THE DECISION TO EVACUATE A PASSENGER SHIP – AN ASSESSMENT OF THE NORMATIVE VIEW OF THE SHIPMASTER

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ABSTRACT

The shipmaster is the centralised focal point of power on a passenger ship, and upon him/her rests the decision to evacuate the ship if it is deemed to be in a situation that is non-survivable. This thesis set out to explore a societal normative view of the shipmaster in this decision space; a view that can be observed in accident reports and maritime legislation. A case study, of a government accident report about the foundering of a large passenger ship and data collected by interviews with active passenger ship shipmasters, has shed light on the validity of that societal view.

It was found that the owner's mercantile interests and control of risk, and the society's demand for safety for the citizens, which is exerted through the SMS and legislation, necessitates a view of the shipmaster as a rational autonomous agent with legitimized power to secure positive outcomes. In contrast, it was also found that different applications of power co-exist and are not excluding each other, but are on the contrary supplementary and co-dependent for constituting the shipmaster's position of power, while at the same time subverting the shipmaster hierarchal position of power. In a reluctance to dissolve his power the shipmaster is not facing a go or no-go situation. Instead, the shipmaster is applying a decision strategy of gradually collecting enough information to make an informed decision, while seeking alternative solutions to the emergency situation, which challenges his ableness to secure a positive outcome.

These findings supported a hypothesis that assumed that the shipmaster's place in an authoritarian hierarchy brings about a view of the shipmaster as person with rational decision-making capability and power to secure certain outcomes. Furthermore, the findings indicate that the validity of the normative view of the shipmaster can be brought into question.

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INTRODUCTION

In January 2011, while I was attending a learning laboratory at Lund University, I had a telephone conversation with a Danish news agency that requested a comment on the foundering of the Italian passenger ship Costa Concordia that had occurred a few days earlier. The questions from the reporter were mainly about the conduct of the captain and how he had caused the ship to founder. I realized that a narrative was being created about the captain being the single cause of the accident. He was made accountable, because he was the authority on board; he should have known what was about to happen and should have reacted in order to prevent it. The use counterfactual language[1] and reasoning served as an explanatory framework for what had happened – he had failed in his duty to secure the safety of the ship and passengers.

As a marine accident investigator the creation of that narrative was not new to me. On the contrary, using counter-factual reasoning to explain complex adverse events with the captain as the primary cause has been the norm for explaining marine accidents such as Scandinavian Star (1990), Herald of Free Enterprise (1987) and the Estonia (1994), which made me sceptical to the view given by media and official reports. That the narratives about marine accident are centred on the captain raises questions about who that person is. The purpose of this thesis is to learn about that person.

SHIP TERMINOLOGY

In this thesis there are references to ship specific terminology that is not intuitively understood by someone with little in-depth knowledge about the maritime domain. The maritime terminology is, therefore, explained where it is being used, with the depth that is necessary for

[1] Relating to or expressing what has not happened or is not the case.

understanding the context. Some key phrases are however appropriate to introduce at this early stage. These phrases are: "The shipmaster", "evacuation" and "owner/operator".

The Shipmaster

On the website[2] of The International Federation of Shipmasters' Associations (IFSMA) there is an explanation of the term "shipmaster":

> *"In the Merchant Navy the person in charge and having ultimate responsibility for the command of the vessel is the SHIPMASTER and his rank is that of a MASTER. In the view of IFSMA this RANK is accorded to SHIPMASTERS who are in possession of an Internationally recognised Certificate of Competency issued by the Government of an established maritime nation and who are or have been in command of a seagoing Merchant Ship".*

IFSMA points out that captain is a courtesy title that is awarded in connection to internal proceedings of particular institutes of which a master mariner wishes to be a member. Furthermore, the title is also connected to various industries outside the maritime domain such as the military and government agencies. The title shipmaster is in this thesis chosen to describe the person being legitimised to be in overall command of the ship.

Evacuation

When an emergency situation on board a passenger ship is deemed to be so serious that it will result in the non-survivability of a passenger ship, then the passengers and crewmembers are to leave the ship in an orderly manner via the lifeboats and/or inflatable life rafts. It is an international mandatory requirement[3] that the evacuation can be executed within 30 minutes after the passengers have been assembled at the evacuation areas. If the ship is listing more than 20

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[2] http://www.ifsma.org
[3] SOLAS 1974, chapter III, regulation 21.1.3 (effective from 1998).

degrees, then the evacuation systems are non-effective. According to the international mandatory requirements, there is only 50% lifeboat capacity on each side of the ship. Unlike cargo ships that have 100% on each side. The thinking behind these percentages is that passenger ships are deemed to have a better survivability and the ship is considered to be the best lifeboat. Evacuation is the last resource to be used and only if everything else fails. The terms "evacuation" and "abandon ship" are used interchangeably in this thesis.

Owner of the ship

In everyday shipping terminology there is not necessarily a meaningful distinction between the terms owner and operator of a ship. In legal terms the operator is the entity that has the legal responsibility of operating the ship safely, and possesses the operational risks associated with it. The owner is the entity that has the legal ownership of the ship as an asset.

Historically, the owner of the ship and the operator were the same, but in recent decades the owner has delegated the risk to the operator. By holding a Document of Compliance, which is a mandatory certificate for all companies operating passenger ships, the risk is transferred from the owner to the operator. It is mandatory for the operator to have a Designated Person Ashore (DPA) that acts as a liaison between the ship and the highest level in the shipping company. In this thesis the terms shore organisation, owner, operator and DPA are used synonymously.

BACKGROUND – THE IDEALISED VIEW OF THE SHIPMASTER

> *"Why is it that the effect of a sensational catastrophe on a modern nation is to cast it into transports, not of weeping, not of prayer, not of sympathy with the bereaved nor congratulation of the rescued, not of poetic expression of the soul purified by pity and terror, but of a wild defiance of inexorable Fate and undeniable Fact by an explosion of outrageous romantic lying?"… "Though all the men must be heroes (except the foreigners, who must all be shot by*

> *stern British officers in attempting to rush the boats over the bodies of the women and children), the Captain must be a superhero, a magnificent seaman, cool, brave, delighting in death and danger, and a living guarantee that the wreck was nobody's fault, but, on the contrary, a triumph of British navigation"…"He* [the shipmaster] *paid the penalty; so did most of those for whose lives he was responsible. Had he brought them and the ship safely to land, nobody would have taken the smallest notice of him",* George Bernard Shaw, 14 May 1912 (Pearson, 1946).

George Bernard Shaw wrote the above in a letter to the editor in The Daily News and Leader that was published a month after the foundering of the Titanic on 15 April 1912. It was a response to the romantic hero stories that were being told in the press about the shipmaster and crewmembers that perished, which he meant clouded the circumstantial facts of the foundering; bearing in mind that George Bernard Shaw did it somewhat sarcastically. A week later, in a rebuttal to George Bernard Shaw, Sir Arthur Conan Doyle took the public view of the shipmaster into defence:

> *"Now everyone - including Mr Bernard Shaw - knows perfectly well that no defense has ever been made of the risk which was run, and that the sympathy was at the spectacle of an old and honored sailor who has made one terrible mistake, and who deliberately gave his life in reparation, discarding his lifebelt, working to the last for those whom he had unwillingly injured, and finally swimming with a child to a boat into which he himself refused to enter",*
> Sir Arthur Conan Doyle, 20 May 1912 (Pearson, 1946)

The above citations represent two different views on how the narrative about the foundering of the Titanic could be constructed and who the shipmaster of the Titanic was; the ordinary person in extraordinary circumstances that paid the penalty for his actions - or the shipmaster that honourably went down with the ship and became a hero in the process.

A century later, the shipmaster of a passenger ship is still in the epicentre in the constructed narratives about marine accidents.

The shipmaster plays an important role in the narrative of the accidents, because he is at the top of an authoritarian hierarchal organization and is legally responsible, not only the safety of the ship and passengers, but also, responsible for the mercantile success of the ship. In addition to the formal structures that define the shipmaster's role, there are also moral and ethical values that are attributed to the shipmaster, as portrayed in the above correspondence. These values are not necessarily visible or recognizable in the everyday work on board a passenger ship, where most operations are conducted on the basis of routine practices. However, in an emergency situation the shipboard organization by design defaults into a centralized hierarchal structure with practised routines that facilitate collaboration, and predefined tasks for every crewmember on board. In this situation the shipmaster becomes the centralized focal point of decision-making and power, and the subordinates are resources for the shipmaster to use in order to gain knowledge to make optimal decisions. In that capacity, the shipmaster will be measured up against an ideal view of the shipmaster.

This idealised view can be observed in various (inter)national maritime legislation and in formal accident investigation reports.

The (inter)national legislation formally defines the shipmaster's role with the primary aim to establish responsibility. How the shipmaster's specific role is defined varies from country to country, but is largely based on the same underlying thinking from international regulation. In this thesis samples of legislation from Denmark and Italy and will be presented.

In Danish maritime law[4] it is stated:

> *"Section 132. The master shall ensure that the ship is navigated and treated in a manner, which is consistent with good seamanship.*
> *Section 135. If the ship comes into distress, the master shall do everything within his power to save those on board and safeguard the ship and cargo. The master shall ensure that the logbooks and ship's papers, if necessary, are brought into safety. The master shall also ensure salvage of the ship and cargo as far as possible. Unless there is serious danger for the life of the person in question, the master shall not leave the ship while there are reasonable prospects for saving it.*
> *Section 140. The master shall be liable to compensate for damage which he causes through fault or negligence in the course of service to the ship owner, cargo owner or others".*

The phrases: shall ensure and shall be liable from the above citation are not only describing the shipmaster's responsibilities, but are also indicators of his or hers formal powers. The premise of the phrases is that the shipmaster has power to ensure the safety of the ship, cargo and passengers. Furthermore, the legislation assigns responsibilities to the shipmaster that imply that the shipmaster is able to perform within acceptable norms, which is described as: *"do everything within his power"*, *"while there are reasonable prospects"* and "*good seamanship"*. A case study in this thesis will shed light on how these phrases are idealized standards that are only manifested by an ex post facto evaluation of outcome of adverse events.

4 Merchant Shipping Act. Consolidated act no. 75 of 17 January 2014 issued by the Danish Maritime Authority.

Morriss (2002, p. 200) describes how descriptive concepts, as those mentioned above from the legislation, can carry idealized views, which can be useful in creating inspirational language as part of everyday linguistic habits, but descriptive concepts can also promote a discourse that creates a regime of truth about the shipmaster's power and decision-making capabilities – a truth that can be observed in formal marine accident reports (see p. 72).

Formal marine accident accounts can, depending on time period, nationality, status of the investigation etc., have different agendas and analytical frameworks. Nevertheless, they represent a formalized narrative of the accident that typically becomes a societal accepted truth about the events, and are highly influential in creating what roles and values that are assigned to the shipmaster. As Brown (2004) formulates it: *"reports are constructed according to the conventions of the public policy in which they are located and to which they contribute – creating, clarifying, sustaining, and modifying this particular version of reality"* (p. 98).

An example of apportioning responsibility and duty is seen in the report of the capsizing of the Herald of Free Enterprise in 1987:

> *"The fact that other Masters operated the same defective system does not relieve Shipmaster Lewry of his personal responsibility for taking his ship to sea in an unsafe condition. In so doing he was seriously negligent in the discharge of his duties. That negligence was one of the causes contributing to the casualty"* (Sheen, 1987, p. 13).

And in the accident investigation report about the foundering of the passenger ship Costa Concordia in 2011:

> *"…the Master's unconventional behaviour, which represents the main cause of the shipwreck. It is worth to anticipate, closing this summary, that the human element is again the root cause in the Costa Concordia casualty, both for the first phase of it, which means the unconventional action which caused the contact with the rocks, and for the general emergency management".* (MIT, 2013, p. 9).

Both reports elaborate on the many factors that influenced the accidental events and they, to some extent, provide explanatory frameworks for how and why the accidents happened. In addition to the explanatory frameworks, the shipmasters were singled out as causes of the accidents in their own right (by being responsible), not by analytical reasoning, but by an ex post facto interpretation of their *"personal"* responsibility and *"unconventional"* behaviour.

The citation from the report about the foundering of Herald of Free Enterprise is about the shipmaster's responsibility, which relates to his position in the hierarchy – his position of power, i.e. he did not as a leader exercise good seamanship by "*taking his ship to sea in an unsafe condition"* and was therefore *"negligent"*. The example from Costa Concordia highlights the shipmaster's decisions and actions, which is elaborated in below citation from the same report:

> *"The general emergency and the abandon ship signals were activated with delay in respect to the moment when the awareness that at least three contiguous WTC of the ship were flooded; this meant that the seriousness was evident, and this information reached the bridge at 22.01 but the first lifeboats were lowered in the sea only at 22.55"* (p. 160).

The report thereby stated that the shipmaster did not respond to information that was *"evident"*. The shipmaster had, however, in the inquiry stated: *"…that he* [the shipmaster] *never would unload 4.000 persons till he was not so quite sure that the ship would have sunk"* (MIT, 2013, p. 92). Especially the latter citation from the report is interesting, because it relates to his motivation, but it was not further explored in the report. A case study in this thesis will show that in the report there are indications that the shipmaster had the belief the situation was containable, and that the ship to some extent could be recovered from the emergency, or the situation could at least be stabilized. Alternatively, that the passengers could be evacuated by shuttling them to shore without using the abandon ship procedures – given they were only approximately 300 meters from shore. This information from the shipmaster suggests that the unfolding events presented the shipmaster with opportunities that were within the shipmaster's decision space. However, the shipmaster's behaviour was in the report measured against an ideal of having access to all information (having perfect information) and, more importantly, having recognized the relevance and importance of that information in a rational manner.

In the report (MIT, 2013) and in the legislation it is assumed that the shipmaster's is a rational decision-maker with a place in the hierarchy that gives him the power to act to secure the optimal outcomes. This idealised view of the shipmaster is in the following considered the normative view of the shipmaster.

In an article by Schröder-Hinrichs, Hollnagel and Baldauf, M. (2012):

> *"It is argued that the widespread confidence in the efficacy of new or improved technical regulations, that characterizes the recommendations from most maritime accident investigations, has led to a lack of awareness of complex interactions of factors and components in socio-technical systems. If maritime safety is to be sustainably improved, a systemic focus must be adopted in future accident investigations" (p. 1).*

The authors assert that too little has been learned since the foundering of Titanic and the loss of

Costa Concordia. The authors specifically address the decision-making and authority on board ships, and that these subjects have been underdeveloped in the efforts to understand marine accidents. This thesis is an attempt to unpack the normative view of the shipmaster's decision-making capability and authority on board passenger ships.

THE QUESTION

This thesis sets out to assess the validity of the normative view of the shipmaster in the context of the decision to evacuate a passenger ship.

The underlying hypothesis of the question assumes that the shipmaster's place in an authoritarian hierarchy brings about a societal view of the shipmaster as person with rational decision-making capability and power to secure certain outcomes, a view that is promoted by legislation and by the analytical framework that underpins formal accident investigations.

In contrast, the shipmaster can be also be viewed as a focal point of power in a complex socio-technical system, where there is imperfect knowledge about the interactions the system that challenges the shipmaster's decision-making capability. Furthermore, that other mechanisms of power exist in an abandon ship situation that both constitutes and subverts the shipmaster's position of power. The shipmaster is considered the custodian of safety on behalf of the society and the ship owner. When crewmembers and passengers loose faith in the shipmaster ability to uphold control (e.g. ship listing excessively), then his authority will be lost, and they will act independently from the organisational structures that the shipmaster governs. The shipmaster's authority is lost on the boundary of control.

The more conspicuous and indirect influences on the management of shipboard operations will in this thesis be explored in the context of a single decision - how is the decision to evacuate the ship made? Is it about doing too much to early, in the meaning that the passengers are evacuated while the ship is still seaworthy; or is it about too little too late, which means accumulating information until the optimal decision can be made, which may be too late.

In the following a literature review will explore the ship as a system and the shipmaster as a decision-maker within it. Furthermore, will the shipmaster's place in various conceptions of power be unfolded.

THE PASSENGER SHIP AS A SYSTEM

Perrow (1999) introduces how accidents emerge from complex systems as a result of interactions between system components and processes that are tightly coupled in conjunction with a centralized governing of the system. These accidents are labelled normal accidents, as they are a result of the properties of the system. The implications of this view on accidents will not be elaborated further in this context, suffice it to say, it is a radical departure from the optimistic view that accidents can be foreseen and avoided, and introduces a more pessimistic view where some systems are considered inherently unsafe.

Perrow (1999) has a chapter that specifically addresses shipping as an overall system. He does not distinguish between the various segments within that vast industry. Even though examples from e.g. tankers, passenger ships and naval ships are introduced, it is implied that the same underlying mechanisms govern the different segments, which result in what he describes as: *"I will call it an "error-inducing" system; the configuration of its many components induces errors and defeats attempts at error reduction"* (Perrow, 1999, p. 172). This error-inducing system creates incidents and accidents that are caused by the crewmembers behaviour: *"…we still have no choice but to call many errors unforced in the immediate sense; the officers or crew should have known better"* (Perrow, 1999, p. 174) and that it is: *"…abundantly clear to me…that operator error does abound"* (Perrow, 1999, p. 174). One could argue that the above citations are describing component failures (human components) and not system failures. However, Perrow (1999) also addresses the economic pressures that the crew and specifically the shipmasters are influenced by, however, without an in-depth elaboration on how these economic factors are influencing the system.

Perrow (1999) points out the difficulty in categorizing shipping within the interaction/coupling chart and identifies both loosely and tightly coupled interactions as well as simple and complex system attributes. He characterizes shipping as an "error-inducing" system and argues that: *"Ships operate where most of nature and most of man conspire to ravage them"* (Perrow, 1999, p. 176). Arguably, in this context Perrow (1999) uses the term error in a different way than the normal accident theory proposes. Perrow (1999) thereby suggests that shipping is somewhat out of category in relation to the general concepts of coupling and complexity that he builds his normal accident thinking on.

Perrow's (1999) primary source of data is some 200 detailed accounts of marine accidents (p. 174). It is, however, unclear what the nature of these accounts is - i.e. who made them and when these accounts are from. These questions are essential for understanding the underlying thinking, analytical choices and sacrifices that are made in constructing accident accounts. Stoop and Dekker (2012) describe how accident accounts, such as formal and informal investigation reports, can be characterized as social constructions. How they are constructed determines how they can be used for analytical purposes.

Perrow's reluctance to use normal accident thinking in the marine domain is based on a 1984 understanding of shipping, human error and system failures. It should be noted that the chapter on marine accidents is from the 1984 edition of the book, which remained largely unchanged in the second edition from 1999, which is reflected in Perrow's 1984 view on causal factors in marine accidents.

This Perrowian 1984 view shall be taken into consideration, when reading within the context of progressive development in the understanding of human error in the context of system failures, as is evident from more recent literature by e.g. Reason (1990), Rasmussen, Nixon and Warner (1990), Woods and Cook (1999) and Dekker (2002). However, while the approach to human error in complex socio-technical systems has developed and become more nuanced within the last two decades, it does not necessarily mean that the maritime domains have recognized this and adopted such thinking. The accident investigation report about the foundering of Costa Concordia (MIT, 2013), and the earlier report about the foundering of the Herald of Free Enterprise (Sheen, 1987) are a testament to this, which will be addressed in this thesis by a case study of the Costa Concordia accident report.

Perrow (1999) places marine transportation in quadrant 1 in his interaction/coupling chart (p. 97). It implies that the system that is linear and tightly coupled, which makes it prone for system accidents. In such a system is centralized governance believed to be best strategy for mitigating risk. On having a centralized governing of a ship Perrow (1999) states: *"The authoritarian structure aboard ships, perhaps functional for simpler times, appears to be inappropriate for complex ships in complex situations"* (p. 230).

Mills, C. W. (1956, p. 3) captures the centralized actor well when he describes the power elite in the United States:

> *"As the means of information and of power are centralized…they* [some people] *are in positions to make decisions having major consequences. Whether they do or do not make such decisions is less important than the fact they do occupy such pivotal positions: their failure to act, their failure to make decisions, is itself an act that is often of great consequence than the decisions they do make. For they are in command of the major hierarchies and organizations of modern society".*

Passenger ships are characterized by having a centralized power[5] and the shipmaster makes decisions having major consequences.

At this stage it is appropriate to concisely examine how the passenger ship as a system can be characterized as complex as Perrow (1999) asserts.

Harris (2013) writes about distributed cognition on modern ships. In his paper he proposes that modern ships should not only be considered as complex socio-technical systems, but also as joint cognitive systems were there is interaction between the crewmembers and the ship's equipment. He widens the use of the joint cognitive systems thinking to include shared cognition, which is the interaction among the crewmembers that have an approximately aligned situational awareness. Harris (2013) constructs his article on an understanding of situational awareness, as an explanatory framework for evaluating decision-making in hindsight that can be problematic (Dekker & Hollnagel, 2004). However, his thinking about the ship as a complex distributed cognitive system, where no one has the overall understanding of the system is essential for understanding the ship as a complex system and how the distribution of knowledge can influence power. His premise is that knowledge about the system flows democratically between the actors in the system and he pays little attention to the possibility that knowledge, or lack of it, can be what constitutes the position of the individual crewmember. Knowledge is therefore not necessarily exchanged or shared freely or willingly between the actors in the system with the aim of reaching a unified view of a certain outcome. Furthermore, knowledge is not relevant information per se, but can also be data that creates "system noise" (Lanir, 1986).

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[5] International Safety Management Code, chapter 5.2.

Dekker, S., Cilliers, P., & Hofmeyr, J. (2011) and Dekker (2011) distinguish between complex and complicated, and summarise some of the characteristics of complexity compared to the Newtonian linear thinking, where proportional strict cause and effect relationships govern the system. Their view on complexity supplements well Harris's (2013) view about ships as complex systems E.g. they are open systems that are not functioning in equilibrium, but are in need of an actor that fine-tunes the system to keep it in balance. Specifically the individual component's (e.g. crewmember's) ignorance about the functioning of the system as a whole is important when analysing decision-making and power mechanisms.

POWER AND DECISION-MAKING

In this chapter, literature that will shed light on the topics of power and decision-making will be discussed separately.

Why the study of power is relevant when investigating the shipmaster

Apart from establishing that technological advances have made the shipboard system more complex, Perrow (1999) also questions the power structure, not only within the shipboard system, but also regarding culture as such: *"We miss a great deal when we substitute culture for power"* (p. 380). He uses the concept of power in relation to organisational power i.e. organisational hierarchal power without elaborating further on the subject of power. Diane Vaughan (1996) in her book about the Challenger space shuttle disaster in 1986 states: *"…the structure of power and the power of structure and culture – factors that are difficult to identify and untangle yet have great impact on decision-making in organisations",* (p. xv). Vaughan does also not elaborate further on the mechanisms of power apart from the organisational hierarchal power structures. Conceptions of power are thereby recognized as being important in understanding safety and decision-making.

On large passenger ships there is historically and presently a formalized hierarchal authoritarian structure with the shipmaster as a centralized focal point of power. However, having a formalized structured hierarchy of power does not necessarily reveal much about how power on board a ship manifests itself and whether or not it is centralized in the way Perrow (1999) and Vaughan (1996) proposed it.

In order to gain an understanding of who the shipmaster is, beyond the folklore description as earlier accounted for in the case of the foundering of TITANIC, it is necessary to dig deeper into the anatomy of the shipmaster as a focal point of power in a safety critical complex socio-technical system. It is therefore necessary to expand on the common understanding of power as a hierarchical and dominant structure where *"A has power over B to the extent that he can get B to do something that B would not otherwise do"* (Dahl, 1957, p. 202).

Expanding the conceptions of power can give a more nuanced understanding of the shipmaster's decision-making space, or even the space of non-decision-making, in an environment that is effected by not only distributed knowledge and cognition on board the ship, but also interaction between the ship and the shore organisation that, due to increased communication capabilities, play an increasing role in the handling of an emergency situation.

Thereby, the existing normative discourse of the shipmaster as a focal point of power is expanded with the purpose of shedding light on other mechanisms of power, which influence the decision to evacuate a passenger ship.

In this thesis, power will be addressed in relation to the decision to evacuate a passenger ship with the purpose of assessing the validity of the normative view of the shipmaster. Before the conceptions of power are applied within the scope of the research question and hypothesis, some of the thinking in the literature will be presented that underpins the framework that will be used for analysing the shipmaster within different conceptions of power. A schematic overview of these conceptions can be found at the end of the section about power (p. 30-31).

Framing of the concept of power within the question and the hypothesis

Although the word power can bear intuitive and semantic meaning, it is not easily defined or as Dahl (1957) puts it: *"…a Thing to which people attach many labels with subtle or grossly different meanings in many different cultures and times is probably not a Thing at all but many Things…"* (p. 201).

The words of Dahl (1957) suggest that there are significant methodological and epistemological challenges in the analysis of power. Some of these challenges will be described in the method section and some in this chapter, as different approaches to the conceptions of power and its mechanisms are presented.

It should be noted that the different analytical approaches to the conceptions power are addressed within different scientific contexts. This is most visible when contrasting Dahl (1957) to Foucault's approach to power. Dahl (1957) has a strict empirical approach to power rooted in political science, whereas Foucault has a philosophical approach, which is not bound by the methodological thinking of political science. These different approaches to the conceptions of power are not necessarily mutually exclusive, but rather widen the way the conceptions and mechanisms of power that can be used.

First and foremost, power is, as stated above by Dahl (1957), many things. It is social structures and relations among individuals, and between individuals and institutions. Furthermore, it can be viewed as an attribute or a strategy that exists everywhere in society and is semantically used as a noun or a verb.

In this thesis several conceptions of power will be drawn from the thinking of Dahl (1957), Lukes (1974, 2005), Morriss (2002) and selected works from Foucault. These authors are chosen, because they represent different perspectives of the conceptions of power, which illustrates that the thinking about power has evolved and how varied this is. The various authors draw extensively upon each other's thinking with the exception of Foucault who, with a different method or lack of consistent method, approaches the concept of power from a philosophical viewpoint, and not from a sociological or political scientific epistemological standpoint.

Power as domination of the (un)willing - power over

Lukes (2005) develops much of his underlying thinking from Dahl (1957), but distances himself from the operational and empirical study of power, which leads to a focus on the results of power – measured primarily in terms of the experience of success in decision-making - or that a resource comes into action resulting in a positive outcome for the entity exerting power. What Lukes (2005) refers to as the exercise fallacy (decision) and the vehicle fallacy (resources).

It should be noted that Lukes (2005) develops, or rather widens, his approach to power from the 1st edition from 1974 to the 2nd edition in 2005 by introducing the analysis of power by Morriss (2002) and elaborates on the Foucauldian thinking, with a focus on the epistemological challenges when studying power. He does not expand much on his own concepts of power, but distances himself from the earlier underlying thinking of power as centred on the *exercise* of power, and to some degree the direct mechanisms of domination with the simplistic and direct purpose of securing the compliance of the unwilling (Lukes, 2005, p. 109-110).

Overall Lukes (2005) is conceptually studying power as having power over another or others by domination - how to secure their compliance by having power as a resource to be exerted upon others (p. 12). He operationalizes this view on power by introducing the third dimension of power.

The third dimension of power stands in contrast to what he labels the one- and two-dimensional power. The first dimension is the pluralist view of power introduced by Dahl (1957) among others, who studied behaviour within a decision-making political environment, where the analytical starting point was the outcome of the mechanisms of power and the intuitive idea of power: *"A has power over B to the extent that he can get B to do something that B would not otherwise do", (Dahl, 1957, p. 202-203).* This means that A secures B's compliance irrespectively of B's willingness. In this sense, power is a capacity that A possesses – a capacity to secure a certain outcome in a social conflicting environment with different interests. By studying successful or faulty decision outcomes one can analyse the underlying mechanisms of power. It should be noted that the anatomy of the domination of A over B is not explored in any detail and, therefore, it is difficult to elaborate on the legitimisation of power - i.e. why can A dominate B.

In response to the one-dimensional view on power Bachrach and Baratz (1962) assert that it is restrictive, because it only addresses concrete decisions and the effects thereof. They oppose the elitist view on power that seeks to determine who has power, assuming that power is centralized in specific entities and that power is an ordered structure in a given system. Furthermore, they oppose the pluralist view of Dahl (1957) where the power is to be studied in an environment of conflict and the object of study is the outcome of decisions on a variety of issues. Although Bachrach and Baratz (1962) recognise that power is exercised when A participates in the making of decisions that affect B, but:

> "*…power is also exercised when A devotes his energies to creating or reinforcing social and political values and institutional practices that limit the scope of the political process to public consideration of only those issues which are comparatively innocuous to A. To the extent that A succeeds in doing this, B is prevented, for all practical purposes, from bringing to the fore any*

issues that might in their resolution be seriously detrimental to A's set of preference" (p.948).

This means they include the social mechanisms that invoke non-decision-making in both an unwilling and willing manner, but still on the basic premise that power is about domination and one actor will gain an advantage over another unwilling actor. This is the two-dimensional view on power.

Lukes' (2005) third dimension of power expands on the prior two dimensions of power. Lukes describes the third dimension by what it is not as much as he tries to frame what it is. The focus is on the securing of <u>willing</u> compliance to domination and not necessarily contrary to existing interests, because power is also about A's capacity to change the interest of B so they become aligned or enacted with A. It is furthermore asserted that A also has power, when A is able to satisfy and advance B's interests. Lukes' change in thinking thus becomes evident: from exclusively addressing power as asymmetrical domination when some can exercise <u>power over</u> others he has developed his thinking to include potentials i.e. as an ability when having <u>power to</u>.

Lukes' (2005) use of the terms ability and capacity as dispositional characteristics of power are essential in Morriss' (2002) view of power. These attributes of power are essential in the efforts to understand the mechanisms of power that the shipmaster finds himself or herself in - an understanding that moves beyond the thinking of domination as an effect of organisational hierarchy, and into the underlying mechanisms that govern the shipboard operations centralised in the position of the shipmaster.

Power as a dispositional property – power to

In Morriss' (2002) understanding, power is a dispositional property. This dispositional approach to power is described as an individual's ability or ableness, which is a capacity that an individual is able to act out under hypothetical conditions, and a capacity that an individual is able capacity under actual conditions respectively, i.e. power as an potentiality or power as an actuality.

These power potentials and actualities are further expanded: An epistemic ability is when A has the ability to do X if A knows that a string of certain actions will lead to X. Non-epistemic ability is when A has the ability to do X, but does not know that the string of actions will lead to X.

Understanding the epistemic nature of power is relevant when considering a perceived ability to secure a certain outcome by having perfect knowledge in order to make optimal rational decisions, which is associated with the normative view of the person holding the position as shipmaster, as discussed earlier. Recognizing non-epistemic power and that knowledge is unevenly distributed in a complex system, becomes relevant when exploring the perceived ability of the shipmaster to reach a certain outcome without knowing which strategy to use.

"Power as a dispositional concept is neither a resource or a vehicle nor an event as an exercise of power, but it is a capacity residing in the individual or group" (Morriss, 2002, p. 19).

Morriss (2002) elaborates on the differences in the exercise of power and power as a capacity, which is a potentiality that is not necessarily observable by the cause and effect of action and response alone. This is an important point – distinguishing between a given act and the capacity to act. If this distinction is not clear we might be tempted to interpret various sorts of acts with a certain outcome as an exercise of power incorrectly (Morriss, 2002).

This is one of the pivotal points where Morriss' (2002) concept of power is different from Dahl' and Lukes' approach. Morriss (2002) is internalising the study of power whereas Lukes is engaged in a purely external and pluralist approach by studying power by evaluation of the results of decision-making and the entities that are seeking these results.

Morriss' approach to power is a particularly interesting concept to use when studying the shipmaster's place in power structure on board a passenger ship. Understanding the dispositional nature of power residing in the shipmaster can be useful for descriptive as well as predictive purposes (predicting the shipmaster's behaviour), but will not be suitable for explaining why the power mechanisms on the bridge of a passenger ship are the way they are (Morriss, 2002, p. 44).

The sort of description that is worth examining is the shipmaster's capacity to make a specific decision, where the subject of analysis is the nature of the shipmaster's ableness (actual power) and how a discourse is created that defines the episteme about the shipmaster as a focal point of power and decision-making. Having the ability (potential power) to affect a given outcome does not necessarily imply that the shipmaster has the ableness (actual power) to do so. E.g. having legitimized power to order abandon ship does not necessarily mean that the shipmaster has actual power to carry it out at the right time and in an orderly fashion.

This difference is linked to the normative description of the shipmaster that does not distinguish between ability and ableness. Morriss (2002) addresses this issue when describing how one cannot be responsible for something that one cannot do – *"ought does not imply can"* (p. 38). So, if the shipmaster can demonstrate lack of ableness (actual powerlessness) then responsibility can be denied. Whether the last statement is valid in the context of the research question will be addressed later in this thesis.

Power as strategy that constitutes and legitimizes the shipmaster

Michel Foucault's rhetorical style about power is very different from what is found in political science. Morriss (2002) asserts that Foucault is not writing about power at all and refers to his writing as *"…distorted."* (p. xvi) and Lukes describes it as *"…excessively rhetorical style entirely free of* *methodological rigour…"* (p. 61), but acknowledges that his writing is broadening and deepening the discussions about power.

Foucault's rhetorical style can be challenging. He makes use of constructs of which the ramifications are not easily understood before they are applied in the context of a specific analysis.

Foucault's thinking about power cannot easily, or not at all, be placed into a theoretical framework and applied in a given organization or entity within it, e.g. the shipmaster. The many labels that have been attributed to him indicate that Foucault's writing is constantly evolving: poststructuralist (Callinicos, 1989), post modernist (Flynn, 2005) or neo-conservative (Isenberg, 1991).

Foucault's thinking about power cannot be narrowed into one specific article, interview or book, but is spread out over a large volume of work that developed over more than a decade. Therefore, it is useful to draw on secondary literature (Mills, 2003), (Isenberg, 1991), (Karlberg, 2005), (Wickham, 1983), (Gallagher, 2008) that unifies Foucault's work on power and his methods - or lack of consistency thereof – through critical interpretation. In relation to the latter there is an important point to be made: Foucault is not attempting to create a unified theory about power, he examines how relationships of power interact and distances himself from power as an oppressive or constraining construct as a dispositional capacity (potential or actual) as Lukes and Morriss assert. Rather, he thinks about power as a strategy, that acts and manifests itself in a certain way: *"…individuals are the vehicles of power, not its point of application…The individual which power has constituted is at the same time its vehicle"*, (Foucault, 1980, p. 98). Power is of a capillary nature and is thereby not only creating and shaping subjects, but the subject is also in a reciprocal process changing and shaping the mechanisms of power.

In *The Subject and Power*, Foucault (1982), writes about his motivation to analyse power. Central questions are: What legitimizes power and how power makes the individual a subject by *"…categorizes the individual…attaches him to his own identify, imposes a law of truth on him which he must recognize and which other must recognize in him"* (p. 781). The individual is an effect of power - and the individual that power has constituted is at the same time its vehicle Foucault (1980, p. 98). Foucault later describes that the individual constitutes himself in an active fashion by the practises of self. These practises are not something the individual invents himself, but patterns that he finds in the culture and which are proposed, suggested and imposed on him by his culture, his society and his social group – constitution created by even theoretical discourses, Foucault (1987, p. 122).

Needless to say, this view of power is epistemologically different than Dahl's, Lukes' and Morriss' concepts of power.

Foucault's thinking about power can be used for shedding light on how power is manifested in less overt ways in the interrelations between the shipmaster and the system he is functioning in – less overt than described in international legislation and accident reports. Thereby, moving away from power as domination and <u>power over</u>.

In this thesis the aim is not to use Foucault to gain knowledge about power on a ship per se, but rather to observe the shipmaster of a ship through the lens of Foucault's approach to power to gain an understanding of the discourse about the shipmaster that shapes the shipmaster's formal role as a decision maker and a focal point of power, and more importantly how the mechanisms of power influences the societal perception of the shipmaster's decision-making capability.

Furthermore, to examine how power is manifested through socially recognized superiority in knowledge and expertise that creates the shipmaster's self.

The shipmaster's position is constituted by power mechanisms and he/she becomes the vehicle for this power. It is therefore important to understand the shipmaster from a broader perspective than an organizational dominant figure who has been given power over the system, but from a Foucauldian view of power, where power is a set of practices and not a commodity (Gallagher, 2008).

Foucault's approach to power can be useful when addressing questions about how the shipmaster's institutionalized knowledge and expertize legitimizes the power mechanisms that he/she operates within. How are the passengers and crewmembers willingly entrusting him/her to be the custodian and provider of safety, in a pastoral like power (Foucault, 1982, p. 783), where the shipmaster is expected to sacrifice himself/herself for the safety of the ship and passengers? What happens if this trust is broken and the passengers and crewmembers are no longer subject to the power of the shipmaster and the shipmaster can no longer practise his/her self? These questions are relevant because they influence the discourse about the shipmaster; his/hers appointed role and view on himself/herself and place in the system. The discourse can influence how the normative view of the shipmaster's decision-making capability is produced, but more importantly, how the shipmaster becomes the subject of power by others in the system, and how authority dissipates on the boundary of control.

Lukes, Morris and Foucault have different approaches to power, but these can be seen as complementary when viewing power externally, when describing the formalized hierarchical structure, and internally when describing the reciprocal processes that shape power between the shipmaster and the organisational environment he operates in.

Below is a simplified schematic overview of the conceptions of power that has been presented.

Author	**Conception of power**	**Analysis of the shipmaster**
Dahl	Power as domination <u>over</u> the unwilling: A has power over B to the extent that he can get B to do something that B would not otherwise do. Power as success in decision-making or application of resources. Power as ableness to act to secure the desired outcome. Power can be observed by the achievement of certain outcomes.	The shipmaster is a bureaucratically legitimized organisational authority. In this position the authority is seen as an actual <u>power over</u> the ship, and where the shipmaster has ableness to secure positive outcomes by domination of the unwilling. This is a dominant externalist approach to power.
Lukes	<u>Power to</u> dominate by willing compliance – third dimension of power: changing B's interest so it becomes aligned with A's interest.	The ship owner legitimizes the shipmaster to be in a position of power. By having superior knowledge and expertise the shipmaster can align the interests of others with his/her own interest. This is a dominant externalist approach to power where power flows from the ship owner; as well as the regulation.
Morriss	Power is not necessarily domination, but a dispositional property. Power as a *capacity*: <u>power to</u> act or not act, which can be potential or actual: Power as *ability* is the potential to act. Power as *ableness* is the possibility to actually act. Power can be epistemic or non-epistemic: knowing how to reach a goal or not knowing how to reach a certain goal.	That the shipmaster has bureaucratic legitimized power and a position in the organizational hierarchy does not mean that there is actual power to act to secure positive outcomes. There is thus a difference in the potential power that rests in the bureaucratic legitimized power (ability) and the actual power to act (ableness). This is an internalised approach to power.
Foucault	The individual is an effect of power - and the individual that power has constituted is at the same time its vehicle These practises are not something the individual invents himself, but patterns that he	Power is not a dispositional property or capacity, but a set of practises that in a reciprocal process shape the shipmaster and where the shipmaster becomes its vehicle. The culture, society, social group

	finds in the culture and which are proposed, suggested and imposed on him by his culture, his society and his social group – constitution created by even theoretical discourses,	and theoretical discourses shape these practises.

Table 1: Conceptions of power: a comparison

The relation between power and decision-making

As the previous citations from the Danish maritime law illustrated, the shipmaster has legitimized authority and responsibility to make decisions that affects the crewmembers and passengers. Although the legislation does not specifically elaborate on the shipmaster's empowerment to make decisions, it presumes that the responsibility to make decisions entails having the power to make decisions. Authority thereby carries responsibility, which tacitly implies actual power.

The nature of shipmaster's power is described in the International Safety Management Code: *"The Company should establish in the SMS* [safety management system] *that the master has the overriding authority and the responsibility to make decisions with respect to safety and pollution prevention and to request the Company's assistance as may be necessary"* (ISM code 2014, chapter 5, section 5.2). Making the right decision is thus closely connected to the shipmaster's legal authority: *"The master's professional judgement is the key feature upon which command decisions are taken on the management of risk"* (Daniels, 2012, p. 107).

There is, therefore, a connection between the shipmaster's power, professional judgement (knowledge) and decision-making when managing risk on a ship. The decision to evacuate a passenger ship is, beyond a certain point, an irreversible decision. Once the passengers are in the lifeboats or liferafts, they cannot be brought on board again (the load limits of the davits are normally only designed for launch and not lift). The non-reversible decision to terminate the functioning of the ship is both a manifestation of the shipmaster's power, and the abolishment of his power.

Decision-making

When addressing the subject of decision-making we will depart from the normative views of the shipmaster as accounted for by George Bernard Shaw and Sir Arthur Conan Doyle. Instead the shipmaster will be considered as an individual with a strong sense of self-preservation that acts with imperfect knowledge in an uncertain environment, whose decisions are biased by feelings, human cognitive limitations and a lack of knowledge about a given emergency situation that arises as a surprise; not only for the shipmaster, but for the organization as a whole.

The subject of decision-making will in the following be described in three stages in relation to the decision to evacuate the ship: The decision environment, the decision-maker and selected decision-making theory.

The decision-making environment

In the maritime domain accidents are defined by their outcome i.e. the consequence of a given occurrence. This means that a loss of life or ship is categorized as a "very serious accident" and a "serious accident" is defined by a variety of minor damages[6]. Before these consequences are manifested, there can be a number of accidental events that are not necessarily recognized or considered to be significant individually, but, as time passes and events unfold, they can accumulate into a scenario that becomes very serious. These accidental events, or their outcome, are surprises for the crewmembers in the moment they occur even though warning signs may have preceded the surprise event, however these signs, or signals, may not have been recognized as warnings, but merely as normal system variations in the daily operations i.e. experienced individually with known outcomes that are anticipated.

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[6] International Maritime Organisation circular: MSC-MEPC 3/Circ. 3

Lanir (1986) describes two types of operational surprises: fundamental or situational. Fundamental surprises are events that challenge our view of the world, the way we expect our environment to function and our place within it. These fundamental surprises are profoundly unexpected and thus difficult to prepare for. Situational surprises are events that are within the scope of already considered eventualities and may have been visualized before the situation arises and are thus not challenging our view of our world. In theory, we would be able to design early warning signals for these situational surprises and create training scenarios for such events. Lanir (1986) describes how surprises are preceded by signals (warnings), but they are hidden by the noises that overcome the signals and thereby make them hidden within the normal system variability. Lanir (1986) describes the relationship between the two types of surprises in complex systems:

> *"Both situational and fundamental surprises become more prominent as technological and organizational complexity increases. On one hand, in complex systems, even a minor situational surprise can start chain reactions that can develop into a catastrophe. On the other hand, rapid changes in the human environment, caused by the increasing use of powerful organizations and sophisticated technologies in shaping and changing the environment, create a new need for learning about one's "self." Such learning is basically different and substantially slower and more difficult than learning about the environment. The more complex and technologically advanced the organization is, the greater the gaps between its ability to prevent the recurrence of situational surprises and its vulnerability to fundamental surprises"* (p. 28).

The initial grounding and flooding of Costa Concordia can be characterized as situational surprises for the shipmaster, because the scenario of grounding and flooding is not unheard of. The scenario is part of training and drill schemes. However, as the grounding occurred as a consequence of what was part of everyday practises of navigating in confined waters, it became a fundamental surprise, because it changed the shipmaster's view of what was safe and unsafe. In the aftermath of the grounding, the accumulation of events (immediate loss of propulsion, power and steering) added to the fundamental surprise as the events accumulated into a scenario that was filled with noise making effective rational decision-making difficult. Lanir (1986) states: *"As cognitive psychology has shown, human beings have difficulty interpreting the meaning of the signal because of their cognitive limitations in dealing with vast amounts of information as well as in judging complex and fuzzy situations"* (p. 12).

The decision-maker

Decision support tools in the maritime domain are made on the traditional engineering premise that information propagates in an orderly fashion ready for the shipmaster to take into consideration when making a decision. Hence, there are several decision aid systems based on if/then responses to critical situations with little room for "maybe", i.e. decision support tools based on a decision three design. It is evident from the legal requirements[7] for decision support systems that it will suffice to make the information available to the expert with the expectation that the optimal solution to a given emergency situation will be found by the expert, e.g. the shipmaster. This view of decision-making is grounded in rational decision making thinking and expected utility, which does not take various types of bias and heuristics into ample consideration (Kahneman, Slovic & Tversky, 1982). Other decision support systems are not so much a support for decision-making as they are aiding the shipmaster's memory, e.g. checklists.

In this context, it is relevant to shortly describe what constitutes an expert and what limitations such a person has. Rasmussen (1983) introduces three different levels of expertise, and how information is perceived in the three different skill levels: skill-, rule- and knowledge based skills where the latter is the expert. This approach to knowledge and the utilization of it is useful, not

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[7] IMO Resolution A.796(19) Recommendations on a decision support system for masters on passenger ships.

only when describing decision support tools, but also when describing the shipmaster as a domain expert who uses the decision support tools. It is, however, necessary to go beyond the technical knowledge based approach, and put the shipmaster in the context of a novel situation, where the past history which constitutes the knowledge base, does not seem relevant for mitigating a present risk scenario – i.e. a fundamental surprise scenario. It can therefore be argued that even though the shipmaster is an expert, then he might have difficulty in applying his knowledge base in a situation that requires the creating of a *"…need for learning about one's "self."* (Lanir, 1986, p. 28) described.

Decision-making theory

Yates, Veinott and Patalano (2003) critically analyse why decision aids have little documented success. They find support for their assertion on data, which is based on two empirical studies of a convenience sample among 99 and 110 college students respectively. These studies were supplemented by a critical review of the most utilized decision aiding approaches, and of decision analysis in expert systems. On basis of the results it is asserted that decision aids are predicated to a conception of decision quality that is different from what the decider holds as quality. Decision-makers, therefore, often ignore the aids, because they appear to be irrelevant for their situation. Furthermore, their research showed that decision-makers rarely acknowledge a concern with the rationality of their decision processes. Instead, they are preoccupied with results. In a shipboard situation it can be argued that the decision support system has an imbedded view of the shipmaster that is not aligned with the complex nature of an emergency situation, and that the decision support tool is designed for one scenario and mode of operation only; not the interaction of different scenarios and modes of operation. International regulation (IMO Resolution A.796(19), 1995) states that the emergency procedure *"…should also provide decision support for handling any combined situation" (p. 4).* This requirement to decision support will be problematic in a complex system, where the development of the accidental events can be unpredictable.

Klein (2008) uses the above-mentioned research in his article on natural decision-making and finds support from the seminal work done by Kahneman, Slovic & Tversky (1982). His article is a descriptive overview article of natural decision-making that concludes that: *"…that people did not adhere to the principles of optimal performance; respondents relied on heuristic as opposed to algorithmic strategies even when these strategies generated systematic deviations from optimal judgments…"* (p. 456) and *"The NDM movement shifted our conception of human decision making from a domain-independent general approach to a knowledge-based approach exemplified by decision makers who had substantial experience"* (p. 457).

In relation to an analysis of a shipmaster making the single decision to abandon the ship, the above approaches to the field of decision-making will give theoretical support for an analysis of the shipmaster as an expert decision-maker in a novel situation, which challenges his expertize. The human expert relies on previous experience and the ability to discriminate between different situations while expert decision support systems rely on the basic idea of teaching a novice. Flyvbjerg (2006) describes the difference between expert system and human expert:

> *"This is because the experts do not use rules but operate on the basis of detailed case experience. This is real expertise. The rules for expert systems are formulated only because the systems require it; rules are characteristic of expert systems but not of real human experts"* (p. 239).

The shipmaster might therefore be in a decision space where his strategy is to accumulate information about a novel and uncertain situation. Thereby, the shipmaster delays the decision to abandon ship while sampling information to be better assured that the optimal decision can be made – before it is too late to act.

There is one important element that is absent from the concepts of naturalistic decision-making – namely that the shipmaster is not removed from the decision-making situation at hand, but is on the contrary often responsible for not only the accident, but also for resolving for the emergency situation. Accountability is not part of the traditional research of natural decision-making, but rather an addition to the way the decision-maker perceives risk, and how adverse the choices will be in relation to risk. This topic is, however, outside the boundaries of this thesis.

METHODOLOGY AND METHODS

Methodology

In the literature review the research question and the underlying hypothesis was placed within the theoretical framework of several scientific disciplines such as safety science (why do accidents happen?), psychology (decision-making) and philosophy (power). Although these disciplines are using different epistemological and methodological approaches to research, they have common approaches to the choice of methods e.g. case studies, interviews and theoretical analytical induction.

The research question and hypothesis set out to assess the validity of who the shipmaster is in the context of power and decision-making. Testing the validity of this phenomenon lent itself to a comparative analysis of data – e.g. an analysis of an accident account view, which represents the normative view of the shipmaster, vs. an analysis of his/her view.

The sources that were suitable and available for shedding light on the research question were different in nature. It was, therefore, necessary to apply different methods for gathering qualitative data about these phenomena.

A quantitative approach was not deemed useful, because the research question was basically about abstract phenomena, which was not easily defined or framed within a class of data that would enable quantitative approaches to data gathering and analysis – e.g. surveys or creating large-scale statistical material on the basis of existing documentation.

When studying power it must be determined what counts as power and how wide is the lens is that we use to study power. The wider the conceptual framework is the more power will be found (Morriss, 2002). In that sense the study of power becomes a matter of the nature of the judgements made from subjective criteria - i.e. is a person's ability to breathe a question of power or just an ability that does not entail power?

Lukes (2005) and Morriss (2002) present sceptic views on whether power can be studied or not, and are addressing various challenges that present themselves when studying power in its varying conceptual forms. Rather than looking for power as something there is to be found Morriss (2002) states that one, first and foremost, needs to determine the purpose of studying power: *"Concepts that render facts significant must render them significant for something; there must be a purpose behind studying something like power"* (p. 36). By this assertion the methodological thinking behind studying power must be determined by the purpose rather than the phenomenon itself.

In this thesis the purpose of studying power was to shed light on how power is acted upon and from the shipmaster in relation to the evacuation of the ship, in order to assess the validity of the normative view of the shipmaster. The shipmaster was analysed through the lens of a dominant externalist view and an internalised view where power is a dispositional property – what Morriss (2002) characterizes at the practical approach for understanding how the shipmaster ***"…can bring certain things** about"* (p. 37). Finally, there is the Foucauldian view where power is legitimizing and constituting the shipmaster. The latter was analysed by the discourses that are created in accident reports and legislation, but also by how a shipmaster describes his "self".

Methods

To assess the validity of the normative view of the shipmaster's role within the context of a particular situation (evacuating a passenger ship); a case study about a foundering of a passenger ship, which represents the normative view, was juxtaposed to semi-structured interview data about the evacuation of a passenger ship seen from the shipmaster's view. The findings from the case study and the interviews were analysed within the theoretical frameworks of power and decision-making. Thereby, the research question was triangulated by case studies, data gathered from interviews and theoretical analysis. This enabled an application of different sources and categories of data onto the one question. Furthermore, the individual method gave opportunity for falsification of the other data. The use of the methods is presented in the table below.

<table>
<tr><td rowspan="3">Case study</td><td rowspan="5">Theoretical analysis of findings from case study and interviews</td><td rowspan="3">Power</td><td>Dominant externalist approach</td><td rowspan="5">Discussion of case study and interviews</td><td rowspan="5">Concluding assessment of the validity of the normative view of the shipmaster</td></tr>
<tr><td>Internalised approach</td></tr>
<tr><td>The constitution of the shipmaster</td></tr>
<tr><td rowspan="2">Semi-structured interviews</td><td rowspan="2">Decision-making</td><td>The rational decision-maker</td></tr>
<tr><td>Naturalistic decision-making</td></tr>
</table>

Figure 1: Overview of method

Method - Case study

The accident report about the foundering of the Costa Concordia (2013) (appendix 1) provided one narrative about how and why a passenger ship foundered. This particular report was chosen, because the accident report has served as a contemporary account that established a truth for what happened, and has been used for promoting new international legislation. Thereby, the report has been accepted in the international community.

