

## Ship-Platform Collisions in the North Sea

Helle A. Oltedal

Stord/Haugesund University College, Haugesund, Norway

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**Abstract:** This study addresses collisions between offshore facilities and visiting vessels on the Norwegian Continental Shelf. From 2001 to 2011, 26 collisions between offshore facilities and visiting vessels have taken place on the Norwegian Continental Shelf. Six of these incidents, which had a very large hazard potential, are further analyzed in the current study. The analysis aims to identify common causal and underlying personal, situational, and organizational factors. The analyses suggest that the direct cause of the six ship–platform events all fall into one of two categories; unmonitored approach related to inadequate transfer of command or human deficiency to detect or interpret a technical state or error. All cases may be traced back to a shipboard practice of non-compliance with established procedures and guidelines, which in all cases apparently was standard shipboard behaviour—labelled as drifting operational practice. All incidents could be traced back to a lack of shore management system control and poor awareness of how work on the vessels is normally performed. Based on the results, organizations should use their safety management systems to identify the areas in which crews' behaviour are drifting from the formal organizational scripts as well as understand the nature of the drift.

**Keywords:** ship/platform collision, safety management, organizational causes, offshore vessel safety

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### 1. INTRODUCTION

In July 2005, a multipurpose support vessel lost control, drifted, and hit a platform in the Mumbai High North (MHN) complex along the western coast of India. The collision caused a severe fire. After two hours the entire MHN complex collapsed, leaving only the stump of its jacket above sea level. The involved vessel also caught fire, sinking four days later. Although 362 people were rescued, 22 people died (IAOGP, 2010). The MHN incident shows the catastrophic potential of collisions between offshore facilities and visiting vessels.

From 2001 to 2011, 26 collisions between offshore facilities and visiting vessels have taken place on the Norwegian Continental Shelf (PSA, 2011). According to the Petroleum Safety Authority (PSA), six of these collisions had a very large hazard potential. Identification of (common) causes to these incidents can lead to the development of improved prevention strategies, and thus investigation reports from these six collisions will be further analyzed in this study. Within shipping in general, human error is traditionally associated with the vast majority of accidents and incidents. An estimated 75% to 96% of marine casualties are explained by some form of human error (Oltedal, 2011). The current study aims to go beyond the label of human error and identify the underlying factors influencing ship–platform collisions. The findings will be used to develop a questionnaire directed towards offshore vessel safety. In order to pursue this research aim, two research questions were developed:

1. What are the main common causal factors in ship–platform collisions on the Norwegian Continental Shelf?
2. How can the identified factors be traced back to direct and indirect underlying factors?

With reference to ship–platform collisions, this article will more concretely analyze the relationship between the features influencing the incidents in relation to their human contribution. Influencing factors of a more technical characteristic are only addressed if and when they may be related to actions and decisions made by the involved crew. The article includes factors leading up to the incidents; it does not address factors related to the crew's response in the aftermath of the collisions. The scope of the study is limited to shipboard factors; factors related to other actors (e.g., the installation or traffic-monitoring systems) are not addressed.

## 2. PREVIOUS RESEARCH EXAMINING CAUSES OF NAVIGATIONAL ACCIDENTS

In order to identify previous research on ship–platform collisions, a search of several databases—namely, ScienceDirect, ISI Web of Science, and Google Scholar—was performed using search terms such as *ship installation collision*, *ship platform collision*, *ship installation* and *ship platform*. The search was limited to publications addressing human factors and published within the last 20 years. Only two research articles were retrieved (C.P., 1995 and Kvitrud, 2011). The majority of the retrieved documents are reports written on behalf of governmental bodies (HSE, 2000; HSE, 2003 and Petroleumstilsynet, 2011). Thus, the human contribution to ship–platform collisions seems to be under-researched within the academic community. In order to expand the theoretical review, articles and reports addressing ship–platform collisions in the UK sector in the North Sea were included.

Collisions between ships and platforms can be divided into two groups: (1) powered collisions and (2) drifting collisions. Powered collisions are vessels moving under power towards the installation and include navigational/manoeuvring errors, human/technical failures, watch-keeping failures and bad visibility/ineffective radar use. Meanwhile, a drifting vessel has lost its propulsion or steering and is drifting only under the influence of environmental forces (IAOGP, 2010). The loss of propulsion or steering may also be related to failure stemming from humans' interface with technical arrangements, such as inadequate maintenance. According to the IAOGP (2010), for a powered collision to happen, three conditions are required: (1) the vessel needs to be on a collision course with the installation; (2) the navigator/watch keeper must be unaware of the collision course long enough for the ship to reach the installation; and (3) the installation must be either unaware of the developing situation or unable to warn the vessel to “normalise” the situation.

