad and Roth (2008) discussed the well liked, but at deficient, on board experience and education, which is required for certification. The deficient and irregularity of quality could potentially be addressed with assigned and dedicated assessors and trainers on the Company vessels. This would mean Floatel Int. would play their part in supporting students in gaining relevant proficiency and refining the current MET system. Although the authors along with Emad and Roth (2008) believes universal standards from IMO or appropriate administrators is the way to address the uncertainties universally, since it is naive to trust all marine companies to volunteer and spontaneously address the issue. One of the assignments for the Training Manager could be to improve the experience transfer and lesson learned between the vessels. However, this Thesis has not researched the current set up of training co-ordinators within the Company.

As previous study shows, well-developed simulators are successful in familiarizing students to situations and testing their proficiency from a competency-based perspective (Emad & Roth, 2008). The study was verified in our research since the respondents repeatedly praised the current simulator course held by Kongsberg Maritime. The course is developed from a replica of one of the Company's vessel, which is recommended by Emad and Roth (2008) in order to maximize user learning.

Emad and Roth's (2008) article *Contradictions in the practices of training for and assessment of competency* is critical towards today's MET training. The authors do however state towards the end of the article, that the main reason for accidents at sea is not inadequate competency amongst officers, but rather human error. This supports the findings in this study, where the operators identified the Human Factor as the most crucial factor to include in accommodation specific simulator course. (Emad & Roth, 2008, p.266-267).

## 5.2 Methodology

The method used by the authors had an impact on the outcome of the study. If a different method had been applied the result would probably not be identical. A TNA approach with mixed method is still after the study regarded as appropriate. Current critical elements to include in simulator training were identified. Authors tried to emphasize the importance of studying future training needs, not only present requirements. However, respondents had difficulties foreseeing future demands and the authors were not successful in identifying a common denominator. Another research method could have been more effective. The TNA is as mentioned commonly used within the medical and health industry. Both industries are similar since they deliver a service and the reliability of the employees is vital, seen from a quality perspective.

The offshore operators face challenges especially during advanced marine operations. These situations can be compared to the medical and health industry since the stakes are high in both cases and the process complex. Employees play a vital role in both industries, compared to production industries where work can be automated. Each individual error can result in devastating effects unless there are appropriate safety barriers in place. These similarities influenced the authors to use the TNA tool.

Since one of the authors was employed at Floatel Int. it was logical to contact the company and carry out the study on its operators. There were debates of studying additional DP operators working for another accommodation vessel company, in order to increase the population included in the study. A larger number of participants in the survey would have affected the result and credibility of the survey. However, it would have been challenging to receive a great commitment and relationship to Floatel Int. with another competitor included in the study. A competitor would also question the objectiveness of the authors due to the professional commitments to Floatel Int. The discussion of including an additional company was discarded at an early stage. It was considered sufficient to exclusively study Floatel Int., since they make up for such an evident part of the accommodation segment.

The chosen qualitative method, would most likely been enhanced by observations as a supplement to the interviews. Unaware and subconscious DP operator training needs could have been identified through on board observations. The interviews solely identified conscious needs; we seldom realize all of our own needs. Observations over a period of time could have identified increasing demands and been valuable from a TNA perspective. Another useful tool would have been focus groups consisting of several operators. Then the individuals could discuss and argue why certain elements were critical. It was noticeable through the interviews that certain individuals had diverse opinions at times. A focus group discussion could have been productive to extrapolate on arguments and motivate the choices. Neither observations nor focus groups were feasible in terms of resources. The cost and time to carry out the observations on board the company vessels would be immense. The focus group option was however achievable from the authors point of view, however it would be challenging to recruit participants who could attend the in-person discussion.

Nevertheless, the authors are pleased with the results that came from collecting the opinions in a survey and discussing them further via in-depth interviews. Not only expectations on simulator training but furthermore, operator-training needs were identified. The operator interviews had to be carried out over the phone due to the global spread of the respondents. The option was suitable from a resource perspective and the external simulator trainer could afterwards assess the outcomes.