Even though the case study was based on an Italian investigation report about an Italian registered ship with primarily Italian officers, the cultural dimension was assessed to be minimal, because shipping is characterized by being multicultural and relies on strong international legal frameworks and training schemas. The ratings on the bridge e.g. the look-out, helmsman and cadet were of other nationalities than Italian. On the Costa Concordia the total crew consisted of 38 different nationalities (MIT, 2013, p. 75).

This case study was, firstly, used for describing how the shipmaster becomes the focal point in an accident. Secondly, it was used for testing and revising the hypothesis about the shipmaster's role in relation to both the mechanisms of power and decision-making. Della Porta & Keating (2008) describe these two varieties of case studies (describing phenomena and building hypothesis) in conjunction with theoretical and causal descriptions. The case study was therefor: *"…an empirical inquiry that investigates a contemporary phenomenon (the "case") in depth and within its real-world context, especially when the boundaries between phenomenon and context may not be clearly evident",* (Yin, 2014, p. 16).

The qualitative case study of the accident report was analysed with the theoretical frameworks of power and decision-making as seen in figure 1 above. The case study shed empirical light about the theoretical concepts (Yin, 2014, p. 40) about power and decision-making. It was qualitative in nature, because it was analysed for the purpose of identifying tacit opinions and knowledge about the shipmaster of a passenger ship; unspoken and socially constructed opinions without analytical reasoning – that are accepted by the shipmasters that and thus be: *"…a critical reflection on the conventional boundaries and commonly accepted categories of social and political phenomena"*, (Donatella & Keating, 2008, p. 230). The case study was not a study of the accident itself, but rather served as

"…examples…" (Flyvbjerg, 2006, p. 228) of the normative discourse that is created from accident reports that shapes the normative view of the shipmaster as a vehicle of power and a rational decision-maker.

The concept of power is not being specifically addressed in the report, and the word power or other phrases commonly used as synonyms, such as influence or control, are not used. The analysis of power was, therefore, to be derived from observation of the language used for describing the shipmaster's position, his interaction with others and the tacit views that are expressed about the role of the shipmaster.

It is important to emphasize that the purpose was neither to evaluate the behaviour or performance of the shipmaster and crew, nor to assess the quality of the report, but to use it as qualitative data about the view of the shipmaster – a view that has been accepted by the public and an international legislative body (IMO). That acceptance implies that the report is not a black swan i.e. an outlier event, and it was, therefore, useful as a descriptive object of subjective bias and a social construct, and by being that it could give valuable insight into the popular belief systems (the normative view) in its time (Flyvbjerg, 2006).

Method – Interviews

"Interviews are targeted as they can focus directly on the case study topic and provide explanations as well as personal views i.e. perceptions, attitude and how meaning is created", (Yin, 2014, p. 106). These words by Yin summarises how interviews could be used in obtaining data about how the shipmaster creates meaning in an operational reality and his place within the mechanisms of power. Data was also gathered on the shipmasters' views on the decision support systems and how they are applied. Data was therefore created in the interaction between the researcher and the informants in a social construction of reality. This approach had a constructive nature of the knowledge created through the interaction between the interviewer and informant in the conversation

(Kvale, 1996, p. 11 and 38). This means that the data was not be used for finding objective facts, but used for shedding light on how meaning is created by individuals, which enabled an understanding of the shipmaster beyond the normative view presented in the research question and hypothesis.

The interviews were conducted as semi-structured interviews: *"…an interview whose purpose is to obtain descriptions of the life world of the interviewee with respect to interpreting the meaning of the described phenomena"*, (Kvale, 1996, p. 6), with the aim of obtaining qualitative information. This approach was chosen for giving the shipmasters room to freely express and elaborate on how their subjective meaning is created in relation to the research topic. The information was qualitative for two reasons: Firstly, very few shipmasters have been in a situation where an evacuation of the ship was an option; therefore, would the case that the shipmasters were presented for, make them hypothesize about an evacuation situation. Secondly, as the subjects of decision-making and power are abstract conceptions they are not suitable for quantitative data gathering and analysis or strictly controlled questions. The interview questions were therefore formulated in such a way that they allowed for a certain range of answers, which were not quantifiable. Furthermore, the informants were expected to provide varying answers, because the questions were understood on different premises, e.g. some shipmasters may have had experienced adverse events that changed their view of their operational environment.

Five interviews were made with the expectation that data saturation was met. There was no reliable information about the total population of shipmaster and/or passenger ships trading in Europe. However, the population of active shipmasters on large passenger ships (above 1,000 passengers) is limited. The informants were chosen from two different companies, but all within different trading areas in Europe. In order to ensure that the data was culturally diverse three different nationalities were chosen: French, English and Danish. Choosing different nationalities was not only about securing some regional cultural diversity, but also to test the reproducibility of the data.

The informants are in this thesis referred to as informant 1-5. The Danish shipmasters were interviewed in Danish and the citations are translated into English by the author. This approach was chosen, because the author is a Danish master mariner with in-depth technical knowledge about Danish and English marine terminology.

The interview sessions were designed as seen in appendix 2. To ensure consistency the same questions was specifically asked even though the informants had addressed the specific topic before. All of the interviews had a starting point in the Costa Concordia accident report. The report was forwarded to the informants along with the informed consent form (appendix 3) several weeks before the interview. Thereby, they considered the problem area before the interview and their minds were set on the topic about the decision to abandon ship. There was no prior discussion of the report in order not to influence the personal impression of the content, but debate among peers was to be expected. During the interview key elements related to the decision-making and power structures in the report were described and the informants were express personal opinions about the content of the report.

The interview topics were firstly the decision to evacuate the ship, secondly, the decision aid systems and sources of information used in that decision, and thirdly, power structures. As the latter subject was not a familiar subject to the informants, it had a more stringent structure and they was asked specific questions from which the informant was expected to express their opinion. Decision support systems are common tools and even if the informants had not been using a specific decision support tool in an abandon ship situation, then the verbalization of the use of the tool could be used for understanding their personal view on decision making in their domain.

The data reduction process consisted of a simple matrix comparison of the different answers to the questions. As the interviews were semi-structured it was expected that the answers to the specific topics would be given at any given time throughout the interview session. The limited number of informants and the semi-structured design of the interview created manageable amounts of data without the need of formal coding with qualitative assessments. However, the possibility of coding would reveal itself once the data was collected.

FINDINGS AND ANALYSIS – CASE STUDY

As described in the method section, this case can, firstly, be used to describe how the master becomes the focal point in an accident account. Secondly, it can be used for testing and revising the hypothesis about the shipmaster's role in relation to the mechanisms of power and the decision-making process.

In the Costa Concordia accident 4,229 passengers were evacuated and 32 were trapped inside the ship and perished (mainly in the elevators). Considering the scale of the accident and compared with other major passenger ship accidents, the number of fatalities was relatively low. This was, presumably, mainly due to the ship foundering in shallow waters and close to shore. Model simulations have demonstrated (Dankowski, H., Russell, P., & Krüger, S., 2014) that had the ship foundered while in deep sea, it would have completely capsized within a short timeframe (approx. 15 minutes), presumably resulting in a higher number of fatalities. In the official investigation report (MIT, 2013), the evacuation of the ship is, however, considered a failure rather than a success, because of the unorganized way the evacuation was conducted, and how the shipmaster failed in effectively mitigating the accidental events.

In appendix 4 a short summary of the case and a timeline of the main events can be found.

In May 2013 the Italian Ministry of Infrastructure and Transport issued an accident investigation report about the foundering of Costa Concordia.

The shipmaster as a focal point – constructing a narrative about an accident

Throughout the report there is an identifiable thinking of linear strict cause-effect relationships, and a reliance on counter-factual reasoning for explaining why the accidental events occurred, and why the consequences became so severe. The authors have grounded their linear approach in safety management thinking and maritime legislation in the report, which can be observed by how the reports consistently makes references to the requirements of the safety management system (SMS) and the Italian national and international legislation. It will in this case study be shown how the events on 13 January 2012 are in the accident report (MIT, 2013) measured against this procedural and legislative norm that reflects the societal norm, which promotes the normative view of the shipmaster.

The shipmaster is in the report described as the root cause of the accident and the outcome severity of the accident is proportional with the shipmaster's negligence, which in this context means lack of effective decision-making and power to ensure a certain outcome.

The report is, in time and space, focusing on the proximate events as they unfolded on board the Costa Concordia by concentrating on the seconds and minutes leading up to the grounding until an anomaly is found that is then considered the cause of the accident. The shipmaster's actions in these crucial seconds and minutes are measured against how work is described in the SMS, the legislation and the standard for correct behaviour set out by the authors of the report. An example is found on page 72: "*Particularly, during the emergency, different behaviour from the expected above* *mentioned procedures were noted. These are the following:"* (MIT, 2013). Thereafter, thirteen issues were described that showed how the shipmaster acted different from the expected i.e. in other ways than the procedure prescribed.

The most readily apparent indication of the report using a Newtonian linear cause-effect approach to the accident, can be seen in the summary of the report: *"…that the human element is again the root cause in the Costa Concordia casualty, both for the first phase of it, which means the unconventional action which caused the contact with the rocks, and for the general emergency management"* (p. 9). The reference to human element as the single root cause for the casualty (marine terminology for accident) is one indication that the pre-existing thinking and mind-set in the analysis is that of a simple linear system and not of a complex socio-technical system – the thinking that one unreliable component that malfunctions can cause a system breakdown. Finding and replacing that malfunctioning component will restore the equilibrium of an already reliable system:

> *"That does not mean that such decisions are not singled out in retrospective analyses. That they do is but one consequence of Newtonian thinking: accidents have typically been modelled as a chain of events. While a particular historical decision can be cast as an "event," it becomes very difficult to locate the immediately preceding "event" that was its cause. So the decision (the human error, or "violation") is cast as the aboriginal cause, the root cause"* (Dekker, S., Cilliers, P., & Hofmeyr, J., 2011, p. 943).

The report analyses the events leading up to the contact by using the terminology from the latent failure model thinking (Reason, 1990):

> *"Therefore, distractions, errors and violations can be established as the elements which characterized the human factors as root causes in the Costa Concordia casualty. Both distractions*

and errors (in all terms of slips, lapses and mistakes) had been made during the Master's performance before the contact, according to the previous detailed analysis" (MIT, 2013, 161).

Understanding how the report is epistemologically constructed is relevant for understanding how the accident report shapes the shipmaster as a decision-maker, and the expectations related to the manifestation of his power.

The accident report presents a single linear chronological narrative that is centred on the shipmaster and his performance, which is measured against the emergency procedures and the outcome of the accident. This linear approach is to be expected. Decision-making related to the evacuation of the ship, is done on the bridge by the centralized decision-maker – the shipmaster. Furthermore, objective data, such as voice recordings, course, speed etc. has been derived from the bridge, which gives the narrative a Newtonian scientific weight, and places the shipmaster as the focal point of the accident account where he became the cause of the accident; the broken component, because he was the authority on board.

The shipmaster of Costa Concordia was an experienced navigator. He had been at sea for almost 17 years, had been shipmaster since 2002 and had not been involved in other accidents before. He was in the accident report not described as a person that lacked formal competencies or expertize in general, but he was described as lacking the capacity to make effective judgements: *"…nothing can justify the Master's judgement…"* (MIT, 2013, p. 87).

In the following will the subject of decision-making and power be analysed separately.

Decision-making

The shipmaster's decision-making is in the following addressed in three stages:

- Firstly, the navigation leading to the grounding of the ship.
- Secondly, the shipmaster's management of the emergency situation after the grounding.
- Thirdly, concluding remarks about the findings related to decision-making

In the report's section about the sequence of events as well as in the analysis, there is an assumption that if information is available, then it is also being perceived and its significance recognized and assimilated into decision-making for its relevance for short-term and/or long-term outcomes. As the events unfold in the report they are mainly described in relation to the bridge, which becomes synonymous with the shipmaster and not in relation to the other actors in the system i.e. engine room officers or hotel staff.

In the following, decision-making related to the bridge will be addressed individually with the purpose of shedding light specifically on the *decision space* the shipmaster occupied.

Navigation before the grounding

In the report's analysis section there is the assumption that the shipmaster knew that he was bringing the ship into a dangerous situation by approaching the Island of Giglio:

> "…*the Master arrived on the bridge only about 10 minutes before the contact and was also distracted by a phone call, he still had the time to realize that the ship was proceeding insidiously toward the coast, and could therefore have time to correct the heading and speed."* (MIT,2013, p. 67).

The analysis and the conclusions elaborately describe how the technical information about the ships speed, course, distance to the shoreline and the manoeuvrability of the ship clearly showed that the ship was in a dangerous situation, and that the shipmaster, by not recognizing the hazardous situation, displayed a *"…negative overall performance…"* (MIT, 2013, p. 67). In this context it should be noted that the deviation from the original voyage plans was not a result of a sudden initiative by the shipmaster, but was planned by the shipmaster and the 2nd officer before departure at the last port, and was therefore a conscious planned action. Prior to the shipmaster's arrival on the bridge, the bridge team had initiated the approach.

Having all information available for predictive purposes does not necessarily include recognition of how the information has relevance for future events. The shipmaster's competence and experience did not warn him about the immediate risk of contact with the rocks, because passing close to the coastline was not an unusual event, and as an expert he had the confidence to use his past experience to judge the future events as safe (otherwise he wouldn't have done it). The margin between success and failure was narrow in terms of distance to the shoreline, but the shipmaster was used to manoeuvring the ship in narrow waters (ports, channels etc.), and thereby most likely used a heuristic strategy for bringing the ship to a close approach to the island.

The accident report presupposes in an analysis about the navigation phase before the impact that the shipmaster should have had perfect knowledge about the risks associated with the manoeuvre, but his negative performance made him fail (MIT, 2013, p. 5-6 and 67).

There is no factually supported narrative about his motivation for approaching this specific island, but navigating close to shorelines and providing the passengers with shoreline scenery was part of the job of giving the passengers a scenic evening view. In other words, up until a few minutes before the grounding, there was nothing unusual about this evening on the bridge.

In the report there is no account of when the approach to the Island of Giglio went from a normal operation to an abnormal operation - i.e. at what time did the shipmaster and/or the rest of the bridge team realize that something was about to go wrong. This is illustrated below account and in the time line in appendix 4.

The shipmaster arrived on bridge at 2134 in order to execute the planned close passing of the island. He changed the distance indicator on the radar to 0.5 nautical miles (approx. 1000 meters) and told the rating to be helmsman and to change from the auto steering to manual steering. At 2139, he took the con and gave various course orders to the helmsman. At 2143, he corrected the helmsman, because a course order was wrongly executed and warned the helmsman that the ship otherwise would end up on the rocks. From 2144 the shipmaster only gave manual rudder orders instead of course orders. Shortly after the 2nd officer warned that the ship had gone aground, and at 2145 it became evident, from the impact noise and reduction in speed, that the ship had grounded on the underwater rocks

Within a time span of approximately two minutes (from correcting the helmsman until the grounding) the events went from normal operation to abnormal, and then to an emergency situation, where there would be no recovery. The timespan is important, because it frames the pre-existing safety margins for success and failure in which the decisions are made. There were no opinions voiced from the bridge team members about the decisions made by the shipmaster. The report uses this silence from the other officers as an indication that the bridge team resource management was poor: *"The passive attitude of the staff (team) on the bridge is just as reprehensible…"* (MIT, 2013, p. 153). That the shipmaster had not participated in a bridge resource management course (MIT, 2013, p. 79) was not addressed in further detail when analysing the team response. However, it was used to describe how it: *"…could have represented a weakness in terms of competency (human factor as bad human performance) in this casualty",* (MIT, 2013, p. 161-162).

The language in the citations in the above paragraph shows the report's premise that the crewmembers on the bridge had a common approach to the risk exposure they were subjected to, and they, therefore, should have intervened and been part of the safety critical decision-making; that they should have had perfect knowledge. This counter-factual reasoning indicates that the investigation did not focus on the perception of risk that the individual bridge team members had in the given circumstance, and whether or not they found themselves in a normal operational situation, where there was little knowledge about how much the system had migrated towards the boundaries of acceptable behaviour (Cook, R., & Rasmussen, J., 2005). Presumably, this situation was not a novel situation for the shipmaster, because he was used to manoeuvring the ship in confined areas (e.g. ports, channels, straits) and therefore his strategy was to use his knowledge about the past (expertise) to handle the situation.

It is given that the shipmaster was the domain expert and it is in this context useful to understand how the shipmaster's command and decision-making was legitimized, and how it affected the other team members when addressing the subordinate officers reluctance to assert their opinions on the situation at hand. This will be addressed in the section on power where the power mechanisms on the bridge will be analysed.

Events after the grounding

When the ship had struck the underwater rocks, the shipmaster and the officers were faced with a new situation, where the normal evening had changed into an emergency situation and where the complexity of the situation was uncovered. A situation of multiple interconnected events, uneven distribution of knowledge, information noise and choices between different strategies, all of which would result in more or less adverse outcomes.

The confusion that is part of an emergency situation such as this is not visible in the factual information in the report's narrative, because the information in the report presents itself in an orderly fashion, the narrative is designed to be chronological and single linear (primarily the bridge perspective).

In the narrative it is stated that as the chief engineer at 2155 observes water in compartment 5: *"…meaning therefore that the compartments flooded are at least 3 (WTC 3, WTC 6 and WTC 7). This situation is communicated to the bridge"*[8] (MIT, 2013, p. 30). How and to whom this information was conveyed is not specified.

In the report it is indirectly argued that the accidental event was a situational surprize for the shipmaster, because there was a procedure to be followed that was designed for the situation at hand:

> *"Costa Crociere has provided, its ships, with the procedure "P12.4-IO 2 SMS" "Decisional Support System for the Master" (Annex. 43), assigning to the Master the responsibility to apply the related procedures; however, pointing out the possibility that the Master can adopt other suitable measures, necessary in accordance with both the scenario and his own experience.*
> *In case of contact-breach, the procedure establishes the following actions (some steps are not reported because these do not influence the analysis of the present casualty):…"* (MIT, 2013, p. 70).

The procedure describes the measures to be taken in case of breach of the hull as an isolated event, and not in conjunction with other events e.g. loss of power, steering, propulsion and loss of the computerized stability calculation program that acted as a decision aid to determine the survivability of the ship. Furthermore, the procedure did not take into account that the ship was

[8] The ship had no survivability with three compartments filling with water.

near a port and how that might affect the shipmaster's choice of strategy to stabilize the situation. It thus becomes apparent that the procedure was not designed for the cascading effects that arose from a single accidental event that occurred in a complex system. Even though the procedure lists certain actions to be taken and considerations to make, then it also leaves room for and encourages the shipmaster's adaptive behaviour where he can apply the expert knowledge that he possesses, as stated above: *"…Master can adopt other suitable measures…with the scenario and his own experience"*. It is unclear what experience the procedure is referring to, but it is unlikely that it is refers to experience with complex emergency scenarios that seldom, if ever, occurs for that same shipmaster. Arguably it refers to his professional expertise, i.e. years of experience with the normal operation of the ship and how he expected it to function.

This complex situation rose out of a normal operation on a normal day and, therefore, the shipmaster was in a chaotic situation that fundamentally surprized him. It was a situation that changed his view of the world and how he expected his environment to function; it created a new need for learning about his self as described by Lanir (1986) - a self that might not be an expert.

The procedure incorporated two different views of the shipmaster: the novice and the expert. In the procedure there is listed a range of actions to be taken, which could be useful for the novice who needs basic rules to work by (remember to do this and that). The latter part of the procedure gives the shipmaster the opportunity to act according to his best judgement, which is about giving the expert freedom to apply his knowledge in the given situation (giving room for adaptive behaviour) as described by Rasmussen (1986). However, in the report the quality of the decisions are only judged ex post facto and based on the specific items listed in the procedure i.e. which elements were adhered to and which were not (MIT, 2013, p. 70). The shipmaster and the procedure will have different views on what constitutes decision quality; the shipmaster will be preoccupied with choosing strategies for securing a certain outcome, while the procedure is preoccupied with decision process in the immediate moment (Yates, Veinott and Patalano, 2003). Therefore, as indicated below, the shipmaster will not rely on the procedure, because it does not seem relevant to his present situation and perspective of the events, where he is about to choose the strategy that will secure the least adverse outcome, or even that they willfully did not tell even though they knew.

Throughout the report there are fragments of information about what his strategy was, for stabilizing the situation, a strategy that was somewhat different from what the procedure suggested. At 2222, the shipmaster informs the coast guard centre that the situation is under control and the situation is being assessed, and that two tugboats are required for assistance due to loss of power and propulsion. The report states that the *"…correct information about the actual situation of flooding is not provided* [to the coastguard]*…"* (MIT, 2013, p. 32). The report's narrative thereby asserts that the information, which is available somewhere in the system, is not recognized and utilized in a sufficiently effective manner to secure a less adverse outcome of the emergency situation.

At 2245 hours, the personnel at the MRSC[9] Livorno contacts the shipmaster, who informs them that the ship is still floating and they will try to manoeuvre the ship closer to shore and attempt to anchor (MIT, 2013, p. 17), in fact the anchors had already been lowered at 2149 (MIT, 2013, p. 92) with the purpose of being ready to anchor when the ship reached shallow water. Below is a picture that illustrates the ships distance to shore shortly after the final grounding.

[9] Maritime Rescue Sub Centre

Figure 4: Costa Concordia shortly after the grounding at 2240
Source: MIT (2013)

Item 10 in the procedure for handling contact (e.g. grounding) and breech of hull (flooding) states: *"If retaining of persons on board is dangerous, procedures for the abandon ship must be taken, and scenario is monitored till the evacuation of ship is completed"* (MIT, 2013, p. 71). The shipmaster had realized that the situation was dangerous, but an evacuation was not desirable because, as mentioned above, other options presented themselves and: *"...he* [the shipmaster] *never would unload 4.000 persons till he was not so quite sure that the ship would have sunk"* (MIT, 2013, 92).

The decision to abandon ship was announced by the shipmaster to the passengers at 2236, after having been advised, at 2230, by the chief engineer that the ship should be abandoned (MIT, 2013, p. 32). How instrumental that advice was for the shipmaster's decision is not described in the report. Furthermore, it is unclear how important the shore based fleet crises coordinator was in relation to the decision-making process. The crises coordinator (DPA)[10] did in fact not participate in the decision: *"Spite of those above mentioned serious warning, the DPA never thought (as declared during two interviews towards the Prosecutor) to speed up the Master to plan the abandon ship"* (MIT, 2013, p. 89).

At 2311, during the disembarking of the passengers, the ship grounded and listed over 20°, which was the designed limit for the safe launching of the lifeboats. From then on, the list quickly increased. The passenger ship as a system fell apart, because the emergency equipment was not effective, the orderly assembly of passengers was hindered by the list, which was trapping passengers inside the ship and the centralized decision-maker could not govern effectively from the bridge. Some time after midnight, the shipmaster left the ship because *"…that he was somehow forced to disembark, going on one of the boats, because of the high list of the ship, otherwise would have slipped into the sea"* (MIT, 2013, p. 35).

The report concludes that the shipmaster acted too late when deciding to order the evacuation of the ship at 2236. If he had done it earlier, at 2203, when the engine room officers had provided information about three flooded compartments, then there would be ample time for an orderly evacuation of the passengers (MIT, 2013, p. 87). In other words the shipmaster did too little too late when postponing the decision to abandon the ship, while waiting for more information and negotiating alternative strategies. Strategies for saving the ship that he was by law obligated to seek according to article 303 of the Italian national regulation - Codice della Navigazione:

> *"the Master cannot order the abandon ship in distress, if he does not carry out, without success, all the instrument suggested by the seamanship to save her, and without any consulting with the Deck*

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[10] Designated Person Ashore

Officers or, if they are not on the scene, the two best seafarers of the crew. The Master must abandon the ship as the last person on board, providing as soon as possible to put in safety the related documents and books, and valuable objects in his safekeeping" (MIT, 2013, p. 87).

Concluding remarks about decision-making

The report presents a view of the shipmaster as a centralized rational expert decision-maker that failed to use the information that was available and to utilize the decision support tool effectively to provide the optimal outcome, namely the safe and orderly evacuation of the passengers. Thereby, he was considered the root cause of, not only the grounding, but also the failed orderly abandonment of the ship. The overall narrative in the report, thereby, suggests that the shipmaster due to his position should have had perfect knowledge and rational decision-making capability. This view was upheld by Italian national legislation.

There were, however, indications that he did not apply the decision support procedure, because he was preoccupied with decision quality in terms of outcome and not process, and that he was, within the time frame of approximately one hour, in the process of choosing alternative strategies such as using tugs and/or getting closer to shore for anchoring and shuttling the passengers to shore. Only after having attempted to apply those alternatives he ordered the abandonment of the ship. The shipmaster changed strategy from saving the ship to abandoning the ship once enough information was available that revealed which strategies would work and which would not work. This, however, happened too late for the orderly evacuation of the ship.

Power

It has previously in this chapter been described how the shipmaster became the focal point in the account of the accident. This focus is to be expected, because the final decision to evacuate the ship is made by him. However, it reveals little about how the shipmaster is empowered to make that decision or how the mechanisms of power influenced that decision.

Expanding the concepts of power will give an opportunity to widen the understanding of how power mechanisms legitimise the shipmaster in relation to decision-making or non-decision-making. The purpose is to shed light on how the report constructs the shipmaster within the mechanisms of power in the context of the decision to evacuate the ship. As described in the method section, the subject of power will be considered in three different ways: The externalised (dominant) power, the internalised (dispositional) power and how the power constitutes the shipmaster.

In order to be consistent with the structure of the previous section, the externalised and internalised view power will be addressed jointly in two stages: before and after the grounding. The constitution of the shipmaster in relation to power will be addressed separately.

Before the grounding – externalised and internalised power mechanisms

Externalized power

The shipmaster on Costa Concordia was recruited and appointed by the shipping company that operated the ship, and he held international statutory certificates for competency as shipmaster. He was therefore bureaucratically legitimized as being the authority on board. Furthermore, he was accepted as a part of the shipmaster's community via the apprenticeship between the shipmaster and the chief officer that he was part of during his training. Thereby, the shipmaster was also professionally legitimized among his peers and subordinates to be the authority.

As the shipmaster he was obligated to take responsibility for the fitness of the ship i.e. authority carries responsibility: *"The master must ensure that the ship is ready and suitable for the voyage to be undertaken."* (MIT, 2013, p. 58). In a centralized governed system, the shipmaster's authority and responsibility is to be used purposefully for effecting power over the system (ship, crew and passengers), which is an externalized and dominant view on power as proposed by Dahl (1957) and Lukes (2005). This form of power had, however, its limitations, which will be addressed in the following.

Throughout the accident report (MIT, 2013), there are references to the SMS that is juxtaposed to the shipmaster's actual behaviour and decision-making: *"…the Master was committed, even before the onset of impact, in telephone communications, in conflict with the provisions ISM "rules of conduct for the Bridge Team"…"* (MIT, 2013, p. 51) and *"…the procedure is given to the Master of the possibility, if deemed necessary, to keep open while sailing some watertight doors indicating explicitly the doors 7-8-12-13 and 24"* (MIT, 2013, p. 56).

The two examples above show that the shipmaster in some circumstances should strictly follow the SMS and in other circumstances he could use his best judgement. This raises the question about the shipmaster's position in the formal power hierarchy in relation to the SMS. The above examples indicate that the shipmaster's dominant power is limited to the extent that the SMS is considered an extension of the owner's power. The content of the SMS is in part made by the owner and in part by the mandatory legislation, which means that the shipmaster's dominant power is restricted by the both the owner and the society.

From the above legislation it can be seen that there is room for the shipmaster's judgement, when the procedure is related to emergency scenarios, e.g. abandon ship, and issues related to the operation of watertight doors, where the organisation is strongly centralized on the shipmaster. On 13 January, this decision space left the shipmaster in a dilemma: follow the procedure or ignore it and pursue other strategies. The appropriate choice was inherently difficult to make in a complex unfolding emergency situation, and the correct choice would be judged ex post facto. As described in the section about decision-making, the choice of compliance or non-compliance might not have been relevant at all, because as a decision-maker, he would have been preoccupied with outcome, and not the process that was described in the procedure. In that sense the choice is irrelevant because outcome was the dominant schema. In relation to power it means that the shipmaster was preoccupied with exerting his dominant power over the ship by demonstrating ableness (actual power) to secure a positive outcome, rather than following the procedure, which is Dahl's (1957) notion of power as previously described.

In the report (MIT, 2013) the shipmaster's competence is brought into question: *"Master's arbitrary attitude in reviewing the initial navigation plan (making it quite hazardous in including a passage 0,5 mile off the coast by using an inappropriate nautical chart), disregarding to properly consider the distance from the coast…"* (MIT, 2013, p. 6). By demonstrating lack of competence *"…and not relying on the support of the Bridge Team…" (MIT, 2013 p. 6).* It is recognized in the report (MIT, 2013) that the shipmaster was functioning as part of a bridge team and that the team did not function properly according bridge resource management standards: *"The passive attitude of the staff (team) on the bridge is just as reprehensible…"* (MIT, 2013, p. 153). In bridge resource management the idea of assertiveness is that the systemic weaknesses inherent in having a centralized decision-maker can be strengthened by having the lower ranking officers intervene in an appropriate way at the appropriate time and thereby avoiding that technical and/or human behaviour anomalies develop into hazardous situations. By being assertive, the subordinate bridge officers are able to overcome the power gradient that exists in the hierarchy and instantaneously assert that they in a particular setting are more knowledgeable than the shipmaster about immediate risk patterns and how to mitigate them. Simultaneously, the shipmaster must accept and be accepted as the leader and the final arbiter. Assertiveness is thus about the lower ranking officers' knowledge being superior enough to overcome the legitimized decision-making power of the shipmaster. By virtue of the difference in technical knowledge and expertize between the shipmaster and the subordinates the power gradient will be more difficult to overcome.

The bureaucratic legitimization of position or hierarchy is, however, an over-simplistic view of power (Smoker, 2011, p. 20). In a hegemonic system as the Costa Concordia there will exist differential views of what constitutes risk, and there will be an uneven distribution of knowledge to acknowledge the migration of risk (Cook and Rasmussen, 2005). This affects internalized power. Therefore, the distribution of knowledge and expertize will be instrumental in understanding the power to make decisions.

It is uncertain whether or not the subordinate crewmembers on the bridge were more knowledgeable about the risk of grounding than the shipmaster was since the report states that *"It is not clear if one of the members of the bridge team or the Master himself, has closely followed the navigation at the radar operating on the safety trim of 0.5 miles…The audio recordings of the bridge, therefore, do not show any warning to the Master, or the master itself, for the entire stretch of navigation before the contact."* (MIT, 2013, p. 62). The report (MIT, 2013) does not unambiguously state whether or not the officers on bridge had knowledge about the navigational situation becoming hazardous. Without having appropriate knowledge about the risk of collision the officers on duty would not intervene and challenge the authority of the shipmaster. It should be noted that some of the officers on bridge were off duty and would therefore not necessarily see themselves as part of the operational bridge team and be following the navigation closely. In such an organizational setting there will be differential views of what constitutes risk: *"How safety is constructed at the top or intermediate levels, with its embedded view of risk, will be different from elsewhere in the hierarchy…The view of risk may itself be generated from differential sources of information leading to differential knowledge"* (Smoker, 2011, p. 42).

What constituted acceptable and unacceptable risk was determined by the shipmaster, because he was the authority on the bridge. The knowledge to challenge the external dominant authority gradient was not apparent before the grounding occurred, because the result of the manoeuvre was not apparent. The officers on the bridge would, therefore, not challenge the shipmaster, because the plan was to make a close approach (0.5 nautical miles) and the appropriate knowledge (certainty about the grounding) would only manifest itself a short moment before the grounding – hence the: *"…overall passive attitude of the Bridge Staff. Nobody seemed to have urged the Master to accelerate the turn or to give warning on the looming danger"* (MIT, 2013, p. 6).

Acknowledging knowledge distribution becomes important for understanding how power functions in the bridge environment under what was, or is, considered normal daily operation. The lower ranking officers resistance towards the shipmaster's bureaucratic legitimized power could not be manifested, because they did not have superior knowledge and expertize to exert their epistemic power towards the shipmaster. There is, however, no information in the report (MIT, 2013) about whether or not there was any level of countervailing power present in the first place.

Internalized power

A description of how the shipmaster was the bureaucratically and professionally legitimized *dominant* power on board, and how that power was not challenged is presented above. There are, however, other views on power that can be utilized for understanding the shipmaster's position in the emergency situation, specifically related to knowledge. For this purpose it is not useful to only view the shipmaster's power externally using domination as an instrument of power to secure outcomes in decision-making, but rather to apply an internalised view as asserted by Morriss (2002).

The shipmaster's power and authority is connected to his technical and managerial expertize as seaman, i.e. his potential to bring about a certain outcome. He held the mandatory certificates and was thereby, per legislation, technically competent except for his perceived lack knowledge in bridge resource management, a course that he had not attended and neither was mandatory it at the time of the accident: *"…not having attended a training course on Bridge Resources Management course…could have represented a weakness in terms of competency…in this casualty*" (MIT, 2013, p. 161-162). This lack of competence is in the report pertaining to the lack of management of the subordinate officers before the grounding, but also the other officers' lack of assertiveness towards the shipmaster. The shipmaster is thus in the report described as having lacked ability (actual power) in the form of lack of competence in bridge resource management and therefore failed in obtaining the desired outcome (bringing the ship safely to port). In Morriss' meaning of power, the shipmaster did not have the ability, and is thereby not empowered, which in the report denies him sole responsibility:

> *"It is worth to point out that the above error (the lapse) and violations (the two short cuts) regard also the First Mate (in duty before the contact). While all the Bridge Team carried out both lapse and mistake/failure of attention, respectively not making the look out and the adequate support/warning to the Master during the most dangerous phase of approaching (not anticipating the maneuvers to correct the wrong course)"* (MIT, 2013, p. 162).

As seen in the above citation the other officers on the bridge also became accountable, because they did not empower the shipmaster with knowledge (warning) about the hazard of approaching close to the shoreline. Morriss (2002) addresses this issue when describing how one cannot be responsible for something that one cannot do – *"ought does not imply can"* (p. 38).

After the grounding - externalised and internalised power mechanisms

In this chapter the externalised and the internalised power be analysed jointly.

The accident report's narrative about the events after the grounding is centred on the shipmaster, and does not substantially involve the other officers. From the time of the grounding, it was not a matter of the bridge team performance, but about how the shipmaster performed as a focal point of decision-making and power to secure a positive outcome i.e. the safe and orderly evacuation of the passengers. In the evacuation situation the ship organization was designed to default into a pre-planned structure, which was described in the ship's decision support tool. The organizational structure was designed with the shipmaster as the dominant decision-maker as previously cited from the Italian national legislation. There were, however, other structures that could challenge the legitimized dominant power of the shipmaster - e.g. the shore organization via the DPA:

> *"…the DPA was continually warned about the serious development of the scenario (meanwhile the Master was in the bridge, in fact their dialogue, although discontinue, started at 21 57 58 and finished at 23 14 34), he never thought…to speed up the Master to plan the abandon ship"* (MIT, 2013, p. 8).

It is suggested that the shore organization should have played a part in the decision to evacuate the ship and the failure thereof was a moral one*: "The DPA, indirectly, could have contributed to cause of the dead persons as well (at least in terms of moral obligation, taking into account that he realized the serious danger too late)"* (MIT, 2013, p. 161). It is unclear how the DPA should have intervened and overruled the legally established authority gradient, especially, if he not only recognized the bureaucratic legitimized power, but also believed that the shipmaster had the capacity to secure the best possible outcome: *"The evidence that DPA testified he was confident of the Master proficiency for solving those emergency, confirms that he didn't give any kind of support to the Master and never stressed him to decide for an immediate procedure to put in place for the abandon ship"* (MIT, 2013, p. 89). This suggests that the shipmaster's bureaucratically legitimized power was unchallenged by the shore organization. Furthermore, that the DPA acknowledged the shipmaster's bureaucratic and dispositional power; on board the ship the shipmaster had the necessary technical knowledge and expertize, and therefore was better qualified to make the decision to evacuate the ship.

As long as the shipmaster had a mandate from the SMS to use his judgement and exercise his authority, then he had bureaucratic legitimized power over the ship, crew and passengers. He did, however, not have legal power to directly order the abandonment of the ship: *"…the Master cannot order the abandon ship in distress, if he does not carry out, without success, all the instrument suggested by the seamanship to save her, and without any consulting with the Deck Officers…"* (MIT, 2013, p. 87). From the legislation it can be inferred that his power was dependent on external conditions being fulfilled, i.e. he could not order the evacuation without consulting with the other deck officers or use the instruments of good seamanship.

The legislation is constraining the dominant power of the shipmaster over the (un)willing and makes the decision-making process less centralized by introducing the mandatory consultation of others, but also introduces another mechanism of power, namely knowledge. By making it mandatory to seek consultation it is indirectly suggested that the shipmaster lacks vital knowledge that the other officers can provide.

At 2230, the chief engineer, who was in the engine room and therefore had first hand knowledge about the consequences of the damage, suggested to the shipmaster that the ship should be abandoned. Shortly after, the engine control room is abandoned thereby disobeying the shipmaster's orders to stay a while longer. At the same time, the passengers started to board the lifeboats by their own initiative. Six minutes later, the shipmaster announced on the public address system that the passengers were to assemble on the muster stations (open deck areas where the passenger were to be distributed to the various lifeboats).

By the chief engineers proximity to the events, it is suggested in the report that the chief engineer, by providing knowledge, could affect the behaviour of the shipmaster and exert power to bring the evacuation about. Furthermore, at this stage, when the passengers were acting on their own initiative, because conceivably they believed that a total system breakdown was imminent, the shipmaster no longer had the dominant power on the ship – he could not ensure the compliance of all other actors in the system against their will.

The dominant power was thus diminished as the ship began to list so heavily that a total system breakdown was a reality and the control and mechanisms of power could no longer be employed or sustained. By ordering the evacuation, he would effectively terminate the system and his power over it. Prolonging that decision would, however, only keep the shipmaster in actual dominant power, as long as the passengers and crewmembers were convinced that the system was still to be governed - and that the shipmaster was an effective custodian of safety. Hence, he early on tried to convince the passengers that the ship is under the shipmaster's control: "*At 21:54:47 is announced a blackout on board, passengers will be reassured that the situation is under control and that the technicians are working to restore the functionality of the ship"* (MIT, 2013, p. 30).

The report's (MIT, 2013) summary of the events after the grounding is concisely described as: *"About the emergency, the performance of the Master was affected by errors"* (p. 162). Within the listed errors are not necessarily the lack of ability, but rather the lack of ableness – lack of epistemic power. Specifically: *"…mistake (lack of knowledge about the vital equipment located in each compartment below the bulkhead)"* and *"…failure of attention (he seemed such as absent by the context of the emergency and disoriented both his Staff and DPA)…"* (MIT, 2013, p. 162). When he did not have knowledge about how the different compartments in the engine room were arranged, then he displayed a lack of knowledge about the system he was legitimized to govern with superior knowledge. That influenced his understanding about the reports he got from the engine room and thereby the seriousness of the situation. The distribution of knowledge would entail that the chief engineer had the information about the situation and would, therefore, also be the one advising the shipmaster about the timeliness of an evacuation. In this context it means that power resided in the chief engineer – knowledge was his capacity.

The shipmaster was in a double bind when making the decision to abandon the ship. The institutionalized checks and balances that were put in place to mitigate emergencies and evacuation situation gave the shipmaster the option to strictly follow the standard procedure for evacuation or use his best judgement. In this context, the shipmaster's judgement was related to the term "seamanship", which could refer to the practical wisdom and virtue connected to the expert mariner, Knudsen (2009). If the outcome of the emergency was adverse, then the shipmaster either had demonstrated lack of seamanship (judgement) or he had failed in appropriately using the procedure. This double bind limited the shipmaster's capacity to act freely and reduced his dispositional power. The limitation was brought about by the institutionalised social control or power that was exerted upon the shipmaster by the national legislation and the SMS exercised by the society and the ship owner. This control diminished the shipmaster's external and internal power i.e. his ableness to act freely according to his legitimized power.

The constitution of the shipmaster within the mechanisms of power

As described earlier in this thesis, power can also be used as a concept for gaining an understanding of the constitution of the shipmaster, with the purpose of expanding the view on the decision to abandon the ship. This can be done by presenting an alternative view of the ship as a system and the shipmaster's role within it.

Costa Concordia was manned by 38 different nationalities that worked in different departments (MIT, 2013). They worked in an isolated environment with repetitive circular work patterns of revolving watch-keeping duties. This work pattern was pronounced on the bridge, but also occurred in the engine room and the hotel department. As a system, the ship was purportedly established to pursue a mercantile work-like task, justifying itself only to this instrumental goal, and was relatively self-sustainable and isolated under a single organisational authority – the shipmaster. Costa Concordia could, therefore, be considered a total institution: *"We shall call such systems with Goffman* [1967]*,"total institutions". By a total institution is meant a social system which is geographically distinct usually isolated by some barrier by the surrounding community and territory"* (Aubert, 1982, 239).

The total institution not only controlled the crewmembers' work, but also their private life e.g. what and when to eat, regulated sleep and limited their freedom to move outside the physical confinements of the ship (Aubert, 1958). The isolation of the crewmembers was not a function of the system, but a consequence of its mercantile function; a function where the shipmaster was not only promoting the mercantile goals as the owner's representative on board, but also acting as the society's representative; opposing laws on the crewmembers and passengers. Thereby, the shipmaster was not only exerting power, but was also subjugated by the owner and society.

It was described at the end of the last section that the shipmaster's external and internal power was limited by the SMS and legislation. In the SMS there is a description of how the DPA acts as a liaison between the ship and the highest level of the shipping company[11], and the SMS and legislation describes how the shipmaster is expected to behave in various circumstances. The owner and society were thereby observing the shipmaster via the SMS and the national legislation. This observation is made possible by the enhanced communication that made the owner always present: *"At 22:26:38 the Master - worried - contacts by phone the company updating it on the actual situation"* (MIT, 2013, p.32) and *"…their dialogue* [DPA and shipmaster]*, although discontinue, started at 21 57 58 and finished at 23 14 34"* (MIT, 2013, p. 8).

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11 ISM Code, part A, section 4.

Not only was the DPA closely involved in the management of the emergency, the Italian national emergency agencies were also monitoring the shipmaster and ordered him back on the ship: *"At 1:46 the OR contacts the Master ordering him again to go back on board and provide a situation report"* (MIT, 2013, p. 35). The shipmaster's autonomy was thus denied by the owner's and the society's surveillance. This surveillance was reinforced by the SMS and national legislation that contributed in an active fashion to constitute the shipmaster's self: *"…the subject constitutes himself in an active fashion, by the practices of self, these practices are nevertheless not something that the individual invents by himself. They are patterns that he finds in his culture and which are proposed, suggested and imposed on him by his culture, his society and his social group"* (Fornet-Betancourt, Becker, Gomez-Muller & Gauthier, 1987). The shipmaster on Costa Concordia practice of self, which was produced by the surveillance, made him custodian of safety on board the ship. These practices were in part propagated from the SMS and national legislation, but also from the historical normative narrative about the shipmaster as accounted earlier in this thesis.

From the shipmaster's account, he delayed the abandonment of the ship until he was sure that the ship was going to sink and all the options to save the ship were exhausted. However, by abandoning the ship he did not live up to his pastoral duties related to the moral agent for the society, as described in the Italian national legislation, where it is implied that he was to sacrifice himself by being the last person to leave the ship (which presumably means that he will perish). By ordering the abandonment of the ship, the shipmaster was not only disbanding the system, but also his self, which was defined by the existence of the ship. He was assigned a moral dimension connected to his pastoral like power (Foucault, 1982, p. 783), where the shipmaster was expected to sacrifice himself for the safety of the ship and passengers, when being the last person to leave the ship. This pastoral power should be seen in contrast to dominant regal power, where the lower ranks are supposed to sacrifice themselves for the hierarchal structure of power. This episteme is not a practise that can be derived only from the Italian legislation and the foundering of Costa Concordia, but it is more deeply rooted in maritime practises that also existed at time of the Titanic disaster in 1912, as described earlier in this thesis.

The SMS instilled the crewmembers and the shipmaster with a certain view of how the shipmaster was to be constituted. It was a mechanism of power that the SMS indirectly described the shipmaster as a rational decision-maker and where the ship-owner defined the shipmaster by defining what counted as rational. The owner's mercantile interests and control of risk, which was exercised through the SMS, necessitated and defined the concept of the shipmaster as a rational autonomous agent. In this way was power producing a regime of truth about rationality and vice versa, but the relationship was asymmetrical. Power dominated rationality in the dynamic relationship between the two (Flyvbjerg, 1998).

> *"Those who plan, build and manage ships, the shipowners, are not directly concerned with changes in individuals caused by the social structures of the ship. Often they are aware that such consequences are likely or inevitable. In so far as their basic economic purposes do not prevent it, they may in various ways take cognizance of the probable impact of life at sea upon the seaman, and try to stave of unfortunate aspects of this impact or encourage other developments"* (Aubert, 1982, p. 248).

Aubert (1982) was writing about total institutions and not power per se. The writing pre-dates the safety management thinking in the maritime domain by almost two decades. However, it can be viewed as an early thinking of how the control of the seafarer is exerted by changing the seafarer. Not by domination, but by encouraging other developments than the effects of the social structures on board ships, e.g. by a safety management system.

The discourse and reasoning in the accident report (MIT, 2013) shows that the decision to evacuate the ship is viewed with the rational autonomous moral agent in mind and juxtaposed with the actual decision or lack thereof. The shortcoming of the shipmaster is then labelled human element or error with different labels such as violation and lapse (MIT, 2013, p. 9 and 161).

The case study in relation to the hypothesis

The case study has described and analysed the foundering of Costa Concordia from the perspective of the decision-making and mechanisms of external dominant power, internalised power and how the shipmaster was constituted by mechanisms of power.

There are indications that the shipmaster's decision space presented him with alternatives that constrained him from early ordering an abandonment of the ship. The shipmaster's actions were described from the premise that he was, or should have been, a rational decision-maker. What was found in the case study is that he was in a situation of conflicting goals, preoccupied with decision quality in terms of outcome and not process, and that he was, within the time frame of approximately one hour, in the process of choosing alternative and diverse strategies for mitigating an unfolding emergency situation. Once enough information was available that revealed which strategies would work and which would not work, he announced the evacuation of the ship. The evacuation was, in the report's (MIT, 2013) view, executed too late, because the ship was already about to founder, and was in the midst of a total system breakdown.

The shipmaster was in the report described as a dominant centralized authority representing the company and the government with legislative legitimacy and thereby with a perceived form of power to make effective decisions leading to an optimal outcome, which was the successful evacuation of the ship without casualties. In the failure to manifest the power to secure a positive outcome, he became the root cause of the accident. The case study has found that the formalized power structures were, however, supplemented by power mechanisms in relation to his dominating power, his ableness to secure certain outcomes and how he himself was constituted. Ultimately, these mechanisms in various ways subverted his position of power.

These findings support the hypothesis that assumes that the shipmaster's place in an authoritarian hierarchy establishes the widely held wisdom and tacit understanding of the shipmaster as person with rational decision-making capability and power to secure certain outcomes. Furthermore, the findings indicate that the validity of the normative view of the shipmaster can be brought into question.

FINDINGS AND ANALYSIS – INTERVIEWS

In this chapter the results of the interviews will be presented in the theoretical framework of decision-making and power. As described in the method section, the data collected from the interviews is not fact, but are the personal reflections of the informant's role as shipmasters of passenger ships.

All of the informants work in a formal hierarchy consisting of a shipmaster, a chief officer and two or three mates. Three of the informants worked on ships that had two shipmasters on board that enabled the ship to operate 24 hours on a busy schedule. All of the informants thought of themselves as being in command and identified the chief officer as the second in command.

The amount interview data was found be manageable and it was, therefore, found to be sufficient to make a sorting and coding process in a matrix (appendix 5) containing the interview questions and the informant's responses. Thereby, the responses to the questions could be compared. The informants are in the following numbered 1-5 for securing their anonymity.

All the interviews were semi-structured and gave the informants the possibility to elaborate on their views about their position as shipmasters. Therefore, the answers to the questions were not given in a consecutive order.

From the interview recordings it has been possible to sort the informant's responses in relation to the interview questions. Some of the citations are not responses to specific questions, but are general reflections that the informants made during the interview session.

In the following, the findings will be presented by selected responses to the interview questions about decision-making and power. The findings will be analysed in relation to the hypothesis and the research question in the final part of this chapter.

Decision-making

> *"...is there any other way I can avoid to abandon ship. It is not a question in my mind of abandoning ship - it is a question of is there any other reason I should not abandon the ship...If I had no other option to turn to that's when I would say I've got to abandon ship for the safety of everyone...It is a decision that no master in his right mind would ever take lightly - it is such a big decision to make"* (Informant 4).

The above citation is a response to the question: What would your concerns be in an evacuation situation?

The informant's response describes that the decision to abandon ship is the final stage of a decision-making process that involves evaluating different strategies or options to handle the emergency scenario e.g. grounding the ship or going the to nearest port. The complexity of that decision space is further elaborated by the same informant: *"You cannot use a decision support tool for everything that goes wrong otherwise you would have a book twice as big as the bible"* (Informant 4).

All the informants stated that they have access to decision-support tools that are designed as checklists or aide memoires that assist them in which actions to take in an unfolding emergency scenario. One of the informants had made a personal generalized aide memoir of 28 items that were to be addressed during an emergency:

> *"If I go blank, then I have something to follow step by step. It is a good idea, because it* [the emergency] *always happens at the worst possible time during night time and when I step in the bridge where it is dark and all the alarms are sounding, then I would like to have something to get me going…when I have to make an announcement to the passengers, then I will know what to say, but it will only be useful for less serious events…"* (Informant 3).

The citation indicates that the existing decision-making tools are not useful for the operational reality that this specific informant expects to meet. What the informant seems to need is not a tool for making decisions, but an aid to solve immediate practical tasks in a less complex scenario.

All of the informants expressed in different ways that a decision support tool that is designed as a checklist is useful as an aide memoir for ensuring that certain things are remembered, but is not useful for mitigating developing situations in a stringent manner. Three informants expressed:

> *"It* [the checklist] *works as an aide memoir. There are 101 thousand things on a ship that can go wrong. Everyone have his or her own particular point of interest. When <u>this</u> happens then we will do <u>that</u>, because…things can happen in some completely different resource, so it works well, because it is open and fluid"* (Informant 4).

"[We use a] *checklist, how we remember to do this and to do that"* (Informant 5). *"It will never fit the specific situation"* (Informant 1). None of the informants found it valuable to use a decision support system if they were to order the abandonment of the ship. Instead they expressed various views on what strategy to follow e.g.: *"There are two schools for calling to assembly stations. Either you wait to the very end to call to go to assembly stations or you do it very soon"* (Informant 1). What strategy would be chosen depended on various factors e.g. the weather conditions or how best to avoid panic among the passengers.

One informant was asked why the decision tool for abandoning ship was not used: *"I am convinced that it is the way it is designed. It* [the checklist] *was included in SOLAS*[12] *many years ago. They [regulators] did not consider the persons that were supposed to deal with it"* (Informant 2)

The above quotes indicate that the informants are faced with developing situations that are not easily mitigated with static decision support tools. However, they found aide memoirs useful for remembering standard operational precautions or as a scheme for how to address the passengers in an emergency. Overall the informants expressed a preoccupation with having freedom to choose and develop strategies that would secure the best possible outcome.