Based on a review of reported incidents involving collisions between jack-up platforms and vessels occurring between 1975 and 1991, Ellinas (1995) classified the causes of the incidents into five main groups: (1) misjudgement by the vessel's captain, (2) weather, (3) equipment failure, (4) problems with anchors or mooring ropes, and (5) other. Misjudgement by the vessel's captain was the most common cause, accounting for more than 46% of the incidents. Weather conditions were the second most quoted cause of failure. Causes within the remaining three causal categories were evenly spread amongst the incidents (C.P., 1995).

In a report prepared for the Health and Safety Executive (HSE) (HSE, 2000), ship impacts with offshore installations are regarded as the result of one of three issues or a combination of these issues—namely, (1) human error (e.g., poor judgment or ship handling, inattention, ineffective watch keeping, fatigue, workload), (2) mechanical or system failure aboard the vessel, and/or (3) freak or unplanned environmental conditions. With reference to these causal factors, HSE (2000) determined that the primary cause was due to human error in 45% of the cases, followed by equipment failure (33%), and external factors (22%). Meanwhile, according to HSE (2000), an investigation of causes of marine accidents performed by the US Coastguard found that human error accounted for 89% to 96% of ship collisions. However, the US Coastguard's definition of human error also includes categories not commonly thought of as “human error”, such as management (e.g., faulty standards, policies and insufficient manning related to on-shore activities), knowledge (e.g., inadequate knowledge of technical equipment, own ship procedures and others related to training), and work environment (e.g., hazardous natural environment and poor equipment design). Thus, more than half of these human errors are attributable to other factors.

In a later report also prepared for the HSE (2003), the primary causes of ship–platform collisions were broken down into four main categories: (1) external factors, (2) mechanical control failure, (3) human control failure, and (4) watch keeping failure. These causal factors overlap those found in the HSE 2000 report, although watch keeping failure is now distinguished as a separate category. The report concluded that the majority of incidents' primary cause is linked to some form of control failure—be it human or mechanical related. Furthermore, although the category of external factors contains predominantly environmental causes, these too could fall within the human control failure as perhaps the operation should have been aborted or postponed due to these severe conditions. Watch keeping failure was assessed as the primary cause in each

incident involving a passing vessel. However, the precise nature of the watch keeping failure is unknown (HSE, 2003).

On behalf of the PSA, Kvitrud (2011) outlines identified causes in the six most severe ship-platform collisions in the period of 2001-2010, and put forward following for causes as most important: (1) poor safety culture and non compliance of procedures, (2) lack of training in use of technical equipments, (3) equipment not adjusted to user needs and, (4) the platform owners do not sufficiently monitor approaching vessels. With reference to an internal PSA report (Bang, 2010 cited in Kvitrud, 2011) some vessel owners in general have more frequent violations of procedures than others, which give a possible link to organizational characteristics within the shipping companies.

The PSA of Norway (Petroleumstilsynet, 2011) concluded that the most prevalent causes of collisions between visiting vessels and installations on the Norwegian Continental Shelf are (1) poor safety culture and compliance of procedures, (2) poor understanding of and training in advanced technical equipment, (3) poor bridge team communication (i.e., responsibilities and roles are not clear), (4) technical equipment does not meet users' needs and, (5) visiting vessels are not sufficiently followed up by the installations when approaching. The first three causes can be defined as human error; however, the report failed to sufficiently address how underlying (organizational) factors influenced the identified causes. The report identified safety culture as a causal factor. The definition and application of the safety culture concept within the maritime industry commonly relate to crew error, poor seamanship, violations of procedures, and the like (Oltedal, 2011). Thus, safety culture in the current study will not be distinguished in its own category. Many of the findings in the PSA report overlap those emphasized by Kvitrud (2011), with the exception being poor bridge team communication.

Based on the literature reviewed, the following main categories of causes of ship–platform collisions can be identified: (1) human control failure, (2) mechanical/technical control failure, (3) design failure, (4) external factors, and (5) others. The review revealed that human error or human failure is seen as a major cause of ship–platform collision, but the need still exists to research how the human factor relates to underlying features—namely, organizational safety management.

### **3. THEORETICAL FOUNDATION**

Theories related to the cause of accidents and safety management have progressed over time (Borys et al., 2009). Borys et al. (2009) identified five ages of existing and emerging approaches related to accident causation and safety management. The first four ages are, in order, the technical age, the human factors age, the management systems age, and the integration age. Given the limitations of the current safety management systems, in which safety rules are utilized to control human behaviours, Borys et al. (2009) proposed that we are currently moving towards a fifth age of safety: the adaptive age. The adaptive age embraces adaptive cultures and resilience engineering and requires a change in perspective from human variability as a liability needing to be controlled to human variability as an asset that is important for safety. This change reflects a shift in safety management theory from regarding human error as a cause of incidents to enhancing the understanding of how systematic features of people's work environments can reasonably trigger particular actions—namely, actions that make sense given the situation that helped bring them forth (Woods, 2010). When human error is dealt with as a cause, it is not recognized that human beings are not reliable in the same sense as technical components; indeed, it is in our nature as human beings to have variations with regard to behaviour, perception, communication, information processing, and others when coping with operational uncertainties of risk. Thus, human error as a cause is an over-simplification of human behaviour that does not consider how individual, situational and organizational characteristics influence their behaviour. Moreover, when human error is perceived as a cause, safety measures are often developed in order to command and control human behaviour in a prescribed direction as well as reduce the possibility for human variation. Such control often occurs in the form of prescribed rules and procedures. However, when underlying causes and influencing factors are found elsewhere in the organization (e.g., deficiencies in the organization's management system), risk is not eliminated by such command and control strategies. Human errors will most likely continue to occur, simply being transferred to other areas. For