The usage of an external part gave the Thesis more credibility in the sense that the result had been discussed with an objective party. The simulator trainer’s offshore experience is limited or close to non-existent although his experience of setting up marine simulator training added useful inputs. One reason for the simulator trainer’s willingness to participate could be his previous studies at the same university as the authors, or the correlation to other involved parties in the Thesis. The operators on the other hand, had more to gain personally since they could affect the set up of their employer’s training course.

Since the method did not include observations, other accommodation companies or their operators, the result of this Thesis should only act as an indication. Clear tendencies of training needs for DP operators of accommodation vessels were identified; however no actual generalisation can be made.

### 5.2.1 Credibility of the study

Information gathered in the research must be evaluated in terms of validity and reliability in order to ensure adequate quality and credibility. The following sub-Section discusses the issue of authenticity further.

#### 5.2.1.1 Validity

Validity of a study is the degree to which it truly measures what is intended to be measured. In the case of this study the accuracy of our measurement along with the sample representativeness can be discussed.

The face validity, which includes matter of appearances and content validity, the ability to design questions that covers the matter researched, was debated both with the supervisor and examiner at Chalmers. A pilots-study was carried out with the purpose to ensure high validity of the survey questions. The respondents had the opportunity at the end of the interview to express themselves if they felt any important subject or element was excluded in the study. No respondent did however have anything to add. This was considered satisfying since it acted as a confirmation that the authors included all relevant subjects.

The Thesis shall be considered valid since the researched questions have been answered using primary sources. A handful critically reviewed secondary sources were used to analyse the outcome in the discussion. The validity of the result should be regarded as high since the primary sources were considered highly competent to answer the research questions. DP personnel operating accommodation vessels on a daily bases were considered the appropriate source of information. The trustworthiness of the respondents must be considered. Respondents in a survey could alter answers to avoid exposing personal insufficiencies or opinions. In qualitative studies, respondent's behaviour and answers may alter from time to time depending on new experiences. Respondents could also have an agenda of their own when taking part of a study. However, the author's does not find any reason to mistrust the respondents, which were part of this Thesis.

Furthermore, an external opinion was included from a qualified individual who's working on educating seafarers in simulator training on a regular basis. By adding an external opinion the dependability of the study could be ensured.

#### 5.2.1.2 Reliability

A study is reliable when a new study with the same methods would result in an identical outcome. It means the study can be replicated at a later time.

The author Jan Trost (1997, p.99-104) discussed the challenges of reliability in quality interviews. Respondents are active people in processes, which mean they may experience sudden or temporary notions. This means their answers or thoughts may not always be identical from time to time. In our case the interviewers focused on listening to the tone of the voice and how they formulated their responses. The belief was that the responses were well thought of and not temporary or random. The fact that the interview topics were published in advanced, could have contributed to the well-developed answers.

#### 5.2.1.3 Anonymity & confidentiality

Respondents in the survey were asked to fill in their e-mail address if they sought to be a part of the planned semi-structured interviews. Respondents' volunteering for the interview eased the process of the study in terms of time and resources. The issue of disclosure does however arise; the participants are no longer anonymous. Although respondents identifiable in the survey and interviews were insured by the authors that their identity would be confidential in the Thesis. The matters of social desirability increases, individuals usually want to appear respectable in front of others. When the survey no longer is anonymous they could provide a respectable rather than genuine response (De Vaus, 2013, p.107). Plenty of non-responses can be expected, since the respondents know that if answering, the authors can trace answers back to the individual.

#### 5.2.1.4 Non-response analysis

Duncan D. Nulty (2008) researched the response rates of online questionnaires. Nine previous studies on the subject were compared; the average response rate was calculated at 33%. The survey in this Thesis had a response rate of 70%, which is considered satisfactory, although there were several non-responses in the study.