Two of the informants had been in serious emergency situations that made them uncertain about some aspects of the role as centralized decision-makers: *"In the space between knowing and not knowing you will feel very lonely"* (Informant 1). *"I don't think any decision support to that point could...would be useful for the final decision to abandon ship. You can stop the decision, but not reverse it…what would affect myself was the enormity of the situation."* (Informant 4).

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[12] Convention for the Safety Of Life At Sea

The informants were presented with a hypothetical scenario where the emergency was developing into a situation where the ship listed more than the design parameters of the lifesaving equipment allowed. In response to this scenario the informants were not responding in terms of decision-making, as if they realized that designing a decision-making strategy would be superfluous. Instead they responded as if action would be required on their part and the informants were preoccupied by outcome: *"First and foremost, we will probably be in the process of sinking or capsizing…So we will have to abandon ship as best as we can"* (Informant 3). In addition, the informants were focused on their role and responsibility related to the ship sinking: *"You are basically as a captain saying I failed in my duty of looking after this ship, I've lost my ship I've got to get these passengers off in a safe way it is a huge, huge responsibility to have on our shoulders"* (Informant 4).

> *"You can continue to help people. You stay on board. I do not understand why the captain runs away the bridge is the safest place to stay. I couldn't watch my self in the mirror if I left the ship with people still on board, because it is my job and responsibility. Even if you have no power you still have the responsibility if the ship is on the side. But I would stay on the bridge with VHF/telephone whatever. It is responsibility - moral. It is selfish for one self, because I* [could say: I] *did what I could"* (Informant 1).

The informants' internalized view on their position as shipmasters is connected to their sense of duty and responsibility. In this context there seems to be a close relationship between decision-making and responsibility, because effective decisions to save the ship are linked to the shipmaster's knowledge about the ship: *"I couldn't watch my self in the mirror if I left the ship with people still on board…It is responsibility – moral"* (Informant 1). The ability to handle an emergency is part of the responsibility to safeguard the ship. The concept of responsibility it tied to the legislative norms and dimensions of morality, which is seen in the above wording.

However, there will always be uncertainty: *"I will never be sure that the ship has been completely evacuated…the next day I will be told that 200 children were hiding in the aft of the ship"* (Informant 3).

Power

The interview was structured in such a way that the questions regarding the formal power structures were asked first followed by questions about the informal power structures. As the interview sessions progressed, it became clear that the informants found it difficult to separate the formal from the informal power structures. In the following, both power structures will therefore be presented jointly.

The interview sessions started with establishing the formal framework that the informants were working within. Once the formal organizational structure had been established then the informants were asked to describe why they specifically had been chosen to be shipmasters and what the nature of their power was. It was noted that none of the informants had been hired on the basis of psychometric testing.

When the informants were asked about why they specifically were appointed shipmasters, then all of the informants referred to their knowledge/expertise and formal certification as master mariners. Three of the informants additionally elaborated on the company's legitimization of their position:

> *"…a company - they interview for a master, they're the people that make the decision: I'm happy giving 100 mill pound worth of equipment to this chap who could quite easily destroy it in one easy go…I think this is were your experience…they say he has got the exams he has got the working knowledge, he has the sea time to tell us that he's got the knowledge that he learns on*

> *board and* [by] *talking to the man…do I feel that this man is OK to the job…"* (Informant 4).

The second informant: *"I think it is was interest and commitment…I guess I had the experience, because I had been in the company since 1994 and was the best qualified…"* (Informant 3). The third informant: *"It has been like this for centuries. If you stayed in the company long enough then you were made captain…I was the one who had been in the company the longest and had seniority…"* (Informant 2).

Overall it was difficult to get the informants to elaborate, beyond knowledge, expertise and formal certification, about the reason why they specifically were selected to be shipmasters – assuming that others had similar knowledge and experience. The informants even recognized that other officers on board might have similar or even more knowledge. When asked to elaborate on their legitimization, their overall opinion was that their position was obtained, because they had been in their respective companies for a long time and had gained the necessary knowledge and expertize. Specifically expertize in manually manoeuvring the ship, which is exclusively done by the shipmaster except for the purpose of training the chief officer.

The shipmaster's legitimization among the crewmembers seems also to be rooted in knowledge and expertize: *"I hope the officers look up to me look to me for advice when they are not sure on something.* (Informant 4). When asked what could challenge their power e.g. if their knowledge and expertize is not considered to be superior then:

> *"It is not unthinkable that there can exist a form of shadow cabinet when the "old man"* [shipmaster] *looses his grip and it has been seen…that they* [shipmasters] *cannot see the whole picture and only can keep focus on single problem areas…then there is the danger that the power can be subverted"* (Informant 3).

The shipmaster's superior organizational position also gave the shipmasters a bureaucratic power over the crewmembers:

> *"They* [the bridge crew] *also benefit in keeping the "idiot" happy, because it is me who is making their appraisal and it is me who reports back to the company that him and him has done a good job - and decides who is going to relieve me as captain"* (Informant 3).

The above statement becomes relevant in relation to the chief officer in training, i.e. who is considered an apprentice whose future depends on the training and approval of the shipmaster. This apprenticeship between the shipmaster and the chief officer is thus also part of how the shipmaster exerts power by having superior abilities. Furthermore, it legitimizes the shipmaster's position, because he/she has been trained and approved by a peer. Although the apprenticeship is somewhat informal (i.e. not bureaucratically described) then it is still such a vital part of the process of becoming shipmaster that it can be considered part of the formality. Furthermore, the apprenticeship re-produces the power structures that constitute the shipmaster's self.

The informants agreed that the formal hierarchy did not change during an emergency: *"Everybody accepts that the captain is in charge. Everybody knows their jobs and conform to their duties in an emergency"* (Informant 5). Two of the shipmasters expressed that the working relationship was somewhat informal in everyday settings, but there was no doubt about who was in charge and that the shipmaster was the only one that would take the decision to abandon the ship. The power to make that specific decision was, however, not described as being legitimized in knowledge and expertize, but in the shipmaster's legal position of authority:

"The captain, but I will imagine he would make that decision if it was me I would probably tell the company I am going to evacuate the vessel I cannot see them ever overriding that decision, because the master is by law responsible for the safety of his passengers" (Informant 5).

All of the informants expected that the officers would overcome the power gradient by being assertive and voice their opinion if the situation was becoming critical and they actively sought to promote a assertive behaviour from the junior officers: *"…it is structured in such a way that people are encouraged to question authority in a dignified way, they are not allowed to overrun it by any means, but they are allowed to question it"* (Informant 4). What seems to be expressed is the balance between promoting assertiveness without the shipmaster loosing power over the organization. If that balance is not kept in favour of the subordinates then: *"The third time they provide their opinion and you do not listen - then you will not get anything again"* (Informant 3). The power gradient is thereby upheld and confirmed, which makes it more difficult for the subordinates to countervail it.

Two of the informants had difficulty getting feedback from the Eastern European junior officers, because they were overly respectful towards the shipmaster's authority that indicates that these officers have some difficulty in balancing the assertiveness without giving the impression that they are challenging the shipmaster's position. *"You cannot expect to get feedback if you do not show an interest in them by asking about their home etc.…you have to de-mystify the role of the shipmaster…"* (informant 4). The latter statement is indicating a strategy of making the working environment more informal in order to mitigate the power gradient that exists.

Most of the informants were of the opinion that the relationship between the shipmaster and crewmembers changed in an emergency. However: *"The way you give orders is different in emergency situation. You must show that you know what you are doing - otherwise chaos"* (Informant 1). For this informant it was important to give an impression of superior knowledge in order to exert power.

Another informant emphasized that what happened in normal operation would effect the reaction of the crewmembers in an emergency: *"There will always be a time when someone has a different opinion and as a captain you have to adapt and you have to decide to assert your authority or listen to that person. How you react as a captain in peacetime will equally offer an outcome in the emergency…"* (Informant 5).

The informants were preoccupied with promoting an assertive attitude from the crewmembers, but also recognized that it was difficult to achieve. Two of the problem areas are: *"I am reluctant to discuss with anyone in an emergency…"* (Informant 3) and

> *"I haven't actually experienced resistance,* [but] *I have experienced once or twice where people tried not to do what I asked them to do and I've had to reprimanded them and then say basically either you do what I say or you know of course you are in trouble. If I have asked them to do something stupidly then I expect them to say I'm not doing that…"* (Informant 4).

The informants' statements are indicating the inherent difficulty in defining the boundaries for the appropriate intervention from the subordinated officers as described in the case study.

The informants were asked about the shore organization's involvement in the decision to abandoning the ship. Among the informants the shared opinion was that it was the shipmaster's decision alone, in part due to the legal responsibility, but mainly, because the shipmaster is in the midst of the events:

> *"When it is a straight forward decision I think it would be very easy to make, but if it there was other factors then it would cloud your judgment and I don't think anybody ashore would have a real understanding of what the situation is on the ship" (Informant 5).*

> *"If we are talking to them and they suggest that we abandon ship then it is something again that the master can consider, but they cannot order us to abandon ship we still have an overall duty of we maintain the overall command of the ship - it still comes down to the masters authority" (Informant 4).*

Parts of the interview were about power from more abstract viewpoints than merely legislative and organizational legitimized power. The informants were asked questions that were directed towards their internalized view of power e.g. what happens to power if the ship is not working as a system anymore? or why do the subordinates see you as a superior? As a response to these questions the informants referred to values and qualities residing in their person e.g.: *"The passengers put their trust in the captain…"* (Informant 2). *"The power is primarily connected to the position and secondly to the personality and commitment"* (Informant 3). *"They* [the crew] *look at me as the figurehead of the ship something like that - the father of the ship I suppose"* (Informant 4).

> *"You are basically as a captain saying I failed in my duty of looking after this ship, I've lost my ship I've got to get these passengers off in a safe way it is a huge, huge responsibility to have on our shoulders" (Informant 4)*

"There is an old saying that the captain is the master after god" (Informant 1). Informant 3 elaborated a bit more by introducing the sense of responsibility and duty when asked what would happen to the power if the ship stopped working as a system (e.g. excessive list or even in the process of foundering):

> *"I would stay on board until the funnel goes under…(question: why is it so?) It is a vote of confidence…it is responsibility. If I walk around on the ship on a summer evening, then there can be 400-500 children and 600-700 adults, babies and old people. They look upon you and*

think that I walk around and look confident then everything is under control. When I accepted the job then I have to take responsibility" (Informant 3).

The mind-set of the informants in this part of the interview (about system breakdown) was different than earlier in the interview. The informants' self was constituted in a pastoral-like manner as a subject of power that acts on behalf of the passengers and crew. In this concept of power the shipmasters are not acting as representatives of the society and owner - acting with regal power where the passengers and crew are expected to sacrifice themselves for the greater good. On the contrary, the shipmaster must sacrifice himself when the ship goes under and is lost. Responsibility is only denied, as Morriss (2007) described it, when all power is lost e.g. when the crewmembers and passengers are in panic, and the shipmaster looses the capacity to act according to the passengers' best interest, and is the last person to leave the ship.

The informants are expressing a pastoral view of themselves where they act on behalf of the passengers and crew – they constitute themselves by their own practices of duty. This view co-exits with power as domination and the exertion of control:

It [power] will disintegrate and I cannot trust the crewmembers anymore, because it is every man for himself" (Informant 2) and *"...we [crewmembers] have discussed the word abandon ship against the word evacuate passengers or against the word transfer passengers into lifeboats, because we have discussed what causes more panic the word transfer or abandon ship"* (Informant 5).

The two informants are concerned with the loss of control over the crewmembers and passengers, because otherwise the position of shipmaster cannot be upheld and the passengers cannot be saved. Upholding the normative view of the shipmaster is an element in exerting pastoral and dominant power: *"They [the passengers] would think of me as all knowing and powerful being* *that runs the ship that stays on the bridge 24 hours a day steering it and does nothing else. That is what you properly want the passengers to think - you do whereas in reality obviously it is a whole different kettle of fish"* (Informant 4).

Conclusions in relation to the hypothesis

The interviews findings have shed light on how the shipmasters create meaning within the mechanisms of power, and gave information about how they negotiated their decision space within the context of an abandon ship scenario.

Among the informants there was an overall consistency in the responses to the different questions considering the level of abstraction of the interview topic and the subjective nature of the responses. The informants predominantly expressed scepticism towards decision support tools, because an abandon ship situation was considered to involve too many variations to be mitigated with a static support system. None of the informants used wording such as complex or complicated, but the informants did in different ways express concerns that are related to the attributes of complex systems. In the decision process the informants seemed preoccupied with testing different strategies for avoiding evacuation. Thereby, they recognized the non-epistemic nature of their power i.e. the shipmaster does not know what string of actions will lead to a certain outcome, but they were confident about the ability to reach it.

Overall, the informants were confident in their decision-making capability, which was in part based on their knowledge and expertize, but also in a belief that information would flow democratically to them during the emergency situation. Thereby, they had a view of themselves as having the ableness (actual power) to make effective decisions, because the necessary information would be available. However, the informants that had been in an actual emergency situation were less confident about the availability of information, indicating that shipmasters that have been in an emergency have a different perspective on their ableness (actual power), than those who did not have the same experience in handling emergencies.

During the interview it was difficult to separate the topics of decision-making and power, because the informants related to the subjects simultaneously. The informants viewed the decision to evacuate the ship as being an integral part of their position of power over the ship, crew and passengers. At times the power could take the power to form, e.g. when building the confidence of the Eastern Europeans officer to exercise assertiveness i.e. countervailing power. The position of power over the ship was driven by a sense of duty and responsibility that was connected to the informants being the focal point of power in the organisational hierarchy. This was expressed as an obligation to sacrifice themselves by being the last person to leave the ship if it was about to founder. This was an internalised view on power in contrast to the dominant power over form that is external. The wording that the informants used (e.g. *"god"*, *"figure head"*, *"my ship"*) was defining their position, not only towards themselves, but also towards their subordinates and passengers. The informants viewed their power as a combination of a dominant hierarchal power and pastoral self-sacrificing power.

The informants' responses seemed at times contradictory, e.g. when the informants described their legitimization of power by referring to having superior knowledge, while at the same time acknowledging that other officers might be more knowledgeable in both general terms and in specific areas of the shipboard operations. However, the informants presumably referred to different notions of knowledge, where the shipmaster possesses knowledge in terms of the situation at hand, and the subordinates possess knowledge in terms of specific technical information.

In conclusion it was found that the informants largely reproduced the normative view of the shipmaster, because it was how their hierarchal dominant power was legitimized. This supports the underlying hypothesis to the question that assumes that the shipmaster's place in an authoritarian hierarchy brings about a normative view of the shipmaster as person with rational decision-making capability and power to secure certain outcomes. However, other mechanisms of power were uncovered that influenced how the shipmaster negotiates the decision to abandon the ship.

DISCUSSION

Purpose of the thesis

The aim of this thesis was to assess the validity of the normative view of the shipmaster in the context of the decision to abandon a passenger ship. Choosing this topic was motivated by a scepticism toward the narratives about the shipmaster that were created in the aftermath of the foundering of the Italian passenger ship COSTA CONCORDIA in 2011. In the narratives and the Italian legislation there was an underlying normative ideal of the shipmaster. An ideal of the shipmaster having access to all information and, more importantly, having recognized the relevance and importance of that information within a system where there is a democratic and evenly distribution of knowledge. Furthermore, that the shipmaster's place in the hierarchy gave him the power to act according to the information to secure the optimal outcome. This was defined to be the normative view of the shipmaster.

Therefore, the research question was to assess the validity of the normative view of the shipmaster.

In support of the research question a hypothesis was presented that proposed that the shipmaster's place in an authoritarian hierarchy brings about a societal view of the shipmaster as person with rational decision-making capability and power to secure certain outcomes, a view that is promoted by the SMS, legislation and by the analytical framework that underpins formal accident investigations. In contrast, the shipmaster could also be viewed as a centralized focal point of power in a complex socio-technical system, where there is imperfect knowledge about the interactions the system and constant trade-offs and conflicting goals that influence the shipmaster's power.

The research question was triangulated by case studies, theoretical analysis and data gathered from interviews with shipmasters. This enabled an application of different sources and categories of data onto the one question. Furthermore, the individual method gave opportunity for falsification of the data gathered and the theoretical analysis.

Discussion of the findings

In the following, the overall findings from the case study and the interviews will be discussed in the context of the research question, and the theoretical frameworks that were chosen to shed light on the analysis of the data.

In the case study and the interviews elements from the theoretical frameworks of Dahl's (1957) and Lukes' (2005) views on dominant power could be traced, specifically when the shipmaster was described with an externalized view as having power as a resource to be exerted upon others. Dahl's (1957) externalised view of power, by the securing of positive outcomes from decision-making, was from the case study found to be the predominant thinking in legislation and how the accident narrative (MIT, 2013) was constructed, where the authors grounded their linear approach in safety management thinking and maritime legislation. The interviews also supported this notion of legitimization of power.

The preoccupation with the outcome of decision-making promotes a certain way of thinking about rationality in decision-making, and the shipmaster position of power becomes a subject to this rationality, which is fundamental in relation to the legislative and bureaucratic legitimization of the shipmaster's power. In the context of the hypothesis this application of rationality is tied to the normative view of the shipmaster as a custodian of safety, because he by the exertion of power secures positive outcomes. Arguably, this perception could stem from the existing discourses about the shipmaster's authority and control, and how the shipmaster's bureaucratically legitimized power secures it. The interview data supported the latter when the informants reproduced this view of the shipmaster that was found in the case study.

From the interviews it was found that the informants reproduced the discourses about the shipmaster as the autonomous moral agent. I.e. they positioned themselves within a certain framework of power, where they viewed themselves through the lens of the normative abstractions in the SMS, legislation and a historical context. They did not see the shipmaster on Costa Concordia as representing themselves, because he violated the values associated with the autonomous moral agent. This challenged the hypothesis' revisionist approach with regard to the informants view on power.

Lukes' (2005) third dimension of power could not be directly observed in the case study or the interviews. However, indirectly the alignment of the crewmembers interests with the shipmasters interests were part of the way the shipmaster exerted power, because the crewmembers see safety as residing in the shipmaster legitimized position of knowledge and expertize. Without resistance toward that legitimized position (third dimension of power), it would no longer be necessary for the shipmaster to actively exert a dominant hierarchal power over the bridge team. Paradoxically, the shipmaster is expected to actively pursue a strategy to undermine the third dimension of power by encouraging the crewmembers assertiveness by encouraging and promoting divergent views on his knowledge.

It was found that the shipmaster's power as a dispositional property i.e. as an ability to be exercised is only intact until the window of opportunity closed for the abandonment of the ship in an orderly fashion. The shipmaster's ableness (actual power) is limited by the complex nature of the decision-making under uncertainty, his lack of knowledge about the system and the unfolding events that prevents him from mitigating the risks. After a certain tipping point the ship is lost and both the ability (potential power) and ableness (actual power) is lost – the shipmaster is rendered powerless, which challenges the normative view of the shipmaster. Paradoxically is the actual abandoning of the ship is a non-reversible decision to terminate the functioning of the ship, which is both a manifestation of the shipmaster's power, and the abolishment of his power.

The case study furthermore showed that the SMS the limited the capacity of the shipmaster to act freely and reduced his dispositional power. The limitation was brought about by the institutionalised social control of power that was exerted upon the shipmaster by the national legislation and the SMS exercised by the society and the ship owner. This control diminished the shipmaster's external and internal power, which in turn implies that with authority and responsibility does ableness not necessarily follow. By Morriss (2002) assertion, if the shipmaster can demonstrate lack of ableness (actual powerlessness) then responsibility can be denied. The validity of that assertion can be brought into question if the shipmaster's pastoral power is considered. Pastoral power implies responsibility towards self-sacrifice and not necessarily ableness to bring certain things about. Nevertheless, Morriss (2002) was found to be useful from a methodological standpoint, because his notions of power were both adaptive to sub-level description and to the larger level analysis.

The research did not elaborate on the different strategies that a SMS could pursue depending on the context it is meant to function in. Arguably, there will a difference in perception of risk from legislative bodies, management and shipmaster, which makes it a poor instrument for mitigating risk from an operator point of view. The interviews indicated that a SMS is not containing one document with one strategy, but several documents that mitigate different situations, e.g. check lists (how to remember things) and procedures (how to do things). From the interviews there was clear data that there was little trust in the decision support tools, and shipmasters were not going to use it. They presented viewpoints that indicated the problem of the difference in work as done and work as imagined. These viewpoints challenged the validity of the normative view of the shipmaster to the extent that the view of the shipmaster rests on work as imagined.

Limitations to the research

During the interviews it has been recognized by the author that it is difficult to generalize from a context-dependent interpretation of a specific event i.e. the abandonment of a passenger ship. Mainly, because the informants did not talk about an actual event visualised in hindsight, but a hypothetical situation. Therefore, the informants viewed the abandon ship decision as an emergent decision-space, which is manageable, because information presumably would flow democratically to them. This would enable the shipmaster to make an informed decision early in the emergency. The exception to this mind-set were two informants that had a more sceptic view on their own ableness, because they had been in an emergency situation that fundamentally changed the view of their self as shipmasters and the system they operate within.

The amount interview data was limited to five active shipmasters on large passenger ships. Even though data saturation was meet in the key areas of decision-making and legitimization of power, then there were unexpected areas that were not sufficiently covered. It was found that the informants that had experienced serious emergencies had different views on their own self as shipmasters, and a more thorough exploration into how shipmasters reproduce their self, would have given a further understanding of the shipmaster. However, the amount of the informants that had been in such a situation did not justify a more in depth analysis. If the scope of the research had permitted, a comparative analysis between shipmasters that had been in emergencies and those who had not would have strengthened the research.

During the research, the topic of assertiveness became relevant in the understanding of the subordinated officers' role in shaping the shipmaster as a subject of power. This was not part of the research question or the hypothesis per se, but the subject involves facets of power. Even though the language in the accident report and in the interviews was predominantly related to the power over form, then there was at the same time a taken for granted opinion that the power gradient residing in the hierarchy could and should be challenged by the bridge team, if something was about to go amiss. This is an assertion based on an ex post facto reasoning that does not take the nature of the legitimization of the dominant power over mechanism into consideration. It is not taken into account that the crewmembers are legitimizing the shipmaster's power by acknowledging the superior decision-making capability. If they do not, then they will not only be subverting the shipmaster's position with the risk of sanctions, but they will also be challenging the power-knowledge relations that define how safety is created and risk mitigated, namely by the shipmaster superiority. The shipmasters might allow the subordinates a space for exploring new knowledge and the construction of new truths, but in an emergency situation the power relations default back to the power over form. Arguably, the power over form cannot be exerted effectively without elements of Lukes' (2005) third dimension of power where the shipmaster has aligned the crewmembers view of the world in accordance with his own view.

Further research

During the case study and the interview it was found that the sense of duty and accountability was essential parts of the shipmaster's power and decision-making. Accountability is a topic that is closely connected to this subject area, but was not part of the research question. Further research into the issue of accountability can be vital for understanding the shipmaster's position and provide knowledge about the decision to evacuate a passenger ship.

CONCLUSIONS

It was found that the subjects of decision-making and power were highly inter-connected. The discourse that was created in the accident report (MIT, 2013) was based on the pre-existing thinking from the SMS and (inter)national legislation. This discourse was, from the case study and interview data, found to be problematic in terms of understanding how the shipmaster occupies the decision space when the abandonment of a passenger ship is decided.

There were found to be different application of power during the daily shipboard operations and in emergency situations. Furthermore, it was found that these different applications of power (power over and power to) co-exist and are not excluding each other, but are on the contrary supplementary and co-dependent for constituting the shipmaster's position of power, while at the same time subverting the shipmaster hierarchal position of power. Power was thus found not to be one thing, but many things as asserted by Dahl (1957).

Making the decision to abandon the ship is a manifestation of power that leads to the termination of the shipmaster's power, because it inevitably results in the discontinuation of the system that the shipmaster is legitimized to govern. Simultaneously, it is the manifestation of the shipmaster's lack of dominant power to secure the safety of the ship as a safe haven for the crew and passengers. In the late stages of an abandon ship scenario it becomes visible how the shipmaster's authority brings about a pastoral power where the shipmaster is expected to sacrifice himself by being the last person to leave the ship, even though he has lost the ableness to govern the ship, because there is nothing left to govern.

In a reluctance to dissolve his power the shipmaster is not facing a go or no-go situation. Instead, the shipmaster is applying a decision strategy of gradually collecting enough information to make an informed decision, while seeking alternative solutions to the emergency situation, e.g. seeking a safe port or grounding the ship, which renders static decision supports systems lacking usefulness. This confirms the assertion by Yates, Veinott and Patalano (2003) that decision support systems have little documented success, due to the preoccupation with outcome and not process in the decision-making process. Thereby the shipmaster delays the decision to abandon ship while sampling information to be better assured that the optimal decision can be made – before it is too late to act.

It is a mechanism of power that the SMS and legislation indirectly describes the shipmaster, as a rational decision-maker, where the ship owner and society defines the shipmaster by defining what counts as rational. The owner's mercantile interests and control of risk, and the society's demand for safety for the citizens, which is exerted through the SMS and legislation, necessitates the concept of the shipmaster as a rational autonomous agent. In this way power is producing a regime of truth about rationality and vice versa, but the relationship is asymmetrical. The owner and society's power dominates rationality in the dynamic relationship between the SMS and the shipmaster. Although the SMS and legislation does not specifically elaborate on the shipmaster's empowerment to make decisions, it presumes that the responsibility to make decisions acts as a proxy for the power to make decisions.

Thereby, the centralized governing of a passenger ship necessitates a view of the shipmaster as a rational decision-maker with an ableness to secure certain outcomes. In the absence of countervailing power (BRM) there will be no decentralisation of power, which is necessary for the functioning of a complex system. Thereby, the shipmaster as a Perrowian central actor in a complex system is to some extent unpacked.

These findings support the hypothesis that assumed that the shipmaster's place in an authoritarian hierarchy brings about a view of the shipmaster as person with rational decision-making capability and power to secure certain outcomes. Furthermore, the findings indicate that the validity of the normative view of the shipmaster can be brought into question.

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Appendix 1

MINISTRY OF INFRASTRUCTURES AND TRANSPORTS

Marine Casualties Investigative Body

Cruise Ship

COSTA CONCORDIA

Marine casualty on January 13, 2012

Report on the safety technical investigation

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"The only aim of this Investigation performed in accordance with this decree is to prevent future accidents through the ascertainment of its causes and circumstances. Investigations on the basis of the provisions contained in this Decree, shall not include the determination of responsibility** [1] **".

0. GLOSSARY OF ABBREVIATIONS AND ACRONYMS

ARES - AUTOMATED SEARCH AND RESCUE
CCTF - Costa Crisis Task Force
CCTV - Close Circuit Television
CE - Chief Engineer
D/G - Diesel Generator
DCP – Damage Control Plan
DCB – Damage Control Booklet
DOC - Document of Compliance
DPA - Designated Person Ashore
DPR – Presidential Decree
ECR – Engine Control Room
EDG - Emergency Diesel Generator
EEBD - Emergency Escape Breathing Device
ETA - Estimated Time of Arrival
EU - European Union
FCC - Fleet Crisis Co-ordinator
GRT - Gross Registered Tons
Hz - Hertz
IB - Investigative Body
IIS - The Italian Welding Institute
IMO - International Maritime Organization
IMRCC - Italian Maritime Rescue Coordination Centre
ITCG – Italian Coast Guard
ISM - International Safety Management (Code)
kHz - Kilohertz
kW - Kilowatt
L.T. - Local Time
MLC – Maritime Labour Convention
MRCC - Maritime Rescue Coordination Centre
MRSC – Maritime Rescuer Sub Center
UCG – Coastal Guard Unit
OR - Operations room
OSC - On scene Commander
PEM – propulsion electric engine
PMS - Planned Maintenance System
QEE – Electrical emergency panel
RINA - Italian Classification Society

SAR - Search and Rescue
SCA - Suez Canal Authority
SCD - Damage Control Squad
SMS - Safety Management System
SOLAS - International Convention for the Safety of Life at Sea 1974, as amended
SCP - (Propulsion Control Room)
STCW - International Convention on Standards of Training, Certification and Watch keeping for Seafarers 1978, as amended
UMS – Unattended machinery spaces
UKMTO - United Kingdom Maritime Trade Organization
UTC - Universal Time Co-ordinated
VDR - Voyage Data Recorder
VHF - Very High Frequency radio

1. SUMMARY

If the danger of fire has always been the utmost threat for passenger vessels and still is, despite the technological evolution and the progress of rules and regulations as well as the higher skills resulting from the training and from the severe safety management system (on board and ashore), in the Concordia casualty we have discovered that a contact characterized by the dynamic that occurred in this event also represents a serious risk.

Efforts made in the issue of flooding after a contact also regarding passenger vessels, have in particular recently produced the “safety return to the port” SOLAS package of regulations. These have already been considered, as you will note at the end of this Report, as recommendations to improve safety against flooding after a contact.

We point out, first of all, that the immediate flooding of five contiguous watertight compartments, where most of the vital equipment of the ship was located, makes the Costa Concordia casualty quite a unique event, because of the extent of damage is well beyond the survivability standard applicable to the ship according to her keel laying date. Although, if we want to analyse this casualty (as we did) to try, in the end, to avoid similar consequences, the related correction measures should be truly significant, despite the measures may not be sufficient to render the ship unsinkable when more than two contiguous watertight compartments are flooded.

Despite the above mentioned, we anticipate that we however carried out the present investigation to identify some concrete practical solutions which could provide certain useful indications for possible future improvements of the current regulations.

The aim of this Report is therefore to set the serious flooding in an analytical and complete way, by means of a detailed analysis of the phenomenon, supported by scientific methods, with the purpose to reduce, as far as practicable, the range of variables - among those which contribute to cause a flooding - predictable, thus preventable.

On 13 January 2012, whilst the Costa Concordia was in navigation in the Mediterranean Sea (Tyrrhenian sea, Italian coastline) with 4229 persons on board (3206 passengers and 1023 crewmembers), in favourable meteo-marine conditions, at 21 45 07 LT (local time) the ship suddenly collided with the “Scole Rocks” at the Giglio Island. The ship had just left the port of Civitavecchia and was directed to Savona (Italy).

The ship was sailing too close to the coastline, in a poorly lit shore area, under the Master’s command who had planned to pass at an unsafe distance at night time and at high speed (15.5 kts). The danger was considered so late that the attempt to avoid the grounding was

useless, and everyone on board realized that something very serious was happening, because the ship violently heeled and the speed immediately decreased.

The vessel immediately lost propulsion and was consequently effected by a black-out. The Emergency Generator Power switched on as expected, but was not able to supply the utilities to handle the emergency and on the other hand worked in a discontinuous way. The rudder remained blocked completely starboard and no longer handled. The ship turned starboard by herself and finally grounded (due to favourable wind and current) at the Giglio Island at around 23.00 and was seriously heeled (approximately 15°).

From the analysis carried out under the direct coordination of the Master, the seriousness of the scenario was reported after 16 minutes. After about 40 minutes (22 27) the water reached the bulkhead deck in the aft area.

The assessment of the damage was continued by the crew, realizing, at the end, that watertight compartments (WTC) nos. 4, 5, 6, 7 and 8 were involved. These WTCs accommodated, among others, machinery and equipment vital for the propulsion and steering of the ship, such as:

- within WTC 4 - main thrusts bearings and hydraulic units, machinery spaces air conditioning compressors;
- within WTC 5 - propulsion electric motors (PEM), fire and bilge pumps, propulsion and engine room ventilation transformers, propulsion transformers;
- within WTC 6 - three main diesel generators (aft);
- within WTC 7 - three main diesel generators (fwd); and
- within WTC 8 - ballast and bilge pumps.

Only after the following days, it was discovered that the breach was 53 meters long.

The Master did not warn the SAR Authority of his own initiative (the warning was received by a person calling from shore) and, despite the SAR Authority started to contact the ship few minutes after 22 00, he informed these Authorities about a breach only at 22 26 02, launching the related distress only at 22 38 (on insistence of Livorno SAR Authority).

However SAR activities had started at 22 16, when Livorno Authority had ordered the GDF Patrol Boat 104, already in the area, to approach the Concordia. From the above mentioned time the following SAR resources were involved: 25 patrol boats, 14 vessels, 4 tugs, 8 helicopters.

Only at 22 54 10 the abandon ship was ordered but it was not preceded by an effective general emergency alarm definitely (several passengers – in fact - testified that they did not catch those signal-voice announcement). The first lifeboats result being lowered at 22.55 and at 23:10 they moved to the shore with the first passengers on board.

Crewmembers, Master included, abandoned the bridge at about 23 20 (one officer only remained on the bridge to coordinate the abandon ship).

At about 24 00 the heeling of the vessel seriously increased reaching a value of 40°. During the rescue operations it reached 80°.

At 00 34 the Master communicated to the SAR Authorities that he was on board a lifeboat with other officers.

All the saved passengers and crewmembers reached Giglio Island (the ship had grounded just few meters from the port of Giglio). First rescue operations were completed at 06 17, saving 4194 persons. Three more persons were put in safety on 15 January.

The rescue operations continued and on 22nd March the last victim was found. The number of victim is 32, and 2 of these are still missing (one passenger, one crewmember).
The person died are 26 passengers and 4 crewmembers.
Environment operations immediately took place recovering within the 24 March the 2042.5mc of oils.

Caretaking of seabed is still underway, as well as wreck recovering, which started last June.

The analysis of this casualty briefly puts in evidence the following results:

a. The navigation phases before the impact are to be considered as a crucial aspect, because they relate with the causes originating the accident. In particular, the focus is on the behaviour of the Master and his decision to make that hazardous passage in shallow waters. The computer simulation somewhat confirmed delays in the ship's manoeuvring in that particular circumstance. In this respect, the following critical points can be preliminarily indicated as contributing factors to the accident:
   - shifting from a perpendicular to a parallel course extremely close to the coast by intervening softly for accomplishing a smooth and broad turn;
   - instead of choosing, as reference point for turning, the most extreme landmark (Scole reef, close to Giglio town lights) the ship proceeded toward the inner

coastline (Punta del Faro, southern and almost uninhabited area, with scarce illumination);
- keeping a high speed (16 kts) in night conditions is too close to the shore line (breakers/reef);
- using an inappropriate cartography, i.e. use of Italian Hydrographical Institute. chart nr. 6 (1/100.000 size scale), instead of at least nr. 122 (1/50.000 size scale) and failing to use nautical publications;
- handover between the Master and the Chief Mate did not concretely occur;
- bridge (full closed with glasses) did not allow verifying, physically outside, a clear outlook in nighttime (which instead could have made easier the Master eyes adaptation towards the dark scenario).
- Master’s inattention/distraction due to the presence of persons extraneous to Bridge watch and a phone call not related to the navigation operations;
- Master’s orders to the helmsman aimed at providing the compass course to be followed instead of the rudder angle.
- Bridge Team, although more than suitable in terms of number of crewmembers, not paying the required attention (e.g. ship steering, acquisition of the ship position, lookout);
- Master’s arbitrary attitude in reviewing the initial navigation plan (making it quite hazardous in including a passage 0,5 mile off the coast by using an inappropriate nautical chart), disregarding to properly consider the distance from the coast and not relying on the support of the Bridge Team;
- overall passive attitude of the Bridge Staff. Nobody seemed to have urged the Master to accelerate the turn or to give warning on the looming danger.

Therefore the accident may lead to an overall discussion on the adequacy, in terms of organization and roles of Bridge Teams.

b. The General Emergency Alarm was not activated immediately after the impact. This fact led to a delay in the management of the subsequent phases of the emergency (flooding-abandon ship process). With regard to the organization on board, the analysis of crew certification, of the Muster List (ML) and of the familiarization and training highlighted some inconsistencies in the assignment of duties to some crewmembers.
c. In addition, the lack of direct orders from the Bridge to crew involved in safety issues somehow hindered the management of the general emergency-abandon ship phase and contributed to initiatives being taken by individuals. The presence of different backgrounds and basic training of crew members may have played a role in the management of emergencies.
d. About the different scope of the Minimum Safe Manning (MSM) document and the Muster List (ML), the SOLAS regulation V/14.1 requires that the ship shall be

sufficiently and efficiently manned, from the point of view of the protection of the safety of life at sea. This regulation makes reference, but not in a mandatory way, to the Principles of Safe Manning adopted by the Organization by Resolution A.890(21) as amended by resolution A.955(23).

e. Too often the scope of the Muster List is confused with that of the Minimum Safe Manning. In fact, while the crew designated in the MSM has to meet the STCW requirements for being appointed to specific safety tasks aboard the ship, this may not be the case for those crew members to whom the same safety tasks are assigned through the ML (and not through the MSM).

f. A combination of factors has caused the immediate and irreversible flooding of the ship beyond any manageable level. The scenario of two contiguous compartments (WTC 5 and 6) being violently flooded - thus in a very short period of time after the contact (for WTC 5 the time for its complete flooding was only few minutes) - already represents a limit condition, as far as buoyancy, trim and list are concerned, in which the order for ship's abandon is given to allow a safe and orderly evacuation.

g. The ship stability was further hampered by the simultaneous flooding of other three contiguous compartments, namely WTCs 4, 7 and 8. The flooding of these additional compartments dramatically increased the ship's draught so that Deck 0 (bulkhead deck) started to be submerged. Also, the effect of the free surface created in these compartments prior to their complete flooding (occurred in about 40 minutes) was detrimental for the stability of the ship, causing the first significant heeling to starboard, which increased more and more the progressive flooding of adjacent WTC 3. In WTC 3 the water entered from the bulkhead deck (Deck 0), through the stairway enclosures connecting such deck to Deck C. 45 minutes after the contact, the heeling to starboard reached 10°, and just before grounded 1h 09' after the impact almost 20°. Then, 15' after grounded, the heeling was more than 30°.

h. A concomitant critical factor, caused by the severe and fast income of water, was the immediate loss of propulsion and general services located in WTCs 5 and 6.

i. One of the consequences was that the various high capacity sea-water service pumps (capacity between 500 to 1300 m3/h, fed by the main switchboard only) that were fitted with a direct suction in the space where they were located, became unavailable.

j. It is noted that the rules applicable to the Costa Concordia did not require the installation of a flood detection system in watertight compartments, and that the ship was fitted, on a voluntary basis, with a computerized program capable to verify the compliance of the loading conditions with the acceptance criteria set out in SOLAS Chapter II-1. Therefore, said program was not (and was not required to be) designed to provide direct information on the calculation of the residual damage stability during the flooding.

k. The further analysis related to the sequence of the functioning of the Emergency Diesel Generator (black-out of the main electrical network, isolation of the emergency network and automatic starting of the emergency diesel generator), allowed to show that due to the high complexity of the electric production/distribution network (bearing in mind that the violent impact and the enormous quantity of water that invaded the vital parts of the ship) created critical aspects that generated uncontrollable consequences and damage, even invisible, rightly so imponderable. For this reason the connection between the Emergency Diesel Generator and the related Switchboard, which initially worked and after collapsed, and then worked forcedly in a discontinuous way.
l. Another factor that may have impaired the management of the situation was the lack of orders according to the Muster List addressing disoriented - of course - the crew assigned on the base of the Muster List, taking into account this specific emergency. Some contribution in the disorienting situation could be due also to the wireless communication system, which is not supplied by emergency power but the key persons were all equipped with PMR devices, and therefore those wireless breakdown was not influent.
m. Poor consideration can be made about the five contiguous watertight compartments, where most of the vital equipment of the ship was located, because no residual stability could have been maintained either by the Costa Concordia or any other ship. However the stability calculation and simulation showed that the ship responded to the SOLAS requirement applied to her.

Finally, after the casualty, caused by the Master in combine with his officers staff present with him on the bridge, the coordination lack in the emergency - due to not applying the related SMS procedures and not following these as the best guideline to face the serious event - resulted the main and crucial unsuccessful factor for its management. Master together with some of the staff deck officers, as well the Hotel Director, failed their role determining a fundamental influence for reaching the above mentioned fail. Moreover, spite off the DPA was continually warned about the serious development of the scenario (meanwhile the Master was in the bridge, in fact their dialogue, although discontinue, started at 21 57 58 and finished at 23 14 34), he never thought (as declared during two interviews with the Prosecutor) to speed up the Master to plan the abandon ship. This could represents an indirectly contributing factor, even if the Master minimized (till 22.27 hours) the information about the seriousness of the situation towards the DPA. In fact, this last key person should have speed up the Master, at least in terms of his own moral obligation.

It is worth to anticipate that, according with the evidences found at the end of the present investigation, Costa Concordia resulted in full compliance with all the SOLAS applicable regulations, matching therefore all the related requirements once she left the Civitavecchia Port on the evening of the 13 January 2013.

As above anticipated, the analysis and the relevant lessons learnt allowed however the identification of a series of interesting measures, for details we readdress you to chapter VI, titled “recommendations”. They regard, among other things, stability and flooding, hull, vital equipment, emergency powering, redundancy of equipment, emergency management, minimum safe manning, muster list, and so on. Some of them could represent, if accepted and brought into force in a very short time, a must to improve the safety of very large cruise ships, even for existing ship.

Those above mentioned recommendations have been made, despite the human element is the root cause in the Costa Concordia casualty.

After this investigation, there is the opportunity to deliver in the hands of the International Maritime Community some suggestions regarding as the naval gigantism, represented in this case by the Very Large Cruise Ships, to face this actually and rising wonder through to the following items should be focused systematically also in the future:

- mitigate the human contribution factor with education, training and technology;
- operate day by day directly to support the shipping industry (shipbuilding), investing in the innovation technology;
- stress all the maritime field cluster to make the maximum contribute for the related study and consequent technical research.

Therefore, the above summarized recommendations have to be considered the starting point of the action taken consequently to this extraordinary tragedy, since we believe that many other things could be done, reflecting on the deep and taking time to react more, among others, with the three suggestions fore mentioned.

In conclusion it is needless to put in evidence that the case of the Costa Concordia is considered by this Investigative Body (and we believe by everyone in the maritime field) a unique example for the lessons which may be learnt, despite the human tragedy and the Master’s unconventional behaviour, which represents the main cause of the shipwreck.

it is worth to anticipate, closing this summary, that the human element is again the root cause in the Costa Concordia casualty, both for the first phase of it, which means the unconventional action which caused the contact with the rocks, and for the general emergency management.

It is also worth to point out, moreover, that the Costa Concordia casualty is, first of all, a tragedy, where and that the fact of 32 decedents and 157 injured, would have depended only by the above mentioned human element, which shows inadequate proficiency by key crewmembers.[1]

[1] Some elements of the present report are partially extracted by the Leghorn Maritime initial Investigation and by the technical report forwarded by the consultants team appointed by the Grosseto Trial Office

2. FACTUAL INFORMATION

2.1 Ship Facts

Name: Costa Concordia

Flag: ITALY

IMO number: 9320544

Number of registration: Nr. 73 of the International Registers of the Port of Genoa

Ship Type: INTERNATIONAL PASSENGER

Identification: IBHD

Ownership and management: COSTA CROCIERE SPA

Details of construction YEAR 2006 - FINCANTIERI BOATYARDS SPA

Set keel: (to be added)

Length: 247.37 mt

Width: 35.5 mt

Height: 11.2 mt

Draft: 14.18 mt

Tonnage: 114,147 t.

Length in between pp.: 247.4 mt

Hull Material: Steel

Passenger capacity: 3780

Propulsion Type: Fixed pitch propeller

Main engines: 2

Electricity generation: Diesel Electric

Propellers: 2 fixed pitch

Thrusters: (aft 3 x 1720 KW - bow 3 x 1720 KW)

Maximum speed: 21.5 kts

Minimum Safe Manning[2]

Grade / Function	Certificate (Rule STCW)	Operating Area
		Unrestricted
Master	II / 2	1
Second Master	II / 2	1
Chief Mate	II / 2	1
Mate	II / 1	4
Chief Engineer	III / 2	1
2nd Chief Engineer	III / 2	1
2nd Engineer	III / 2	1
Engineer	III / 1	5
GMDSS Operator	IV / 2	1
Bosun	II / 4	1
2nd Bosun	II / 4	2
Able Seaman	II / 4	1
Carpenter	VI / 1	2
Plumber	VI / 1	2
Ordinary Seaman	VI / 1	1
Foreman	VI / 1	1
Motorman	III / 4	1
Fitter	VI / 1	2
Electrician	VI / 1	5
Oiler	III / 4	3
Freezer	VI / 1	1
Engine boy	VI / 1	1
Chief Purser	VI / 1	1
Doctor	VI / 1	1
Nurse	VI / 1	1
Total		**75**

[2] The present Functions are indicated as written on the Costa Concordia approved Minimum Safe Manning

2.2 Voyage particulars

Departure: Port of Savona

Ports of Call: TOULON[3], BARCELONA, PALMA DE MALLORCA, CAGLIARI-PALERMO, CIVITAVECCHIA.

Arrival (term cruise): SAVONA (destination is not reached).

Voyage type: WEEKLY CRUISE IN THE MEDITERRANEAN

Crew Composition: 1023 MEMBERS

Ship's itinerary

2.3 Information about the marine casualty

Event Type: CONTACT - BREACH - BLACK OUT

Date and Time: 13/01/2012 - 21:45

Scene of the accident: GIGLIO ISLAND - MAR TIRRENO C.LE - ITALY

Position: LAT. 42 ° 22 ', 20 N - LONG. 10 ° 55'50 E

Weather and sea conditions: ROUGH SEA - NE 4;

[3] Originally planned route Marsiglia.

WIND 17 KNOTS E-NE(Annexes 1-2-3-4)

VISIBILITY 'PARTLY CLOUDY

Ship operation: IN NAVIGATION

and part of the journey: From Civitavecchia to Savona

Part of the stricken ship: hull LEFT AFT

Consequences: VERY SERIOUS ACCIDENT:

DEAD OR MISSING: 32.

INJURED: 157 of which 20 with need for admission to hospital.

TOTAL LOSS OF THE SHIP

2.4 Search and Rescue Activities

2.4.1 National SAR Organization

Italy has adopted the Convention of Hamburg which has already been implemented since September 1994. With a special legislative measure was entrusted to the Italian Coast Guard Headquarters the task to guarantee the organization of search and rescue services throughout its own SAR region employing, therefore, the function of MRCC (Maritime Rescue Coordination Centre). The entire Italian SAR region is then divided into 16 Maritime Rescue Sub Centres (MRSC), 15 of which are part of many departments and one to the Maritime Authority - Maritime Authority of the Messina Strait. The entire national organization has men and vessels and aircraft highly skilled and sufficiently distributed throughout the journey coast of the country. The M.R.C.C. Italian, employees M.R.S.C. together with 295 U.C.G. (Coast Guard Unit) may request in case of need the assistance of vessels and aircraft belonging to all the government departments or private organizations.

2.4.2 Agencies and Departments SAR organization involved

- M.R.S.C. Department of Livorno is the element of organization that at 22:06 received the news of unspecified problems on board the cruiser Costa Concordia by Prato Carabinieri station. These were, in turn, informed by the mother of a ship passenger that reported the collapse of a portion of a room ceiling for refreshment and, also, spoke about an order given to passengers of wearing life jackets. It is the M.R.S.C. that has kept in touch with the ship and coordinated SAR operations since the casualty occurred in the SRR of responsibility. Sent its own naval units and coordinated intervention of naval and air units belonging to other Italian Coast Guard and others government and private.

- IMRCC has contributed to the planning of intervention and to coordinate vessels, aircraft and divers of the Italian Coast Guard, beside, sent his men to support the operations.

- U.C.G. Civitavecchia: as registered on books of the operations room at 22:07 (22:02:18 by VDR), contacted the C/s Costa Concordia because between 22.00 and 22.05 hours had received some requests for information relating to the same ship. Someone on Board had reported a momentary power failure and that the situation was under control. Then it has contributed to relief efforts by sending their vessels and harbour tugs under the coordination of MRSC Livorno.

- M.R.S.C. Rome has contributed to the rescue by sending its own patrol boat under the coordination of MRSC Livorno.

- M.R.S.C. Olbia: contributed to the rescue by sending their naval patrol boats under the coordination of MRSC Livorno.

- U.C.G. Portoferraio: contributed to the rescue by sending their naval patrol boats under the coordination of MRSC Livorno.

- U.C.G. Porto Santo Stefano: contributed to the rescue by sending their patrol boats under the coordination of MRSC Livorno. It also organized the transfer of the survivors (from the Island of Giglio) to Porto Santo Stefano and first identification operations and contributed to the operations of first aid.

- U.C.G. Isola del Giglio cooperated, on the island, in first aid operations to survivors and to transfer the same people to the port of Porto Santo Stefano.

- Section 1 C.G. Helicopters Luni-Sarzana: is the air base from which three helicopters belonging to Italian Coast Guard took off.

- GC Diver Unit 1: based in San Benedetto del Tronto has worked on underwater scenery with its own personnel.

- GC Diver Unit 2 : based in Naples has worked on underwater scenery with its own personnel.

- GC Diver UNIT 5: based in Genoa has worked on underwater scenery with its own personnel.

2.4.3 Naval units and aircrafts of the Italian Organization used in the early SAR operations until the morning of the day 14.01.2012.

- n. 13 Italian Coast Guard patrol boats of which;
- n. 2 patrol boat of M.R.S.C. Livorno;
- n. 2 patrol boats U.C.G. Civitavecchia;
- n. 1 patrol boat of M.R.S.C. Rome;
- n. 1 patrol boat of M.R.S.C. Olbia;
- n. 2 patrol boats U.C.G. Portoferraio;
- n. 3 patrol boats U.C.G. Porto Santo Stefano;
- n. 1 patrol boat UCG Porto Ercole;
- n. 1 patrol boat UCG Talamone
- n. 3 helicopters of the 1st Section of the Coast Guard Aircraft Base Luni-Sarzana

2.4.4 Naval and aviation units of other government departments and private companies used in the early SAR operations

- n. 7 Patrol boats of Italian G.d.F.;
- n. 3 Patrol Boats of Italian Carabinieri ;
- n. 1 Patrol Boat of Italian Polizia di Stato;
- n. 1 Patrol boat Firebrigade
- n. 1 Rhib Firebrigade
- n. 2 Helicopters of Italian Navy;
- n. 1 Helicopter of Italian Air Force;
- n. 2 Helicopters of G.d.F;
- n. 14 Merchant vessels
- n. 4 Tugs.

2.4.5 Chronology about most significant events

At 21:45:07 (VDR) of 13.01.2012 the hull of the ship, left side, crash into the rock further east of the islands "Le Scole".

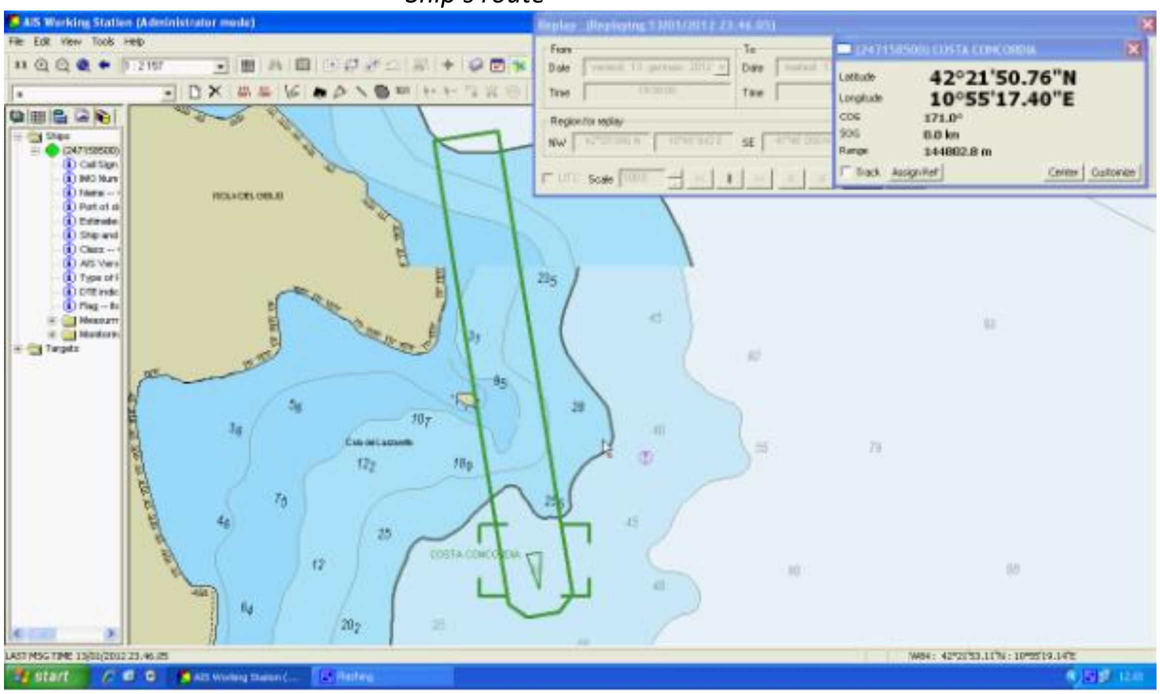
At 22:06 the M.R.S.C. Livorno is contacted by the Carabinieri of Prato (Appendix. 1) stating that they have received the phone call from the mother of a passenger who reported to make aware that on board of the ship, after the collapse of a portion of the ceiling of a room for the rest of the passengers, was ordered to wear life jackets.