example, if pressure for efficiency results in the vessel's position not being verified in a particular situation, a checklist ensuring that the particular action is taken will not minimize that pressure for efficiency, bringing about other risk-inducing actions in other situations (Oltedal, 2011; Woods, 2010; Hollnagel, 2009 and Reason, 2001). Based on these theories, the current article goes beyond the "human error" label to more concretely identifying the individual, situational and organizational features influencing the human contribution to the selected ship–platform collisions incidents.

#### 4. METHODOLOGY

Six cases are included in the current analysis: *Far Symphony's* collision with West Venture Semi in 2004 (Case 1), *Ocean Carrier's* collision with the bridge at Ekofisk in 2005 (Case 2), *Navion Hispania's* collision with Njord B FSU in 2006 (Case 3), *Bourbon Surf's* collision with Grane jacket in 2007 (Case 4), *Big Orange XVIII's* collision with Ekofisk in 2009 (Case 5), and *Far Grimshader's* collision with Songa Dee Semi in 2010 (Case 6). The accident investigation reports used in the analysis were retrieved from the Norwegian PSA and the Norwegian Maritime Authority, including preliminary and final reports written on behalf of the shipping company, charterer, customer and/or the PSA. The reports vary in scope and information provided, which created a challenge influencing the validity of the study. The information may be biased as it represents the view of the investigators and their perspective towards accident causation. In addition, what is perceived as a cause or enabling condition, along with conditions within the investigation process itself, may be biased depending on the investigators' background (Woods, 2010 and Sarantakos, 1998).

Initially, the Human Factor Analysis and Classification System (HFCAS) (Wiegmann and Shappell, 2003) was adopted as a framework for the current analysis. However, as the reports vary with respect to scope and information provided, it was difficult to use a single common framework for all incidents. Thus, the information available in the report was used to guide the process. All identified direct and underlying causes related to the individual, situation and organization were plotted in a matrix for analysis. Information available for only some of the incidents was excluded, such as crew experience and team characteristics. At some level of the analysis, all incidents were unique whereas, at other levels, they revealed common patterns. In this study emphasis was placed on information common across the incidents. All cases and findings are further presented in the following section.

#### 5. PRESENTATION OF CASES AND RESULTS

All vessels served in normal operations with a scheduled approach to installation: Four were in a supply operation, one was a tanker, and one was a well stimulation vessel. The vessels were flying both national and international flags. One of the vessels had a full Norwegian crew while three of the vessels had a mixed European crew. In all cases, the crew held valid certificates as required by national and international authorities. The weather conditions and visibility were good in all cases except one. All incidents happened between the times of 19.42 (evening) and 08.20 (morning). Table 1 summarizes the background information.

Table 1 Background information from selected cases

	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
Flag State	N/A	Norwegian	Norwegian	Norwegian	Bahamas	Isle of Man
Vessel operation	Supply	Supply	Tanker	Supply	Well stim.	Supply
Crew Nat.	N/A	N/A	Mixed	Norwegian	Mixed	Mixed
Certificates	OK	OK	OK	OK	OK	OK
Weather conditions	Good	Good	Moderate	Good	Good	Poor
Visibility	Good	Poor	N/A	Good	Good	Good
Time at accident	02.48	08.20	19.42	07.35	04.17	21.40

**Case 1:** The incident took place during normal operations while approaching an installation. The captain and a second navigator were at the bridge. Within the installation's 500-metre security zone, the vessel is required to disengage the autopilot and switch to manual steering. In this case, the autopilot was not disengaged. The design of the autopilot overrides manual steering when the autopilot is on. Approximately

150 to 200 metres from the installation, the officer on watch tried to change course and reduce speed. As the autopilot was mistakenly left on, this manoeuvre resulted in an increased speed, from 4,4 knots to 7,3 knots, with the same heading against the installation. The bridge crew did not understand why the vessel did not respond as normal. One minute later, the vessel hit the installation. The investigation report identifies the autopilots on-modus as the direct cause of the incident. The 500-metre pre-entry checklist was signed as completed, but according to the investigation team, this could not have been done in an adequate manner as completion of the checklist would have detected the autopilot status. Thus, the underlying factor is linked to the violation of procedures. In addition, a lack of understanding of the autopilot system was pointed out, indicating that the error was not correctly identified. In this case, the navigators had not familiarized themselves with the emergency steering system, and their response to the situation was inadequate. It is also noted in the report that the particular crew on board had a record of a poor safety culture, and deviations were presumed to be normal practice on board (labelled as drifting operational practice in this study). The proposed safety measures developed in wake of the incident were all directed towards local and vessel-specific problems related to the incidents—namely, altering the auto pilot design and the checklist for entering 500-metre zones. The report did not identify any elements addressing the overall system in the company’s management. The course of the event and causal factors of the incident are depicted in Figure 1.