One can only speculate why the non-response rate was 30%. A reason could be a minor miscommunication amongst the authors and Floatel Int. management. The authors' intention was that the management would e-mail the survey and the cover letter directly to all operators. However this was not communicated clearly and the e-mail was sent out to Captain/OIMs. It was then his or her task to distribute it further to Chief Officers, DPO/SDPOs. The issue was however discovered, the following E-mail with the reminder and link to the survey was sent out to all operators directly. Another reason could be time limitations on board or the unwillingness to fill in questionnaires.

# 6 CONCLUSION

The research questions were investigated through an online survey on the studied company's operators. In order to verify and elaborate the results, in-depth interviews were carried out. The result of this Thesis should be considered as recommendations for training, no precise generalisations could be made due to the limitations of the study.

The results from the survey indicate seven main categories of elements as critical: PMS, Sensors, PRS, Gangway system, Human Factors, Follow Target and Communication. These categories have been arranged in a declining order. In the interviews the categories were verified and motivated as critical elements during advanced marine DP operations.

To improve the content of the accommodation specific DP course, the respondents were asked in the survey to identify which elements to include in a course. Out of the seven main categories of elements, all with exception of one, communication was to be included. The interviewers confirmed the elements mentioned in the survey were critical. However, the order of most critical shifted from PMS to Human Factors. The shift was believed to occur once the respondents discussed and reflected over the various elements. The authors believe respondents detected an interrelation between the Human Factor aspect and all the other elements. Later respondents singled out the three most critical elements: Human Factors, PRS and Follow Target. The simulator trainer could relate to the importance of the Human Factors and the PRS element. Majority of the respondents suggested vessel specific DP courses, although several individuals mentioned the financial difficulty that may follow.

Respondents indicated a need for both proactive and reactive simulator training. The aim of proactive training would be to prevent incidents. The Swedish Maritime Administrations has identified proactive training as the most beneficial approach. Courses under their regime are performed with an interval of about 1 to 2 years too keep the knowledge up-to-date. Reactive training on the other hand focuses on managing emergency situations.

## 6.1 Further research

The results in this Thesis could be triangulated and developed through on board observations. This was not feasible in this study due to the limitations, however a PhD student could have the necessary resources needed. The responses and data regarding future demands on the operators were limited. On board observations and more comprehensive studies could however identify increasing demands.

In the interviews with the operators other areas for improvement were identified. The two most commonly mentioned areas were lesson learned and experience transfer. By researching and developing these topics, the number of incidents at sea could be reduced.

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# Appendix A – Floatel Int. LSOG

| Location: | | | | | Date: |
|---|---|---|---|---|---|
| Fixed Installation | | | | | |
| DP Class 3 Gangway Operations | | | | | |
| **Condition** | | **Green** | **Advisory** | **Red** | **Gangway Lift** |
| ANY INCIDENT | Blackout of all HV Networks | | | Immediately | Immediately when gangway clear |
| | DRIVE OFF incident and/ *or* DRIFT OFF incident | | Uncontrolled situation may develop | Immediately when recognised by DPO | Immediately when gangway clear |
| INTACT SYSTEM | Gangway movement | < 4.0 m | > 4.0 m | > 5.0m | > ±6.0m |
| | Gangway elevation | With even keel < -10° < +10 ° | With even keel < -10 ° < +10 ° | With even keel > -12 ° | Situation specific |
| | DP heading footprint | | Frequent* > 3 ° | If threat to position | If threat to position |
| Power consumption each network | | < 67 % | Any PMS warning | >67% power used or Consequence alarm | Situation specific |
| Thruster consumption at each network | | < 67 % | Thruster and / or PMS warning | Consequence alarm | Situation specific |
| Position reference available | | 3 independent online excluding DGPS | Loss of a system or performance limitation | 2 independent online excluding DGPS | If threat to position |
| DP control system | | 3+1 | Any failure or loss of performance in any system | 1 or loss of performance of backup controller | Loss of all system and / or unable to maintain position |
| Wind sensors | | 3 | 2 | 1 or loss of back up wind sensor (wind 3) | If threat to position |
| Motion sensors (MRU) | | 3 | 2 | 1 or loss of back up MRU (MRU 3). | If threat to position |
| Heading sensors (Gyro) | | 2 + Gyro 3 | Failure any Gyro | 2 or loss of back up gyro (gyro 3). | If threat to position |
| DP-UPS | | 4 | Failure any DP-UPS | 2 or loss of backup UPS | If threat to position |
| Network | | No alarms on A and B | Regular alarm on A or B | Loss of one network | If threat to position |
| Comms systems CCR to ECR | | 3 systems | 1 system not operating | Situation specific | Situation specific |
| Wind speed (30m, 3s) | | < 40 knots | >40 knots | 60 knots | 70 knots |
| DP current | | 0-2 knots | > 2 knots | Situation specific | Situation specific |
| Wind direction | | Situation specific | Situation specific | Situation specific | 0-270 deg |
| Significant Wave height | | < 4 m | >4m | >5,5m | >7m |
| Action required | | Normal status | Inform relevant parties | Issue alarm and follow procedures | Issue alarm and follow procedures |
| Notify OIM immediately (Y/N) | | No | Yes | Yes | Yes |
| Notify Client immediately (Y/N) | | No | Yes | Yes | Yes |