At 22:14 the M.R.S.C. Livorno identifies the ship, on the A.I.S. at Punta Lazaretto (Giglio island) at the point of Lat. 42 ° 22.1 'N Long. 010 ° 55.32 'E . The SAR authority contacts the cruiser that reports to have a blackout for about 20 minutes, without

formalizing any request for assistance, though the Master on 22:00:57 makes already aware that three adjacent compartments flooded (compartments 5, 6 and 7).
At 22:16 MRSC Livorno orders the immediate displacement of the patrol boat G. 104 of the G.d.F., in this area for other reasons, in order to verify the current situation. It 's the first emergency naval unit to reach the point, at 22:39. The same unit will then be appointed O.S.C.
At 22:25:15 (VDR) the Master of the ship, contacted by MRSC Livorno, communicates that the ship has a hull breach, on the left side, that is causing a gradual heel, that on board there are dead or injured people and he only requires the assistance of a tug. At this point M.R.S.C. Livorno is ready to take on the situation of emergency to operate in the operational situation now ongoing: from Porto Santo Stefano leaves the SAR unit "CP 803", and are alerted crews of all dependents SAR patrol boats. Is decided to hijack in zone all ships can provide assistance and identifies, through the A.I.S, ships ALESSANDRO F. "and" GIUSEPPE SA ".
22:36:34 hours (VDR) the ship is contacted again by MRSC Livorno. The bridge communicates moreover that heeling is increasing, and only after the same stresses MRSC, declares to be in distress. He notifies also, to have on board 3208 passengers (in reality 3206) and 1023 crew members (in each case in a different number from that stated at the Port of Civitavecchia on departure: 3216 passengers and 1030 members of crew). Following, therefore, MRSC Livorno orders, in sequence, the intervention of rescue units as well as the employment of two tugs from Civitavecchia (will be added subsequently one more tug coming always from Civitavecchia and a fourth coming from Piombino). After this, MRCC Rome announced the activation of the Operations Centre of Civil Protection in Rome.
22:39 hours The patrol boat "G. 104" of G.d.F. informs MRSC Livorno to have come alongside the vessel that looks visibly down by the stern, reporting back at 22:44 that the ship is resting on the starboard side on the bottom, the weather conditions are good.
22:45:08 hours (VDR) MRSC Livorno contacts the Master of the ship which affirms that the unit is still floating and trying to manoeuvre in order to bring the ship to the shore and at anchor, even though it really is not able to control neither propulsion nor rudder. Comes from the Giglio island, on the instructions of local UCG, the passenger ship "Aegilium." meanwhile also converge in the area the SAR patrol the UCG of Portoferraio, a patrol boat of the State Police and MRSC Livorno order take-off in the helicopter operational readiness of the Coast Guard from the base of Luni-Sarzana.
22:54:10 hours (VDR) Through the "Publ address system" is communicated the "Abandon ship order" (solicited to the ship by MRSC Livorno).
22:55 hours UCG Civitavecchia receiving a communication from the local State Police who reports that the ship is launching the lifeboats with passengers on board (in fact, the operation is already in place for some time as evidenced by the fact that at the same

time the M / V "G. 104," warns the M/n "Aegilium" to pay attention because there are already three lifeboats in the water).
22:57 the FCC communicates to MRCC Rome that the abandon ship has begun .
22:57:41 hours (VDR) The Master of the Costa Concordia inform the MRSC Livorno to have ordered the abandon ship.
22:58 M/n Costa Concordia is practically still in its final position. Point of sinking in position 42° 21'50 .76 "N 010° 55'17 .40" E (Isola del Giglio - Cala del Lazzaretto).

Ship's route



23:10 hours the patrol boat "G. 104 "tells MRSC Livorno lifeboats begins to move and heads for the harbour of Giglio island , the liferafts, however, are towed by the SAR UCG Porto Santo Stefano and placed alongside the ferry" Aegilium ".
Other vessels converge in the area.
23:35 hours MRCC Rome contact the FCC who announced that the abandonment is almost complete.
23:38 hours MRSC Livorno contact by phone the ship's Master that reports to suppose there is still on board the presence of about 200/300 people including passengers and crew. This value is confirmed (300/400), from the M / V "G. 104 ".

<u>14.01.2012</u>

At 00:00 the scenario changes. In fact, the ships starts to list on the right side and the list becomes such as to create significant difficulties in embarking on life-saving appliances on the left side, thus creating three large groups of people (bow, centre and stern of the ship) . In view of the simultaneous presence of shipwrecked at sea and the need to search and recover even within the now submerged part of the ship, Livorno MRSC dispose the activation of the divers teams: UCG Civitavecchia Patrol reports that the "Buratti" (G. 200) of GdF., arrived in the area of the accident, has two divers on board, and also requires the activation of the local fire brigade divers as well as those of the Coast Guard.

00:18 hours the OSC informs about the presence of a hundred people on the left side of the ship. Three minutes after it reports that several passengers, in a panic, began to jump into the water and orders that the rescue units proceed to pick them up; MRSC Livorno orders all vessels engaged in rescue operations to put their liferafts at sea in order facilitate the rescue of survivors. Meanwhile, two patrol boats (CC 711 and CC272) are sent on the starboard side of the ship to see if there are any survivors in the water between she and the coast.

00:27 hours given the presence of multiple aircraft in the operations area and its narrowness , MRSC Livorno appoints helicopter "Koala 9.9" Coast Guard "Coordinator of the air traffic", which will be replaced in that duty (04:10 hours) by HH3F Air Force helicopter.

00:34 hours MRSC Livorno contacts , after several attempts, on the mobile phone, the Master of the Costa Concordia, which refers about the landing of all persons on board. To the requests of clarifications relating to what is happening on the left side, the Master declares to be found along with a sailor on board a lifeboat on the opposite side; he also reports that it is engaged in the recovery of some survivors. When asked to know who has remained on board to coordinate abandon ship operations , he replies that the entire crew has landed.

00:36 hours the patrol boat "G. 104 " communicates to MRSC Livorno that there are at least 70/80 people on board the ship, including elderly and children, and this information is confirmed by an helicopter that also refers about the presence of other people at sea.

00:41 Hours The FCC calls MRCC Rome in order to ask for assistance as it considers the actual situation very critical of the ship being completely listed to the right side for 90 °, about 50 people are no longer able to leave the ship, and considers the intervention of helicopters also announces that - except for a person - he has no news about injuries and that the Master is not on the ship.

00:42 Hours MRSC Leghorn contact the ship's master who says that there seems to be a hundred passengers on the ship; MRSC Livorno strongly urges the ship's Master to go on board with the other officers to coordinate the disembarking passengers still on board .

00:53 begins the evacuation / rescue of people still on the ship by helicopter and continue the rescue of the survivors with the help of the media occurred in the area.

01:35 hours the OSC updates MRSC Livorno about the situation and report information gathered by a passenger who reported that on board there are still about 400 people assisted by crew members that coordinate the disembarking on the port side.
02:00 am the patrol SAR "CP 892", as requested by MRSC Livorno, takes on board the first team of seven fire-fighters with thermal cutting equipment (to release any people trapped inside the ship). This team will be joined by two other similarly equipped.
03:44 hours is estimated to have still on board the presence of at least 40/50 people.
04:20 hours the OSC updates the situation, it is in progress the disembarkation of people, through the aft side ladder of people still on board, collected by the M / V SAR "CP 305", no additional transfers by winch, are on board, on patrol, three fire-fighters and two Coast Guard specialists rescuer.
04:30 MRSC Livorno orders that a motor lead aboard the Costa Concordia, the Safety Officer, Mr. Pilgrim, with a team of fire brigade to assist the rescuer in the search for the missing people.
05:15 another team of Fire Department boarded the ship to see if there are still people trapped on board and recovered shortly after, two traumatized.
06:17 hours the first rescuers suspend search operations on the ship. Subsequently the research on board will continue seamlessly. The Fire Department will coordinate the exploration of the ship, both in the emerged and immersed part of the ship, in searching for missing people.. MRSC Livorno, however, will continue until 25 January the search at sea, on increasingly large areas, based on the calculation of the drift due to the current.
Finally, the rescue operations, between the send time of the first patrol boat at 22:16 of 13.01.2012 and the moment in which all persons visible and immediately reachable were landed (hours of 06:17 14.01.2012), were conducted with the use of the rescue means referred to in paragraphs 2.4.3 and 2.4.4.
The data, then corrected, supplied by the company indicate that there were on board the vessel at the time of the accident 4,229 people, including 3,206 passengers, as follows:

- 2954 adults;
- 200 children (under 12 years);
- 52 babies (under 3 years);
  (19 of which are in need of assistance)
- 1023 crew.

At 22:57, as described above, and began to abandon ship with the launching of survival crafts. The lifeboat reached the port of the island of Giglio own rafts while you were towed by the media in attendance.
The people present at the stern and amidships reached emergency vehicles through a boarding ladder placed the stern , at the base of which did alternate patrol boats of the Coast Guard "CP803", "CP868" and "CP305" for the rescue of survivors and their subsequent transfer to the survival craft or other units for landing in the port of the Giglio island. since it was not possible to be able to fix in safety to the hull of the ship, patrol

boats were alternated in the operations of disembarkation of passengers performing a particular manoeuvre where it was expected the use of a unit class 300 (M / V SAR "CP 305" of UCG Civitavecchia) used as a "platform", held adjacent to the hull of the ship by a class 800 patrol boat , which alternated in the task and transferred the survivors of other units for the subsequent landing in the port of Giglio.

Some people in the bow area that were in hardly accessible places were recovered by Navy (2 people) and Coast Guard helicopters winch (16 people).

The survivors rescued by helicopters landed at the military airport of Grosseto.

People launched at sea were saved by rescue units. Three of these were recovered lifeless by units of the Coast Guard, G.d.F. and Police.

During the disembarking operations of the survivors were released from helicopters on the ship two air rescue specialists of the Coast Guard that, beside providing for the evacuation of some people by helicopter, sent the survivors to the only escape way and that was the boarding ladder stern. Staff of the Fire Brigade, however, came on board with the help of the patrol boats.

In the following days continued the search and rescue operations with the use of divers team of the Coast Guard, Police, Navy and Fire Department. The search of any further survivor at sea continued with the patrol boats of the Coast Guard and of the other government departments that have contributed in the rescue operations as well as by helicopters.

The surface searches for the identification of possible survivors ended on 25.01.2012 and continued those inside the ship and the surrounding seabed .

January 15th have been recovered by divers of the Coast Guard two dead bodies in the corridor leading to the boats of the bridge 4. Fire brigade personnel have rescued two passengers Koreans alive inside the bridge 8 and a crew member wounded.

On January 16th, the Fire Department have recovered the body of a passenger in the corridor of the second deck of the bridge, in front of the booth No. 2422.

On January 17th, are recovered by Coast Guard divers five bodies, a member of the crew and four passengers, in the aft elevator of the bridge 4.

On January 21st, the body of a passenger is recovered by divers of the Coast Guard in the corridor leading to life rafts to the bridge 4.
On January 22nd, is retrieved by the Fire Department the body of a passenger inside the cabin n ° 7421 of the bridge 7.
On January 23th, are recovered by divers of the Coast Guard, the bodies of two passengers by the deck 4 near the stairs connecting the bridge 3.
On January 24th is recovered, by the Fire Department, the body of a passenger at the end of deck 3 starboard side .
On January 28th, is retrieved by G.d.F. the body of a member of a crewmember outside the cabin n ° 8389 of deck 8.
On February 22nd, are recovered from Fire Department 4 bodies, all passengers, inside the elevators in the atrium of the bridge 4.
On February 23th, are recovered by firemen four bodies near the elevator at the bridge 4.
in the afternoon of March 22, during an exploration with the ROV in prevision of the opening of a new passage in the hull, have been found, including the ship's hull (deck 3) and the bottom, the bodies of five victims. The five bodies, four passengers and one crew member will then be retrieved March 26 by the Navy.

The final budget of the victims is, therefore, 30 people deceased and two bodies still missing as follows (Annex no. 5 decedents details):

number	age	gender	passenger	crew role	crew procurem ent services	status
1	6	F	X			DECEASED
2	37	M	X			DECEASED
3	79	F	X			DECEASED
4	25	M	X			DECEASED
5	49	M		0	X	DECEASED
6	30	F	X			DECEASED
7	30	M			X	DECEASED
8	67	M	X			DECEASED
9	72	M	X			DECEASED
10	30	M			X	DECEASED
11	70	F	X			DECEASED
12	69	M	X			DECEASED
13	52	F	X			DECEASED
14	60	M	X			DECEASED
15	70	F	X			DECEASED
16	70	M	X			DECEASED
17	39	M	X			DECEASED
18	23	F	X			DECEASED
19	86	M	X			DECEASED
20	72	F	X			DECEASED
21	62	M	X			DECEASED
22	70	F	X			DECEASED
23	32	M			X	MISSING
24	72	F	X			DECEASED
25	71	F	X			DECEASED
26	71	M	X			DECEASED
27	35	F			X	MISSING
28	67	F	X			DECEASED
29	50	F	X			DECEASED
30	49	F	X			DECEASED
31	60	F	X			DECEASED
32	73	M	X			DECEASED

2.4.6 Achievements

A total of 4197 people were rescued. Among these, about 1270 were rescued by the rescue units intervened directly under the coordination of MRSC of Livorno. In particular, the rescue units of the Coast Guard showed the following data:

- around 545 people transhipped from the Patrol Boat CP 305 and transferred to the port or bigger supporting rescue units;
- About 235 people gathered at the time of descent o board, thanks to the deployment of the liferafts provided (Patrol Boat CP 803, CP 868, CP 892 and CP 530);
- 80 people on board the Costa Concordia liferafts were tugged
- 16 people were rescued by helicopters;
- 4 people were rescued from the sea.

It is estimated that the remaining approximately 2930 people have abandoned the ship on the survival craft (boats and liferafts) and reached autonomously the coast.
The survivors were taken on the Giglio island and assisted by rescuers, including civil protection arrangement activated by the Mayor and the local population has also made available its own private homes. It was given adequate first aid under the coordination of the Prefecture of Grosseto (Provincial Civil Protection Authority).

2.4.7 Considerations on the measures taken and the ability to react after the event acknowledgment

Despite the criticism and reticent behaviour of both the staff of the ship and the Company, which did not provide immediate and complete information about the real emergency situation in which the ship was to the competent SAR Authorities persevered, among other things, to provide subsequently information not entirely true, and thereafter did fail to guarantee to passengers and rescue coordination authority that indispensable support that only the commanding staff of the ship is ought to give in such circumstances:

- First of it is worth to put in evidence that Italy manages, through his MRCC, the SAR exercise scheduled plan for each year, covering the national and international obligations on the reference according his own policy on SAR mission. In 2011, for instance, Italy carried out 1 International exercise in the Catania MRSC, and 7 national exercise. All the complex drills involved passenger ships, an one of these even a cruise ship. All the simulation were for serious emergency after a contact between two ships;

- The operational capacity of MRSC Livorno proved to be adequate to manage the coordination of operations;
- The development of the information held for the definition of the operational scenario was successful, and the intervention reaction was carried out without delay;
- The SAR procedures in force at national and local level have proved satisfactory and complete also with respect of alerting other State agencies and private vehicles involved in the operation;
- The exchange of information between MRSC Livorno, MRCC Rome and the other MRSC / UCG and with the resources made available by other government departments and private individuals was fast and efficient;
- The location and the number of specialized units for the search and rescue was sufficient to address the emergency;
- Only thanks to the intuition, the capacity and professionalism of Coast Guard personnel, that by their initiative has however alerted and then activated the rescue operations, that the casualty in question has not led to worst consequences;
- A total of 23 lifeboats out of 26 and 6 liferafts out of 69 were used and allowed rescue of survivors. While the lifeboat reached the shore and ferried persons over there, liferafts were tugged to transfer people on the Ferry “Aegilium”. Around 2/3 of those total people on board have been saved by the life saving equipment belonging to C/s Concordia;
- People who delayed to leave the ship because they were not gathered on time for disembarking - due to short time available for arranging the abandon ship when the ship was not heavily listed - disembarked themselves by the only two embarkation ladders available on board (stern and bow positioned). Those two are in compliance with reg. III/11.7 - Solas 74 as amended, but not enough in this case (heeling > 20°), since the alternative hydraulic devices, that should have replaced those fittings, didn’t run due to the heavy list.

3. NARRATIVE

INTRODUCTION

The C/s COSTA CONCORDIA left Civitavecchia port at 19:18 hrs of 13th January 2012 heading to Savona with 3206 passengers and 1023 crew members.

The staff on duty on the bridge is made from 1 Deck Officer, holder of the duty, from the 2nd Deck Officer (alongside the 1st to handover), from the 3rd deck officer, an Apprentice and the Helmsman.

At 21:00:10, in position 42 ° 18'25 "N - 011 ° 10'48" E (230 ° detection of Punta Secca del Giglio island at a distance of 4.2 miles), and is following a route of 302 ° at a speed of 15.8 knots.

At 21:03 the ship starts a series of yaws to the left ending at 21:11:35 in position 42 ° 19'18 "N 011 ° 06'57" E where route takes 279 ° and a speed of 16 knots, the bow of the ship is directed to the Giglio island.

At 21:19:02 the 1st Deck Officer contacts by phone the Master, as per the instructions given after the departure from Civitavecchia, informing him that are to stay at 6 miles from the Giglio island and that will reach the beam at 21:44.
According to the course planned before departure and speed assumed the ship would reach the point of turn fixed to pass the island of Giglio near the coast at about 21:39.
It is noted that on the bridge are also present the Chief Purser, the Metre and the catering services Manager.
At 21:34:36 the Master comes on the bridge and orders the helmsman to move the rudder in manual mode.
At 21 36 02 the 1st Deck Officer ordered the helmsman to come alongside for 285 and 290 degrees after about 1 minute.
From 21 37 11 to 21 38 47 Master is engaged in a phone conversation with a person and ask him about the safe distance from the coast of Giglio there is a safe depth enough to pass, he replies that it is safe till 0,3/0,4 miles away from the island.
At 21:36:35 (VDR) Masters orders to set on radar a distance circle of 0.5 miles.

At 21 39 14, with a 290 heading, the Master takes the command of the watch.

At 21 39 30 with **speed 3.15** Master orders the helmsman to go for 300 , and at 21 40 00 orders to **increase to 16 knots** and then to pull "gently" to 310 °.

Till this point the ship is still on the course as planned and the radar displays a VRM at 0.5 miles. The bow heads towards "Punta Capo Marino" and the ship proceeds, at a distance of 1.35 miles and a speed of 15.4 knots.

The Master now gives orders to the helm for "bows" moves away from the planned course, starting a yaw to starboard wider than planned, thus approaching Giglio island.
At 21:40:48 the Master orders, in English, ***".. 325 .."*** the helmsman answers, to confirm the order ***".. 315 ..",*** the First Deck Officer intervenes to correct the interpretation of the helmsman but pronounces ***".. 335 .."*** then the Master reiterates its order ***".. 325 .."*** and then the Helmsman confirms ***".. 325 ..".***
The ship is at about 0.5 miles far from the coast.
The data show that VDR when the VRM circle "touches" the shore is going to be deactivated.
At 21 42 07 is ordered 330 and the helmsman answered correctly.
At 21 42 40 Master sends the 2nd Officer on the left wing, the speed is about 16 knots.
At 21 43 08 is ordered 335.
At 21 43 33 is ordered 340.
At 21 43 44 the speed is 15.9, the Master orders, always in English, ***".. 350 ..",*** the helmsman does not confirm properly (it repeats 340) and the order is confirmed again, specifying the side ***"starboard"*** and warning that otherwise would end up on the rocks (taken from video recordings of the VDR to 21 43 46 the bow is oriented to 327°)

The turn is still in progress when the ship is at 21:44:05 in position 42 ° 21'05 "N 010 ° 56 'E, with the bow in the direction of "Le Scole " at 0.3 miles and a speed of 16 knots.
The turning radius is such that the ship is located 0.5 miles SW of the planned route so much closer to the coast than planned.

From this moment the Master starts giving orders no more for bows but for rudder angles and in sequence gives:

- 21 44 11 Starboard 10 (ten degrees to starboard);
- 21 44 15 Starboard 20 (twenty degrees to starboard);
- 21 44 20 hard to starboard (rudder fully starboard);
- 21 44 36 mid ship (centre) - the bow is less than 150 meters from Scole rock, while the ship is off the planned course by more than 809 meters.;
- 21 44 43 port ten (ten degrees to the left), but the helmsman reaches only 5 degrees to the left;

- 21 44 45 port twenty (twenty degrees to the left) after this order the helmsman heads erroneously to starboard to correct himself and go alongside to port as requested by the Master, and then pulling again to the left as requested by the master, but spend about 8 seconds for the correction of the manoeuvre;
- 21 45 05 hard to port (rudder to the left). the helmsman runs correctly.

The Second Deck Officer from the left wing warns that the left side is gone aground, a second later it was heard a loud crash.
At 21 45 07 the ship collides into the rocks. The speed decreases to 8.3 knots, loses propulsion of the two engines, and adrift proceeds with direction of 350 °

Master realizes to have collided with a rock, orders the closing of all watertight doors and aft, in 30" from 21 45 33 to 21 45 48, then orders the helmsman to give all the rudder to the left and after an initial misunderstanding between him, the First Deck Officer and the helmsman, this one confirms the order. At 21:45:48 (VDR) Master orders the helm to the centre and the pilot run correctly.

At 21 45 58 VDR communication audio in-dash highlight the Black Out, pumps rudders remain without electricity.

At 21:46:05 the emergency generator that provides power starts only for 41 seconds. In fact, from this moment onwards the emergency generator is not able to provide electrical power with continuity for ship's essential services , in particular the rudder and the bilge pump .

At 21:46:01 the Master orders rudder to starboard, the Helmsman confirms; subsequent orders given by the Master 21:46:43 - 21:46:46 midship and hard to starboard) even if executed will not have effect for the power failure of the steering pumps by electric energy emergency, the two rudders of the ship remain definitively without control to starboard.
The emergency batteries start but they provide only the emergency lighting and systems of internal communication.

Immediately after the crash, all the Officers go to the bridge.
Alarms for rudder failure , the balancing system of the ship and of the propulsion start; crew goes to the lower decks to check the damage and found that, after only 6 minutes by the impact, there is the presence of a waterway in two adjacent compartments which affected the workshop, the engine room, the main switchboard and the emergency switchboard. The water has reached the bridge A, and the ship lists to the left side.

At 21:52:32 the Chief Engineer orders to the Electrician Officer to start the EDG but there are problems but also to the emergency power grid that should take over to the supply of connected users. In fact, the emergency switchboard does not lock automatically to the EDG. Therefore, the crew makes some attempts by acting manually (with the use of a screwdriver) on QEE to urge the link and the connection with the DGE to the emergency power grid .
Such a "mechanical" remedy , which is repeated three times, is problematic and produces a discontinuous result due to non-operation of the cooling system of the generator, due to damage to a cooling fan, which produces the activation of the safety system of the motor on '"high temperature" water; consequently the motor stops each time.

At 21:54:47 is announced a blackout on board, passengers will be reassured that the situation is under control and that the technicians are working to restore the functionality of the ship.
At about 21:55 the Deputy Chief Engineer comes in the SCP (Electric Engine Control Room) and verifies that the local PEM (local electric propulsion engines- compartment 5) is flooded meaning therefore that the compartments flooded are at least 3 (WTC5, WTC6 and WTC7). This situation is communicated to the bridge.

The ship, in accordance with SOLAS requirements, it can withstand flooding of two adjacent main compartments. However not contact the SAR organization i made in order to inform about the situation.

The instrumentation of the bridge is almost entirely in function thanks to the dedicated batteries (UPS) that can guarantee a certain degree of independence, the computer software used for the calculation of stability (NAPA), despite the dedicated UPS, is not working and the crew will try to re-activate it.

At 21:57:58 the Master has a first telephone contact with the Company and reports to the Fleet Crisis Coordinator that the ship hit a rock with the left side towards the stern, reports the dynamics of the casualty, adds that the propellers were not affected and is being assessed for damages, also announces that the ship is in blackout and that water is entering the stern that has reached the main electrical panel.

The Fleet Crisis Coordinator, received this information, incorrectly identifies the flooded local in that of the principal electrical engines (local PEM - compartment 5) and not in the compartment 6, where are positioned instead the DGs and the main electrical panel, and refers the information to the Technical Inspector of the ship which is located at the headquarters of the Company. The latter, who is not informed instead about blackout, suggests that the vessel, with the use of the propellers of the bow, approaches to a shallow and give the anchor to assess the damage.

At 22:07, the ship contacted by the Operations Room of the Civitavecchia Harbour Master, refers only to have a black-out, but that **the situation is under control.**

The 1st Deck Officer and the Deputy Chief Engineer during the inspection meet at the bridge 0 and continue inspection of the watertight compartments. Arrived at the bridge A to verify that there is a leakage of water from the water-tight door 24 and then deduce that the 4 compartment is flooded.
Therefore, the flooded compartments appear to be at least 4 (compartments 4,5,6 and 7)

At 22:05:27 the Fleet Crisis Coordinator receives reassuring information from Master which also reports that he had informed the Port of Civitavecchia to have suffered **only** a blackout.

Meanwhile SAR organization received different news about the situation of ship emergency . In fact, several passengers have informed their relatives or acquaintances on shore that have in turn informed the Police and the Coast Guard.

At 22:10 The Fleet Crisis Coordinator contact the ship Technical Inspector again informing him that the ship is in black-out and there is water even in the stern generators room.

At 22:10:36 the NAPA (Software stability) is running and will operate the Radio Officers and 3rd Deck Officer. Its operation, however, is not constant.

At 22:18 personnel in the ECR realizes he has lost all automation and that no system (balancing pumps , bilge, masses, etc..) can be put into operation. The data is reported to the bridge.
At 22:11 the ship is practically motionless (0.3 knots), begins then to drift and to shift the bow to starboard, heading SW for the combined action of wind, NE, and rudder positioned all to starboard.

At 22:12 the ship is identified by the OR in position 42 ° 22'24 "N - 010 ° 55'36" E - P.ta Lazzaretto near the island of Giglio; contacted by VHF, Safety Trainer reports that the unit is in "black out" and some checks are in progress; does not prompt other assistance.
Between 22:10 and 22:15 the list goes from the left to the right side.

At 22:18:19 Master refers by phone to the Fleet Crisis Coordinator of the Company that there are problems with the emergency diesel generator, also reports that there are at least two compartments flooded, those of diesel generators (compartments 6 and 7); aware of not having propulsion, he assumes that the ship can survive with only two compartments flooded.

Despite the serious actual situation (at least two compartments flooded, lack of propulsion, lack of power from the emergency generator and the failure of the bilge pumps) has not yet been given the general emergency and so far the Company has not made direct contact with the national SAR organization.
At 22:20:45 Master is updated about the flooding that affects the PEM, the main engines and stern generators one, two and three that is the compartments 5, 6 and 7.

At 22:22:22 the ship contacts the operations room of Civitavecchia Coast Guard asking the assistance of two tugs due to a breach, it is reported that the situation is under control thanks to the compartmentalization of the ship. Indeed,/0} correct information about the **actual situation** of flooding are not provided, stating simply that the situation is currently being assessed, that there are no injured or missing people and is necessary only the intervention of one tug.
At 22:26:38 the Master - worried - contacts by phone the company updating it on the actual situation.

At 22:28:36 the 1st Engineer to the motors reports to the ECR that there are cooling problems to the Emergency DG . The cooling fan motor DG water is stuck, the temperature is 110 °.

The news is passed to the bridge, while the Chief Engineer at 22. 29. 27 order to staff present in DG Emergency room to re-start it.

At 22:29:24 the Chief Engineer reports to the bridge that the board power, the communications, and the Martec system (Software that manages the controls for emergency breach and fire) are out of service.

Meanwhile, the water continues to rise and flood through the fire doors at deck Zero, has also passed the aft elevators, kitchen and buffet preparation area .
At 22:30:08 some passengers enter by themselves on lifeboats even though the bridge has not yet been announced neither the abandon ship order, nor the general emergency alarm.
At 22:30:07 the Chief Engineer, suggests to the Master to abandon ship.
At the same time in the Engine area, the Chief Engineer suggests to leave the Deck 0 (where the ECR).The Safety Officer agrees, but first asks the Master, which replies to still wait. At 22. 31. 33 engine staff, in clear danger, leave the ECR with the permission of the Safety Officer and moves to Deck 4.
At 22:33:26 the *"general emergency"* alarm is raised.
Ads are then issued in order to reassure the passengers, saying that the situation is under control

At 22:35:53 the Master decides to *"abandon ship".* The Master orders special instructions to the Cruise Director about the ad and, after , at 22 36 05, he makes the first announcement communicating to the passengers to go to the muster station.

At 22:36:34 the ship contacted again by the OR of the Leghorn Coast Guard station announced that the list is growing and declares "DISTRESS".

The OR of the Coast Guard station orders the intervention of rescue units.
At 22:36 the FCC of the Company, contacted by the Operations Room of the General Headquarters, reports that the ship had collided with a rock that caused a breach which resulted in the flooding of some compartments, since the ship is close to the coast of the island, the Master is considering whether to evacuate the ship, adding that passengers are kept informed of the situation and that the ship has a list of about 5 degrees.

At 22.40 the ship that is resting on the bottom with the right side, launches "DISTRESS" through the INMARSAT "C".
At 22:45:08 the master refers to the OR that the unit is still floating and that he is trying to manoeuvre to bring the ship to the shore and at anchor, even though it really is not able to control neither propulsion nor rudder.
As disposed by the Maritime Authority the Portoferraio SAR patrol boat, a State Police patrol boat, a Coast Guard helicopter took off from the base of Sarzana and the passenger ship "Aegilium" from the Giglio port converge in the area.
At 22:47.22 Master orders to drop the anchor. This operation is problematic, because initially the starboard anchor in fact stops with two chain shackles veered away, without reaching the bottom, and only then when the left anchor is veered away , re-starts to run at the same time the starboard anchor chain .At 22. 48. 04 the Master orders to the Second Master /1} to abandon ship from the right side. The Second Master coordinates from the bridge the communications transferring them the Trainer Officer that is instead the coordinator for the launching of the boats from the muster station. At the same time the 1st Deck Officer and Second Master , together, ask the Master to raise the abandon ship signal. The Master hesitates, because he is expecting that the second anchor is into the sea and engaged.

At 22. 48. 32 the 1st Deck Officer reads the inclinometer, constant 11 ° to starboard.

At 22 .49. 57 Second Master orders to prepare the first lifeboats at starboard side.

At 22. 50. 08 Master order lifeboats at sea 1,3,5,7.

At 22. 51. 15 Master informs the bridge to raise abandon ship order, and then urges it, but when asked to make the announcement he points out that it should be said, ***"Let passengers on shore."*** rather than that.

At 22. 53. 24 Master asks to the Second Master if the VDR recordings were downloaded but there isn't is not an understandable answer .

At 22:54:10 the Second Master through the "public address system" communicates the ***'"Abandon Ship"*** in English.

At 22:55 the ship begins to drop lifeboats carrying passengers. The Master will report to have evaluated to drop into the water the starboard side lifeboats before so that removing weight on that side, ship could reduce list..

To 22.57 The Fleet Crisis Coordinator contacts the OR and said that the ship, with a heel of about 12 ° and a flood of more than to two compartments, began abandon procedure.
At 22:57:41 the ship also contacts the SO via VHF to report that it has begun, as a precaution, to evacuate the passengers to make them reach the shore.

At 23:10 the first lifeboat lowered from the ship began to move toward the port of Giglio, while the rafts are towed by Porto Santo Stefano SAR patrol boat and approached by the ferry "Aegilium."
Other vessels converge in the area.
At 23 11 24 the list of the ship is higher than 25-30 °.

From 23. 11. 54 to 23. 14.34 the last call elapses between the Master and the Head of the Crisis Unit. Master talking about the incident describes a scenario less serious than the reality. Indeed, despite being just been reported severe heel (which may already be greater than 40 °), he refers to the DPA only 20 °.

At 23. 16. 36 Master says to take the radios and everyone has to go to the bridge lifeboats.

At 23. 19. 30 Master orders everyone to go on the external bridge . This is the last communication that the Master recorded the VDR. Till that moment were present on the bridge t: the 2nd Deck Officer, the Chief Purser, a member of the Logistic Department, the 3rd Deck Officer, Second Master.

At 23:19:34 the bridge was abandoned except for the Second Master that stays to coordinate the evacuation. His last communication was recorded at 23 32 55.
At 23.32.56 the Bridge is abandoned.
At 23:38 are still on board of about 300 people including passengers and crew.
At 24.00 the ship accentuates the list to the starboard side and several passengers on the same side, continue to disembark. Many passengers, who jumped into the sea or got off from a boarding ladder, are rescued by patrol boats.
At 00:36, there are about 80 people on the ship while the Master is no longer on board but on shore.

At 00:42 the Master refers to the OR to be, with other officers of the ship on board a lifeboat, the OR invites him to climb on board with the other officers to coordinate the disembarking operations of the passengers.
At 01:11 the Master, contacted by OR explains to stay on the island and that he was somehow forced to disembark, going on one of the boats, because of the high list of the ship, otherwise would have slipped into the sea.
At 1:46 the OR contacts the Master ordering him again to go back on board and provide a situation report.
At 2:53 the staff of the G.d.F. patrol boat "G.104", which took place in the rescue area, comes on board the ship to perform some checks on the number of people still on board; at the same time informs the OR that the Costa Concordia Master is reaching the nearby port with a lifeboat.
At 3:44 there are still on board a number of persons between 40 and 50.
At 4:22 there are still on board around 30 people.
At 4:39 the patrol boat of the G.d.F. "G.104" reports that the ship is in position 42 ° 21 '.36 N - 010 ° 55' .12 E, at a depth of about 27 meters.
At 04:50 Costa Cruises provides a list of passengers and crew on board which shows that there were 4754 people.
At 6:14 on board there are still 30 injured passengers .
At 6:17 rescue operations connected with the evacuation of the persons on board were declared completed.

At the time of the accident there were on board 4229 people, of which 1023 crew and 3206 passengers, among which 2954 adults, 52 infants and 200 children less than 12 years old.
Abandon ship, assistance and first aid operations have allowed the rescue of 4,197 people.

Passengers and crew sheltering/recovering operations, in the Giglio Island, were made thanks, first of all, to the aid of the overall Authorities and inhabitants. On the early 14th morning, the identity verification of each passengers and crewmembers was taken in place by the SAR Authority, supported by the Company and other Authorities, on departure from Giglio.
Some passengers claimed about the shore side reception, which was inadequate according with their opinion, because they caught an overall disorganization. We respect their thought/opinion, evidently, they ignore to have approached in an little island, where the inhabitants are less than the persons arrived by the Concordia; that’s why the support for those passengers, disembarked above all before midnight, could not match their expectations.

After, 157 passengers claimed for their own injuring.

The rescue operations continued and on 22nd March the last victim was found. Unfortunately in the casualty 30 people were found dead and a further two people are still missing. The number of victim is 32, and 2 of these are still missing (one passenger, one crewmember). Total deceased are 26 passengers and 4 crewmembers.

Environment operations took place immediately with the recovering, ending on the 24th March 2012, a quantity of 2042.5 mc oil spill.

Caretaking of seabed is still underway, as well as preliminary wreck recovering operations, which started last June.

4. ANALYSIS

PREAMBLE

This IB planned its investigation first of all sending immediately two investigators to the Giglio island.
Since the wreck was not available, it has been evaluated to carry out the investigation, as well, using the first sister ship in the area. In fact, in the first days of February the investigation team embarked on Costa Serena and begun its investigation plan for several months.
Furthermore, as it is drafted later in some of the following chapters, a specific investigation was carried out on board of Costa Favolosa by the end of November 2012, since it was the first available sister ship without any passenger on board by the time when the VDR data were released from seizure.

4.1 Ship Organization

The present chapter concerns about the human factor, describing and assessing the branch of the ship organization linked with the on board duty; the chapter connects, as well, the application of the rule for the ship management with the actions indeed carried out by the crew, during the crucial phases of the present casualty. The following scheme summarizes the activities which will be described in the following paragraph.

Main chronology	***Activity***	***Reg. Ref***	***Requirement***	***ISM procedure***[4]
On board Organization	Crew List Minimum Safe Manning	SOLAS (em 99-00) CV/R.14 DPR 435 Art.201 C.N. Art 317 R.C.N. Art 426	Minimum crewmembers must be on board to ensure the safe of the life at sea	P5.01.02.01 IO 01 SMS – Recruitment and selection of deck and engine personnel
On board Organization	Seafarers' and personnel' certification and related familiarization with the own tasks	STCW R.I-14/A-I 14 A-V/3/A-VI/1-2 ISM 6 SOLAS (am 99-00) C II-2/R.15 SOLAS (am 2006) C III/R.19	The Company must ensure that personnel employed on board obtained own certification in compliance with the STCW and the Domestic requirements. Moreover, the Company ensure that the related familiarization for their duty and for tasks linked with an emergency	P5.03.03 MAN 1 SMS "Training of the crew" P5.01.02.01 IO 01 SMS – Recruitment and selection of deck and engine personnel

4 Annexes from 6 to 10

On board Organization	Training and drills	DPR 435/91 Art 232 – 233 SOLAS (am 2006) C.III/R.19 SOLAS (am 96-98) C.III/ R.30	a) un appeal for drill referred to the lifeboat, towards the crew, must carried out before the departure, when ship leaves to a long international voyage; b) a drill referred to abandon ship must carried, as soon as possible, at least once for a week; c) each lifeboat must be lowed at the sea and manoeuvred, by the assigned crew, every three months; d) the crew must be trained for using the lowering liferats, at least every four months e) even the crew not appointed in the muster list must be trained to work with the life equipment, within two weeks from the arrival on board	P5.03.03 MAN 1 SMS "Training of the crew"
On board Organization	Language of work	SOLAS (am. 99-00) C.V – R.14 ISM.6	The Company must establish a language of work, to ensure effective performances in the safety field and must receive information on the SMS	MAN 01SMS "Safety Management Manual"
On board Organization	Muster List	SOLAS (am 96-98) C.III – R.37 DPR 435 – ART 203 STCW R.VI-1/A-VI- 1 STCW R.V-3/A-V-3 ISM 6 Circolare Gente di Mare Serie VIII n.17 – para H.1.1	Personnel appointed in the Muster List must be certified and obtain familiarization on: - Basic Safety Training; - Able seafarer for rescue and life boat conduct" (MAMS) - Crow management	P5.03.03 MAN 1 SMS "Training of the crew " P12.04 – IO 06 SMS – Drafting of the Muster list"
On board Organization	Communication	SOLAS (am 94-95)CIV/R.16 SOLAS (am 88) CIV/R.17 Circ SG n°26 Maricogecap 04.12.01	A crewmember tasked for the external communications related to the an emergency, through GMDSS (VHF-MF, shall be assigned (VHF – MF ecc). This representative cannot be the Master	
On board Organization	Hours of work and rest	D.L.vo271/1999 – Art.11 STCW A-VIII/1 D. L.vo 108/2005 – Art.4	All the crewmembers who work in watch-keeping, safety, security, antipollution, must have rest as follows: 1. At least 10 hours respect to the period of 24 hours 2. At least 24 hours respect to the period of 77 hours The rest hours cannot be split in more than two different periods, such as the longest must be at least 6 hours, interrupted by a break, which	P5.05.01 IO2

			cannot be more than 14 hours. Work and rest hours must be recorded in a log book. A copy of it must be signed by the Master or by a representative of him, and it be must forwarded to the crewmember.	

4.1.1 Recruiting

The Company recruits both by itself and through employment/manning agencies located abroad.

Particularly, recruitment for Deck and Engine departments is directly carried out by the Company, as established by the related SMS procedure P5.01.0201 IO 01. With regard to the Hotel department, the Company avails of recruitment manning agencies from abroad. This activity is established by the related SMS procedure n. P5. 2 IO 9 (Annex.11)

4.1.2 Minimum Safe manning – Crew asset

Ships must be manned according with the “minimum safe manning” related to the crew, as endorsed by the Flag Administration.

The minimum safe manning establishes the quantity and the quality of the crew, which must work on board to manage for the safety of the ship and the safety of the life at sea.

The above mentioned document of evidence, is a mandatory administration certificate, established by Solas Convention (emend. 99-00) – Chapter V – Regulation 14 ; the same issue is established, as well, by the national regulation, and particularly in the “Codice della Navigazione (art. 317), and the related “Regolamento di esecuzione (art. 426)”and in Presidential Decree 435/1991 (art. 201).

Italy, besides, has delivered, on the 20 October 2010, the Circular Letter n. 001, named “Guideline for drawing up the Minimum Safe Manning documents for Italian vessel and fishing pursuant to IMO Resolution A. 890 (21) as amended by IMO Resolution A. 955 (23)”. This Letter forwards instructions about the drafting both of the new minimum safe manning certificate and the existent.

The “COSTA CONCORDIA” has the Minimum safe manning certificate n.D41817T0968, delivered at the time (7 November 2007), by the Ministry of Transport (Annex. 12). The above mentioned document forwards the number of 78 as quantity of crew members, divided as follows:

- Officers, nr. 16
- Deck crewmembers, nr. 31
- Engine crewmembers, nr. 28

- Hotel crewmembers, nr. 1
- Complementary services, nr. 2

The Ship Crew list, instead, forwards 1023 members embarked (Annex. 13), actually, has delivered a clearance towards the Company, on the 16 May 2011 and valid until the 29 June 2012 (Annex. 14), which allows to charter, by external companies, for the housekeeping, the galley, the complementary hotel services, and all the cruise services as entertainment, shopping, cosmetic and fitness. This opportunity is established by the domestic Law 5 December 1986, n. 856 “Out of board services Contract”.
The crew is divided as follows:

- - Officers, nr. 39
- - Deck crew, nr 77
- - Engine crew, nr. 58
- - Hotel department, nr. 581
- - Complementary services, nr. 268

Persons belonging to 38 different nationalities were embarked on board, the most represented are (see Crew List Costa Concordia at Civitavecchia departure on 13 January 2012):

- Philippines, 294 persons;
- India, 202 persons
- Indonesia 169 persons
- Italy, 149 persons

4.1.3 Language of work on board

The language of work on board must be established by the Company which manages the ship, according both with the Solas requirements contained in the Solas (em.99/00) – Chapter V – Regulation 14, and ISM Code paragraph 6.6.
Each crewmember must have suitable skill to understand the work language and, for some activities, to give orders and instructions, and consequently to answer using the language of work.
The language of work must assure an effective skill of communication suitable to:

1) to warrantee adequate performance of the crew in the actions related to the safety;
2) receive the information related to the application of the SMS procedures.

The Company, drafting and endorsing the "Management Company System Manual" (MAN 01SMS – Annex- 15), has established, in the paragraph 5-5-3, that the language of work on board of its ships is the Italian language.

4.1.4 Muster List

The SOLAS Convention requirement establishes that the ship adopts an appropriate Muster List, which lists and states all the duties related to managing the various scheduled emergencies.
The Costa Concordia Muster List consisting of 1109 persons (the overall crew is 1023 – the Encl. n. shows a glossary which states the acronym for a correct reading of the muster list). Those persons are appointed to carry out specific tasks when the related emergency occurs, according with ISM P12.04.10 06 SMS procedure (which provides for drafting of Muster List).
Moreover, it is necessary to take into account that the ships' crew can be appointed in the Muster List only if the person has the specific certification established by the international and national rules.
That is why the Company has drafted and endorsed the "P5.03.03 MAN1 SMS" "Safety procedure (Training of the crew -Annex. 07).

4.1.5 Hours of work on board

Hours of work and rest on board for seafarers is established by the Law Decree 271/1999 article 11, as emended – and by the STCW Convention (A-VIII/1 – as emended by Manila Conference 2010).
All the personnel whose duty is for watch-keeping or safety, marine environment protection, and security must obtain an average of sleep as follows:

- at least ten hours in any 24-hour period;
- at least 77 hours in any seven-day period.

Hours of work and rest on board can be divided in more than two different periods, one of which must be at least six continuous hours; the interval between the two related parts cannot exceed more than 14 hours.

Copy of the document of evidence related to the record of the time of work carried by each person on board, after being signed by an officer or his representative, must be forwarded to each workers.
With regard to this, the Company has drafted and endorsed the SMS P5.05.01 IO02 procedure "Monitoring of the rest hours for on board personnel" (Annex 17). The Company, moreover, has updated the related contents according with the adoption of Manila amendments to STCW Convention, through the internal Circular letter n.P5-121/11 on 22 December 2011 (Annex 18).
The above mentioned Company instructions are in compliance with the related SCTW Convention requirements.
Each evidence on work and rest periods, both the related log book and the single paper belonged to every crewmember was lost during the shipwreck.

4.2 Preparation for departure

4.2.1 Certificates of safety and operating limitations

The ship left the port of Civitavecchia with all the Statutory (Annex 19) and Class (Annex 20) certificates in regular validity.
The Master presented the departure information, getting clearance from the Civitavecchia Harbour Master.
Analysis of the documents of the vessel (statutory certificates) did not reveal any deficiencies or irregularities pending or "operational restrictions" (Solas - 99-00 m - CV - R.30) (Annex 21) which limited or restricted the navigation that ship was about to undertake.
The ship, however, had a prescription regarding classification for the left electric propulsion engine, imposed by the Italian Naval Register on July 25, 2011 (interim survey endorsement certificate n.11/SV/325/01 - (Annex 22):
The ship had been passed last PSC inspection without any deficiency on 15th of April 2011 in Malta (Annex 23 which summarizes of all PSC inspections held).

4.3 Navigation

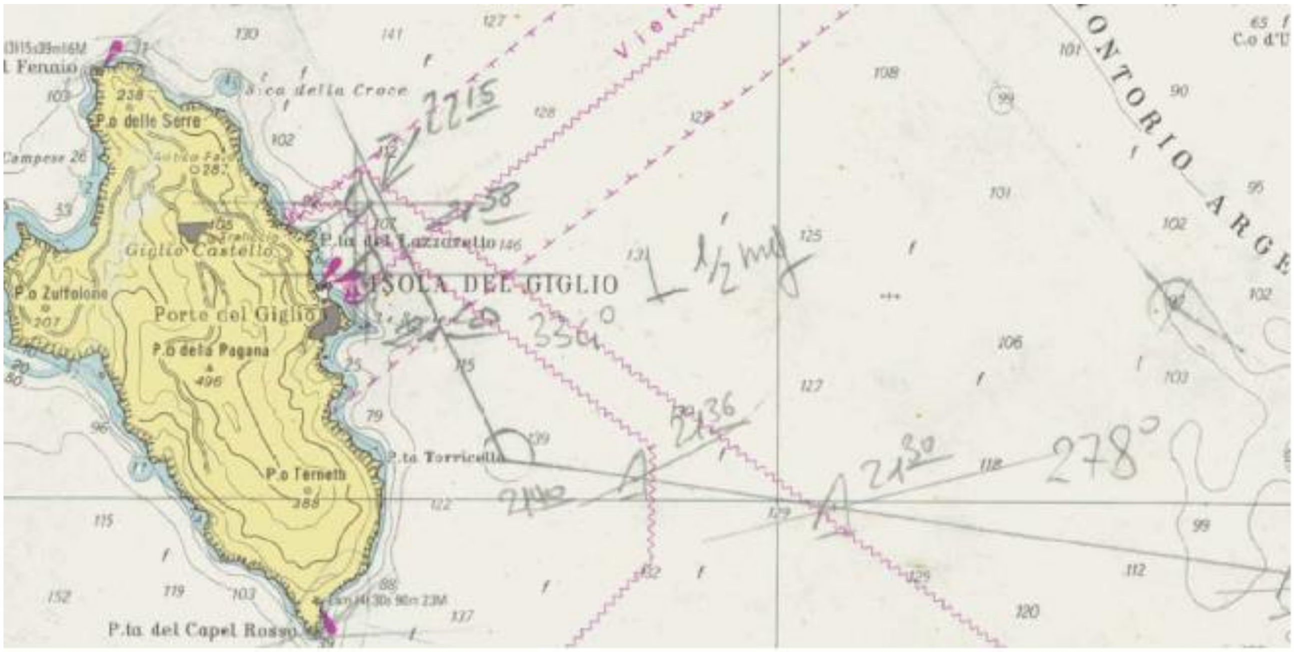
4.3.1 Planning the voyage

Before undertaking the navigation, the officer in charge prepares the route planning of the ship taking into consideration certain safety parameters including meteorological elements, any permanent or temporary hazards to the safety of navigation, always ensuring a sufficient space of sea for the safe passage of the ship.
Any changes to the voyage plan, before implementation, must be previously evaluated in order to ensure all the requirements mentioned above.
The plan must be constantly followed by the instruments on board and the ship detected and indicated on the chart at regular intervals which may vary depending on the area of navigation (ex in narrow waters interval in determining the ship's position is closer).

In accordance with the bridge procedures (Para 4.1.4) the officer in charge of navigational publications prepares a detailed plan to be approved by the Master of the ship model *"P14-man1 MO5 SMS"* (Annex 24) reported that as the letter h) of paragraph 4.1.4.2 of the procedure *P14 - MAN 01 SMS PROCEDURES FOR BRIDGE "(Annex* **25)" ... must be prepared and presented on the charts. "**
The same paragraph of the procedure emphasizes, moreover, in detail, all the elements to be considered in planning.

In addition to what just outlined should be kept in mind that, as indicated in the publication of the Italian Hydrographic Institute 3024 "Standards for the use and conservation of marine equipment" (Chapter II - nautical documents to update systematic) for coastal shipping, that the charts with the greater scale existing for the area in which the ship is located must always be used .
The area where the accident occurred is covered by charts of the Hydrographic Institute 6 - 1:100,000 - and 119 - scale 1:20.000 - (Isola del Giglio).The nautical chart appropriate for the planning and monitoring of navigation in the proximity of the island is therefore 119.
The ship, as it turned out by the inventory of charts (Annex 26), relative to the area of the accident, was not equipped with the 119 chart for navigation near the island of Giglio. This is acceptable because the navigation near the island of Giglio was not scheduled routes normally used by in the ship.

Planning the voyage of the "Costa Concordia" - January 13, 2012 - was carried out using the chart 6 Hydrographic Institute of the Navy. This paper, scale 1:100 000, is not, as we said, for adequate planning of the route close to the coast which requires more detailed information in consideration of the preliminary assessments for the safety of navigation, taking into account the parameters and criteria just set forth and contained in the ISM procedure mentioned above.