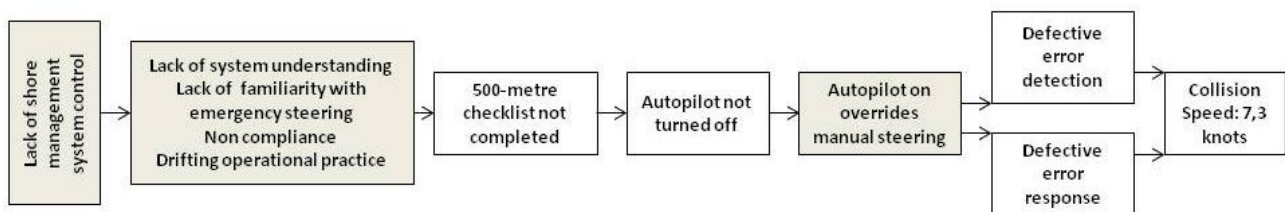


Figure 1. Course of event and causal factors in Case 1

**Case 2:** The incident happened while approaching the installation in heavy fog. The visibility was approximately 100 to 150 metres. The vessel’s captain, a second navigator and a lookout were at the bridge. Confusion related to who was in command led to the incident. The captain arrived at the bridge approximately 20 minutes before the incident, but did not take command formally or familiarize himself with the vessel’s position. The captain understood the second navigator to be in command, but the second navigator assumed that the captain was in command. Approximately 5 minutes before the impact, the captain received a VHF call concerning the transference of a passenger. Meanwhile, the second navigator went aft at the bridge to prepare the paperwork for loading. The second navigator was not explicitly told to start preparing the loading papers; it was more of a “comprehension” that this should be done. Due to unclear company instructions, the 500-metre pre-entry checklist had not been followed as required. According to the requirement, no paperwork is to be done within the 500-meter zone. As the second navigator was aft at the bridge, the captain moved forward towards the steering apparatus to check the vessel’s position. However, he was interrupted by the lookout’s warning that a riser had been observed. After detecting the situation, the captain’s response was correct, but the collision was inevitable. The vessel hit the installation at a speed of 6,0 knots. Identified causes of the incident include poor communication in the transfer of command, non-compliance of procedures and unclear procedures. Several of the company checklists and instructions were violated, and the investigators indicated that the officers had a relaxed attitude towards procedures and guidelines. Thus, deviations from standards were assumed to be normal practice on board the vessel. The shipping company was recommended to offer the Bridge Recourse Management (BRM) course to their officers. In addition, all checklists onboard the particular vessel were to be revisited, not only those relevant for the particular incident. The report also noted that the crew expressed that the onboard workload was heavy during certain periods; however, this and other safety conditions related to shore management activities were not addressed in the safety recommendation. The course of the event and causal factors of the incident are depicted in Figure 2.

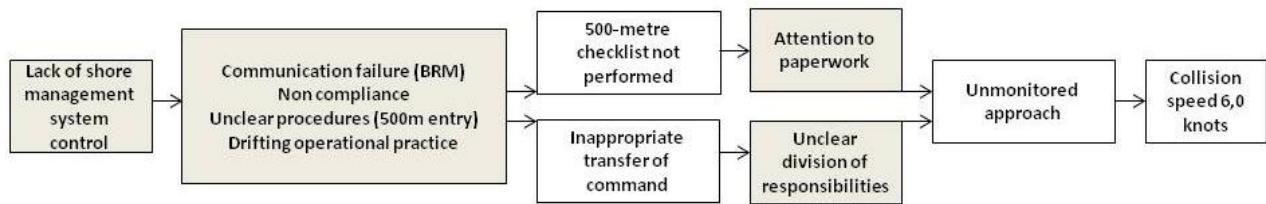


Figure 2. Course of event and causal factors in Case 2

**Case 3:** While preparing to load, the vessel suffered a blackout due to engine failure. At least three early warning signals were ignored and not handled in accordance with procedures and/or best practices. First, three days prior to the incident, the crew experienced related engine problems which were handled inadequately, but in accordance with shipboard practices. Second, a second engine problem was experienced before arriving in the oil field; neither the engine problem nor the crew's responsive action, which were not according to best practices, was reported to the chief engineer. Finally, a third warning was given the day before the incident, when the vessel suffered another blackout. With reference to the actual incident, the bridge team's response to the blackout indicated deficient error detection and error response due to a lack of knowledge and training related to the Dynamic Position (DP) position reference system. With reference to error detection and response, the stress induced by massive visual and multiple alarms along with safety concern for exposed crew was determined to be contributory factors. At the time, relevant emergency procedures were lacking. Thus, underlying causes included the lack of procedures, violation of procedures and improper operational practice, poor communication among engine crew members, and early warnings/faults not being dealt with properly. The investigation revealed that some of the crewmembers expressed concern regarding the onboard work environment, especially the heavy workload and large amount of administrative work required. The crew's concerns were not addressed in preventive measures. Recommended corrective actions address the specific identified causes of the incident rather than the overall management system. The course of the event and causal factors of the incident are depicted in Figure 3.