| Fixed Installation STATUS | Normal status | DPO detects abnormal situation | FIRE / GAS / PAPA Alarm on KVB |
|---|---|---|---|
| Notify OIM immediately (Y/N) | No | Yes | Yes + GA |
| Notify Client immediately (Y/N) | No | Yes | Yes |

***Note:*** For other operations than Gangway Operations special limits and precautions are to be agreed with Client.

**Floatel <Vessel Name> Stand Off Position: Minimum 200m with fixed installation outside Floatel <Vessel Name> drift sector.**

| OIM (name) | Signature |
|---|---|
| | |
| **Client's Representative on behalf of Client (name)** | **Signature** |
| | |

# Appendix B – Online Survey

The purpose of this study is to enhance the company's DP simulator course by increasing the understanding of operator training needs. It is our belief that this will benefit both the company and you as individuals in the long-term perspective.

The study is carried out in collaboration between Floatel International and Chalmers University of Technology - Gothenburg, Sweden.

* Required

1. **Position on board*** *Mark only one oval.*

    - o DPO/SDPO
    - o Chief Officer
    - o Captain/OIM

2. **Name of rig***
(If recently transferred to a new-building, please state the previous rig) *Mark only one oval.*

    - o Floatel Superior
    - o Floatel Reliance
    - o Floatel Victory

3. **Years of experience at sea** * *Mark only one oval.*

    - o Less than 5 years
    - o 6-10 years
    - o 11-15 years
    - o 16-20 years
    - o More than 20 years

4. **Years of experience onboard accommodation vessel(s) as an officer** *
*Mark only one oval.*

- Less than 2 years
- 3-4 years
- 5-6 years
- More than 6 year

5. **Have you participated in any type of advanced marine operation simulator training course?** * *Mark only one oval.*

- Yes
- No

6. **Have you attended a simulator training course specific for accommodation vessels?*** *Mark only one oval.*

- Yes
- No

7. **If Yes, by which company was the course carried out?** *Mark only one oval.*

    - Floatel International
    - Other: ……………………..

8**. An accommodation specific DP simulator course would increase my proficiency as an operator?** * *Mark only one oval.*

Strongly Disagree

- 1
- 2
- 3
- 4
- 5

Strongly Agree

9**. List the 5 most critical elements of a DP system during advanced marine operations of an accommodation vessel? *** (Any component vital for the station keeping is considered to be an element)

Answer:…………………………………………………….

10**. Which of the critical elements would you like to include in a DP simulator course in order to increase your competence? ***

Answer:…………………………………………………….

11. **If you would like to influence the content of future DP courses, please add your e-mail below.** (Participants will be chosen for a 30-40 minutes interview)

E-Mail (optional):…………………… ……………………