Excerpt from the chart IIM 6 recovered on board the Costa Concordia

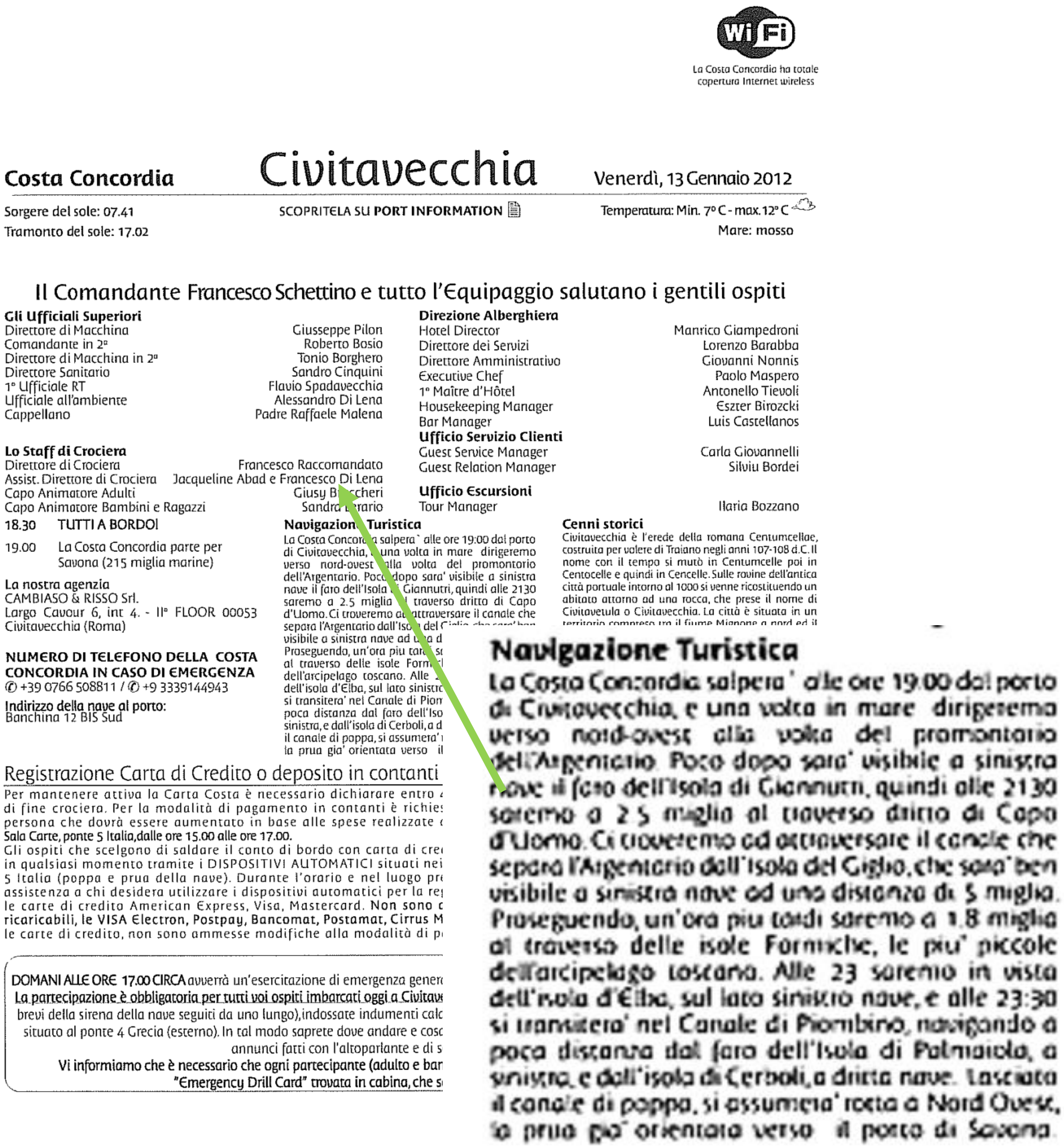
The extract of the original chart used aboard the ship, and then recovered, shows the planned route and the boat's GPS (indicated by a triangle and time).

In anticipation of the navigation to be carried out in the waters off the port of Giglio island should have been used, in addition to relevant nautical publications, the chart 119 - scale 1:20000 - Hydrographic Institute of the Navy that would have allowed a more accurate and adequate view of the hazards to navigation.

It should be noted, in fact, that the decision to change the route followed normally for part of the voyage from Civitavecchia to Savona has been taken by the Master of the ship, just before leaving the port of Civitavecchia, by a verbal order communicated to the Navigation Officer Audio transcription of the VDR – Appendix 2.

The "ARES MANUAL" (Annex 27) 2002 edition of the "Coast Guard Headquarters" establishes that *"... a message of changes to the plan of the voyage is required only in the case that the new route deviates from the previous one by more 15 miles of navigation in the Mediterranean.*

The Costa Concordia announced the route traditionally followed the route Civitavecchia and Savona.



La Costa Concordia ha totale copertura Internet wireless

Costa Concordia — **Civitavecchia** — Venerdì, 13 Gennaio 2012

Sorgere del sole: 07.41
Tramonto del sole: 17.02

SCOPRITELA SU **PORT INFORMATION**

Temperatura: Min. 7° C - max. 12° C
Mare: mosso

Il Comandante Francesco Schettino e tutto l'Equipaggio salutano i gentili ospiti

Gli Ufficiali Superiori

Direttore di Macchina	Giusseppe Pilon
Comandante in 2ª	Roberto Bosio
Direttore di Macchina in 2ª	Tonio Borghero
Direttore Sanitario	Sandro Cinquini
1° Ufficiale RT	Flavio Spadavecchia
Ufficiale all'ambiente	Alessandro Di Lena
Cappellano	Padre Raffaele Malena

Lo Staff di Crociera

Direttore di Crociera	Francesco Raccomandato
Assist. Direttore di Crociera	Jacqueline Abad e Francesco Di Lena
Capo Animatore Adulti	Giusy B…cheri
Capo Animatore Bambini e Ragazzi	Sandra …rario

Direzione Alberghiera

Hotel Director	Manrico Giampedroni
Direttore dei Servizi	Lorenzo Barabba
Direttore Amministrativo	Giovanni Nonnis
Executive Chef	Paolo Maspero
1° Maître d'Hôtel	Antonello Tievoli
Housekeeping Manager	Eszter Birozcki
Bar Manager	Luis Castellanos

Ufficio Servizio Clienti

Guest Service Manager	Carla Giovannelli
Guest Relation Manager	Silviu Bordei

Ufficio Escursioni

Tour Manager	Ilaria Bozzano

18.30 TUTTI A BORDO!

19.00 La Costa Concordia parte per Savona (215 miglia marine)

La nostra agenzia
CAMBIASO & RISSO Srl.
Largo Cavour 6, int 4. - II° FLOOR 00053
Civitavecchia (Roma)

NUMERO DI TELEFONO DELLA COSTA CONCORDIA IN CASO DI EMERGENZA
✆ +39 0766 508811 / ✆ +9 3339144943

Indirizzo della nave al porto:
Banchina 12 BIS Sud

Navigazione Turistica

La Costa Concordia salpera' alle ore 19:00 dal porto di Civitavecchia, e una volta in mare dirigeremo verso nord-ovest alla volta del promontorio dell'Argentario. Poco dopo sara' visibile a sinistra nave il faro dell'Isola di Giannutri, quindi alle 2130 saremo a 2.5 miglia al traverso dritto di Capo d'Uomo. Ci troveremo ad attraversare il canale che separa l'Argentario dall'Isola del Giglio, che sara' ben visibile a sinistra nave ad una distanza di 5 miglia. Proseguendo, un'ora piu tardi saremo a 1.8 miglia al traverso delle isole Formiche, le piu' piccole dell'arcipelago toscano. Alle 23 saremo in vista dell'isola d'Elba, sul lato sinistro nave, e alle 23:30 si transitera' nel Canale di Piombino, navigando a poca distanza dal faro dell'Isola di Palmaiola, a sinistra, e dall'isola di Cerboli, a dritta nave. Lasciato il canale di poppa, si assumera' rotta a Nord Ovest, la prua gia' orientata verso il porto di Savona.

Cenni storici

Civitavecchia è l'erede della romana Centumcellae, costruita per volere di Traiano negli anni 107-108 d.C. Il nome con il tempo si mutò in Centumcelle poi in Centocelle e quindi in Cencelle. Sulle rovine dell'antica città portuale intorno al 1000 si venne ricostituendo un abitato attorno ad una rocca, che prese il nome di Civitavetula o Civitavecchia. La città è situata in un territorio compreso tra il fiume Mignone a nord ed il

Registrazione Carta di Credito o deposito in contanti

Per mantenere attiva la Carta Costa è necessario dichiarare entro …
di fine crociera. Per la modalità di pagamento in contanti è richies…
persona che dovrà essere aumentato in base alle spese realizzate …
Sala Carte, ponte 5 Italia, dalle ore 15.00 alle ore 17.00.
Gli ospiti che scelgono di saldare il conto di bordo con carta di cre…
in qualsiasi momento tramite i DISPOSITIVI AUTOMATICI situati nei…
5 Italia (poppa e prua della nave). Durante l'orario e nel luogo pr…
assistenza a chi desidera utilizzare i dispositivi automatici per la re…
le carte di credito American Express, Visa, Mastercard. **Non sono c…**
ricaricabili, le VISA Electron, Postpay, Bancomat, Postamat, Cirrus M…
le carte di credito, non sono ammesse modifiche alla modalità di p…

DOMANI ALLE ORE 17.00 CIRCA avverrà un'esercitazione di emergenza gener…
La partecipazione è obbligatoria per tutti voi ospiti imbarcati oggi a Civitav…
brevi della sirena della nave seguiti da uno lungo), indossate indumenti cal…
situato al ponte 4 Grecia (esterno). In tal modo saprete dove andare e cos…
annunci fatti con l'altoparlante e di s…
Vi informiamo che è necessario che ogni partecipante (adulto e bam…
"Emergency Drill Card" trovata in cabina, che s…

Image extracted from page 3577 of the file by the Prosecutor of Grosseto

The evidence of the Voyage plan is represented by the ARES communications (Annex no. 28) received by the IMRCC, while the course after planned and really followed, regarding the Giglio passage, is showed in the above picture (the extract of the original chart used on board).

There is no evidence about Company rules which addressed the unscheduled side trip, such as in the event.
A former passage close to Giglio is recorded on the previous August. It happened in daylight, keeping a course with a safe distance by the shoreline and proceeding slowly (manoeuvre speed as she approached the breakwater), to allow the passenger to film or make picture, despite the ship was quite far from the coast.

4.3.2 Nautical charts and publications updating, use of ECDIS (electronic chart display and monitoring system) and VDR

The bridge procedure *"P.14-MAN 01 SMS - Procedures for the bridge"* (Para 4.7.1) states that the charts and nautical publications to be used for navigation are those published by the Admiralty; vessels operating in Italian ports must also use the charts published by the Hydrographic and in particular must be kept the charts for the harbour and the first 2 charts of entry / exit used for arriving in the port.
Therefore, the traditional charts are the primary system for planning and monitoring of navigation.
The ship, as described in "safety certificate for passenger ships", has of "'ECDIS" (Electronic chart display and information system), this equipment is accepted by the SOLAS Convention to replace the charts and nautical publications and ensure the travel planning and monitoring of navigation.
The ECDIS is mandatory as established by Solas - Chapter V - Rule 19 (amended 2009) for existing passenger ships over 500 GT (like the ship in question) the installation is mandatory from 1 July 2014.
In order to use the system is asked by the STCW Convention Regulation A-II / 1 - as rewritten by the amendments of "Manila" entered into force January 1, 2012 - that the on duty on the bridge have supported a specific training; the courses for that purpose have been established in Italy, in the light of these amendments, by Decree of the Ministry of Infrastructure and Transport on December 5, 2011.
Although we think not applicable at the time, the disposition of the Decree 5 December 2011 that should be considered complementary to the technical standard that requires the installation of ECDIS, however, is applicable a general rule that the deck officers are provided familiarization with the equipment to be used (STCW A-VIII / 2 - Part 4 (Para 36) - STCW AI/14).

The ECDIS installed on board the "Costa Concordia" is therefore "voluntary" does not mean that the same can not be used for its intended purposes subject to compliance with the general regulations regarding familiarization.
The procedure *"P.14-MAN 01 SMS - Procedures for the bridge",* while underlining that "integrated navigation systems" (a component of which is the ECDIS) does not replace the

traditional paper charts (Para 4.3.4) considers them a navigation aid, recognizing the need for deck officers to receive general information on the use of electronic charts, so a proper familiarization.
Please also understand that the use of ECDIS (Annex 29) is required to obtain the "integrated navigation system", the planned voyage must be loaded in order that the navigation mode TRACK-MODE can be carried out.

With regard to the familiarization of deck officers with the ECDIS, the objective evidence in this regard would be the procedure with ISM P.5.03.03 MAN1 MO SMS COP 8 (Annex 30), despite it does not show that there is a specific reference ECDIS equipment.
By the investigation, although not resulting in the ISM procedures specific documentary evidence on familiarization with the ECDIS can be considered, from the evidence acquired, that deck officers had received familiarization with the ECDIS installed on board.

The VDR (DEBEG 4300 Model, traded by the SAM Electronic) worked correctly. In the VDR we found also old data, related to some day before the accident, which helped us even in the Emergency diesel generator working investigation, finding old data regarding the former drills.

4.3.3 Watchkeeping and conduct of navigation

The navigation area must be monitored visually with the navigation instruments and must be evaluated every dangerous situation.
The officer on duty on the bridge is responsible for the conduct of navigation, that is to perform according to the schedule of the voyage, even in the presence of the master on the bridge. It 'the same Master who must explicitly take the guard on the bridge pointing to the officer on duty.
The guard must be structured so that it can be ensured the safety of navigation.
Similar service should be carried in the car unless the vessel is not certified UMS (unattended machinery spaces) that the machine is "periodically unattended."
The "Costa Concordia" is in possession of the record class AUT-CCS then there is a guard in the "central control station".

The organization of the guard is deducible from the "planning board of the guard."

The Company's management has taken to the guard on the bridge the procedure *"P14 - MAN 01 SMS PROCEDURES FOR BRIDGE".*

Procedure can be drawn from the following:

1) *Shifts in composition of the guards in normal operating conditions* *(para 4.1.3):*

20.00-24.00 The round consists of the second mate and helmsman without prejudice to the right of the master of the ship to implement the guard for the safety of navigation and environmental protection.

2) *Tasks officer of the watch (Para 4.3):*

primary responsibility is the safety of navigation - is responsible for the guard in presence of the master of the ship unless it is expressly stated and this fact noted in the paper navigation - must follow the planned route and periodically determine the ship's position through more methods - the range is reduced as a function of the navigation area (15 minutes for coastal navigation) - must write down all the details of the guard on the logbook.

3) *Shifts and compositions of the guards (Para 4.1.3):*

If, at any time, the officers of the Guardia Bridge have any doubt the adequacy of the Bridge Team Guard (composition of the guard) to ensure the safety of the ship (or any doubts concerning issues related to navigation, Safety-ship or other), they should not hesitate to advise the Master.

4) *Coastal navigation (Para 4.3.9):*

The radar is used as an aid in the coastal optical observation, when the major points on the ground are not visible you need to check continuously the position of the ship.

5) *Operation of the ship in dangerous conditions (Para 4.3.10):*

situations that may pose a hazard to navigation leading to the adoption of additional measures, including **adjusting the speed** *so as to allow a safe margin of manoeuvre even in case of failure of the main engine* and of the rudder / the government must be done in the manual / **must be reinforced the look-out optics.**

From 20.00 to 24.00 the personnel present on the bridge, on duty, was: 1st Deck Officer, from the 2nd Deck Officer(alongside the 1st to handover), the 3rd Deck Officer, the cadet covered by the helmsman and a seaman.
At 21:34 The Master arrived at 21:39 on the bridge and took the guard. In the moments immediately prior to the accident the structure of the bridge, as described by the 1st Deck Officer (Appendix 3 - Excerpt from the testimony of the 1st Deck Officer) is as follows:

Following pictures taken from sister-ship Costa Serena:

The Master moved between the position indicated by 1st Deck Officer and the windows of the bridge in the central area.

Depending on the circumstances of the marine casualty in question, it seems important to focus on the following issues, deducible from the procedure and which are reflected in international law:

1) guard on the bridge must be appropriate to the current situation and, therefore, for navigation along the coast should reinforce the lookout optical (look-out) - **Colreg R.5 and STCW A-VIII / 2 - Part 4;**

2) ship's speed: must be adjusted so as to ensure a sufficient margin for manoeuvre and stop in case of failure - **Colreg R.6 and STCW A-VIII / 2 - part 4;**

3) Use the radar: it must be to assist the look-out, and when the major points are not clearly visible must be checked continuously the ship - **STCW A-VIII / 2 - Part 4 (para 37.38 and 39).**

The investigations carried out show the following results:

1) watch on the bridge: on-call (and in particular the look out) - even if it was not implemented with the introduction of the second sailor on the lookout when the first sailor passed at the helm - is to be considered, however, adequate, having regard to the presence a Bridge Team (at one point led by Master) consisting of three officers and the Cadet. Certainly, as then emerges in the analysis that follows, the team did not perform the necessary tasks of a systematic and continuous delicate phase of navigation, and none of the four components of the bridge above, at the crucial stages prior to the contact, moved to the extreme part of the bridge (left side); but this is another matter, because the regulation 5 of the Colreg '72 Convention states that *"Every vessel shall at all times maintain a proper look-out by sight and hearing as well as by all available means appropriate in the prevailing circumstances and conditions so as to make a full appraisal of the situation and of the risk of collision.".* For this reason, the missed replacement of the helmsman is not absolutely influent on the look out organization.

2) Speed of the ship was not decreased but remained between 15 and 16 knots, even beyond the point of turn planned but not respected (see in this respect the testimony of 3rd Deck Officer) at a speed of 16 knots the ship, as shown in by "manoeuvring booklet" (Annex 31), requires 1299 meters (0.7 miles) in order to stop his momentum. The ship was found that speed bow to the ground at a distance from the coast than half a mile, as shown by the tracks AIS / VDR (the distance of half a mile to sixteen nodes is covered in about 2 minutes).

3) Use of radar: the ship's radar were both supervised correctly set, based on the evidence obtained, one from the 1st Deck Officer and the other by The 3rd Deck Officer and the 2nd Deck Officer, which according to the general principles contained in the

STCW A-VIII / 2 - part 3 (para 8.9) without hesitation should have informed the Master of any doubt and what actions to take in the interest of safety.

It should also realize that there were people outside on the deck to watch (plus Hotel Director and Metre), in contradiction with standard orders for the officer of the watch on the bridge *(P14-man1 SMS MO 12 - point 10 - Annex 32)* which states *" Reasons For safety, passengers or other people not Involved are not allowed on the Bridge, except in specific cases for which the Master's Authorization is required. "*

Also, from what emerges from the documents acquired, the Master was committed, even before the onset of impact, in telephone communications, in conflict with the provisions ISM "rules of conduct for the Bridge Team" *(P14-IO2 SMS - Annex 33),* where it is ruled (para 4.2) that *"... It 'banned the use of mobile phones and the private cell phone on board, during the watch, as well as manoeuvring ...".*

A comparison of the planned route on the chart no.IIM 6, recovered on board the Costa Concordia (rebuilt also by the Mate, with a good approximation, during the testimony of March 1, 2012), and the layouts AIS / VDR ship, it is clear that the Master has passed the point of turn planned to pass the Giglio island, bringing the ship into position much closer to the coast than expected.

Actuating the rudder

The helmsman, just in the phases immediately before impact, has made mistakes in the handling of the helm than the orders given by the Master.

For ease of understanding we report the indications concerning the reading of the data reported by the gauges of the operation of the control surfaces:

- "0" (zero) rudder to the centre:
- Positive values (0 to 45) helm to starboard;
- Negative values (from 0 to -45) left rudder.

It should be noted that between the actuating the rudder, set by the sailor, and the actual position of the rudder passes a period of time due to the size of the rudders, the speed of the ship etc..

The error occurred between 21:44:43 and 21:45:00.

We proceed following the reconstruction:

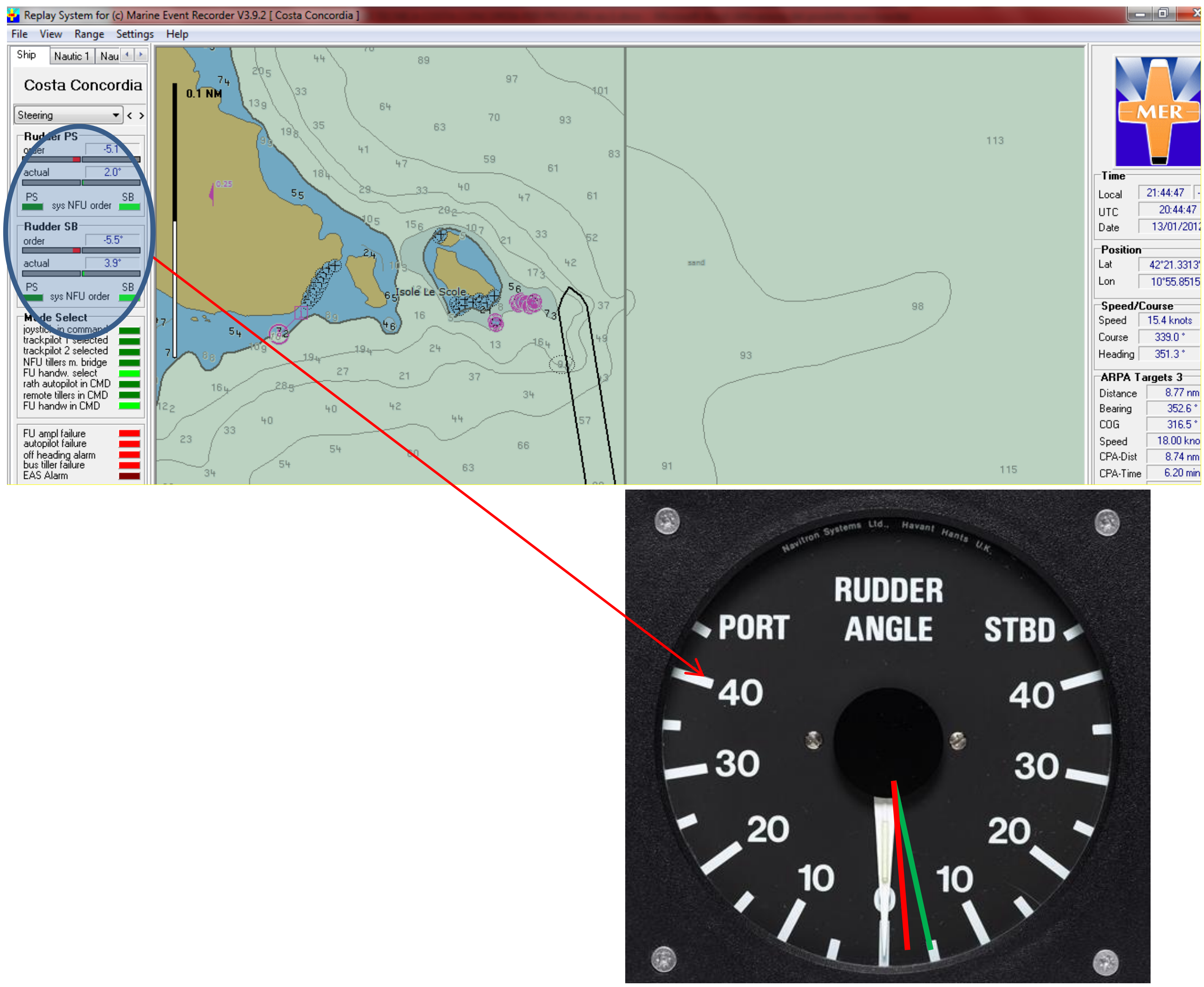
For ease of reference, in addition to images of the VDR used in "Reconstruction of the fact," in following three images of rudder angle indicator has been reproduced in a manner solely indicative to facilitate reading, with a green line position " effective "rudder to starboard and a red line to the left.

At 21:44:21 VDR - Master ordered all to starboard side and at the helm to starboard

21:44:35 VDR is at 36 degrees to starboard and the actual one on the left at 34.6 degrees to starboard effective.

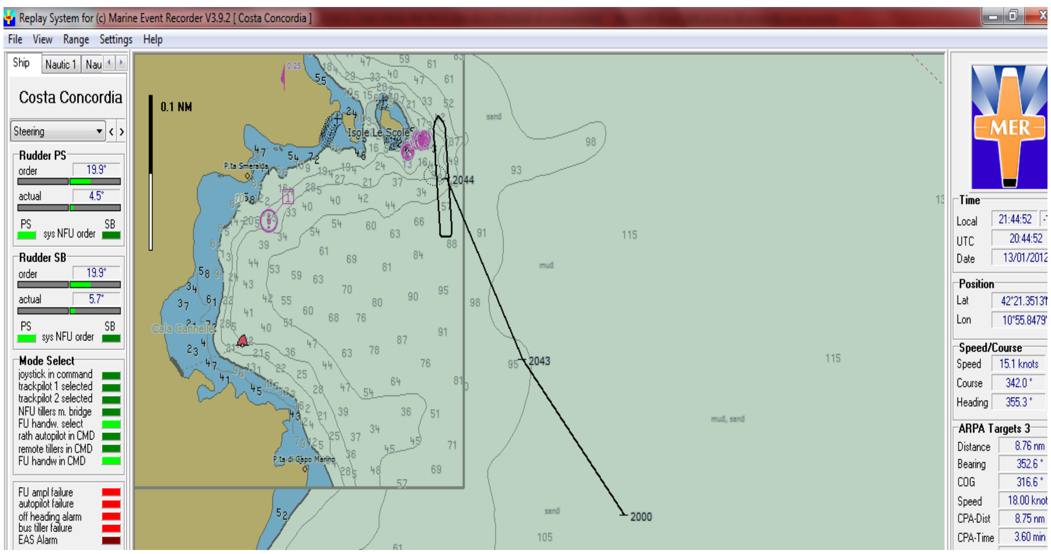
At 21:44:37 VDR - Master ordered to put the rudder to centre.

At 21:44:43 the Master ordered the helmsman "Port ten" (ten degrees to the left)

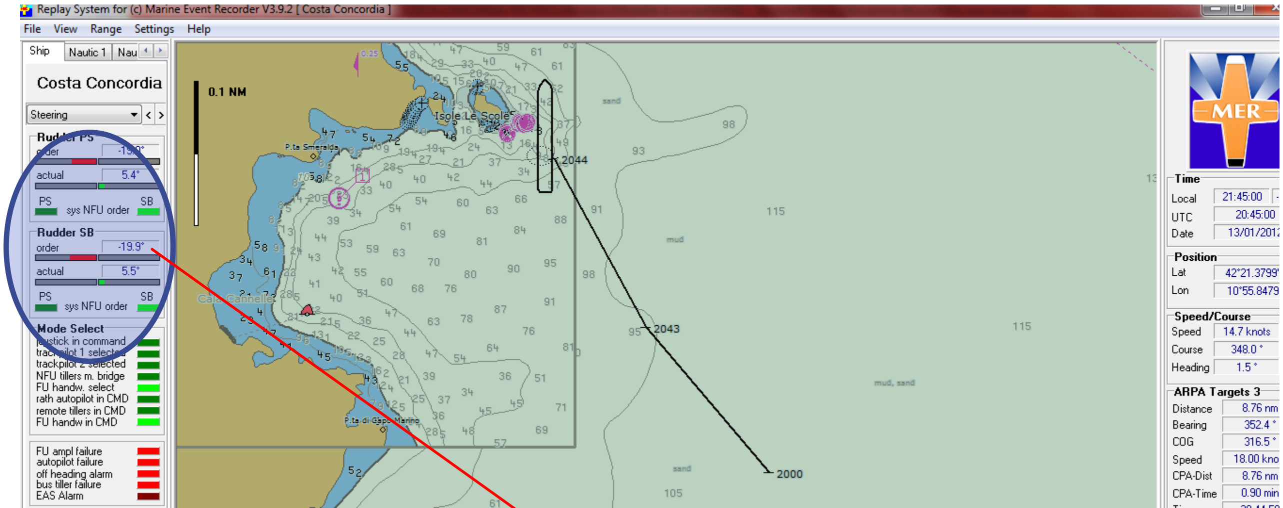


The helmsman, comes a little more than 5 on the left and the rudders move to the left to reach 2 degrees to starboard effective - to the left - and 3.9 degrees to starboard effective - to starboard.

At 21:44:45: The Master ordered the helmsman "Port twenty" (twenty degrees to the left)



The helmsman , on the contrary, it performs 20 degrees to starboard rudder and the rudder therefore not "continuing" its course, as it should according to the intentions of The Master to the left, but returned again to starboard. In fact, the rudder left up to 4.5 degrees to starboard actual (first 2 degrees to starboard) and 5.7 degrees to starboard to starboard (before 3.9 degrees to starboard).

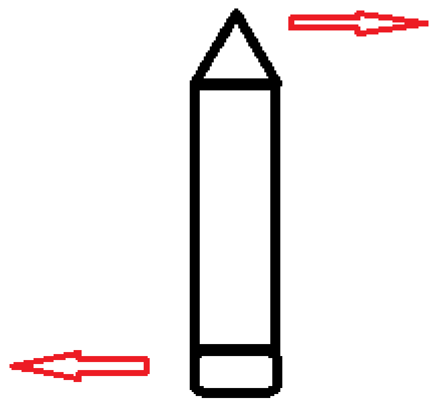


The helmsman realizes the error and corrects it by bringing the left rudder (spend about 8 seconds from the moment when the helmsman maneuver from 20 degrees to starboard at 20 degrees to the left) but the effect on the rudder given by the previous maneuvers carried determines a further shift to the left toward the starboard side and a slight movement to the left of the starboard. In fact, the rudder left up to 5.4 degrees to starboard actual (before 4.5 degrees to starboard) and 5.5 degrees to starboard to starboard (before 5.7 degrees to starboard).

At 21:45:05 (VDR) The Master orders: "hard to port" (far left), the helmsman confirmation and performs; 2nd Deck Officer which in the meantime has moved to the left on the fin informs The Master (VDR 21:45:06) that the stern expire quickly towards the rocks.

At **21:45:07 the hull of the ship collides with the left side of the rock further east "Le Scole".**

The manoeuvre, requested by the Master and properly carried out by The helmsman first error highlighted, determined the placement of all the helm to starboard, with a consequent marked movement of the bow to starboard and stern to the left, then to the ground.



Orders progressive left (up to "hard left") were probably given with the intention to "stop" the rotation of the earth towards the stern.

4.3.4 Checks and before departure

The legislation is contained in the SOLAS Convention and the Presidential Decree 435/1991:
Solas (em 99-00) CV/R26
Solas (em 94-95) CII-1/R15
Solas (81 m) and 25 CII-1/R15
Presidential Decree 435/91: Art.225 - 226 - 228 - 229 to 230.

The Master through designated officials must carry out a series of verifies and functional tests preparatory to departure, to check the efficiency of the equipment on board.
In particular, it must be verified the efficiency of nautical instruments, internal and external communication equipment, alarm systems, generators, closing of watertight doors, steering etc..
Must also be checked for readiness and availability of life-saving and verified the trim and stability.
All of these controls must be properly recorded in the log books.

The Company's management has established, within the procedure *P14 - MAN 01 SMS PROCEDURES FOR BRIDGE,* the use of checklists in preparation for the departure of the ship (P.14 MAN1-MO1 SMS - Annex 34. This checklist supports the officer on guard so that all tests are performed and the outcome is recorded in the Journal of Navigation.
The Master of the vessel which has the supplementary statement of departure without report defects or anomalies, in fact, says that the ship is suitable for the journey to be undertaken.

The compliance of the board with the procedures established by the Company has been verified in the course of" *"Additional ISM audit"* carried out at the headquarters of the Company on 6 and 7 March 2012.

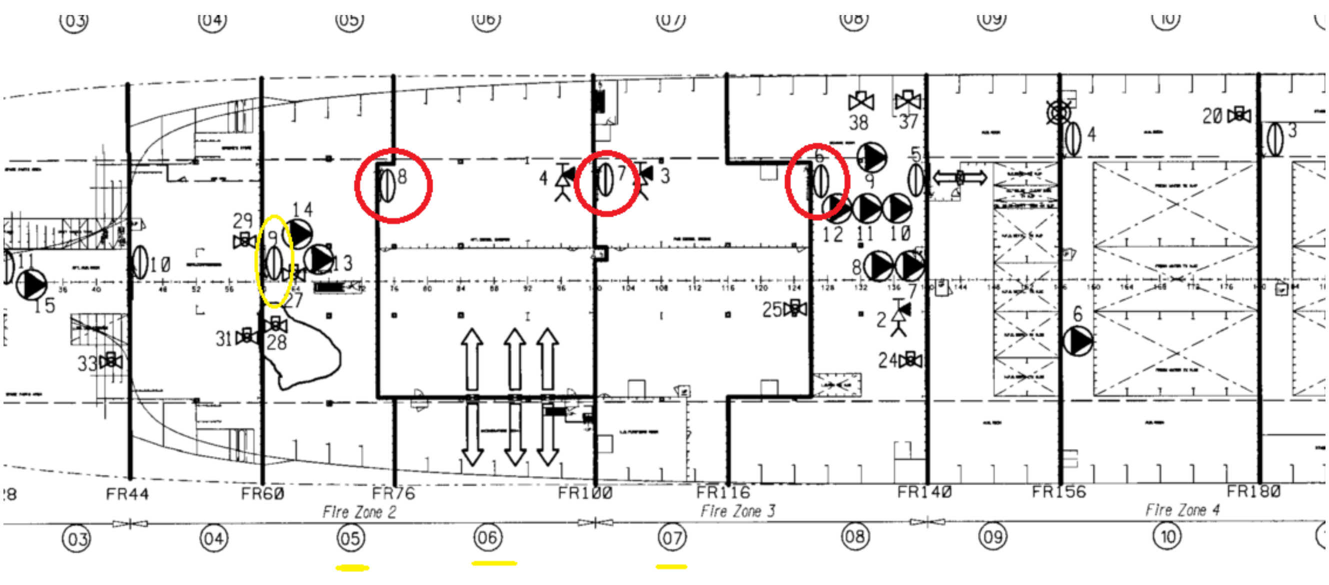
Checks on watertight doors and side scuttles

All watertight doors shall be inspected by an engineer and subsequently closed by designated staff, before the departure of the ship.
There must be specific instructions if there is a need to open them during the navigation, so that the master and / or the officer of the watch on the bridge to keep the continuous control and monitoring.
The actual closing can be checked by a panel with audible indicator.
The Company has set up a procedure ISM P12.05 IO 06 SMS (Annex 35), which establishes guidelines for the use of watertight doors during navigation supplied by the automatic pilot.
Shows that the procedure is given to the Master of the possibility, if deemed necessary, to keep open while sailing some watertight doors indicating explicitly the doors 7-8-12-13 and 24.
These include the automatic watertight doors:

- 7 is located at the bridge C and is placed between the compartments 6 and 7;
- 8 is located at the bridge C and is placed between the compartments 5 and 6.

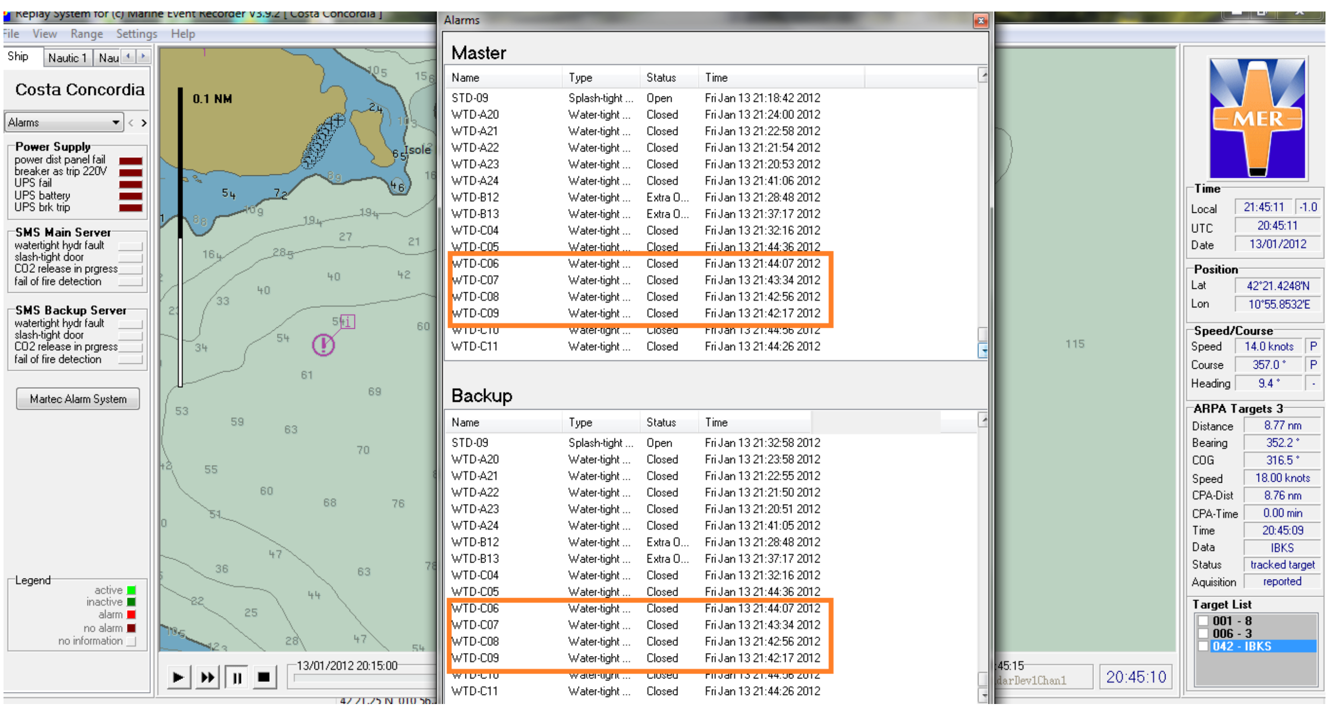
This procedure does not comply with the requirements of Solas as it is not allowed to open during navigation of those watertight doors.
Following the incident, in carrying out this investigation, the difficulties were brought to the attention of the Flag State Administration (Italian Coast Guard Headquarter), that did modify the procedure in question aligning it with the applicable legislation may allow temporary openings supervised in case of need.
The procedure applied on the Costa Concordia, provided by the Company for all its vessels, could create a hazard to the safety of navigation and the protection of persons on board also the other ships operated by Costa Cruises.

The compartments immediately affected by the flooding were, among others, 4, 5, 6 and 7 (the number 8 was flooded immediately only into the related double bottom).



"Damage control plan" - bridge "C"

From the evidence obtained shows that, at the time of the contact, the watertight doors were all closed, however, and this is confirmed by data from the VDR, as can be seen from the below screen.



VDR screen indicating the watertight doors in question

Check trim and stability

Should be checked daily variable elements for the determination of stability.
The ship is equipped with a software called "NAPA" approved by the Italian Naval Register (n.2011 statement.SV.01.545 on November 28, 2011 – Annex 36 associated with the instructions to the Master on the stability of the same approved by the Board on June 22, 2006 (No.CDS005924).
Of these tests do not have objective evidence of response.

Left engine propulsion

As mentioned above (2.2.1) the ship had a prescription for the referred class electric propulsion motor of the left, this requirement was imposed by the Italian Naval Register July 25, 2011 (interim survey endorsement sheet n.11/SV/325/01)
"Continuous working at the following RPMs is to be avoided: 93 rpm - 100/102rpm."
The interval, in which are given by RINa with e-mail dated 28 May 2012 (Annex 37), should be read as follows:
"At 93 rpm and in the range between 100 and 102 rpm including extreme".

The condition of class, in fact, did not involve restrictions on the operation of the ship but was element of secure attention from the control board.

While sailing there is evidence from VDR recordings that personnel on the bridge is coordinated and agreed with the machine about the regime of the engine speed to the left, taking account of the restriction and therefore was properly avoided the regime of critical speed.
So we can say that the staff at this well kept guard has this condition in the course of normal navigation.
Conversely, there is no evidence that, in planning approach Giglio Island - which led then to impact with the rocks of Scole at a speed of 15.5 knots - has been kept in mind the functional limitation of the engine, in case of emergency manoeuvres, during which, of course, it is not possible to take the normal precautions required.

Control Life Saving And Checking The Fitness 'Ship

Before the ship leaves a port and at all times during the voyage, all life-saving appliances shall be kept in working order and ready for immediate use.
The master must ensure that the ship is ready and suitable for the voyage to be undertaken.

Objective evidence that the ship is ready to embark on a safe navigation was given by the presentation of the aforementioned documentation necessary to obtain the authorization to leave the Civitavecchia Harbour (supplementary statement of departure).

4.3.5 Recording system of passengers

Under the Ministerial Decree 13 October 1999, which transposed the EU Directive 98/41 / EC, should be recognized some information about the people on board; such information shall be collected before departure and communicated within 30 minutes after departure, the clerk the registration of the Company's management.
Registration must be made in accordance with a system approved by the Administration; the collected data must be available at all times for the transmission Authority designated for the purposes of search and rescue (SAR) in case of an emergency or following an accident.
"Costa Crociere Spa" is equipped with a system of registration of passengers (Annex 38) amended, most recently, on September 1, 2010 with the approval of the ITCG Headquarters on 31.12.2010 (Annex 39).
This registration system is contained in the procedure *"P12.04 IO 14 SMS - Information about passengers on board."*
The data are managed through a dedicated software called "SAPI".

In this regard, the following is noted:

a) The Civitavecchia Harbour Master with the sheet n.02/01/12/3137 on February 29, 2012 (Annex 40) announced that it had not received the information of the nominee;

b) Data on the number of persons on board (passengers + crew), as shown in the description of the event, were not accurate:

- The statement from the port of Civitavecchia contains 3216 + 1030 pax crew (total **4246);**
- At 22:36:34 (VDR) (about 49 minutes after the contact) the ship (22.34 history of the operations room) has notified the SAR Authority of Livorno 3208 pax + 1023 crew (total **4231);**
- At 04:50, the company announced the Harbour of Leghorn **4754** people, the following is the extract from the chronology of the operations room.

04.50	FAX/A	COMPAGNIA COSTA FORNISCE LISTA PAX ED EQUIPAGGIO DALLA QUALE RISULTA CHE A BORDO ERANO PRESENTI 4754 PERSONE

Only later it was announced the final figure of the total number of persons on board **(4229).**

This highlights the inadequate organization that ensures a fair application of the rules.

4.3.5 Instructions and appeals to passengers

The Solas - Chapter III R.19 (AM 2006), integrated with the content of Articles 202 and 233 of Presidential Decree 435/1991, shall, when they boarded new passengers that:

1. before the ship's departure or immediately provide the necessary ***safety instructions to passengers;*** such instructions, in one or more languages, shall include at least emergency instructions, the name of the assembly, the alarm signals, the location of life jackets and how they should be worn;
2. shall have an ***appeal for passengers to abandon ship drill*** within 24 hours of departure, this appeal must include, among other things, the call of passengers and crew to muster stations, checking that they are all properly dressed, the preparation for the launching and launching survival of a lifeboat.

The Company has established a procedure P12.04 - IO 01 SMS "Managing Emergency instructions for passengers" (Annex 41).

The procedure is that each individual port, whether or not terminal, where passengers embark education is administered through special video, in multiple languages, as shown in the individual cabins for passengers who embark on different ports from the port terminal , where he was made an abandon ship drill, and provided a "safety talk."

The "Costa Concordia" was performed abandon ship drill departure from the port of Savona; exercise meets the requirements for the training of passengers, referred to in the standard concerning the "'appeal for passengers."
The ship, however, has embarked passengers in all subsequent ports (lists number of passengers variation in individual ports and, therefore, should have made ***"an appeal for passengers abandon ship drill"*** ship within 24 hours of departure from each port of call; this call was not performed because the procedure is not covered by P12.04 - IO 01 SMS "Managing Emergency instructions for passengers”.
In this regard it is of the opinion that the appeal, in which, among other things, passengers are physically performed in place of assembly and material wear life jackets, can not in any way be replaced by different forms administration of instructions on passenger safety, so much so

that the procedure adopted by the Company has been subject to "non-compliance", *during* the *"'Additional ISM audit."*

4.4 Navigation before the impact phase

From the chronological reconstruction made through the records it is clearly showed a navigation close to the coast undertaken superficially, as done with a map with an inadequate scale, unsuitable for the needs for a correct and unequivocal appreciation of the distance from the coast, of its own profile, of shallow water and consistency of shallows or rocky outcrops, especially considering the night time.

Despite the effectively reinforced organization of the watch on the bridge, both before and after the arrival of the Master (three Officers included the holder in duty, as well as the look-out, then a cadet and the helmsman), does not appear from the records the presence of an organized team that was supposed to perform that close and dangerous navigation with a particular care, regardless of who was at the time the holder. Of course it was up to the owner to have the team properly available for timely information on the progress of navigation to the shoreline.

There is no evidence about any warning to the Engine Staff Officers on duty in the ECR(Engine Control Room), regarding the order of “keep attention in the engine” which it is usually given when the ship faces navigation in any restricted/shallow waters.

This is clearly showed not only from audio recordings, but also by the testimonies (the 2nd and 3rd Deck Officer), where the same persons seem not to be likely involved with the navigation that was taking place. Basically there has not been by two Officers an active presence at the radionavigation systems (Ecdis and radar), or on the wing to try to appreciate the real distance from the coast.

A different content, however, has the testimony of 1st Deck Officer, who subsequently reported that they had repeatedly urged Master to desist from excessive approaching, considering it dangerous. However, the audio recording does not show anything, either before or after the Master assumed the conduct of the ship, than declared by the 1st Deck Officer within the interrogation of the judicial authority .

In practice, when the Master reaches the bridge the vessel is heading towards the coast (almost perpendicular) at 278 , and at that moment it will take exactly 10 '30" to the impact. At that moment the ship is 2.7 miles. from the ground (simple calculation made by going backwards with respect to the moment of impact).

Master takes command exactly 5 mins later, when the vessel is then to 1.35 mgl., With bow 290 .

Master goes alongside of 60 degrees in four minutes, then slowly without using directly the rudder but by giving to the helmsman, to sweeten the turn deliberately, only the desired heading (values measured by the plotting images extracted from the VDR show a change of heading of 8/10 deg per minute).The Master, after starting the turn, heading 300 deg orders also to increase to 16 Kts.

It should be considered that the ship, the aforementioned speed and with 10 deg rudder produces a lateral displacement of about 0.2 miles(it is calculated in 300 meters).

If we take in consideration - the speed with incident angle with respect to the shoreline (at least until the vessel has had head for 315 deg, then up to 21 41), the component of lateral displacement given by the sweet turning whenever the helmsman (for six times) corrects the bow rudder to starboard until it reaches 350 deg - it is clear that the master did not actually calculate this effect.

In fact, since when the Master took the command to switch to 0.3 miles. from the shoreline (as he later told) , the ship would have to sail for 0.9 miles, around 0.5 miles of distance from the coast, since at 21 39 the unit is 1.55 miles far from this.

The turn for 300 deg was ordered at 21 39 30 exactly 5.5 mins before impact, then at 1.45 miles from the shoreline. It is clear, therefore, that the late turn and repeated lateral movements generated every time was just the rudder angle (at least 5 deg) have cancelled the abundant miles of distance from the coast. The only lateral movement must have had an influence, given the kinematics of at least 0.6 miles. (0.1, then 200 meters every turn).

It is not clear if one of the members of the bridge team or the Master himself, has closely followed the navigation at the radar operating on the safety trim of 0.5 miles set on the apparatus in use at the time (as long as this distance had been taken from the largest rock of Scole, which outcrops clearly off the ground and then detectable to radar).It is believed that fundamental task didn't take care of it, as it would have resulted in a clear warning to those who followed the plotting, in addition, given the facts, the danger would have been reported even if the safety circle had been placed on the tangent to the coast in Scole rather than on the detached and outcropped rock (distant about a hundred yards out to sea).

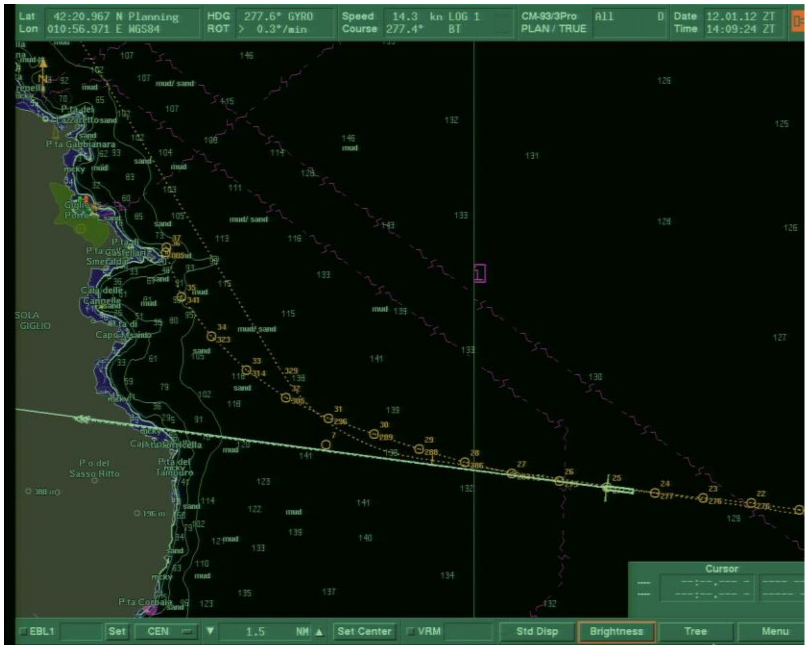
The audio recordings of the bridge, therefore, do not show any warning to the Master, or the master itself, for the entire stretch of navigation before the contact.

The dynamics of impact - also for the effect of breaches on the hull, their location relative to the entire port side, and by the fact that the first half of the vessel was already free (left fin, protruding for 8 meters, integrated and placed on the ordinate 180) - confirms the delay mentioned above, but at the same time the incidence of the rudder full to starboard 32 secs before the impact, preceded by the order of 20 deg given 5 secs before, shows that despite the hull already sailed in shallow waters, it could pass safely free from the rocks, if it would have been kept the heading of 335 deg (parallel to the coast), taken from the ship actually thirty seconds (30 secs) before the contact.

At 21 44 30, that is when the ship is still in turn gradually to reach 350 heading, the Scole are exactly 150 meters far from the bow (the ship is 809 mt off course.).Therefore, if we consider that the first half hull is then disengaged from the rocks before they spent the 37 "missing impact (occurred at 21 45 07), it is plausible that if in the last 32 deg rudder was left in the center, or slightly to starboard, the stern could have overcome the Scole without significant damage. As proof, it can be noted that from the ordinate nr. 150 till extreme stern exist 120 mts and that this distance is made in 15 secs, so it's just in the last 32 secs that hull feels the strong effect of the rudder to starboard, impacting violently with the ship's side, from the second half of the ship (the engine room then hits the rocks at exactly 21 45 15, in respect to the area of the ordinate 130,which collides at 21 45 07).