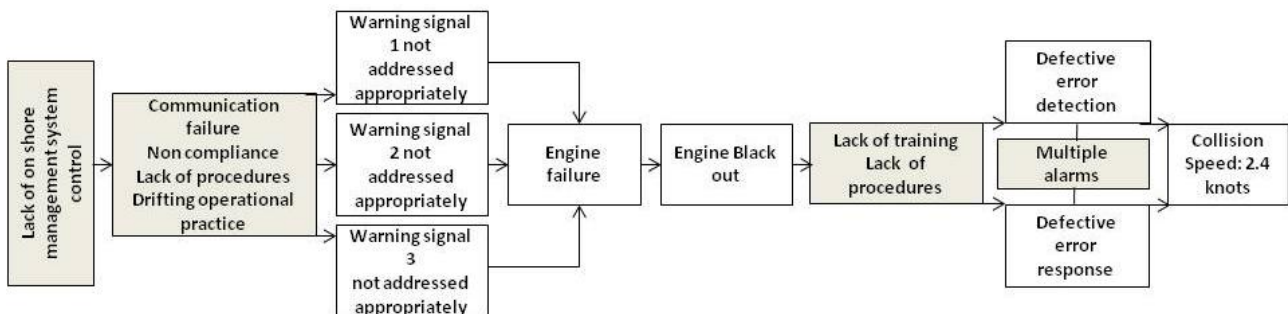


Figure 3. Course of event and causal factors in Case 3

**Case 4:** The incident took place during normal operations approaching the installation. At the time of the incident, the vessel's captain and a second navigator were present on the bridge. Confusion related to who was in command resulted in the incident. After arriving on the bridge shortly before the incident, the captain did not formally take command by giving this verbal order to the navigator. On board, it was normal practice for the captain to automatically take command when on the bridge, which is a breach of formal operating procedures. The second navigator was commanded by the captain to start preparing the vessel for loading, and the second navigator accordingly left the position for manoeuvring the vessel. Then, during the approach to the installation, the captain also left the forward operating position unattended, leaving the approach to the installation unmonitored for approximately one minute, resulting in a collision with the installation at a speed of 7,7 knots. The captain left his position without verifying the vessel's position, speed, heading or distance from the installation. The major influencing factors in the incident seemed to be poor communication among the members of the bridge team and unclear division of responsibilities. Such a bridge team arrangement is a violation of both the shipping company's procedures and NWEA guidelines for the Norwegian Continental Shelf. The 500-metre checklist for pre-entry was not completed; however, it is uncertain whether completion of the checklist would prevent the incident. The investigation report put forward that a culture of poor compliance with existing procedures seemed to exist. For example, the report states that the formal

transference of command was never practiced on board. Thus, normal operational practice had drifted from the formal standardized rules. The investigation found that the company's safety management department was undermanned in relation to the size of the company fleet; however, specific safety measures or requirements for this circumstance were not given. The company had previously experienced near-miss incidents involving a lack of navigation watches and misunderstandings about bridge responsibilities; however, the internal learning process was apparently weak. In this case, the investigation report explicitly addresses several weaknesses in the company's overall safety management system, which is also addressed in the recommended measurements. The course of the event and causal factors of the incident are depicted in Figure 4.