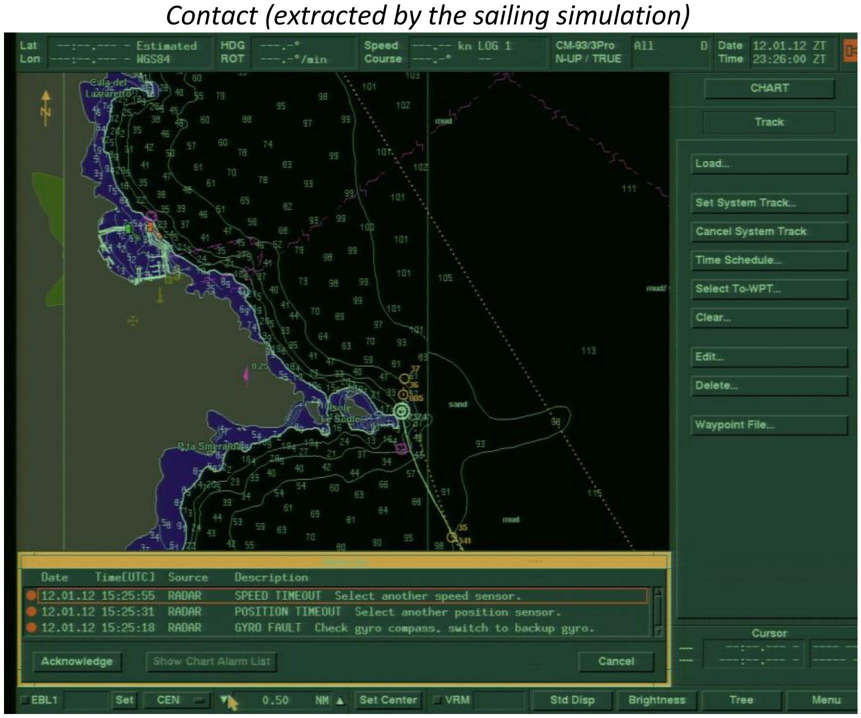
It should be pointed out, moreover, that wrong execution of the rudder order to all starboard, just few seconds before the impact, that was immediately corrected by the same helmsman initiative, has been showed to result not influent (see the same Annex no 42, carried out by the Trial Office Consultant Team).

- A computer simulation has been developed, taking information from various sources, such as witness statements, survey reports and VDR recording data available into account, to obtain a reconstruction of the manoeuvring before the event and the ship's behaviour after the event. This is a reconstruction of the track according to the data extracted by the VDR that was used to make a real simulation of the contact moment that we are going to see in few seconds . It shows the last minutes of navigation before and after the contact against the rocks. Again, to make this simulation, the engaged Company used the official data recovered from the VDR, that's why it is possible to have an actual knowledge of what exactly happened in terms of course/speed/rudder. In particular, the course is reconstructed by simulating manually the track made by the ship during the event and it demonstrates actually how close to the shoreline the course was held and how slow and soft was the related turn. The simulation of the contact was reconstructed by using a reconstruction of the scenario and the track we have just seen, as created into the simulator and the orders given by the Master to the helmsman as recorded and extracted by the VDR. The simulation is done in daytime in order to make visible how close to the shoreline the ship was and that , until the last moments, during the course, the Scole rocks are at starboard, rather than port. However a simulation in night time was made as well (see the video – Appendix no. 4 and statement in Annex no.16).

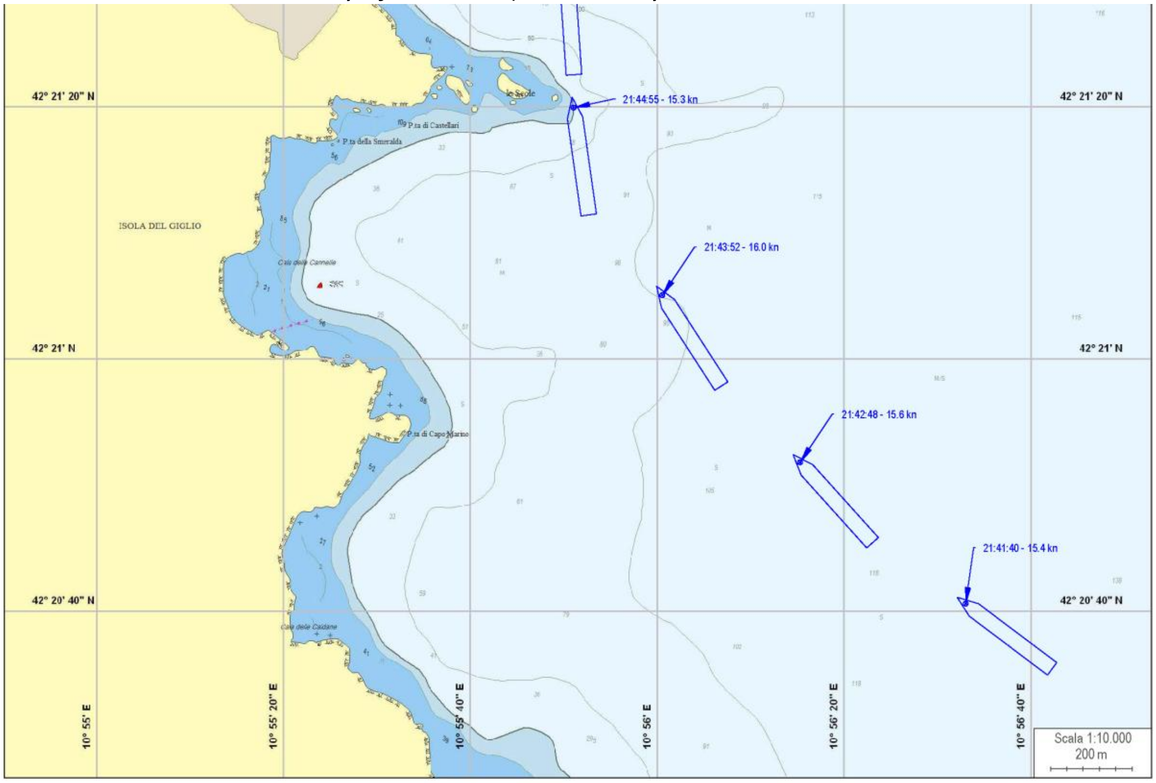


Overview of the track (extracted by the sailing simulation)

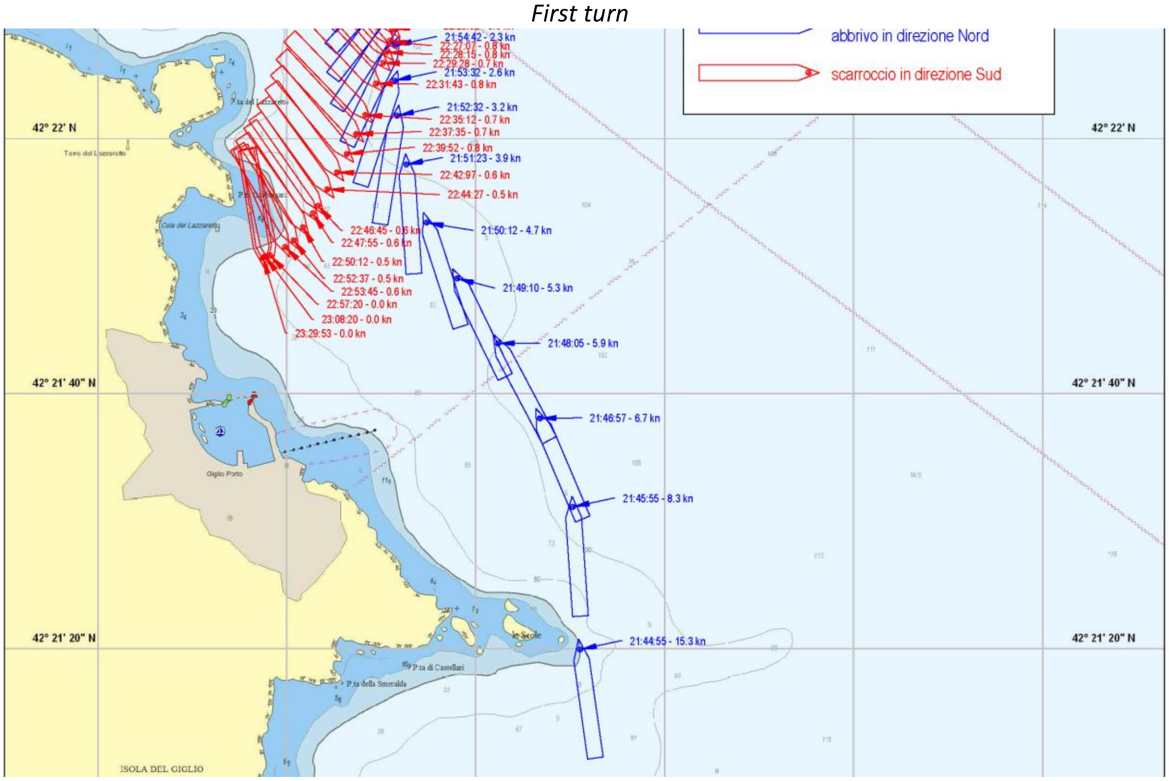
Contact (extracted by the sailing simulation)



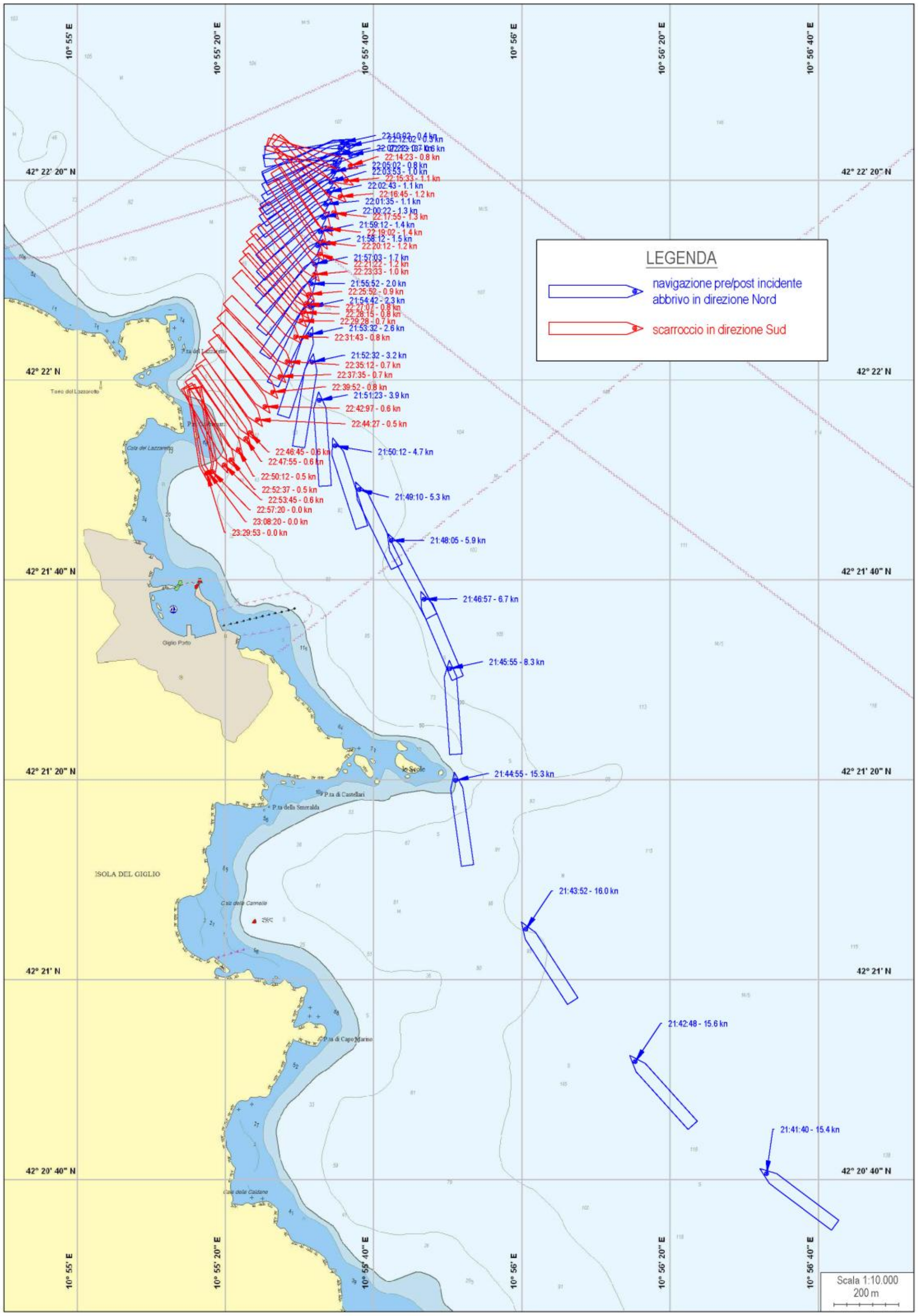
Summary of the track (extracted by the AIS data record



First turn



Second turn



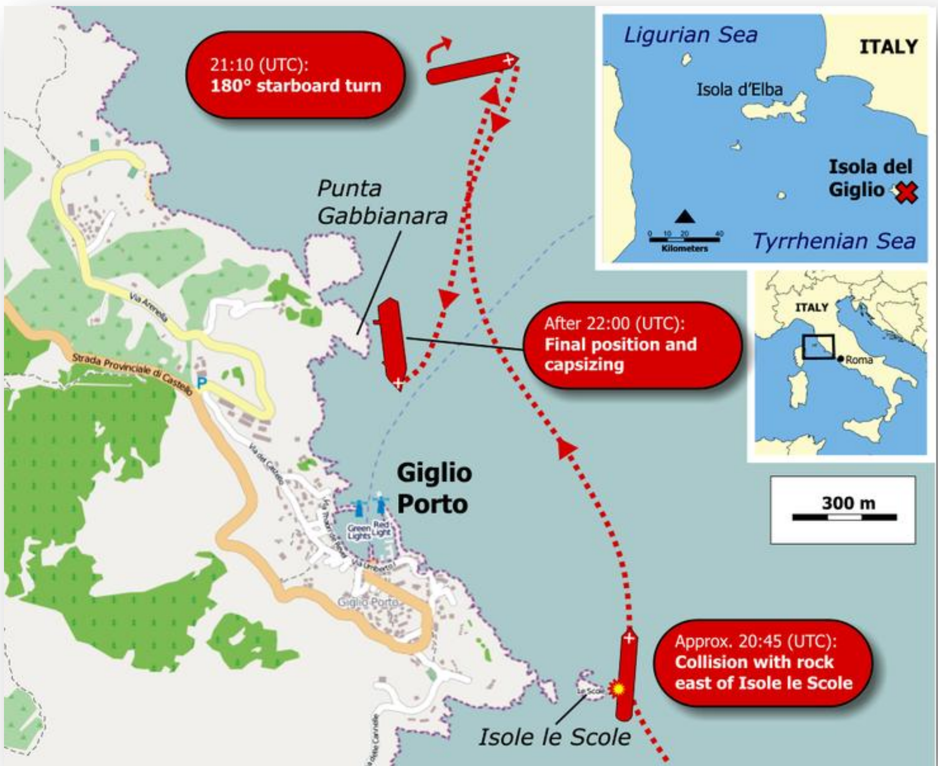
Overall track

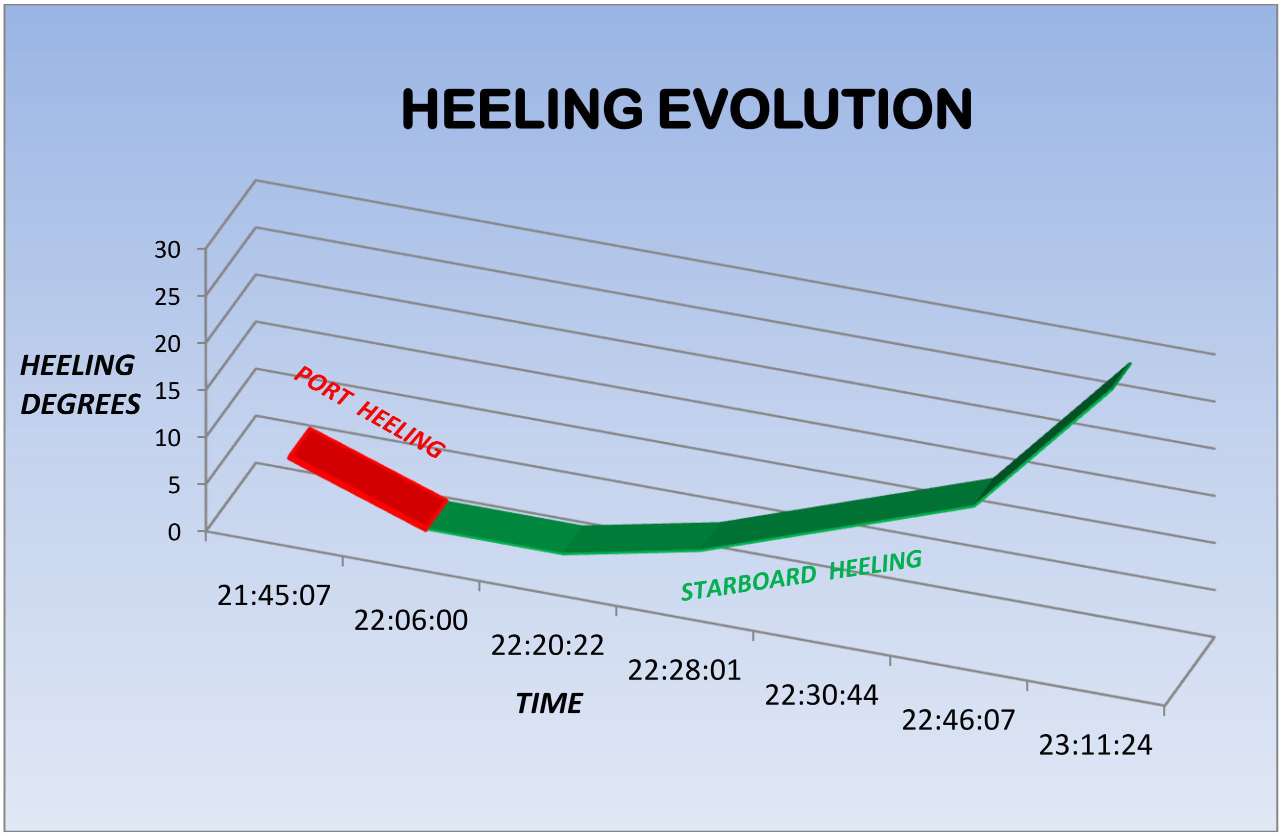
Finally, it should be noted that, despite the Master arrived on the bridge only about 10 minutes before the contact and was also distracted by a phone call, he still had the time to realize that the ship was proceeding insidiously toward the coast, and could therefore have time to correct the heading and speed.

Notwithstanding the negative overall performance of the Master , we must point out, indeed, that no concrete handover (see Annex 42bis) was taken in place by the Chief Mate, despite the Master:

- reached late the bridge , respect his own original willing;
- the bridge hosted guests and the Master was distracted, both for them and for having a call by phone;
- the ship runs fast and directly to the shore in not illuminated landscape;
- it was therefore too dark outside;
- the bridge (full closed with glasses) did not allow verifying, physically outside, a clear outlook in night-time (which instead could have made easier the Master eyes adaptation within the dark scenario).

4.5 Abandon ship




HEELING EVOLUTION
HEELING DEGREES
30
25
20
15
10
5
0
PORT HEELING
STARBOARD HEELING
21:45:07
22:06:00
22:20:22
22:28:01
22:30:44
22:46:07
23:11:24
TIME

A. Planned procedures/actions

SOLAS Convention establishes that the Company provides the Master with a Decisional Support System, to adopt in case of an emergency.

Costa Crociere has provided, its ships, with the procedure "P12.4-IO 2 SMS" "Decisional Support System for the Master" (Annex. 43), assigning to the Master the responsibility to apply the related procedures; however, pointing out the possibility that the Master can adopt other suitable measures, necessary in accordance with both the scenario and his own experience.

In case of contact-breach, the procedure establishes the following actions (some steps are not reported because these do not influence the analysis of the present casualty):

1. Second Master or the Officer on duty verify the damage;
2. When the breach has been ascertained, the related compartments must be identified;
3. The occurrence must be notified to the competent MRSC and to the Company (Fleet Crisis Coordinator e technical advisor);

4. The situation must be assessed and evaluated with the aid of “Damage control plan”;
5. The SCD (Team in charge to verify the damage) is sent to the zone interested by the contact-breach;
6. All measures according to the event, are activate (such as to isolate the compartments – to activate the equipments for pumping dry of flooding – to transfer liquids in other tanks) etc;
7. The “technical advisor” must be informed about the situation developing;
8. If the action taken is not sufficient, the assistance by the on site vessels and MRSC must be requested;
9. The General Emergency signal must be given, thus passengers and crew proceed for the planned gathering;
10. If retaining of persons on board is dangerous, procedures for the abandon ship must be taken, and scenario is monitored till the evacuation of ship is completed.

A black-out on board the ship occurred after the contact-breach; the above mentioned procedure “P14 - MAN 01 SMS BRIDGE PROCEDURE” establishes, moreover, the main actions to take in case of black-out, referring to the appropriate emergency check list “P.14 Man1-MO9 SMS” . This last procedure, divided in 14 points, establishes that, in case of “ship not under control (steering handling off)” and “risks for sailing” the related distress messages must be given and the passengers must be informed and reassured.

The “decisional support system” for the Master must be integrated with the procedures to carry out by the Company during the emergences phases; thus the Company must adopt adequate procedures to respond to the emergency situations on board its ships.

The above mentioned procedures are described in the document named ““Crisis Management Preparedness Plan – Operational & Reporting Procedure” (P15.6 IO 01 – Annex 44). One of the aims of this procedure (par 1.1.) is to provide the necessary technical and management support for the ship, during an emergency situation, through a “Crisis Committee”.

The support is assured by a specific organized framework, located in the Company, based on “3 Crisis Levels” (increasing according to the seriousness); the event that involved the “Costa Concordia” generated a “Crisis Level Three”; the Master, or his representative, is appointed to keep contact with the Company.

B. Actions taken on board

Particularly, during the emergency, different behaviour from the expected above mentioned procedures were noted. These are the following:

1. Due to the initiative of the Second Master, the damage assessment was carried out by the Officer who, according to the Muster List, should have given the Master support with regard to the stability of the ship and should have activated the Damage Control Plan.
2. According to the procedure related to the contact-breach, the Master should have appointed the second Master or the Deck Officer in duty to verify the damage.
3. The Damage Control Plan - which represents the guideline document for the action to take in case of breach – was not used to evaluate the possible actions to be adopted.
4. Partial information related to the entity of the damage was communicated to Leghorn MRSC.
5. The possibility to transfer the liquid in the available tank, to balance the ship, was not considered at all. During the emergency, the Master generically requested action to provide the balancing, but did not give specific instructions on how to take it and did not make an evaluation of the actual effectiveness of the eventual action (however, it must be taken into consideration that the related pumps were out of order due to the black-out).
6. The information given by the ship to the Leghorn MRSC was not an initiative of the bridge, and when communication with shore started, the actual situation on board was not stated; the distress alarm by VHF was not immediately launched to all ships in the area, in accordance with the procedure following a black-out; (the casualty occurred at 21.45.07, and the distress was launched by VHF at 22.38.27), but only after the request by the Leghorn MRSC, and at 22.40 by INMARSAT(55 minutes after the contact).
7. The general emergency alarm on board was given at 22.33.26, with great delay.
8. According to the procedure in case of contact-breach, no related actions were taken and, mainly, the general emergency in favour of the crew and the passengers was not promptly announced. The seriousness of the situation was already known by the Bridge team at 21.51 (6 minutes after the contact), but

the general emergency announcement was given at 22.33.26 (such as 48 minutes after the contact).

9. The abandon ship started at about 22.55, more or less the same time of the related announcement, in English, given by the Second Master at 22.54.10 via the public address system. This activity did not respect the expected procedure stated in the Muster List which says: “ORDER OF THE MASTER THROUGH THE PUBLIC ADDRESS OF THE SHIP, FOLLOWED BY A CONTINUOUS DOUBLE TONE SOUND (OR BY THE ALLARM BELLS), TILL THE SHIP EVACUATION IS COMPLETED”.
10. The Master informed the DPA, about the occurrence, at 21.57.34. This Representative reached the Company building to form the “Crises Team”, to support the Concordia Master.
11. The DPA, according to information received by the Master, contacted the Fleet Manager.
12. At 22.21 the DPA reached a manager of the Company by telephone, considering him the CMD (and the latter declares to be such), to inform this person about the situation. But according to the above mentioned procedure, the CMD was a different person, who was not immediately informed.
13. Only at 23.00 the Crises Committee was formed.

4.6 Decision-making

4.6.1. Emergency management

The emergency management is, in general, influenced by the correct management of the human resources, which depends on the recruitment of seafarers, their training, the arrangement of the Minimum safe manning and the Muster List, and the familiarization with the special duty assigned in case of an emergency.

That is why the development of the present chapter will be drafted on the base of the critical analysis carried out in the previous chapter 3.

4.6.1.1 Recruitment

As stated in chapter 3.1.1, the Company recruits the personnel assigned to Hotel department, via 25 external agencies spread in all the world (Annex 45).

The above mentioned activity is regulated by the SMS P.5.2109 procedure, which refers to the ILO regulations; and it is detailed in the requests and the selection procedure. However, after the ISM audit carried out by the Flag Administration in the Company headquarters (6 and 7 March 2012), the following weakness, which originated a specific "not conformity", have been found in the above mentioned procedure:

a. The procedure for the evaluation related to the recruitment of the deck and engine personnel does not provide for the assessment of the work language.
b. The procedure related to the recruitment of the personnel assigned to the complementary services does not provide for the assessment of the work language, when this personnel is engaged to be assigned in a task linked with the Muster List.

Recruiting the personnel through the external manning agencies – often situated in countries that have dubious or recent seamanship tradition – sets the problem for the Flag Administration of controlling the effective good quality of the recruited personnel.

The only tool, suitable to control the related process for recruiting abroad, is the ISM Code; although, the Company usually limits its influence by sharing the Manning Agency policy, which should also be subjected to audit by the Company itself.

When the MLC 2006 Convention enters in force and is fully implemented, it should consent a more adequate control of the Manning Agencies by the Administration (see Title I, Regulation 1.4 of MLC).

4.6.1.2 Language of work on board

To establish a language of work on board of a ship, which can be understood by personnel of 38 different nationalities who caters for passengers belonging to 26 countries, as in our case, is fundamental to consent communication necessary for the efficient running of the ship and above all, to assure that the expected procedures in case of emergency work.

Costa Crociere has chosen the Italian as language of work on board her ships.

This choice seems linked to the Italian flag of the all ships, and thus for the need to have the related documents (certificates, logbook, etc.) in the Italian language. If from a formal and practical point of view the choice made is not censurable, it could be open to criticism for other aspects, considering the multi-nationality of the personnel on board (38 in this case). To have chosen a more widespread, international, known and shared language, would have given, of course, concrete advantages for communication between the crew, and between the latter and the passengers, above all in situations where understanding each other is of fundamental importance.

As a matter of the fact, from the assessment of the events after the contact and from the statements collected, following considerations emerge:

a. The 1st Engineer. assigned to manage all the engine equipments (interview on 20 March 2012 – Enc. 384), of Bulgarian nationality, testified he does not fully understand the orders given in the Italian language (the work language), during the emergencies situations.

b. The helmsman on duty, testified with the support of an interpreter, (see paper n. 0267 of the Judicial Authority of Grosseto), that he did not at times understand the Master's orders despite they were in English.

c. The Radio Officer (testimony on 16 March 2012 – Encl. 383) testified, that while lowering of the lifeboat, the Boatswain gave instructions both in Italian and in English to the crew coming from South America.

d. The second Boatswain (interview on 30 March 2012 – Encl. 385) declared that they usually spoke In Italian and in when they did not understand each other, they spoke in English, whereas the Officers gave the orders in both languages.

e. The Safety Officer (see interview – pag.7438 and following in the folder of Grosseto Judicial Authority) proved to be quite confused about the SMS instructions related to the language of work on board.

f. The Safety trainer (see interview on 23 May 2012 – Encl. 393) testified that both Italian and the English were the language of work on board, and that the training activities were usually carried out in English.

g. Many USA passengers testified that during the emergency several crewmembers on duty in the muster stations were not able to speak in English.

h. Regarding this, it was also proved that the helmsman didn't understand, for two consecutive times during the last phases, the Master's orders in English.

4.6.1.3 Minimum Safe Manning and Muster List

A) Minimum Safe Manning

As already underlined, the Costa Concordia Minimum Safe Manning provide for 75 crewmembers.

We point out that - according to an assessment related to 50 cruise ships whose size is similar to the Costa Concordia, which approach the Italian ports - that the medium value of crewmember reported in the related Minimum Safe Manning is 50. We specify that this value is between 40 and 60 inclusive.

However, we point out that the above mentioned values seem to be different from the various Muster Lists taken into consideration, where there is instead an increase of crewmembers multiplied by 15.

This remark is fundamental if we relate it to the "certified qualities" of the persons reported in the Minimum Safe Manning, compared to those appointed in the Muster List; who however have special and sensitive tasks during the emergency management. With regard to this consideration, it is necessary to reflect about the requirements for Able Seafarers to Manage the Life Boats and Life Rafts (MAMS is the abbreviation of this seafarers certification in Italian – It means certificate of proficiency in survival craft and rescue boat).

B) Muster List

The Muster List assessment - which represents the pillar of the organization on board to face the various phases of the emergencies – has been developed according with the following criteria:

1. Assessment of Certificates/documents of evidence which are preparatory for admission
2. Familiarization with the specific tasks in case of an emergency;

3. Right assignment of the task, according to each crewmember qualification, particularly referring to the above mentioned MAMS certification.

Seafarers and the other personnel (engaged according with the Domestic law n. 885 on 1986) - according to the International Regulation (SOLAS and STCW Conventions), as integrated by the Italian Circular Letter no 17 on 17 December 2008 (Title “Gente di Mare” – Serie XVII) - must carry out the following requirements, before being assigned their special tasks on board:

- According to the Rule A-VI/1-1 of STCW Convention, personnel must obtain approved training on the survival techniques at sea, or receive adequate information and instructions related to the specific areas, named in the above mentioned rule; the requirements provided by this rule are satisfied, however, if the person has obtained the “basic training” certificate referred to the rule A-ViIi-2 of the STCW Convention (for persons who are not seafarers).
- To have obtained the “basic training” certificate (for persons who are seafarers).
- Moreover, he/she must receive suitable familiarization with the safety equipment of the ship and with the related procedures, this last requirement must be carried out through specific procedures, delivered by the Company who manages the ship (Knowledge of the ship).

Moreover, before being assigned specific tasks related to emergencies (being included in the Muster List), the person must familiarize with those related tasks, before the voyage starts; this requirement is in accordance with Rule 15 of Chapter II-2 SOLAS Convention (em. on 99-00) and with the Rule 19, Chapter III, of the SOLAS as well (em. on 2006). For particular types of ships such as passengers, the STCW Convention (Rule A-V/3) provides for an additional training which involves all personnel appointed to carry out specific tasks in case of an emergency. According to the assigned tasks, this additional training is related to the areas of “crowd management” and “crises management and human behaviour”, and moreover includes a special “safety training”.

Once more we state that, the “Basic Training” certificate is preparatory to being admitted to/included in the Muster List.

The above mentioned rule, related to the mandatory “Basic Training” certificate, has been adopted by the Company and the SMS procedure "P5.03.03 MAN1”, has also been endorsed. This procedure, in paragraph 4.8 points out that the personnel who has a valid

"Basic Training" certificate will however be trained on the above mentioned "Safety Training", but this personnel will be not employed for/will not take part in any active duty during the emergency and be included in the Muster List with a limitation in his/her employment. This person will be indicated in the Muster List with the following wording: "person without specific task". Including the above mentioned type of person in the Muster List - despite he/she must not employed for specific task - does not mean that he /she cannot be employed in specific tasks, if the Master however decides to do so. This opportunity is established by the SMS procedure "P1204 - /O 06 (paragraph 4.4.9.5), in which the "Team of persons available on board without specific task in case of an emergency" can be employed in specific tasks at the Master's discretion. We point out that these elements emerged during the audit of the Company, carried out in Genoa by the Flag Administration on the 6th and 7th March, as previously stated. Indication of personnel assigned to manage the lifeboats and liferafts, has been extracted from the Concordia Muster List. It was pointed out that this personnel must have the "certificate of proficiency in survival craft and rescue boat" (MAMS for Italy). The outcome of this specific verification during the above mentioned audit (fully reported in the Annex 46 and 47 both for lifeboats and liferats) identified the findings summarized as follows:

a. About the lifeboats,_the Muster List establishes the assignment of two persons for each lifeboat, as provided for the Solas regulation; according to the law for 52 necessary persons (taking into account that the lifeboats are 26), 34 of them are deck officers or certified seafarers, while 18 of them resulted without the MAMS certification, or their certification had expired because issued more than 5 years before thus considered not valid.

b. About the liferafts, there were 69 liferafts on board and none of the personnel was allotted to use 36 of these. For the other 33 liferafts (numbered 1 to 35, with the exclusion of no 13 and 34), 13 of them were managed by seafarers who were in possession of MAMS certificates, but personnel with either expired MAMS certificates or without the said qualification, were assigned to the remaining 20.

In conclusion, for both the safety equipment management (lifeboat and liferafts), the findings indicate that this equipment was only partially managed by assigned qualified crewmembers.

On this regard, several passengers from USA testified circumstanced situations about the inadequate preparedness with the safety procedures showed by more crewmembers on duty to manage the abandon ship, notwithstanding their commitment for an adequate relief to the passengers in the muster stations. Similar evidences can be found in the interviews to the press given by several passengers.

These judgments are, moreover, supported in general by two crewmembers belonging to Concordia, such as the Company, the Master and the Safety trainer. In the first case, Company claimed, during an own audit carried out in the last week of July 2011, the unsatisfied performance of the crew in a drill, which showed that the choice for appointing the crewmembers in the muster list, without the suitable familiarization, was not correct. The Master, after a drill for abandoning ship held on the 15 October 2011, warned the Company that the performance of his crew was decreasing and showed critical findings. The Safety trainer, during the interview carried out by the Leghorn Maritime Authority, confirmed to have caught, when embarked, the unaligned training of the crew and the lack of any evidence related to the training carried out on board, according with the ISM procedure, by the same crew. He immediately informed his hierarchy, and the Master reported him that the Company addressed the ship management for improving the training program on board.

Regarding the Deck Officers background, it is reported the related following evidence:

- Master resulted to be qualified as Master on board Passenger Ship according with the Regulation V/3 of STCW Convention and Section A-V/3 of the STCW Code on 2008. He was in compliance with the STCW requirements, because on 2008 he obtained the related competence certificate (mainly due to the seagoing service) to take the Command on Passenger ship. He, anyway, didn't attend any Bridge Resources Management (BRM) course, both for junior/senior officers and for staff Master;
- Master spent overall 16 years 11 months and 6 days of seagoing service;
- He was initially engaged by Costa Crociere on 16 April 2002 as Chief Mate on board Costa Europa and after 2 months and 6 days was promoted 2nd Master on board the same ship;
- Before the 20 June 2004, he spent two previous periods of seagoing service as 2nd Master for overall 14 months on board C/s Costa Vittoria and C/s Costa Tropicale;
- He took the Command for the first time on 26 June 2004 on board Costa Classica, spending over there a short period of 5 months and 2 days;
- He spent again a couple of years as 2nd Master;
- He was definitely promoted Master on 30 October 2006, spending a total of 3 years 9 months and 6 days till 13 January 2012;
- In summary the Master attended as Officer with Costa Crociere in an overall period of 9 years and 9 months, gaining a total of 7 years and 8 months of actual seagoing service with Costa;
- No remarks about previous failures resulted in his own log record of background (seagoing service), kept by the local Maritime Authority;

- The other Officers in charge have been trained at the Carnival Corporation C-Smart Training Centre (Amsterdam) as follows: Bridge Team Management course for one of the Staff Master (2010), the Chief Mate, the Safety Officer, one of the Second Officer, two of the Third Officers (all on 2011). Moreover the same Third Officer has been trained on NACOS ECDIS on 2011.

(All the evidence are gathered in the Annex 48)

The Company procedure for Training are drafted in the P5.03 SMS Procedure (see Annex 7). While before Concordia casualty the above mentioned courses were not mandatory, Carnival established effectively the following courses to be mandatory (Safety Standard), by the 1st September 2012 (Annex 50), for the Officers belonging to the Corporation:

- BRM (two levels);
- ECDIS-NACOS (two levels);
- Ship Handling;
- Stability;

Furthermore:

- Master and Staff Master have to attend all the above courses.
- Senior Officer on Watch the two levels of both BRM and ECDIS.
- Junior Officer on watch BRM and ECDIS 1st Level.
- Course for Instructor is recommended for the Master.

This Carnival Corporation new Safety Standard addresses the proficiency in details as well.

4.6.1.4 Abandon ship – emergency management

To obtain an overall overview that supports the reading of the following analysis - which is based on the operations carried out by the Master and the Crew of "M/N COSTA CONCORDIA" to manage the emergency, after the contact with the rocks and the subsequent abandon ship – it is necessary to briefly reconstruct the timeline of the detailed events, through the following table:

nr.	Time (L.T.)	Event	Note
01	21.45	Contact with the rocks	
02	21.48	Breach and flooding confirmed	
03	21.50	Flooding reaches the Deck A	
04	21.54	Public 1° Announcement to the passengers related to	

		the black-out	
05	21.55	PEM compartment (4) and compartments 5, 6 and 7 ascertained as flooded ,6 e 7	No distress or other securitee message yet
06	22.07	Concordia been contacted by Civitavecchia SAR Organization: Ship communicates only the black out, and is managing to solve the failure	Very serious scenario is held back
07	22.11	Ship at drift towards the coastline	
08	22.12	By public address, passengers receive order to reach the lounges	Crew and passengers move by theirself (without order) to reach the muster stations
09	22.13	First touch between Livorno SAR Organization and the Concordia occurs	
10	22.22	The ship asks for aid through two tugs 22 26 – Is the time when the Chief Mate communicated to the SAR Authority, for the first time, that a breach and a flooding occurred. This is an evident, very serious lye, because the breach was known by the 21 49 23.	
11	22.30	Flooding increases than to reach the Deck 0 (watertight deck)	Passengers, by herself, embark in the lifeboat
12	22.33	General emergency is announced	
13	22.36	Something like an "Abandon ship" is announced but the related sentence was not pronounced, even if the announcement stated only to reach with calm the muster stations, following the crewmembers instructions.	Passengers confirmed, testifying, that the abandon ship signal occurred after.
14	22.39 22.47	Ship in touch with the shoreline and grounds Master ordered to drop the starboard anchor	
15	22.54 22.55 23 19 34	Staff Master orders to launch the lifeboats and lifrats, after the main order by the Master Master ordered to drop the port anchor. Staff Master now announced the abandon ship. Master left the Bridge	
16	00.34	Master embarks in the lifeboat and abandons the ship	
17	00.41	Healing of the ship reaches 80°	
18	06.14	Evacuation of ship is completed	

No video, related to the security cameras deployed on board, are available because these are under sized by the Prosecutor for the trial.

It is necessary to put evidence, moreover, that the analysis drafted in the previous paragraph 3.4 identifies the following considerations referred to the actions taken both by the Ship and the Company.

Ship

- It is worth to point out, first of all, that the emergency was managed by the Master. Anyway, the related procedure according with the Decision Support System was not followed. More bridge staff members followed duties differently by the established procedures. All the remaining Officers – except the second Cadet appointed to reach the muster station - reached the bridge after the casualty.
- it is also worth to point out that all the Engine Staff and the Electrician Department (Appendix n 5), promptly faced, in a struggle way, the emergency situation, transferring all the information necessary to allow, to the Bridge staff, a continue assessment regarding the flooding, the propulsion and emergency powering conditions. These crewmembers, under the adequate proficiency in coordination of the Chief Engineer, ensured all the information, in details, with a systematic updating. The Chief Engineer, several times, spoke directly with the Master, as well. These crewmembers carried out, moreover, each effort in order to set, in vain, the main vital equipments into the flooded WTC, thus risking hard for themselves life. They remained in the area of bulkhead deck for several time, also after the flooding reached the bulkhead deck, despite they were aware that ship was lost. They left the deck 0 (ECR area), only when the bridge provided the related clearance. Electricians as well, and particularly the Chief of this staff, did an exceptional action to force the connection between the emergency diesel generator and the related switchboard, which worked thanks to them, despite in discontinuous way.
- The measures provided on the “Decisional Support System for the Master”, as well for the above mentioned bridge procedures (previous chapter 2.4.1.1),had not adequately taken place,
- The Damage Control Team (SCD) had not been put in place. The evaluation of the appropriate actions to manage the stability of the ship had not been carried out. The seriousness of the situation on board was not intentionally communicated to the SAR Organization;
- The Cruise Director arbitrarily sent the passengers away from the Muster Stations, requesting them to return to the lounges.
- The actions related to the emergency procedures were not carried out in accordance to the Muster List;
- Most of the deck staff was disoriented (may be for the extraordinary, almost unbelievable event). They, as key personnel, didn’t perform in they significant role;

- More crewmembers repeated those arbitrary order inviting several passengers, met in the corridors, to reach their cabins, saying that occurred only a black-out which should have been resolved soon;
- Passengers were not gathered in their cabins by the crew, as instead safety the procedures establishes in case of a general emergency occurred (this was proved by two passengers found still in live, three days after, on the deck 8, were there are not living saloon, but only cabins).
- Several passengers testified that also the internal zone of the ship both out of the cabin and in the living (salon, lounge, corridors) were always (also meanwhile the black-out) illuminated by the emergency lights. Instead, the same passengers claimed that their cabins were completely dark, due to black-out, and they tried to take the own lifejacket into the closet helping with the personal light/mobile telephone.
- The crewmembers appointed to address the passenger to the muster stations didn't address, at all, according with the procedures. There was chaos and confusion, lack of communication; in other words a complete disorganization, mainly because nobody by the bridge coordinated the emergency according with the muster list and the related procedure for abandon ship. Mostly of the passengers caught this evident finding, but they however testified that, despite the chaos and their scars familiarization with the emergency, crewmembers supported with humanity and effective actions to allow the passengers to go in the lifeboats/liferats and leave the ship ferried by the same crew.
    - It should be noted that 272 crewmembers out of 1023, were replaced by the 1st of December 2011. Among the above 272 are listed:
    - 12 embarked the same day
    - 6 embarked the day before
    - 1 two days before
    - 28 six days before
    - 58 embarked between one and around two week before
    - 62 embarked around three weeks before
    - 48 embarked around four weeks before
    - 44 embarked five weeks before
    - 21 forty days before.

(These information are gathered in Annex 51 , which includes also the crew list)

The above mentioned turn over interested mainly the crewmembers employed in the complementary services and very few key personnel of the crew belonged to the new comers. Among the last ones there were the Chief Engineer, the Hotel Engineer (both one month before), the 2nd Master in overlapping (2 days before), the Mate in overlapping, one third Engineer, the Environment Officer, one Electrician Officer (all between , and 10 days before) one Officer Staff Steward (six weeks before).

The above mentioned list is just to state that those replacements are to be considered irrelevant on regard to the resulting performance of the crew during the casualty.

If it could be correct to put in evidence that the crew, on the whole, gave an adequate performance in the core phase of the evacuation (ensuring transferring of the passengers till about 4 in the morning, when the ship was 80° listed and therefore in very dangerous conditions), is likewise necessary to point out the following items:

- Nobody of the crewmembers called the role (or attempted to) or the number of the passengers as they went on board to the lifesaving equipment (both lifeboats and liferats);
- It is enough clear that the lack of orders according to the Muster List addressing disoriented - of course - the crew assigned on the base of the Muster List, taking into account this specific emergency. Some contribution in the disorienting situation could be due also to the wireless communication system, which is not supplied by emergency power, but the key persons were all equipped with the PMR devices, and therefore those wireless breakdown was not influent. On this regard, in fact, it should be noted that the ship was in compliance with SOLAS regulation (II-2/21 4.5 and related Circular MSC 1/Circ. 1214) also in terms of portable radio equipment, addressed by the procedures included in the Annex 49 and in the related list of assigned mobile devices according to the Muster list.
- In reference to this, it is worth pointing out that UHF mobile radios switchboard were located - both on board of Costa Concordia and other sister and similar ships - under the bulkhead deck (luckily forward, close to the bow, in this casualty), and this is why it should be necessary to protect it, shifting it above (at least to the bulkhead deck) that equipment (see related recommendation at the following page 167);

- Several passengers claimed, during the interview, that a concrete practical instruction (drill) on the safety field, and first of all for the abandon ship, should represent a must. They said that if that drill would have been carried out for all passengers on board before the accident, rather than waiting the day after in Savona, most of them would have performed as for real the 13th January abandon ship. This would have avoided that day panic and contributed to reduce, at least, the chaos and confusion instead created. They said that the video conference held in the "Londra Saloon" when the ship was in Barcelona, was not enough. None practical statement/lesson was provided by the crew present in the saloon, and poor instructions in the video were related, as well, to the practical actions to do for the abandon ship. Crewmembers, instead, took care for recording, by the electronic red safety card, their attending to the conference.
- At this stage it is worth to point out that the procedure titled "Safety – training for the Crew" (p5.03.03 MAN1 SMS - last revision made on September 2011) establishes also the drills. The related pages 27 and 28 concern the crew drill for leak. It provides for a drill on the emergency consequent to a leak each six months. By some of the crew interview results that the last drill on the matter was carried out at the end of the year (there is no evidence about this item since records were lost because of the casualty).
- It should be noted that 1270 (those embarked in Savona) out of 3206 passengers attended to the "muster of passengers", while the remaining ones received by video the safety instructions (Annex 52 which includes also the passenger list)
    - For further information about the above light safety instructions:
        - 463 passengers received the above light safety instructions in Tolone (original route plan Marsiglia)
        - 456 of them in Barcelona;
        - 27 in Palma di Maiorca
        - 142 in Cagliari
        - 160 in Palermo
        - 688 in Civitavecchia.
- The "general emergency" announcement was not given with the right schedule, when the awareness of the scenario was known. The general emergency alarm would have permitted the gathering of the passengers and crew in the Master

Stations; this action, if carried out in the right manner, would have permitted to call the roll of all persons (passengers and crew) at the Muster Stations, ready for the possible abandon ship. In fact, despite the first warning about three contiguous WTC flooded, given to the Master at 22.01, he, in an unbelievable criteria, waited 32 minutes to launch the general emergency announcement, and three minutes later he launched one more announcement that was something like an abandon ship, but not so clear.

- The Master never considered the continue increasing of the heeling to the starboard side, and didn't realize the main meaning of the increasing flooding, which would have determinated very soon, when reached the bulkhead deck level, the related sinking. Flooding reached, in fact, the deck 0, at 22 29, and spite off this he waited 26 minutes more to launch the abandon ship.
- The Master showed not to have the appropriate knowledge of the ship vital equipment location. He ignored what main equipments were contained in the core of the ship. He erroneously confused the main switchboard with the emergency switchboard (this last was not located in any of the WTCs flooded but at the 11th deck).
- The Hotel Director failed his own fundamental role in a such serious emergency. He did not perform his duty because ignored that, occurring the flooding, he should have carried out the following tasks:
  - stay in charge for the assigned duty to coordinate, as competent appointed crewmember, the cabins and saloon, lounges, living and each work place into the related main vertical zone, the consequent evacuation;
  - gather all the related information coming from all crewmembers about the scenario, and consequently update the Master;
  - shouldn't have allowed that the Master would have given false communications to the passengers and crew, through public address, which fatal delayed them to reach the muster stations, despite he was aware that the ship would have sunk;
  - once he was aware that the emergency general signal was going to be given, he should have speed up the action to reach the muster stations.
- The signal (alarm) for the abandon ship was not given according to the right criteria. Moreover, rather than by the Master's voice, it was announced by the Staff Master. It occurred 21 minutes after the emergency general signal.

The above mentioned statements, regarding both the adoption of the general emergency and the abandon ship, identifies directly the other two main contributor factors (root causes) which caused, through their related delay, the victims in this tragedy. Nothing can justify the Master judgment, and nothing means, taking into account the dynamic of the event, the assumption according which the Master declared that he never would have evacuated 4.000 person on board until he was not so quite sure that the ship would have sunk.

In other words, if:

- the general emergency was been launched at 22 03 (a couple of minutes after the first information of three WTC flooded, given to the Master by the Engine staff at 22 01), meanwhile the ship was not listed at all, and persons could move easily;
- and at that stage, the passengers would have gained precious time to reach the muster stations (allowing at this stage even the call by the crewmembers assigned also for counting), preparing to get embarking in the respectively life equipments;
- such as all the lifeboats would be handled for lowering in very manageable condition, with all passengers almost ready on board of those lifeboats, waiting for the abandon ship signal;
- and the abandon ship could be launched 36 minutes after the general emergency signal (matching the second grounding, which occurred at 22 39), adequate to gather all persons in the capacious and suitable muster stations,

the passengers would be started to leave the ship meanwhile her had 13° of heeling on starboard, and after 33 minutes, when the ship would be achieved the 30° heeling (23 12), all of them could be reached their salvation out of the Concordia, in the same position (ship already stopped) where 32 persons instead dead, because mostly of them were trapped and the others desperate were thrown into the sea.

The analysis carried out with the flooding simulation detailed in the following Para 4.7, showed that, however, the increased heeling due to the suspended weight represented by the people who left the ship staying on the starboard side was only one degree, therefore not influent for the already seriously compromised ship stability.

Moreover it must be noted that, according to the rule established in the article 303 of the *Codice della Navigazione*, "*the Master cannot order the abandon ship in distress, if he does not carry out, without success, all the instrument suggested by the seamanship to save her, and without any consulting with the Deck Officers or, if they are not on the scene, the two best seafarers of the crew.*

The Master must abandon the ship as the last person on board, providing as soon as possible to put in safety the related documents and books, and valuable objects in his safekeeping".

Finally, regarding the above passengers' opinion in order the training performance of the crew, it is to be take into account, on the whole, that when the lifeboat lowering operation begun, the heeling of the ship was almost 20° (it was already red on starboard 15° at 22 46 07). Here to mean that, during the crucial phase of the lifeboats and liferats handling (by the time of 23 00), the related heeling was more than the approved/allowed limits of life equipments manageability [which is 20° respect a value of 30° (even more) already red at 23 11 24]. This means that those crewmembers, assigned to the abandon ship handling, operated in technical condition beyond the limits, giving however their best. Thus as the same passengers recognized, in terms of their humanity aid, although taking into account that mostly of them ignored, of course, the technical operation limits of those equipment, and therefore they could be mistaken the difficulties occurred to the those crewmembers.

Company (according with this technical investigation, it is intended the DPA, who was, moreover, the responsible in charge who kept the continue link with the SAR Authorities)

- After the acknowledgment of the situation on board - through the serious information received by the Master and although this was not in compliance with the related real scenario - the Company did not respect the obligation established by the article 19 of Legislative Decree 196/2005, which provides for an immediate availability of the Company the SAR competent Authority (IMRSC in Rome). As a matter of fact, the first contact with the SAR Organization occurred by the will of the above mentioned IMRSC at 22.36 (51 minutes after the casualty). The DPA, during the Prosecutor interview on 31st January 2012, ignored the knowledge of this obligation.
- The DPA ignored as well, according with his own testifying, that the WTC interested by the flooding contained the most vital equipment for the ship surviving.
- Even when the Company was in touch by telephone with the SAR Organization (contact at 22.57), the situation reported by it was not in compliance with the related information that the Company had already received from the Master.
- The SMS P15.6 IO 01 procedure “Crisis management Preparedness Plan - Operational & Reporting”, was not activated correctly. It is to point out that the DPA called a person as FCC, but this person was not the FCC instead assigned according with the above mentioned Plan.
- The above mentioned person covered however the role of CMD in the formed Crises Team, the night of 13 January 2012 (and the DPA recognized and was aware about the occurred mistake), assuming a specific task as person different from the actually appointed individual.

- The information given by the DPA to the Crises Team resulted at times ambiguous (it named a wrong compartment, the blackout was not communicated at the beginning, etc.).
- Subsequently to the communication given by the Ship, the Company was aware of the very serious scenario that had occurred on board, but it did not report it to the SAR Organization. Despite of this, the Company did not activate itself to address in the right way the information just reported to the SAR organization.
- At 22.07.23: the Company acknowledged that the information given to the Civitavecchia SAR Organization was wrong;
- At 22.07.38: the Company acknowledged that the ship had not request to that moment any aid, and despite of this, it did not activate itself in accordance to the situation.

  If there is a clear evidence that the Master, at 22 07, said to the DPA that the ship would not have sunk, thus minimizing and influencing the DPA for trust regarding a manageable scenario on board, although it was serious, it is likewise true that the Master, at 22 27 warned the DPA that the situation was bad, stating that three WTC (including the engine room) were flooded.

  Spite of those above mentioned serious warning, the DPA never thought (as declared during two interviews towards the Prosecutor) to speed up the Master to plan the abandon ship. Indeed, the discontinue dialogue between the Master and the DPA (meanwhile the Master was on the bridge), started at 21 57 58 and finished at 23 14 34, but it is worth to point out, that at 22:27 hours it was elapsed too long time since the Master was aware (at 22:01) about the consequences of the casualty and subsequently he should have informed properly the DPA in order to allow him to provide adequate indications about the emergency management.

  The evidence that DPA testified he was confident of the Master proficiency for solving those emergency, confirms that he didn't give any kind of support to the Master and never stressed him to decide for an immediate procedure to put in place for the abandon ship.

In summary, despite the Crisis Management Preparedness Plan (established by the SMS procedure P.15.6 IO 01) was taken in place, and the related shore side Crisis Committee was held (at around 23), the Company did not catch in a suitable way - due to the DPA poor competence and the Master who minimized the scenario - the right elements to correct the

Master errors, at least to stress him for an immediate abandon ship (even if at 22 27, only when the serious danger was realized).

4.7 Second grounding, flooding and stability phases

We may presume that the ship suffered a first listing to port side due to the damages; because of the huge water ingress, the water head caused the opening of the “cross flooding hatch” release (Compartment no. 6 – frame 84-96) allowing the flooding quite immediate symmetrical spread that lead to the ship’s righting.
Once the ship’s portside was exposed to the wind, most probably also due to the passengers assembling on the starboard side and to the life-boats outreach on the same side, the ship started listing to the starboard side.
Following the grounding on the starboard side we may therefore assume the definite loss of the ship’s stability and her subsequent lying on that side.

Grounding phase

It is worth to point out that the second grounding occurred in a sheltered area of the Giglio island results, according with the VDR data, enough fortuitous. The ship, as already showed, lost immediately her propulsion and even the steering; she only drifted, becoming not manoeuvrable. The already mentioned lucky consists in:

- the steering failure, which caused the block of the rudder on the starboard side, according with the last ordered given to the helmsman by the Master. This order was taken by the helmsman at 21 46 58. No more orders were given by the Master;

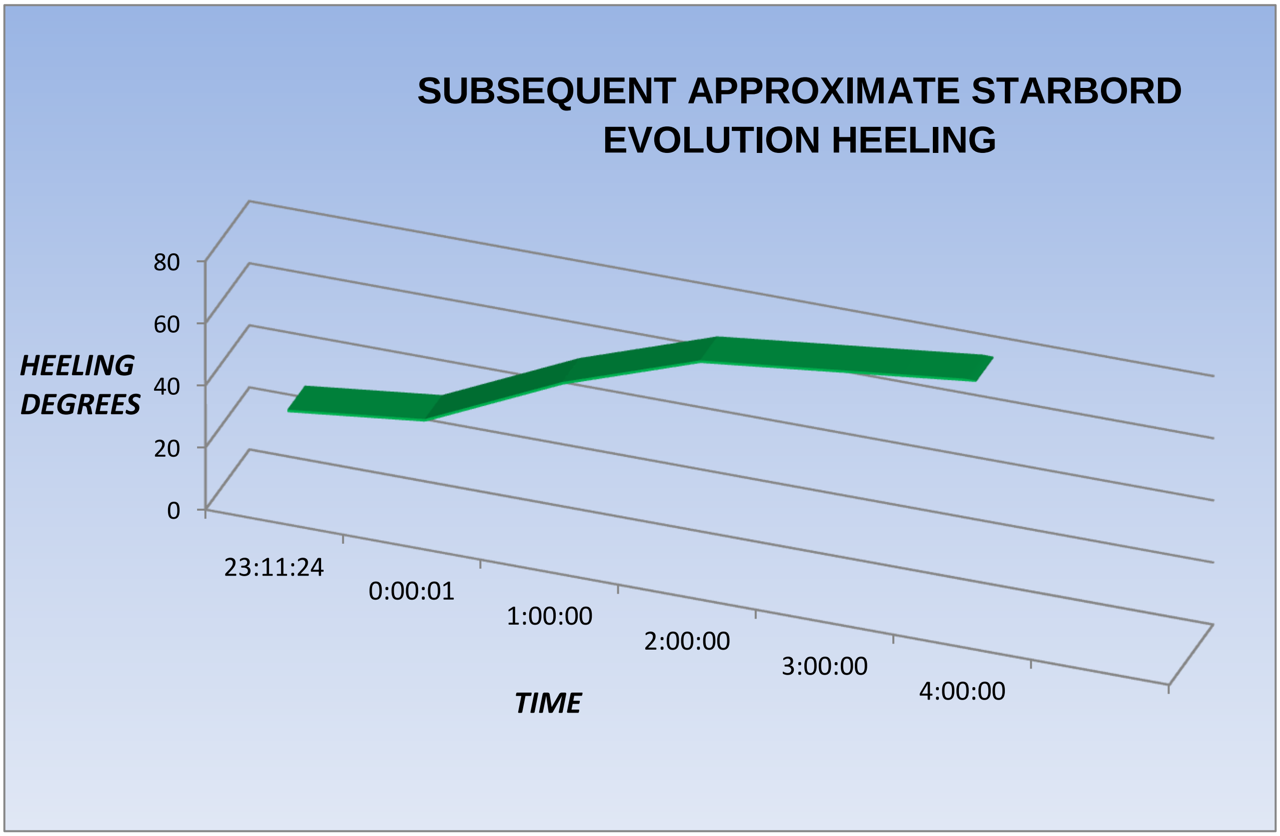
- the favourable weather condition in the area (wind and stream from significant from NE - the same that shifted the ship to SW respect the course, before the contact, without any consideration made by the Bridge team). The ship turned her drift to starboard at 22 08/22 10, pushed by the weather elements, addressing therefore her bow, again, to the Giglio Island. During this time, is recorded by the VDR that the Master did not any more orders for steering or spoke with someone else of his staff, to plan for manoeuvring the helpless hull towards the shoreline.

The Master thought only to send the Boatswain to the bow, to use in some manner the anchors, without stating, never, the related purpose.
Four more consideration we can do to show that he did not planned the manoeuvre at the end achieve:

- First of all it is need to point out that the rudder remained blocked to the starboard side, when the emergency switchboard failed the connection with the related emergency diesel generator. It was the 21.46.44, but we must consider that the VDR strings related to the connected utilities (excluded the bridge equipment where the UTC time was not affected by errors), were all effected by a delay between 7’ and 20”. This means that the last order made by the helmsman regarding the rudder all starboard (21 46 58) was executed just six seconds before the failure of the emergency source of power ;

- If the Master wanted to conduct the ship to the shore line (once known to have three flooded WTC), the most short course to approach the Island was turning to port, instead starboard. This shows that he had no intentions to conduct his ship, immediately, at shore to save people on board, rather than keeping her fair way by that, still credulous that Concordia was not able to sink, and his intention was to use the anchors to stop the course of the ship in a manageable depth, were she could however have floated, for saving not only the passengers, but also his vessel. In fact he ordered, at 22 01, the Boatswain at bow to manage the anchors (when was so soon to catch that the ship would be turn starboard, as after happened). The starboard one was lowered at 22 13, matching the turn ship, and the Master attempt to drop it at 22 17, because he realized that the depth was excessive (100 meters);
- The starboard anchor, when dropped (21 49), did not modify the course of the ship, because she had already stopped her drift (occurred at around 22.40), since she had touched the aft side with the rocks. It was dropped with two shackles at the sea, in the beginning, and eight shackles were lowered at 22 55); when the Master asked the confirmation about the shackles at sea (21.49), the Boatswain added that the ship was already stopped (because she had already grounded with the stern. At 22 55 the port anchor was dropped as well;
- If the Master, who ignored at that time that the rudder did not work, would have kept it in the midship position for some seconds more, Concordia would have continued her course to north, with more serious consequences.

In few words, we confirm that there is no evidence about Master intentions to approach the shore; rather than we realized his opposite will to keep her floating, as he meant when declared to the Prosecutor that he never would unload 4.000 persons till he was not so quite sure that the ship would have sunk.

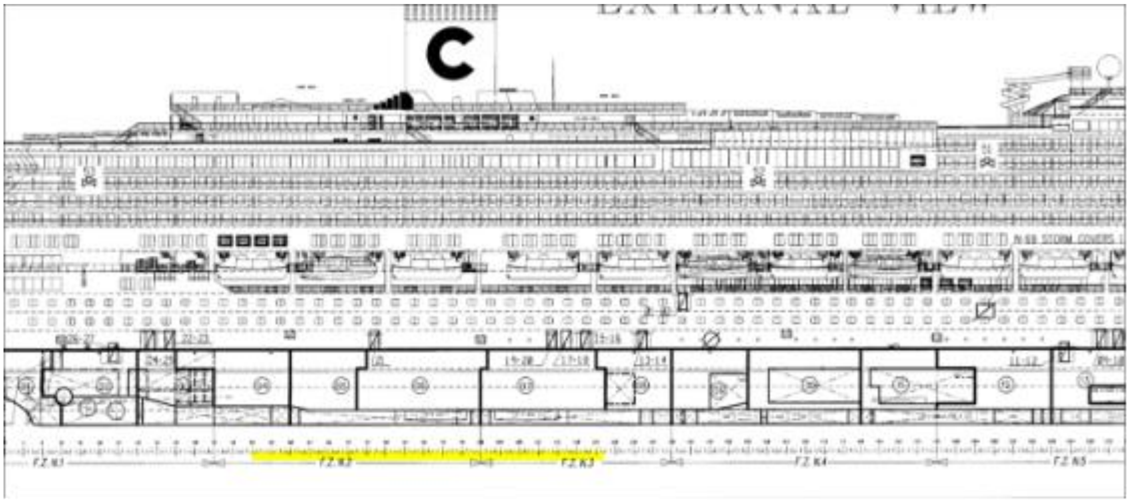


4.7.1 Breach and flooding – Preamble

(For the details related to this issue, see Appendix no.6)

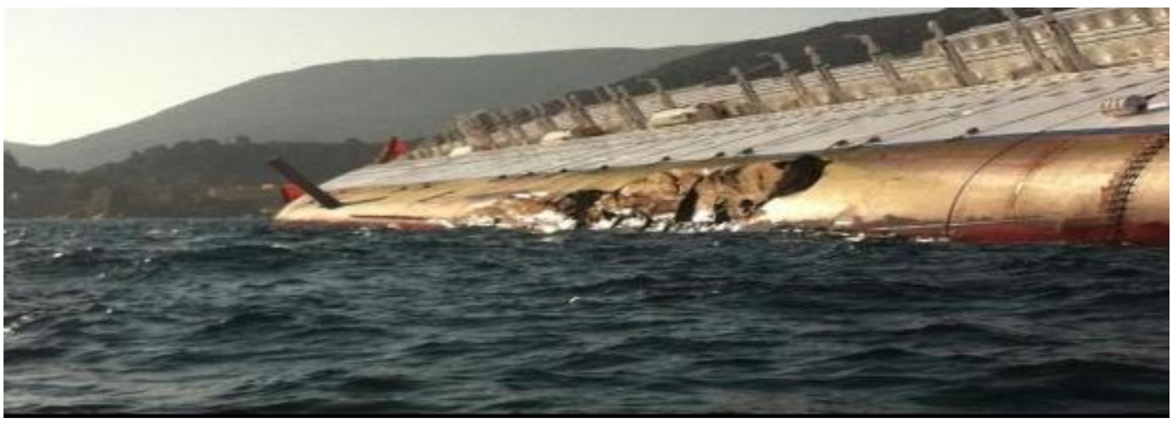
The release of the extraordinary kinetic energy (216,000 Kj[5] - Annex 53) due to the weight of 56,600 tons of the ship - which was sailing at angular speed of over 16 knots [because to the linear advancement of the hull must be added the additional acceleration due to the sudden turn to starboard (ordered at 21 44 20 and completed at 21 44 35, or 22 seconds before impact] - has resulted in an disruptive contact with the rock, which weakened the side and has ripped (torn) due to the simultaneous advancement of the ship. The friction was such strong that the speed, immediately and regardless of subsequent arrest of propulsion was halved at same time.

[5] An average of 216,000 Kj dispersed equivalent to 25,000 Kw of power transmitted to the rock during the contact, corresponding to 250 Tons of thrust



Following pictures show the hull area interested by the contact (taken from sister ship Costa Serena):

The hole on the left side upon impact, it is continuous for about 60 meters (about frames 52 to 124) located too far above the deck of the Double Bottom (so well over two meters from keel line). This was crucial in terms of severity of the accident, because rather than be hit the bottom of the ship, if the more defence due to the double hull, was vice versa affected area clear that, over the plate rail, relies directly its operating compartments (the heart). In particular, the testimonies of the 3rd Engineer Officer and 2nd Engineer Officer, as well as the 2nd Chief Engineer) - combined with audio recordings of communications between the VDR machine and Bridge - have established that in a few minutes (about 3 mins for the EMP and 7 for Diesel Generators Room. aft) the ship has lost Watertight Compartments (WC) nr. 5 and 6 (PEM and then Local DD.GG. aft), while the adjacent WC nr. 4 and 7 (respectively Compressors Galley Room and DG Room), were initially partially flooded, becoming initially dangerous free liquid water surfaces, and then completely filled after about 40 minutes from the contact.



The water appears to have also affected the adjacent WC nr. 3 and 8 (respectively Local Stores and Local Evaporators), which consists of more than free liquid surfaces, hazardous for the purposes of further reduction of the dynamic stability.

The first information about three WC completely flooded reaches the bridge 15 mins after the contact.

At the epilogue, the flooding is, in total, amounting to over 20,000 tons.

This stage is characterized by a series of combinations that led to the immediate and irreversible state of flooding of the ship beyond manageable limits. Indeed, in addition to the two adjacent compartments that were flooded in a few minutes (PEM room, nr. 5, in just three minutes) - which already represent the boundary condition for buoyancy for the purpose of abandon ship safely - impacted significantly on the stability of residual flooding in the two adjacent compartments. In fact, WC 4 and 7 have further burdened the ship until the Bridge 0 (bulkhead) has not reached the same level of the water line outside, and before that they also filled up (40 minutes), determinated huge free liquid surfaces [the first (nr 4) more serious because larger and with few machines that could break the continuity of the liquid surface], affecting the conditions of residual stability of the hull.

The free liquids surfaces, therefore, have determined the first relevant heel to starboard, which is increased more and more with the water income in the adjacent WC nr. 8 and 3 in the latter partly due to the water that had access from above (Bridge 0), the various vertical openings from Bulkhead (0) lead to the Bridge (45 minutes after the heeling to starboard is recorded in 10 deg). Finally results that the water, for the latter effect, have affected the WC 2.

The evidence (the 3rd Officer Engine), and sound recordings, give as pertinent watertight door open at the time of the accident, the nr. 24, namely the one that puts in communication the preparation buffet room (under the Bridge 0) and the elevators for the transport of food to the upper decks. There is currently no evidence if that door, controlled by the Martec system executed immediately after the contact was closed or not.

Following pictures taken from sister-ship C/s Costa Serena:

WTCs nr. 6 and 7 (depth view) sight from 5th

WTC 5 sight from WTC 6

WTC 6 sight from WTC 7

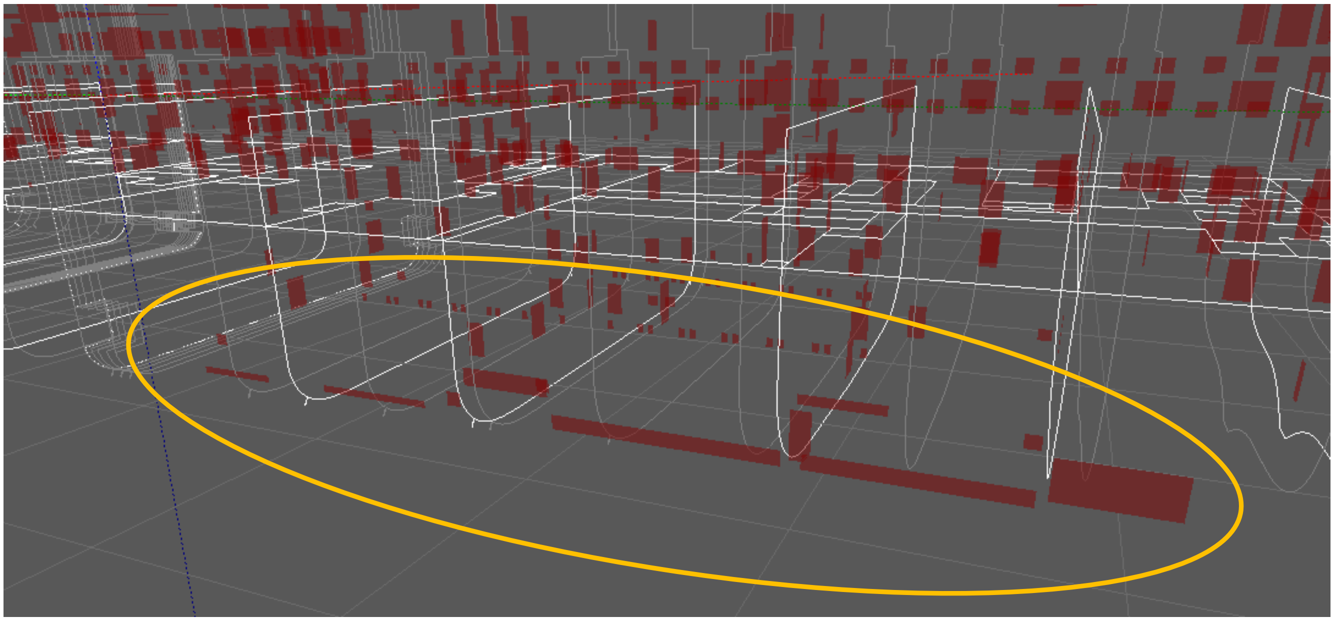
4.7.2 Description of the damage

Rock moment

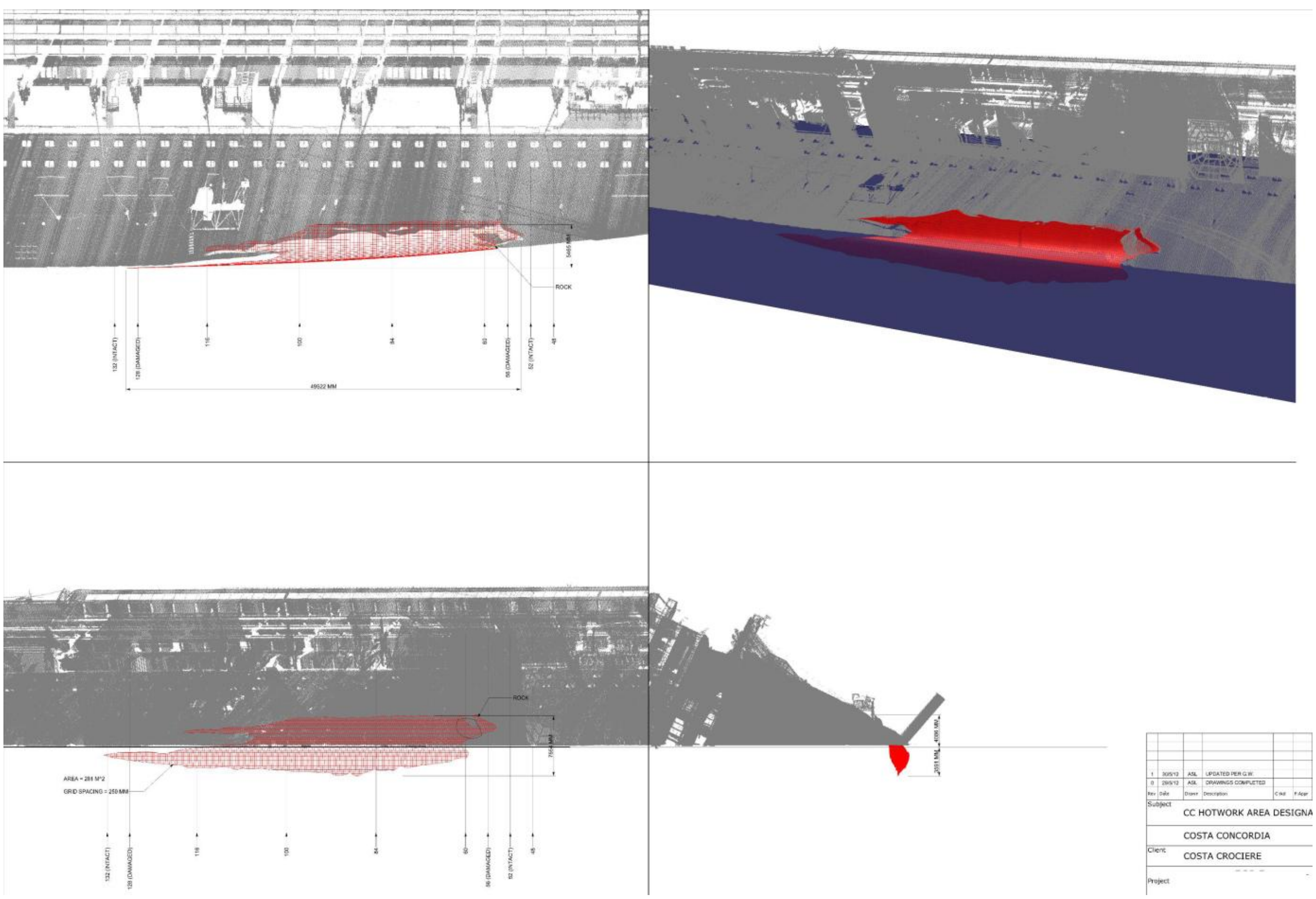
Detached rock in damaged area

An assumed density of 2.7 tonnes/m3 has been used to estimate the buoyancy of the rock to allow the submerged weight of the rock to be applied in the moment calculation. It has been estimated that the transverse centre of gravity of the rock is at 10.7m from the centre line of the vessel. The calculated moment is applied in the simulation at time 213 seconds which is at the end of the first grounding event.

Assumed damaged extent (according with flooding simulation)



Main damage breach openings



Survey data from salvers

According to the VDR data it results that the impact of the ship against the rocks of Le Scole occurred at 21.45.07 hours, immediately after the Master's order "hard to Port".

The damage to the hull structure, after the surveys carried out to the emerged and submerged ship's port side, resulted as follows:

In the area above the water line the shell plating breach openings ran from the frame no. 52 (area where the rock got stuck into after having been torn) until and over the frame no. 101. We can say again that the openings involved the watertight compartments no. 4,5,6 and 7 getting them into direct contact with the sea

In the out water section, apart from the breach running from frame no. 52 until frame no. 101 the bilge keel was torn away, the latter located in way of the ship's bilge strake from frame no. 106 until frame no. 82/83, in way of the bilge keel doubled on shell. It has then been ascertained a further rupture in the shell plating running from frame no. 116 and no. 118, under the bilge keel that resulted bent against the ship's shell plating, in way of the double bottom. Such rupture assuredly involved the water ballast tanks that are located from the frame no. 100 until the frame no.140, as marked on the General Arrangement Plan no. WBDIOC and no. WBDBIIC.

Further to the impact the shell plating, in way of the bilge strake and the ship's port side, suffered deformations and tears.

According to the photogrammetric investigations carried out and, considering that in the area interested by the damage the frame interval is equal to 725 mm, we can deduct that the deformed part extends in length from 413 mm forward of frame no. 124 until 330 mm aft of frame no. 52, for a total length of 52,943 m.

It then would result that in such area there are other breaches, the main one having a length of 35,859 m and running from 4 mm forward of frame no. 101 up to 330 mm aft of frame no. 52.

The breach vertical extent stretches from the bottom/bilge strake up to 1 m under the waterline level (blue stripe on the ship's side). It would therefore seem that the bulkhead deck (deck 0) was not directly involved by the rupture occurred on the shell plating

Besides the above mentioned main rupture, further five smaller damages were noted, out of which four (marked in the report with letters B,C,D,E) within the main rupture extension and another one (marked with letter A) forward of the latter. This latter rupture mainly stretches from stem to stern for a length of about 1.120 mm and a height of about 50 mm and it is across the frame no. 116 (starting 722 mm forward of frame no. 116 and ending 398 mm abaft the same). We have therefore to point out that due to such relatively small openings the water leakage interested also the port side double bottom, which is communicating with the stbd side double bottom, of watertight compartment no. 8.

Summarizing, if we consider the main and the smaller openings, the watertight compartments involved by the flooding since the impact would seem to be 4: nos. 4,5,6 and 7 i.e. from the watertight bulkhead in way of frame no. 44 to the watertight bulkhead in way of frame no. 116, for a total length of 52,943 m.

The compartments no. 5,6 and 7 double bottoms resulted flooded too.

What above, with respect to the openings occurred, is schematically outlined in the drawing here below:

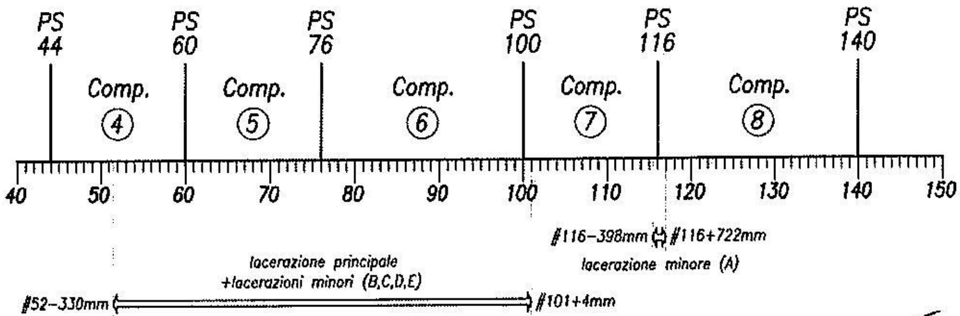


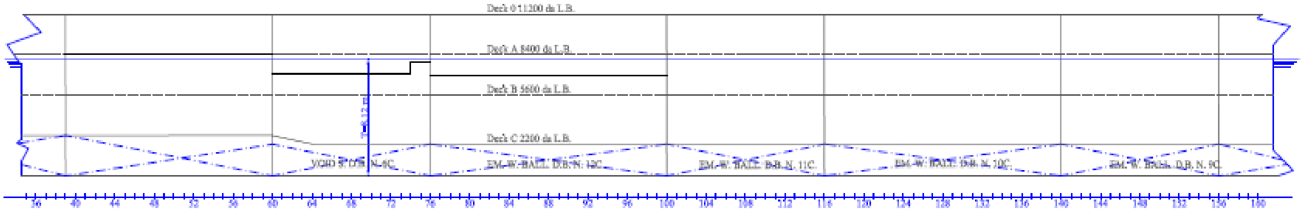
Figura 33

This damage is the cause of the flooding occurred to four contiguous compartments whose damage extension is considerably exceeding the one provided by the relevant regulations regarding the subdivision and stability checks in flooding (two flooded contiguous compartments) that is 10.710 m (ref. FINCANTIERI Booklet APN no. 320024 “INTACT AND DAMAGE STABILITY” approved by CDS no. 3211 dd. 10th March, 2005).

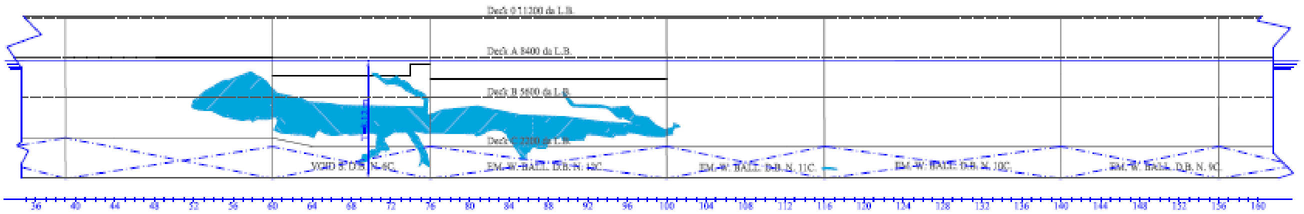
A draft of the damage assessment suffered by the ship, as resulting from BST report, was supplied from Costa Crociere to MCIB in June 2012.

In order to immediately appreciate the position and magnitude of the breaches occurred as a consequence of the impact, please refer to the following drawings:

Compartimentazione nave nel piano longitudinale a murata



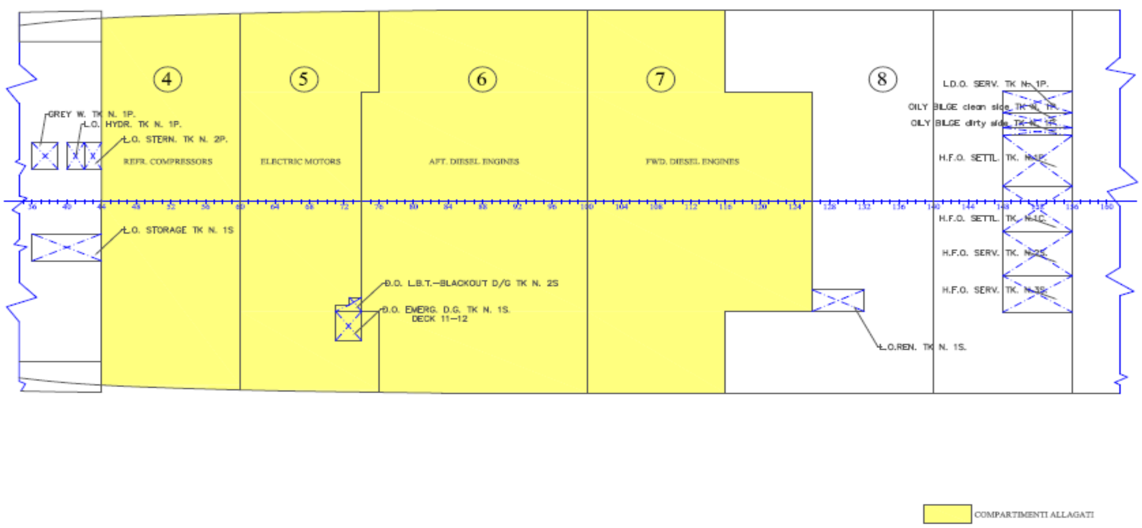
Proiezione sul piano longitudinale della falla principale e di quella minore a cavallo dell'ossatura 116



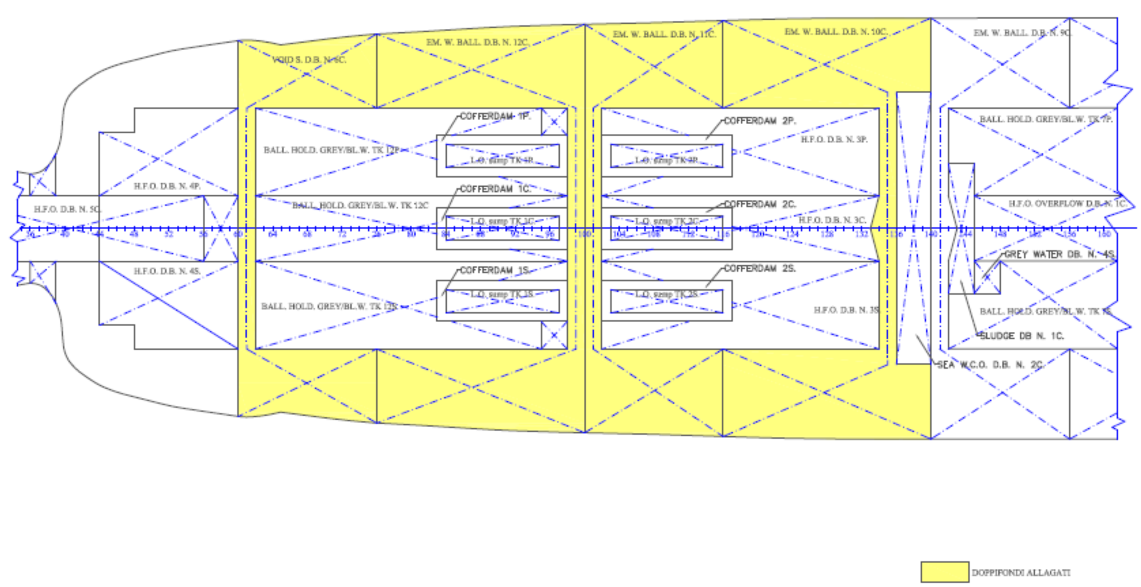
Where it is represented the longitudinal section involved by the damage upon which the shell plating breaches have been overlapped, according to their accurate assessment.
In the same table there is also the subdivision of the compartments and double bottoms in way of the shell plating, in order to immediately visualize and understand the ones flooded directly from outside,

And where it is possible to see the flooded compartments in way of Deck C;

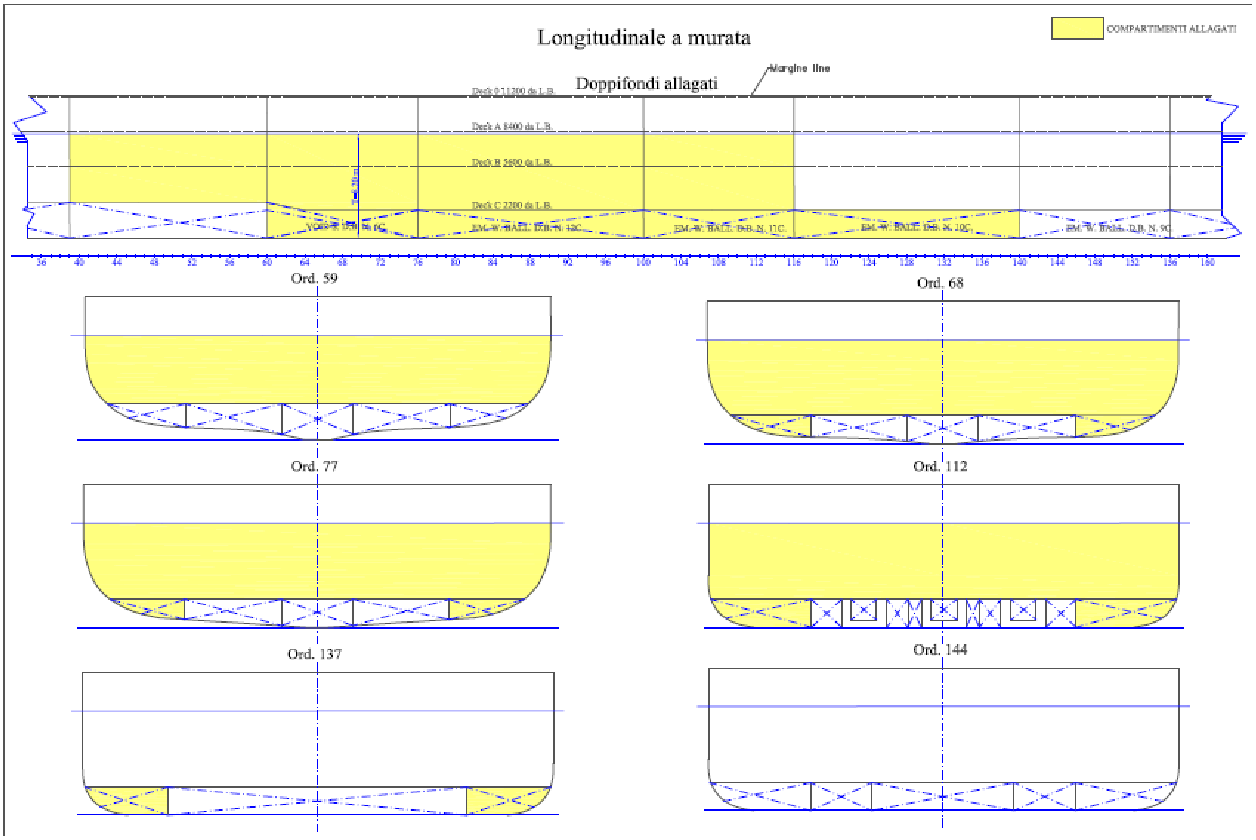
Deck C



Double bottom



Here it is possible to view the flooded compartments with their relevant extension from side to side (the central double bottoms have not been involved by the flooding).



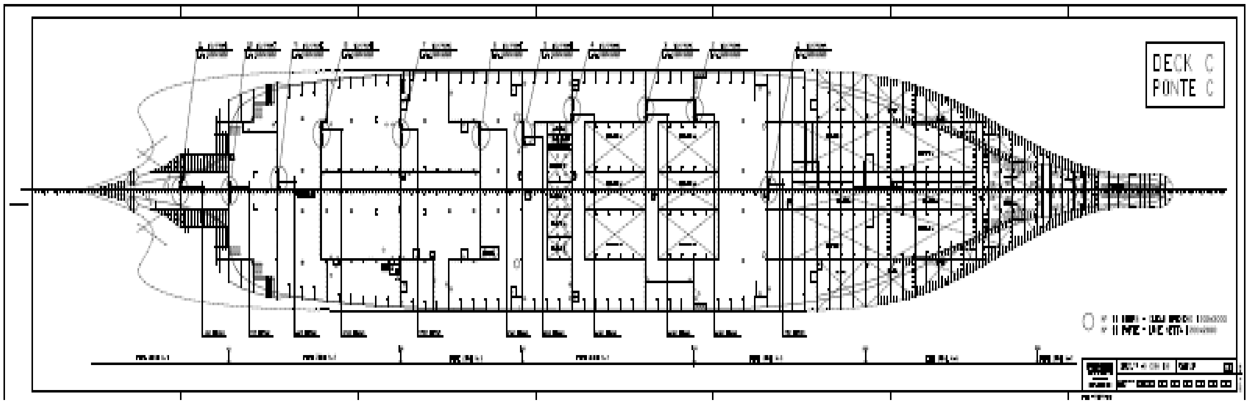
Here in this pictures the yellow parts represent the compartments and side double bottoms immediately flooded from outside at the time of the impact both on the longitudinal plan at side shell and in significant transversal sections too.

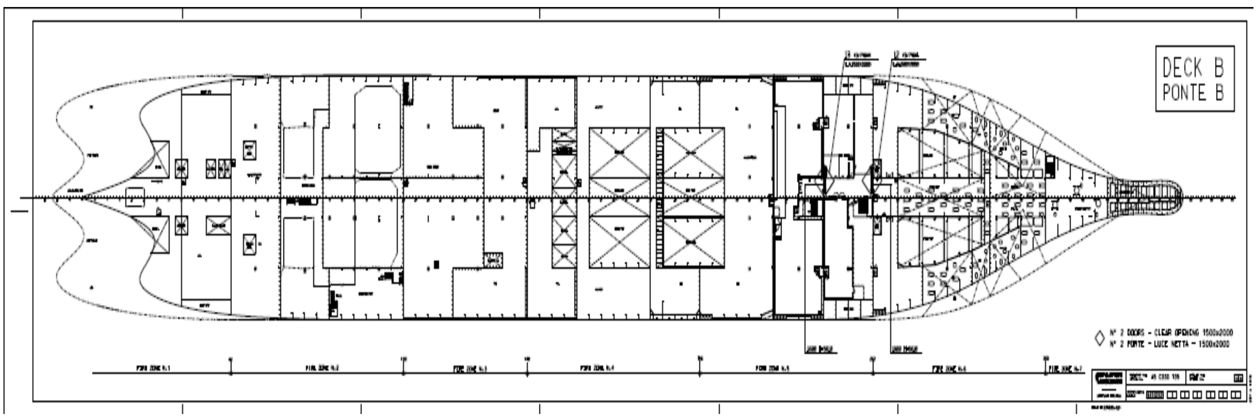
In the previous tables it was also possible to visualize the m/v COSTA CONCORDIA isocarenic even keel trim on a longitudinal plan at the time of the casualty, equal to 8.12 m, relevant to the loading conditions at the departure from Civitavecchia on 13th January, 2012.

Furthermore, in accordance to the collected witnesses, it would result that also the compartment n. 8 had been flooded up to Deck A.

4.7.3 Watertight doors

The watertight doors are located in the subdivision of the following compartments represented below:





A useful information concerning stability is the state of watertight doors within the range of time before and during the contact. These data are extracted by the VDR and they confirm that at 21.45, at the time of the contact, the watertight doors were all closed. This gives confirmation to the declaration delivered by the Third Engineering in duty at the time of the accident in the area interested by the breach.

In particular watertight doors 6,7,8,9,10 connecting the flooded compartments.
The only exception are watertight doors 12 and 13, in the laundry department, which connected watertight compartments not involved by the flooding in any case.

LEGENDA (per ogni porta): colonna n.1 - stato sensore porta ($PMS1)
colonna n.2 - stato porte stagne rilevato ogni 16 secondi ($PSWTD)

PP = Allarma Power Pack ($PMS1)

Voltage = Fault da mancanza di alimentazione di potenza

O = Open
C = Closed
X = Extra Open
M = Intermediate (né su fine corsa aperto, ne su fine corsa chiuso)
F = Fault

ORA LOCALE	PP	WTD1	WTD2	WTD3	WTD4	WTD5	WTD6	WTD7	WTD8	WTD9	WTD10	WTD11	WTD12	WTD13	WTD14	WTD15	WTD16	WTD17	WTD18	WTD19	WTD20	TD21	WTD22	WTD23	WTD24	WTD25
21.45.00																										
21.45.01																										
21.45.02		C																								
21.45.03			C																							
21.45.04				C	C																					
21.45.05						C	C																			
21.45.06								C																		
21.45.07									C	C																
21.45.08	NORMAL										C	C														
21.45.09													O													
21.45.10														O	C											
21.45.11																C	C									
21.45.12																		C								
21.45.13																			C	C						
21.45.14																					C	C				
21.45.15																							C			
21.45.16																								C	C	
21.45.17																										C
21.45.18		C								M																
21.45.19			C	C																						
21.45.20					C																					
21.45.21						C	C																			
21.45.22								C	C																	

(More detailed extracted by the VDR in Appendix 6)

4.7.4 Splashtight doors

On the bulkhead deck (Deck 0) are located nine splashtiqht doors, three of which (STD 5, STD 6 and STD 7) are positioned within the damaged zone (Le. the zone interesting wt compartments 4. 5. 6, 7 and 8) respectively at frames 116 (P and SB) and 100 (P).
All the other six STDs are Iocated outside the damaged zone. No one of the nine STDs Is Iocated at the boundaries of the damage zone (meaning that they do not connect damaged and undamaged compartments).
The assumed status of the Splashtight doors (taken from VDR data) at the time of the first grounding event is listed in Table 5. Doors with an OPEN" status are considered open and do not restrict the flow of water, white doors with a "CLOSED” status are considered closed and are assumed to teak and then collapse once the relevant collapse pressure head has been achieved as detailed in section 3.2

Splashtight Door Status

Door Number	Location (Frame #)	Deck	Status
1	252	0	OPEN
2	236	0	CLOSED
3	232	0	CLOSED
4	220	0	CLOSED
5	116	0	CLOSED
6	115	0	OPEN
7	100	0	OPEN
8	28	0	OPEN
9	12	0	OPEN

The splashtight doors can be seen in Figure A to C

Splashtight Door plan Deck 0 aft

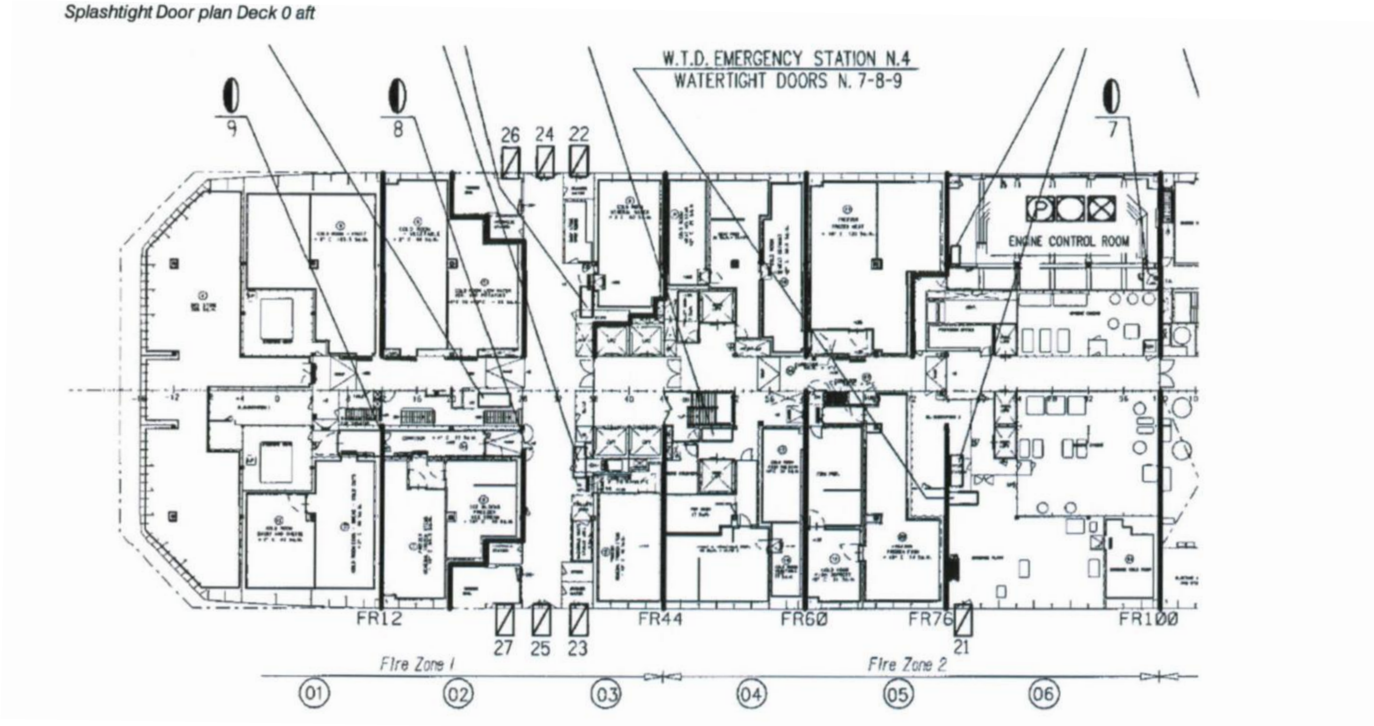


Figure A

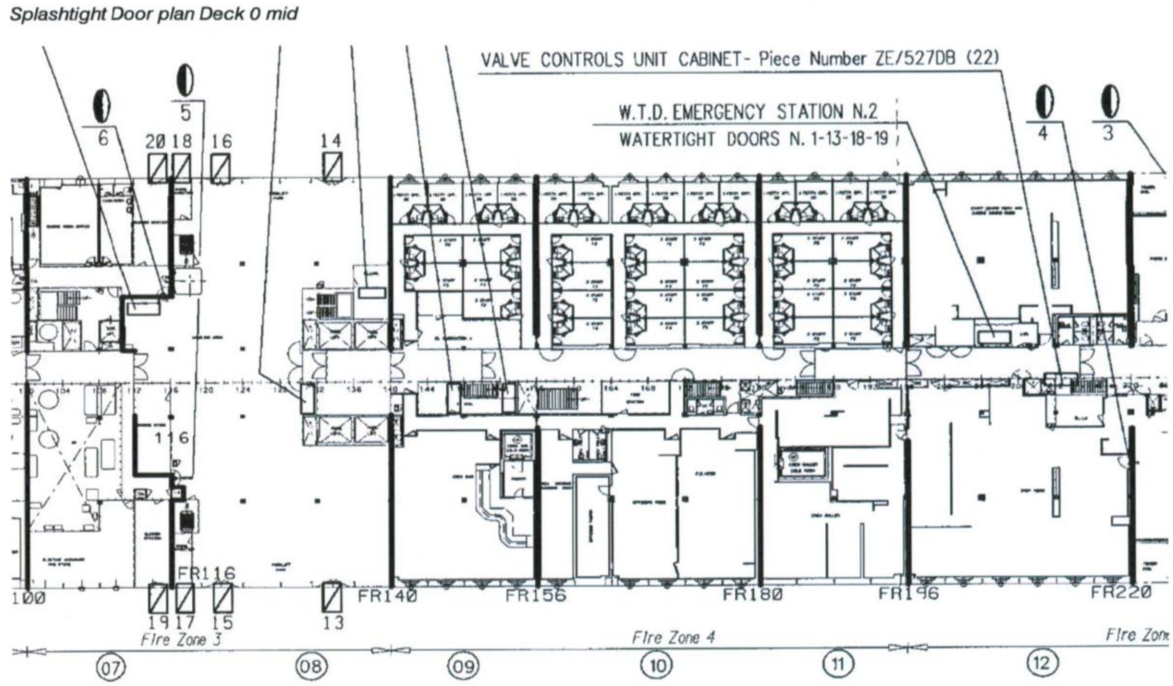


Figure B

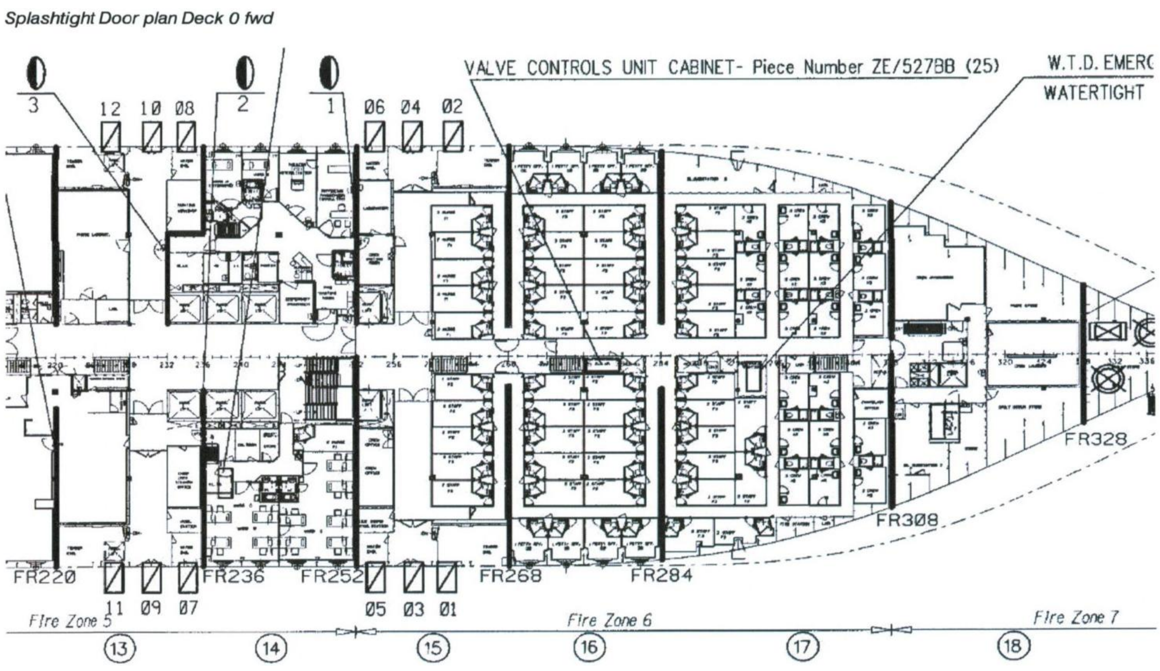


Figure C

(More detailed extracted by the VDR in Appendix 7)

4.7.5 Bulkhead deck permeability

In such a situation the bulkhead deck (Deck 0) is partially submerged in the aft side so that there are 12 water ingresses (flooding points marked by a red dot).

On the area of the bulkhead deck not yet submerged there are anyway other 22 potential water ingresses (yellow dots).