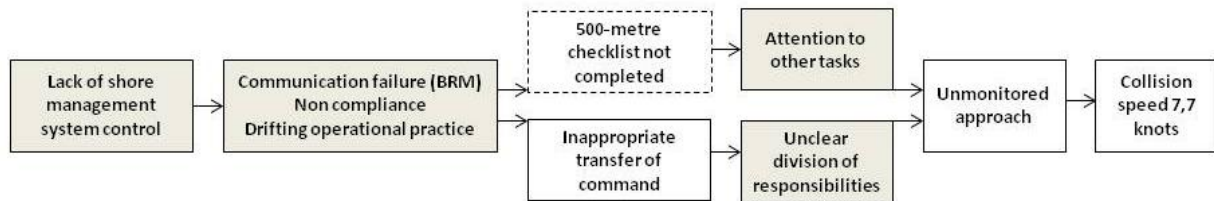


Figure 4. Course of event and causal factors in Case 4

**Case 5:** When approaching the installation, after taking command on the bridge, the captain received a telephone call from the charter's representative in relation to entry permission. When answering the phone, instead of leaving the steering control to the second navigator, the captain switched over from manual steering to autopilot. He subsequently forgot to switch the autopilot off, which resulted in him not being able to override the autopilot, and the speed increased towards the installation. When entering the 500-metre zone, the pre-entry checklist was not completed, although it was signed as completed. In addition, the DP test was not performed, and the autopilot was not switched off. The situation with the autopilot overriding the manual steering was not identified by the captain or the second navigator. The captain assumed that the situation had been caused by a technical issue. The investigation report identifies a lack of installed autopilot or manoeuvring alarms as a contributory factor. From the time the captain realized that he did not have the expected manual control until the time of the collision—approximately three minutes later—both the captain and second navigator failed to activate the emergency stop, turn off the autopilot or use the emergency steering. Thus, the error response was also defective. The report noted that no effort was made by the second navigator to intervene or assist the captain. The second officer had been on board five days and had not received the required familiarization training or vessel-specific DP training, which is also in breach of the requirements, as within the 500-metre zone, the bridge should be manned by two navigators and the co-navigator should be capable of taking over the vessel if required. However, given that the second navigator had not been fully trained for such tasks, this requirement cannot be considered to have been fully completed. The report also notes that, on board, it seems to be a lack of respect for procedures in general; thus, it is assumed that the violation of procedures was normal operational practice on board, and several standards were violated. For example, although it was not a contributory factor in this case, the crew stated that it was not a practice to conduct emergency exercises, including breakdowns of the bridge operation system. Inadequate bridge team management practices were found to be among the most contributory factors (e.g., improper bridge team communication and hand-over practices). Recommended safety measures addressing incident-specific areas included improvement of bridge team management and familiarization with emergency response procedures. However, the report did not question if these weaknesses derived from underlying system deficiencies. For example, if there is an underlying system management deficiency, similar weaknesses could be a problem in other operational areas or vessel departments as well. The course of the event and causal factors of the incident are depicted in Figure 5.

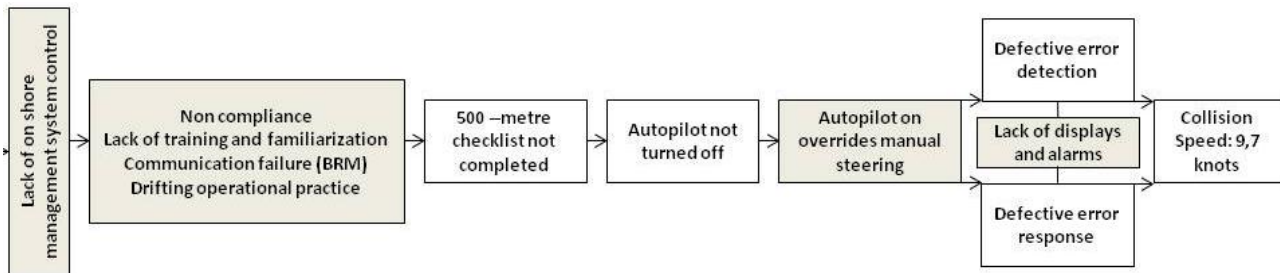


Figure 5. Course of event and causal factors in Case 5

**Case 6:** The incident took place during the loading operation. Three navigators were present on the bridge. Due to technical failure with one of the installation’s cranes, the vessel manoeuvred from the leeside of the installation to the weather side. When moving the vessel, the captain used all available propulsion power for a longer period than normal, causing the deck lights to go out. At this point, the captain did not see the red main engine overload alarm, and he has no recollection of an audible alarm. The captain perceived the darkening of the deck lights as a power supply loss and zeroed the pitch controls on his main propellers; shortly thereafter, the vessel hit the installation. The captain’s interpretation of the situation indicated a lack of understanding of the power distribution in high-load conditions. In the investigation report, four main causes related to the vessel were revealed: lack of awareness and use of relevant procedures and guidelines, decision of manoeuvring of vessel to the weather side, decision of manoeuvring too close to the rig and incorrect interpretation of the deck flood lights going out. The investigation team traced the non-utilization of procedures and guidelines back to previous similar episodes of non-compliance, providing a level of legitimacy for not using relevant procedures. Thus, non-compliance seemed to be normal operational practice. Non-compliance to procedures was partly linked to the insufficient management of change when the North West European Area (NWEA) guidelines replaced previous operational guidelines. This, along with poor communication of the practical implication of the changes, related to the technical redundancy requirements for vessels working on the weather side. When linking human error and operational practice to the development and implementation of national requirements, this case dug deeper than the others in search of a root cause. Improvements related to the NWEA guidelines are also reflected in the final recommendations. Recommendations reflected towards the crew include implementation of Bridge Team Management Training and the need to carry out a safety culture survey. The course of the event and causal factors of the incident are depicted in Figure 6.

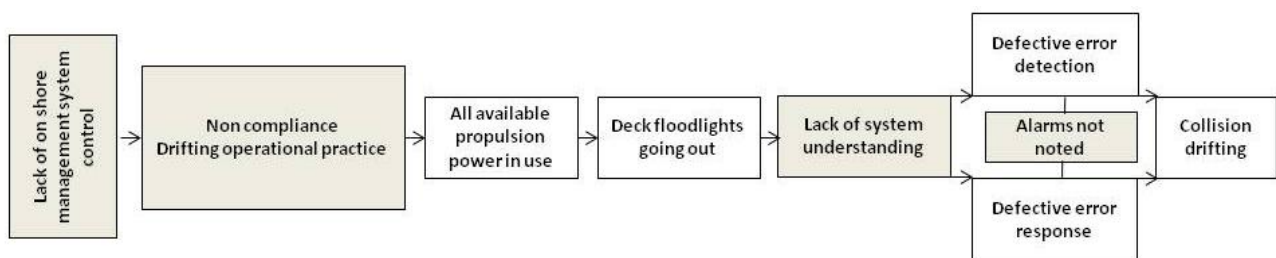


Figure 6. Course of event and causal factors in Case 6

Table 2 summarizes the identified causes common to all six incidents. The direct causes fall into one of two categories: (1) unmonitored approach related to inadequate transfer of command or (2) human deficiency in detecting or interpreting a technical state or error. All cases were traced back to non-compliance with established procedures and guidelines and the lack of shore management system control. In all cases, non-compliance was found or assumed to be standard shipboard practice. In two of the cases (i.e., Case 4 and Case 6), underlying system deficiencies were addressed in the recommended safety measures. In all other cases, the recommendations were related to elements such as the particular incidents without properly addressing underlying system deficiencies.



Table 2. Summary of identified causes

	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
Defective error detection	X		X		X	X
Defective error response	X		X		X	X
Unmonitored approach		X		X		
Human related to technology	X		X		X	X
Inappropriate transferee of command		X		X		
500-metre checklist not completed	X	X		(X)	X	
Lack of competence, understanding or knowledge	X		X		X	X
Communication failure		X	X	X	X	
Deficient procedures and/or guidelines		X	X			
Non-compliance with procedures and/or guidelines	X	X	X	X	X	X
Drifting organizational practice	X	X	X	X	X	X
Lack of shore management system control	X	X	X	X	X	X
Safety measures addressing system weaknesses				X		X

## 6. DISCUSSION

The two direct causes of the incidents were identified: (1) unmonitored approach related to inadequate transfer of command and (2) human deficiency in detecting or interpreting a technical state or error. These causes are discussed in greater detail in this section.

According to high reliability organization (HRO) theory, organizational redundancy is one of the most prominent design features (Weick and Sutcliffe, 2007). Within offshore shipping, organizational social redundancy is promoted by requiring at least two navigators to be on the bridge at the same time. Within the principles of redundancy, these navigators should duplicate and overlap performed tasks on the bridge; for example, when carrying out the 500-metre pre-entry checklist, one does the tasks while the other confirms that each task is satisfactorily completed. However, in Case 2 and Case 4, the second navigators were performing other tasks; thus, there was actually a reduction of redundancy, as the extra crew bridge resources were used to increase efficiency. The idea of redundancy is a feature that is highly desirable from an engineering standpoint; to be truly redundant, the components should be independent (Reason, 2001 and Perrow, 1999). However, in social systems, the components (i.e., the navigators) are not independent of each other. Human behaviour is a result of interdependent interaction, acts of communication and power relations (Stacey, 2007), which is also illustrated in one of the cases, where the captain's personality and management style might have prevented the second navigator from interfering.

In the four cases in which human-technology interface was identified as a cause (Case 1, Case 3, Case 5 and Case 6), the lack of system understanding or training is put forwards as a contributory influencing factor, preventing the error from being detected in time. Few people, if any, are experts in all operational domains. Although some have expertise in, for example, in-depth technical understanding of the autopilot, others have a high level of expertise in other areas (Dreyfus et al., 1988). Thus, as the navigator is the last barrier, it is natural that an incident happens within the domain in which the operator is less competent. Thus, better and more training directed towards the needs identified in a particular incident might have a limited effect on the overall organizational safety level. In all cases except Case 4 and Case 6, recommended measures are directed towards local weaknesses identified in each case rather than addressing a potential underlying organizational system weakness. More emphasis could be placed on understanding the nature of the underlying problems, which in all six cases is identified as a violation of procedures, drifting operational practice, and a lack of management system control.

Violations of procedures, which are present in all cases, may be related to normal traits of human cognitions rather than a deliberate choice (Hollnagel, 2009 and Hollnagel, 2004). Hollnagel (2004) emphasized that it is human nature to trade thoroughness for cost of effort needed to meet the demands. Such trade-offs could be induced from the organizational level in the form of pressure for efficiency, unclear lines between acceptable and unacceptable behaviour or double standards. Over time, violations of procedures become normalized, and the safety margins are gradually reduced. According to Reason (2001), most organizations rely heavily

upon negative outcome measures in their safety management systems, such as the occurrence of actual or potential adverse events (e.g., near-misses, injuries, fatalities). This is also found to be the situation within shipping in general (Oltedal, 2011). However, in all six cases, the underlying factor—the human behaviour leading up to the incident—is apparently standard operational practice on board. Although the operational practice is a deviation from the formal scripts, the deviating behaviour is normalized in practical operations and thus not reported in the safety management system. Through their safety management systems, the shipping organization could strive to identify the areas in which crew are drifting from the formal organization—in other words, identifying areas where normal practice has deviated from the formal scripts—and try to understand why this drifts occurs. Possible reasons could be pressure for efficiency in the design, development and implementation of formal guidelines or as a result of human cognitions as described by Hollnagel (2009). According to Snook (2000), the practical drift could be addressed by focusing on three areas: (1) looking beyond individual error by framing puzzling behaviour in complex organizations as individuals struggling to make sense; (2) following the basic design principles of high-performance teams and thinking twice about chasing the advantages of social redundancy; and (3) treating organizational states of integration and reliability with chronic suspicion. The important thing is to recognize them for what they are: constant outcomes of dynamic systems and ongoing accomplishments that require active preventive maintenance (Oltedal, 2011).

#### 4. CONCLUSION

This study identified two groups of direct causes common to all six incidents: (1) unmonitored approach related to inadequate transfer of command and (2) human deficiency to detect or interpret a technical state or error. The analysis concluded that underlying causal factors to ship–platform collisions are related to violations of procedures that have drifted into normalized operational behaviour. This practical drift—the normalized operational behaviour—is not addressed in the organizations' safety management system. In order to improve offshore vessels' safety, it is concluded that shipping organizations in their safety management system should strive to identify and understand the nature of the crews' practical drift from the formal guidelines and procedures. In future research, these areas will be further addressed in an offshore vessel safety survey.

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#### References

- Borys, D., Dennis, E. and Legget, S. (2009) The fifth age of safety: the adaptive age. *Journal of Health & Safety Research & Practice*, 1(1), 19-27.
- C.P., E. (1995) Mechanics of ship/jack-up collisions. *Journal of Constructional Steel Research*, 33(3), 283-305.
- Dreyfus, H.L., Athanasiou, T. and Dreyfus, S.E. (1988) *Mind over machine: the power of human intuition and expertise in the era of the computer*. New York: Free Press.
- Hollnagel, E. (2009) *The ETTO principle: efficiency-thoroughness trade-off why things that go right sometimes go wrong*. Surrey: Ashgate.
- Hollnagel, E. (2004) *Barriers and accident prevention*. Aldershot: Ashgate.
- HSE (2000) *Effective collision risk management for offshore installations*. Offshore Technology Report OTO 1999 052.
- HSE (2003) *Ship/platform collision incident database (2001)*. Research report 053. ISBN 0 7176 2679 2.

The Annual European Safety and Reliability Conference (ESREL)  
Helsinki, Finland, 25–29 June 2012

- IAOGP, International Association of Oil & Gas Producers (2010) *Ship/installation collisions*. Report 434-13.
- Kvitrud, A. 2011 Collisions between platforms and ships in Norway in the period 2001-2010. *OMAE 30th International Conference on Ocean, Offshore and Arctic Engineering*. Rotterdam, June 19-24, 2011.
- Oltedal, H. (2011) *Safety culture and safety management within the Norwegian controlled shipping industry: state of art, interrelationships and influencing factors* (PhD thesis). UiS no.137.
- Perrow, C. (1999) *Normal accidents: living with high-risk technologies*. Princeton, NJ: Princeton University Press.
- Petroleumstilsynet (2011) *Risikonivå i petroleumsvirksomheten Norsk sokkel 2010* (Hovedrapport). Stavanger: Petroleumstilsynet.
- PSA, Petroleum Safety Authority Norway (2011, January 5) *Risk of collisions with visiting vessels* (newsletter). Stavanger: Petroleumstilsynet.
- Reason, J. (2001) *Managing the risks of organizational accidents*. Aldershot: Ashgate.
- Sarantakos, S. (1998) *Social research*. 2nd edn. Houndmills: Macmillan.
- Snook, S.A. (2000) *Friendly fire: the accidental shutdown of U.S. Black Hawks over Northern Iraq*. Princeton, NJ: Princeton University Press.
- Stacey, R.D. (2007) *Strategic management and organisational dynamics: the challenge of complexity to ways of thinking about organisations*. 5th edn. Harlow: FT Prentice Hall.
- Weick, K.E. and Sutcliffe, K.M. (2007) *Managing the unexpected*. 2nd edn. San Francisco, CA: Jossey-Bass.
- Wiegmann, D.A. and Shappell, S.A. (2003) *A human error approach to aviation accident analysis*. Aldershot: Ashgate.
- Woods, D.D. (2010) *Behind human error*. 2nd edn. Farnham: Ashgate Pub. Ltd.