Thus the progress of flooding through these accesses would have led to the ship's sinking.

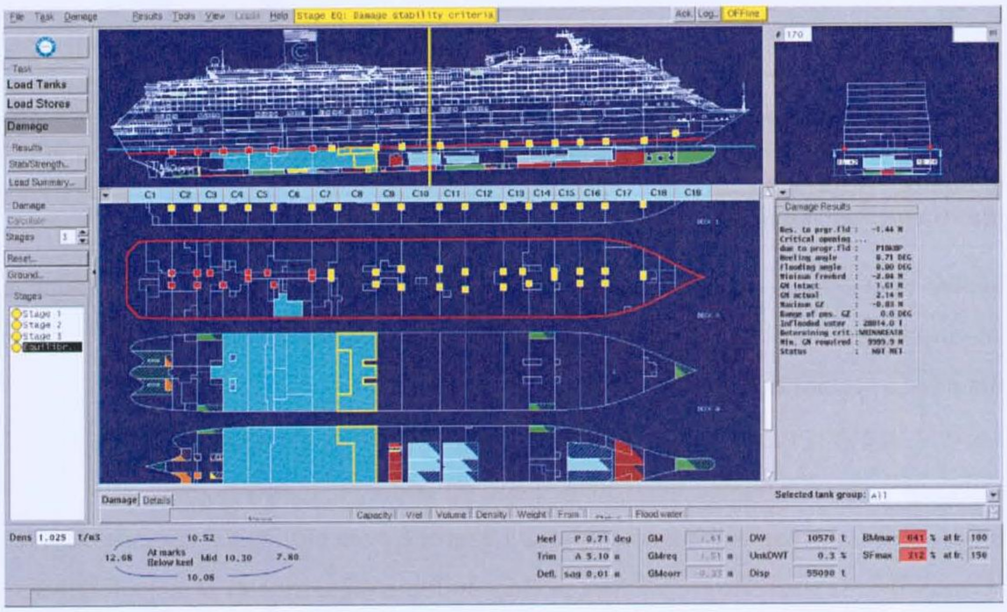


Figura 34

4.7.6 Consequences of the internal compartments flooding

The tear in the ship's shell plating is extraordinarily large.
The bulkhead deck (deck 0) has not been directly involved by the breach on the shell plating.
The main breach directly involved the compartments no. 4, 5, 6 and its dimension caused their immediate flooding (some square metres openings in the shell plating).
The main breach directly involved the compartment no. 7, in way of the ladder space connecting Deck 0 with the Deck C and with such dimensions to let us believe that the flooding of the compartment no. 7 took place progressively.
The main breach directly involved the double bottoms listed on the General Arrangement Plan SDB6C and WBDB12C and with such dimensions as to cause the immediate flooding.
The secondary breach stretches across the frame no. 116 and in way of the bilge keel reasonably caused the progressive flooding of the double bottoms located at the frame no. 116 and listed on the General Arrangement Plan WBDB10C and WBDB11C.

Summarizing, if we consider the main breach and the secondary one, as quoted above, the compartments subject to flooding since the impact are four, those marked with 4, 5, 6 and 7 jointly with the four double bottoms reported in the General Arrangement Plan SDB6C, WBDB12C, WBDB11C and WBDB10C here below detailed with their extent and highlighted in yellow in the previous tables.

Watertight compartment No.	Max limits of watertight compartment (in frames)	Watertight compartment at side shell (in frames)	Services on main watertight compartments
4	From 36 to 60	From 44 to 60	Reefer compressors room
5	From 60 to 76	From 60 to 76	PEM room
6	From 74 to 102	From 76 to 100	DDGG no. 4,5,6 and main electrical switchboards room
7	From 100 to 126	From 100 to 116	DDGG no. 1,2,3 room

Double bottoms	Double bottom maximum extent (in frames)
SDB6C	From 60 to 76
WBDB10C	From 76 to 100
WBDB11C	From 100 to 116
WBDB12C	From 116 to 140

4.7.7 Bilge pump functionality

The enclosed diagram (Annex 54)shows the position of the bilge pumps and their availability in respect to the standard extension of damage (i.e. involving two wt compartments). For such a diagram the following explanations should be taken into account:

- the flooding of the couple or wt compartments 1/2 , 2/3, 15/16, 16/17, 17/18 and 18/19 is not indicated because for these the same consideration/consequences indicated for the flooding of wt compartments 3/4 and 14/15 (as pertinent) apply;
- the location and the relevant source of electrical power of the bilge pump is reported in the upper part of the diagram;

The capacity of the bilge pumps is the following:

- XA 405: Q= 240 m^3/h H= 25 m
- XA 483 B: Q= 265 m^3/h H= 20 m
- XA 483: Q= 240 m^3/h H= 20 m
- XA 405: Q= 240 m^3/h H= 25 m

Additional "direct suctions" (as required by regulation II-1/21.2.7.1 of Solas Convention 74 (em 89/90)) were fitted in wt compartments 6, 7, 8 and 12 as follows:

- XB/050A -Steam dump sea water circulating pump -Q= 500 m^3/h H=13 m (wt compartment 6)
- XB/050B - Steam dump sea water circulating pump - 500 m^3/h H=13 m (wt compartment 7)
- XB/039A - Engine system sea water circulating pump - 1300 / 1017 m^3/h H=17 / 10 m (wt compartment 8)
- YB/494D - Air conditioning sea water circulating pump - 1050 m^3/h H=8 m (wt compartment 12)

As drafted in the present report no bilge pump worked considering the occurred extraordinary casualty, despite engine staff tried to start them.
Therefore, notwithstanding the above, discussion on the bilge system is not considered relevant in respect to the magnitude of the accident occurred.

4.7.8 Stability

Applicable Regulations

The ship, in accordance with her class notations and the date her keel was laid, is subject, as far as stability is concerned, to the regulations here below listed.

Subdivision

In compliance with the provisions of Art. No. 57 – Para no. 2 Book II of D.P.R. dated 8th November, 1991 no. 435 the Chapter II-1 of SOLAS 1974 Consolidated Edition 2004 applies, most notably:

Part A
Regulation. 1 “Application”
Regulation. 2 “Definitions”
Regulation. 3 “Definitions relating to parts C, D and E”.

Part B-1
Regulation. 4 “Floodable length in passenger ships”
Regulation. 5 “Permeability in passenger ships”
Regulation. 6 “Permissible length of compartments in passenger ships”

Regulation. 7 “Special requirements concerning passenger ships subdivision”

Ship’s intact stability criteria

The DPR dated 8th November, 1991 no. 435, Para. No. 1 of Art. No.60 Ship’s intact stability criteria Book II - “Construction and arrangement of ships” provides:

“All ships, in intact conditions, shall have enough stability in accordance with the area of navigation and such criteria shall anyway satisfy the Classification society requirements”.

RINA rules for the classification of ship (Ed. 2004) have been therefore applied, as far as the passenger ship’s intact stability criteria are concerned, the latter requirements including also those contained in the Intact Stability Code, Resolution A.749 (18) of IMO.

Furthermore, the Rule no. 22 of Chapter II-1 of Solas “Stability Information for passenger ships and cargo ships” was concurrently applicable.

Damage stability

The DPR dated 8th November, 1991 no. 435 Art. No. 60 “Ship’s intact conditions stability criteria” Para 2 Book II “Construction and arrangement of ships” provides:

“All ships that, in accordance with Art. 13 – Para 5 and Art. 57, must comply with the subdivision regulations and shall have, under all service conditions, such intact conditions stability criteria so as to be able to withstand the final stage of flooding in the hypothetical flooding damage provided for these ships under the convention”.

Furthermore Art. 61 Damage stability reads as follows:

“The passenger ships previously mentioned in Art. 60 para. 2 when in a final stage of flooding shall comply with the required stability conditions provided by the convention”.

Due to the above the following regulations of Chapter II-1 of SOLAS 1974 Consolidated Edition 2004 applied i.e.:

- Regulation 8 “Stability of passenger ships in damaged conditions”
- Regulation 8-3 “Special requirements for passenger ships, other than ro-ro passenger ships, carrying 400 persons or more”.
- Regulation 23 “Damage control plans in passenger ships”, according to the latter the following regulations of Chapter II-1 Part B of the Convention applied too:
  - Regulation 12 “Double bottoms in passenger ships”
  - Regulation 13 “Assigning, marking and recording of subdivision load lines for passenger ships”
  - Regulation 15 “Openings in watertight bulkheads in passenger ships”
  - Regulation 17 “Openings in the shell plating of passenger ships below the margin line”
  - Regulation 17-1 “Openings in the shell plating below the bulkhead deck of passenger ships and the freeboard deck of cargo ships”
  - Regulation 20 “Watertight integrity of passenger ships above the margin line”.

Stability test

The DPR dated 8th November, 1991 no. 435 Art. No. 62 “Stability test” provides:

“Each ship shall be subject, under the classification society surveillance, to a test in order to assess the stability criteria”:

a) After building completion

b) After the completion of modifications that, in accordance with the classification society, considerably changed the stability criteria.

The stability test was carried out in accordance with the requirements of RINA rules (Ed. 2004), Part B, Chapter 3, Appendix.

Stability information to the Master

The DPR dated 8th November, 1991 no. 435 Art. No. 63 “Stability instructions” provides:

“All necessary information shall be supplied to the Master so as to allow him to rapidly and clearly assess the stability adequacy in all service conditions”.

The Master instructions booklet has been drawn up in compliance with what provided by RINA rules (Ed. 2004), Part B, Chapter 3, Appendix, complete with the admissible GM/GK curves as required by Para 7.2 of Regulation 8 “Stability of passenger ships in damaged conditions” in Chapter II-1 of SOLAS 1974.

A similar requirement is also provided by Rule 22 of Chapter II-1 of SOLAS “Stability information for passenger ships and cargo ships”.

Resolution A.749(18) describes the “stability booklet” preparation and specifies that (para 2.2.1) a loading computer may be used as supplement to the approved stability booklet.

Also Rule II-1/8 (SOLAS 74 Consolidated Edition 2004) provides that a loading computer (or similar equipment) may be accepted by the Administration.

According to all above, we wish to point out that the regulations applicable at the time (and presently too) did not mandatorily required an additional supplement as aid to the Master in order to check stability in case of flooding.

Approved documentation

In compliance with the requirements of above mentioned regulations Fincantieri arranged and RINA approved the following technical documentation:

- FINCANTIERI Booklet no. APN 320026 “FLOODABLE LENGTH CURVES” approved by CDS no. 3212 DD. 18TH February 2005
- FINCANTIERI Booklet no. APN 320050 “STABILITY MANUAL – ART. 35 approved by CDS no. 5924 dd. 22nd June 2006
- FINCANTIERI Booklet no. APN 320057 “INCLINING TEST REPORT AND LIGHT SHIP DETERMINATION” approved by CDS no. 5818 dd. 12th June 2006

In accordance with Chapter II-1 of SOLAS 1974, as far as subdivision is concerned, the ship results to be associated to a criteria Cs = 80.487 and to a factor subdivision F=0.386.

With reference to the subdivision and as resulting in FINCANTIERI Booklet no. APN 320026 “FLOODABLE LENGTH CURVES” approved by CDS no. 3212 dd. 18th February, 2005, the transversal bulkheads position is such as to satisfy the maximum permissible length curves, therefore complying with SOLAS 1974 Consolidated Edition requirements 2004 on passenger ships buoyancy compartment.
With reference to the damage stability, as the factor of subdivision is F=0.386, according to the Rule 8.1.3 of Chapter II-1 of SOLAS 74 Consolidated Edition 2006, the ship must comply with all the damage stability criteria in all conditions of loading with passengers as included in FINCANTIERI Booklet no. APN 320050 “STABILITY MANUAL – Art. 35” approve by CDS no. 5924 dd. 22nd June, 2006, concurrently with damages involving two contiguous flooded compartments. The latter compliance can be evinced in FINCANTIERI Booklet APN no. 320024 “INTACT AND DAMAGE STABILITY” approved by CDS no. 3211 dd. 10th March, 2005 and APN no. 320025 “DAMAGE STABILITY CROSS FLOODIGN” approved by CDS no. 3211 dd. 10th March, 2005.
We wish to underline that the diagrams contained in FINCANTIERI Booklet APN no. 320050 “STABILITY MANUAL – ART. 35” approved by CDS no. 5924 dd. 22nd June, 2006 relevant to the comparison between the envelope curves of minimum permissible GM with those relevant to the actual loading conditions and between the envelope curves of the maximum permissible KG with those relevant to the actual loading conditions, show that the ship meets the intact and the damage stability criteria with a wide margin.

4.7.9 Flooding simulation

In order to investigate the ship’s behaviour after the impact against the Scole, Costa Crociere appointed a technical bureau *Safety at Sea* (Glasgow) for conducting a flooding simulation on the time domain.

Safety at Sea drew up a technical report “COSTA CONCORDIA – FLOODING SIMULATIONS” dd. 5th September, 2012 (herein as Enclosure 1a attached to the Appendix no 10 and a related video).

The aim of said simulation is to provide further understanding as to the ship’s behaviour with respect to the flooding dynamics.

The simulations have been performed using a six degree of freedom time domain software (translations and moments on axes X, Y and Z) capable of modelling vessel dynamics in both

intact and flooded conditions, considering external influences such as waves and/or external forces and moments through time.
The flooding simulations have been developed with information from various sources i.e. witness statements, survey reports and VDR recording data.

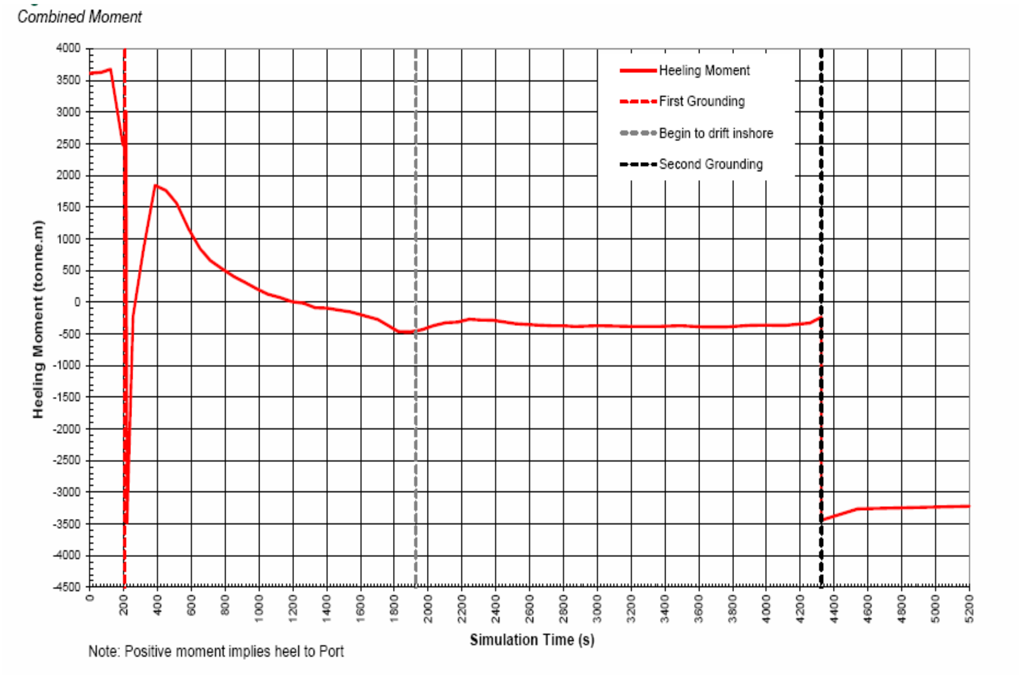
The ship's geometry has been accurately modelled up to the deck no. 4 (the bulkhead deck is the deck no. 0) including all compartments and relevant openings (watertight doors, semi-watertight doors, fire-proof doors, escape trunks, ventilation ducts, air ducts, doors not watertight to head pressure, windows, etc).

The loading condition applied for the simulations was the one obtained from the onboard loading computer.

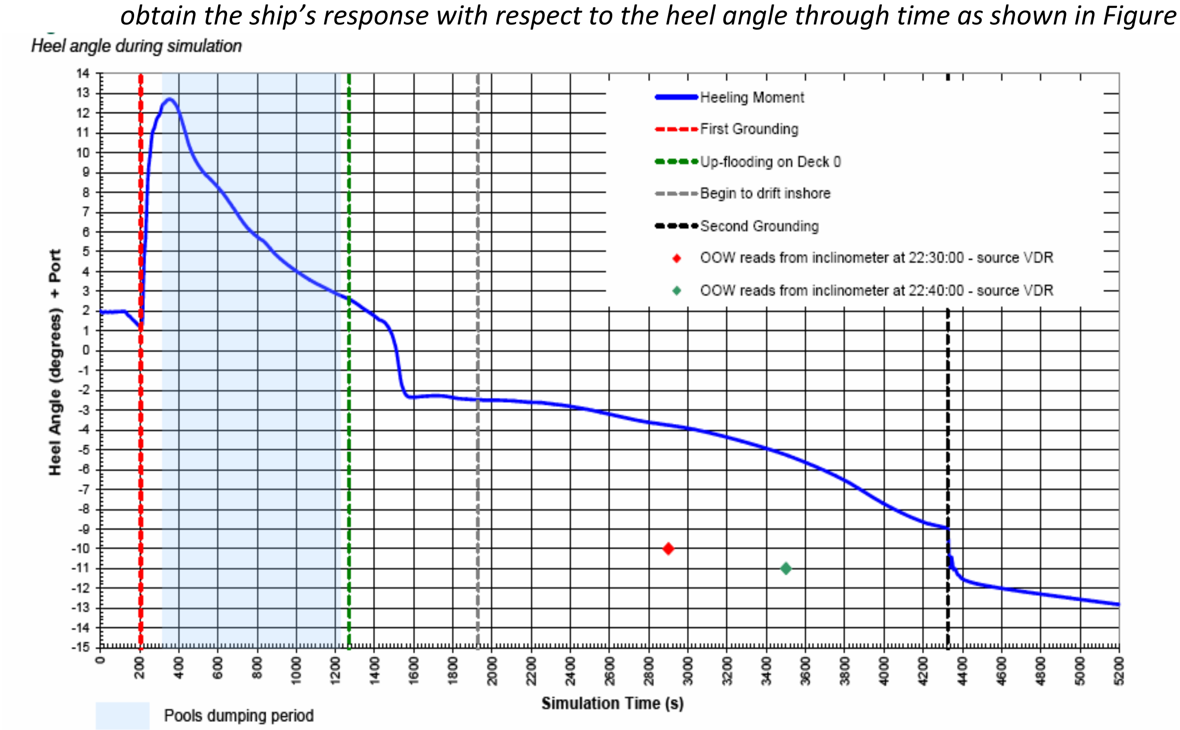
The damage extent has been assumed on the basis of the photographic evidence and measures taken from the external side. We assumed that the initial flooding takes place in the following spaces:

Space	Longitudinal Extent of Space (Frame #)	Vertical Extent of Space (Deck)
Refr. Compressor Room	fr#44 - #60	Deck C – Deck B
PEM Room	fr#60 - #76	Base Line – Deck 0
Aft Engine Room	fr#76 - #100	Base Line – Deck 0
Fwd Engine Room	fr#100 - #126	Base Line – Deck 0
Double Bottom	fr#116 - #140	Base Line – Deck C

The drifting applicable moments are due to the wind (NE 18 knots), turning, final grounding and the weight of the rock got stuck into the hull (97t). The combined moment diagram after the impact with the Scole is the one here below – Figure n. D:



Following this combined moment and the flooding sequence described in Chapter 6.1 in the main 10 points we obtain the ship's response with respect to the heel angle through time as shown in Figure E:



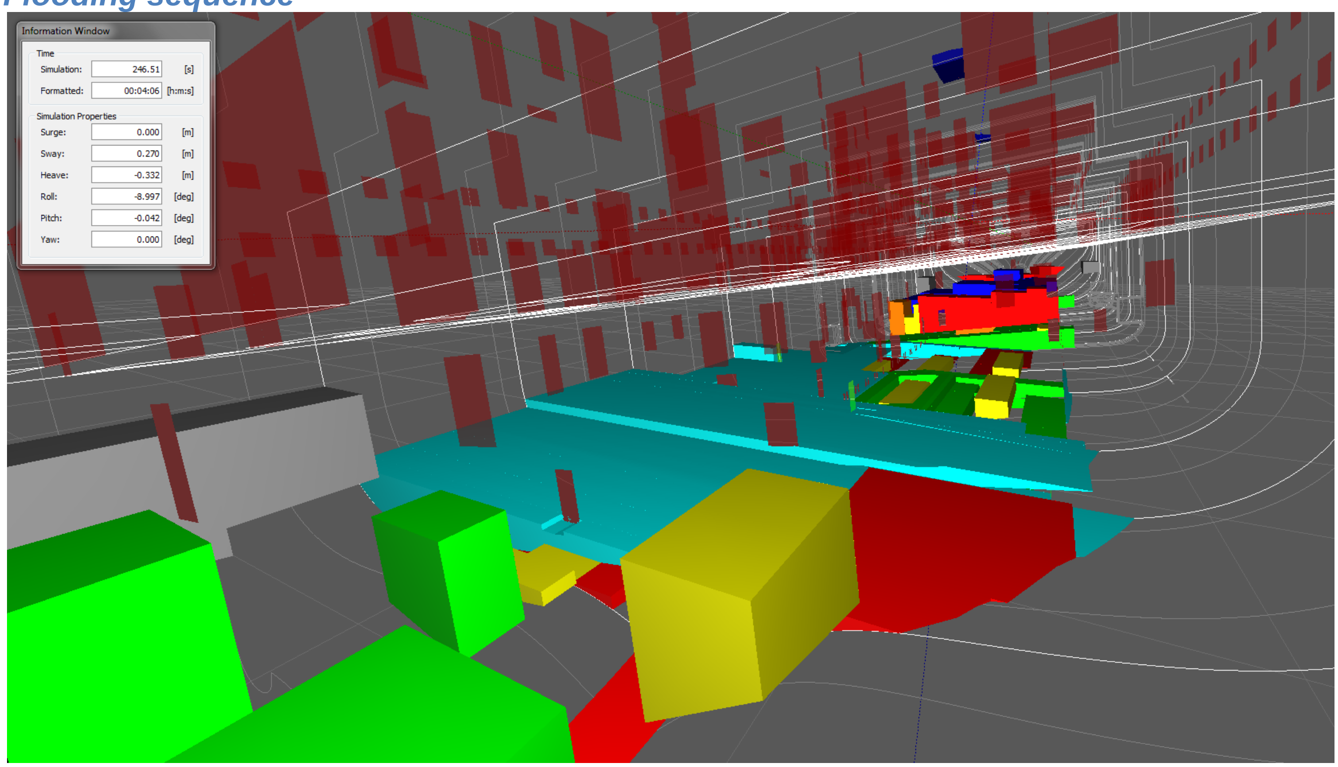
We may evince that the two data points relating to the VDR information on actual heel angles at 22.30 and 22.40 hours read on the ship's inclinometer reveal that the simulation underestimates the heel angle to the stbd side by about 6°.

We wish to point out that the simulation is based on a mathematical model, developed on the available data, so that it is not perfectly adhering to the event dynamics.

Anyway the results of the flooding simulation analyzing the ship's response as from the first impact against the rocks until the final grounding show that the ship's heeling from port to stbd side is well in accordance with the declarations of the crew.

The width of the stbd side heeling seems underestimated if compared with the data read on the ship's inclinometer deriving from the bridge conversations recorded by VDR.

Flooding sequence



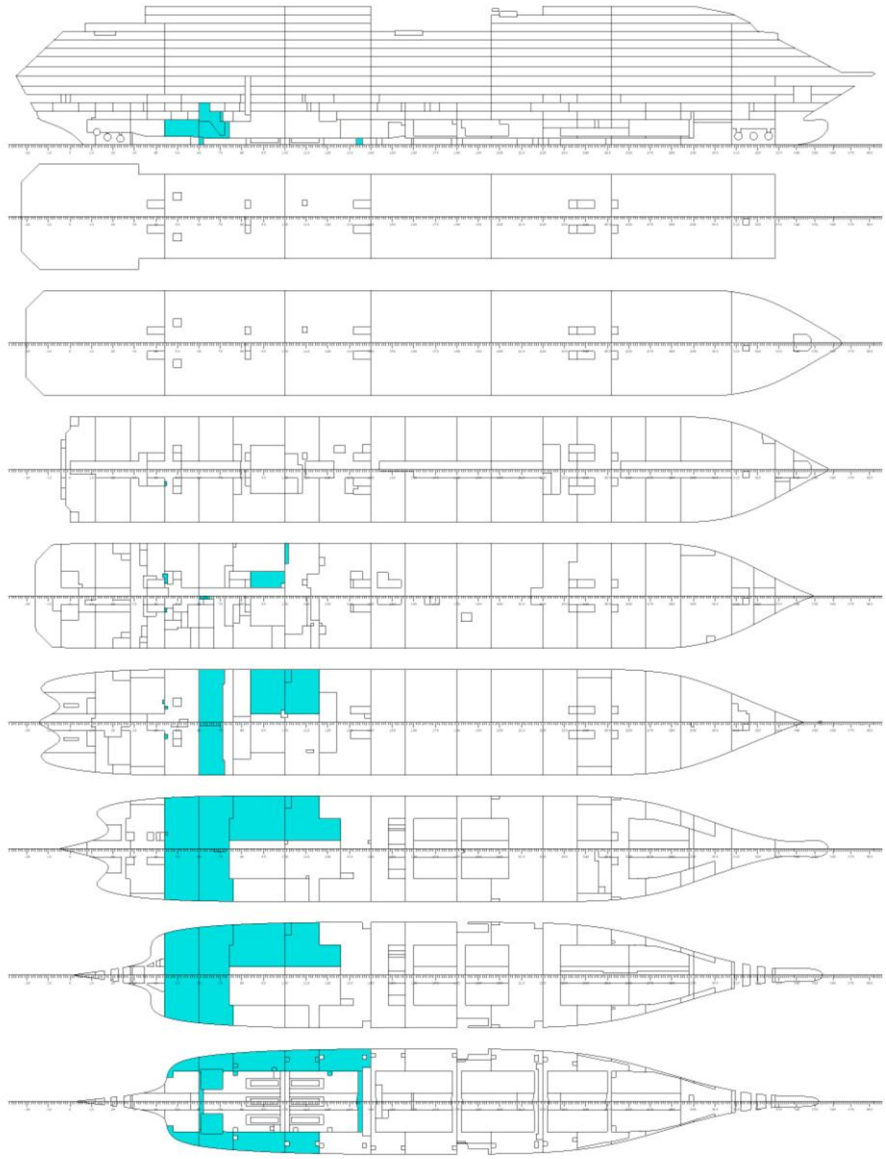
Keypoint 1

Actual time (h:m:s) = 21:45:46

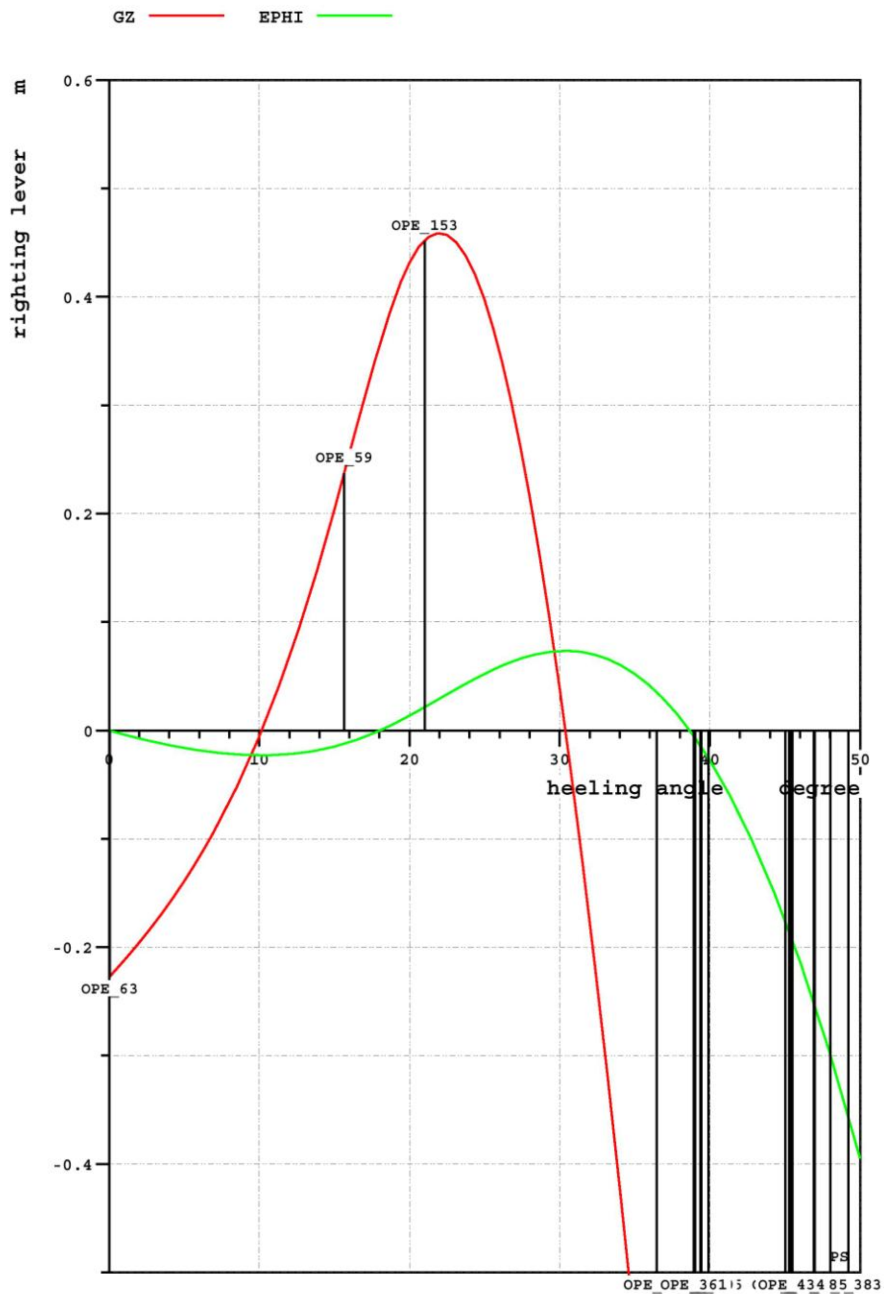
Notes:

Statement correlation – Main WT door into PEM room is opened and water floods into Refrigerator Comp. room due to water level difference. Vertical escape trunk access door starts to submerge stopping crew member from opening door and escaping from Refrigerator Comp. room via vertical escape.

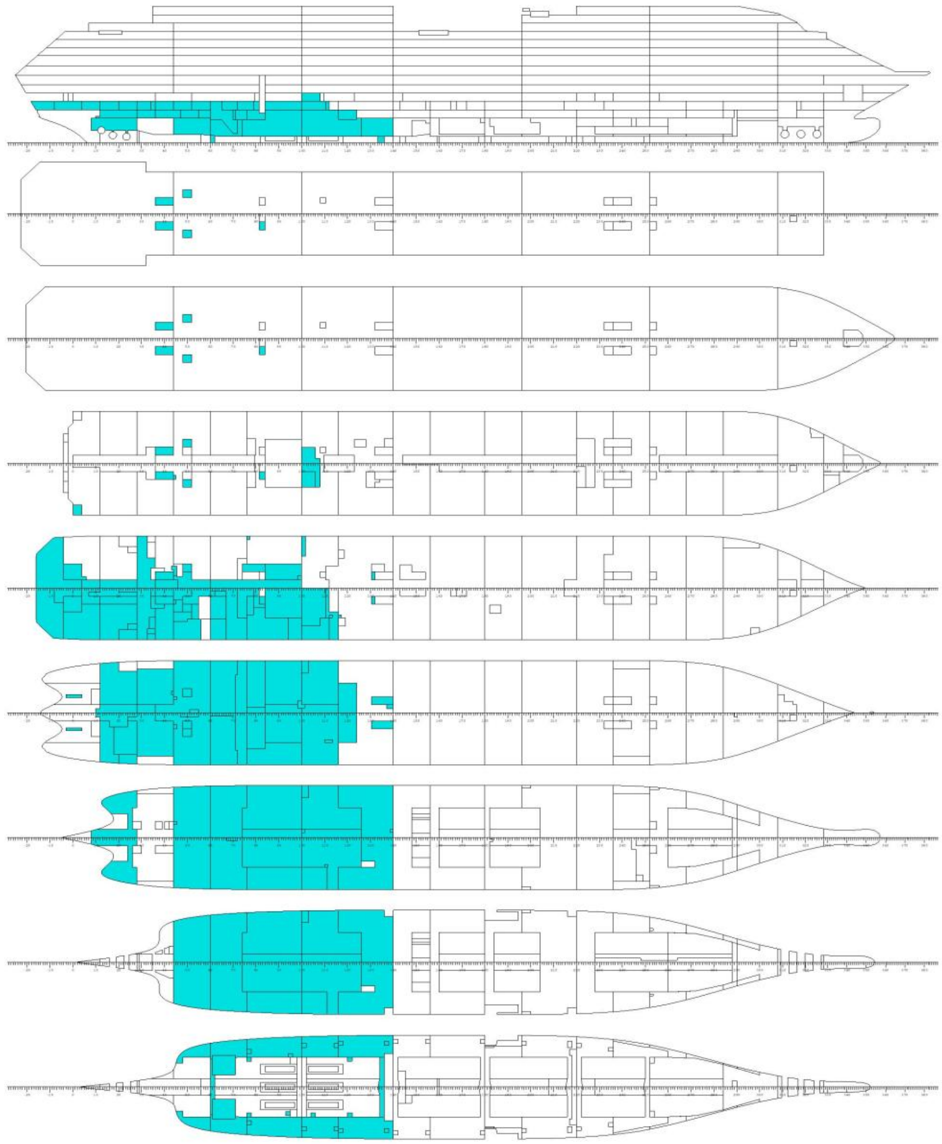
FLOODING EXTENT FOR KP1
NOTE: INDICATION OF SPACES CONTAINING FLOOD WATER NOT AMOUNTS



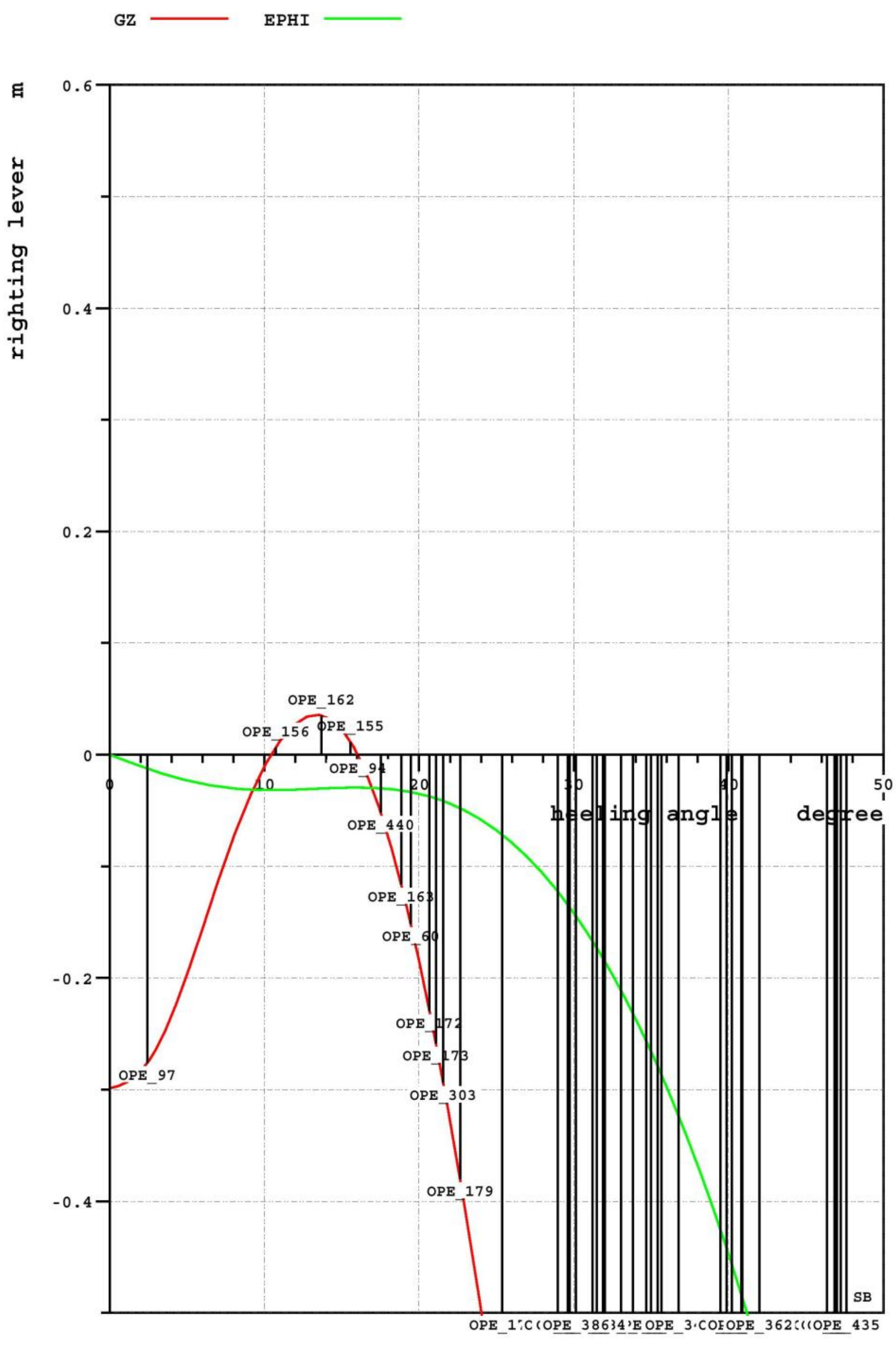
GZ CURVE ASSUMING NO PROGRESSIVE FLOODING FOR KP1

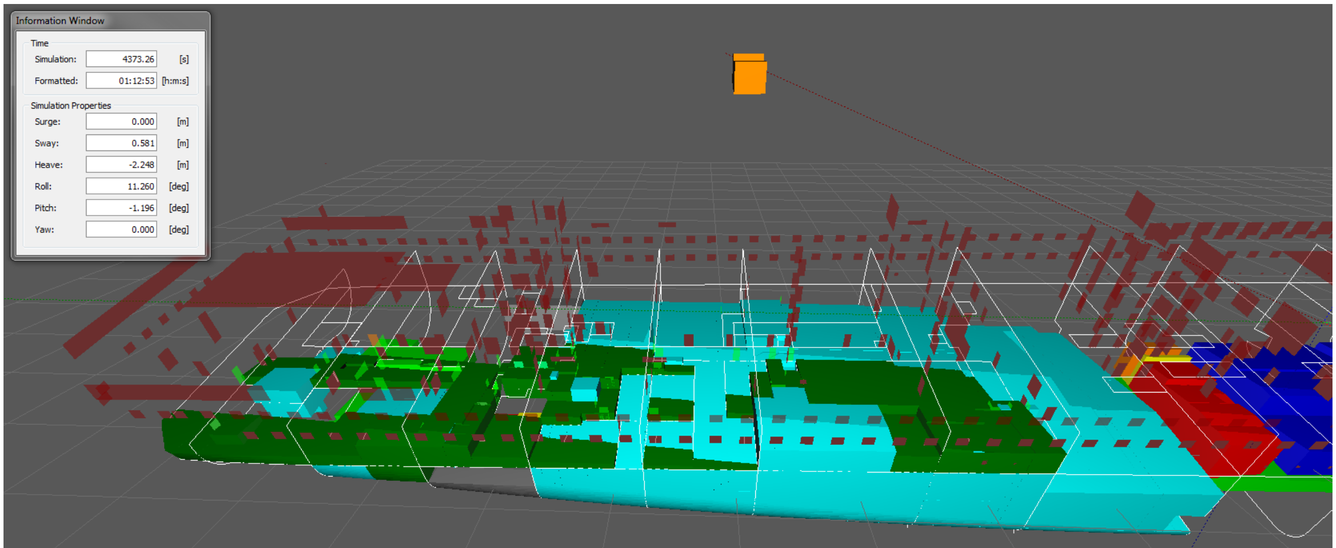


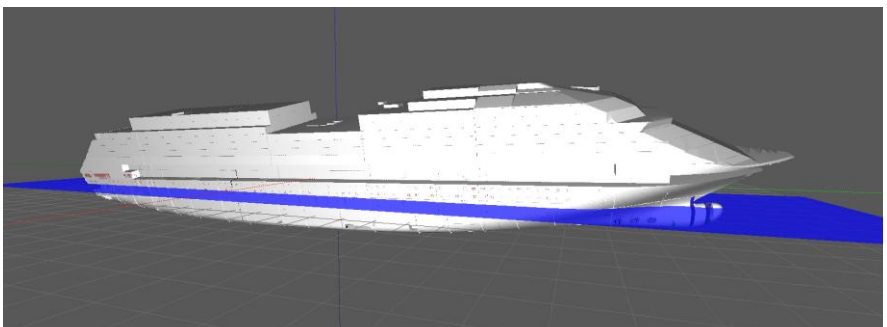
FLOODING EXTENT FOR KP10N
NOTE: INDICATION OF SPACES CONTAINING FLOOD WATER NOT AMOUNTS

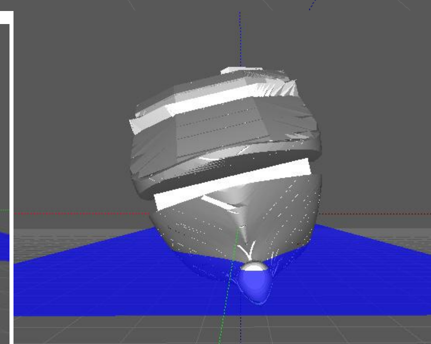


GZ CURVE ASSUMING NO PROGRESSIVE FLOODING FOR KP10N









Keypoint 10

Actual time (h:m:s) = 22:54:33

Notes:

Vessel has now made contact with the underwater rocks in the final grounding event and the associated moment due to the vessel slowing has been applied. The heel angle is 11.26 degrees to starboard (according with the underestimated simulation, in reality about 18 degrees) and the extent of the flood water on the bulkhead deck can be clearly seen. At this time some flooding of Deck 1 is taking place at the aft mooring deck, and no further progressive flooding is occurring along the bulkhead deck at frame #116 due to the splashtight doors being closed on the starboard side, and the normal doors connecting to this forward space are located on the centre line and are not in contact with the flood water.

4.7.10 Enhancement of deterministic methods

Further to the FLOODING SIMULATION report dated 5th September, 2012 performed by Safety at Sea on the m/v Costa Concordia response from the impact against the rock until the final grounding, further damage stability calculations have been supplied.

Such calculations have been carried out in compliance with the methods provided by SOLAS 74 Consolidated Edition 2004, considering the weather data allowed by the regulations and taking into account the various flooding sequences.

The aim of this further analysis is to assess the ship's response (experiencing damages whose extent was larger than the one provided by the ruling provisions i.e. two flooded compartments as previously explained). The damages sustained by the m/v COSTA CONCORDIA on 13th January, 2012 involved the flooding of five contiguous compartments having the extent previously described in the table at para. 3.1 of the simulation report issued by Safety at Sea.

Considering that, as previously stated, the m/v COSTA CONCORDIA is extensively complying with the damage stability criteria applicable with two flooded compartments we investigated the ship's response with the following flooded contiguous compartments (spaces):

Three contiguous compartments:

- damaged compartments 4-5-6 (DS04-06)
- damaged compartments 5-6-7 (DS05-07)
- damaged compartments 6-7-8 (DS06-08).

Four contiguous compartments:

- damaged compartments 4-5-6-7 (DS04-07)
- damaged compartments 5-6-7-8 (DS05-08)

Five contiguous compartments:

- damaged compartments 4-5-6-7-8 (DS04-08).

The spaces no. 5, 6 and 7 correspond to the compartments identified with the same numbers.

The study has been performed using Onboard-NAPA software and, differently from SAFETY at SEA FLOODING SIMULATION, it is not a time domain damage simulation as it considers flooding stages not depending on time.

The study (Enclosure no 3 attached to Appendix no 8) allowed to obtain useful information on the ship's response when associated with the above mentioned damages with respect to residual GM, heel angle, margin line, and other characteristics of the stability diagram such as the area under the lever curve (GZ curve) and the range of stability, the latter being data not available in the SAFETY at SEA flooding simulation.

The study has been performed considering the actual loading conditions relevant to the passage on 13th January, 2012, marked as LC06 and enclosed as Appendix 1 of Enclosure no. 1 of FLOODING SIMULATION dated 5th September, 2012 by SAFETY at SEA, and associating the same to the three damages involving three contiguous compartments, to the two damages to four contiguous compartments and to the actual damage occurred on 13th January.

The damage stability criteria applied are those provided by the applicable rules i.e. those required should there be two flooded compartments.

The possible progress of flooding from the flooded compartments to the void ones (those not involved by the examined damage) are assessed by means of virtual checking openings located at the damage edges.

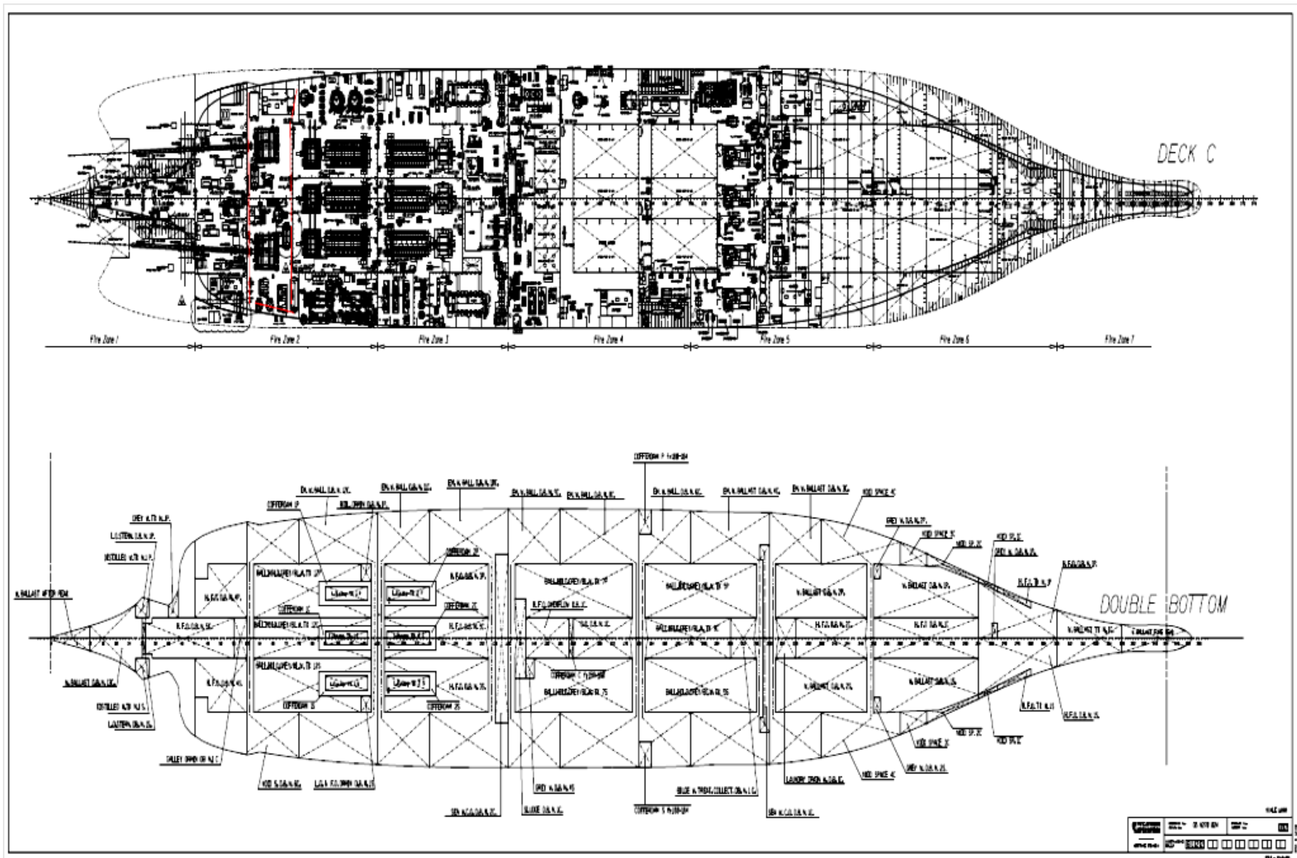
On analyzing the results the following resulted:

as far as the three damages to three flooded compartments are concerned, the C/s Costa Concordia is complying with all the damage stability criteria provided by SOLAS 74 Consolidate Edition 2004 both during the damage intermediate stage and the final one. For each of these three damages there is no progression from the flooded compartments to the void ones (not involved by the damage). The margin line is not submerged, the stability diagram shows more than satisfactory characteristics, GM at the final stage results higher (in the range between 0.67 m and 1.19 m) than the required minimum one of 0,05 m in order to comply with the regulations.
The above confirms the ship's large safety margins in accordance with what reported in FINCANTIERI Booklet no. APN 320050 "STABILITY MANUAL – ART- 35" approved by CDS no. 5924 dated 22th June, 2006.

As far as the two damages to four flooded compartments are concerned, the m/v COSTA CONCORDIA, although complying with all the damage stability criteria provided by SOLAS 74 Consolidated Edition 2004, during the intermediate stages does not show satisfactory stability criteria. As a matter of fact considering the damage to the compartments 4-5-6-7 (DS04-07) the margin line results submerged by 0,111 m., the range of stability is practically null (actual 0,09° against 15°) and the diagram area under the lever curve in the range of stability results null, so that such damage is a quite critical stability situation due to the consequences of the progressive flooding (leakage of water from the damaged compartments to the intact ones) even though the GM is satisfactory enough (GM=0,91M). Furthermore the progressive flooding of the compartments aft of no. 4 is almost reached, i.e. aft of frame no. 44.
With respect to the damage to compartments no. 5-6-7-8 (DSC05-08) the situation is better because the sole stability criteria not complied with it the one relevant to the margin line that results submerged by 0,051 m. The GM results more than satisfactory (GM=0,785m). With this damage there is no progressive flooding.
As far as the damage to five flooded compartments is concerned (DS04-08), the stability criteria are seriously jeopardized: as a matter of fact the margin line is submerged by 0.84 m, the stability diagram shows neither the range of stability nor the area under the lever curve, and furthermore a clear progressive flooding of the areas aft of compartment no. 4 is in progress i.e. aft of frame no. 44, although we have GM= 1,03 m. The latter situation causes a stability inadequacy and the ship’s capsizing.
Above results have been included in Enclosure 1b attached to Appendix no 8 .

4.7.11 Distribution Equipment-board

The compartments involved by flooding contain the machinery that in Enclosure no 3 attached to Appendix no 9 and reproduced in the following arrangements:



4.7.12 Evaluation on application of probabilistic method

As previously described, the m/v COSTA CONCORDIA has been built in order to comply with the deterministic stability criteria as provided by Regulations (SOLAS 74 Consolidated Edition 2004) in force at the date of the building (keel laid on 8th November, 2004).

On the contrary, according to the provisions settled in Part B of Chapter II-1 of Solas, the ships whose keels have been laid as from 1st January, 2009 or later must comply with the new probabilistic method criteria.
Considering these new completely different criteria a study, although a virtual one, of the dynamics and consequences actually occurred during the m/v COSTA CONCORDIA casualty but on the basis of the probabilistic method is to be altogether ruled out. As a matter of fact, once we got in touch with RINA and FINCANTIERI, the latter advised that such a study is not acceptable, because we have two wholly different project criteria and the ship has been built in compliance with only one of the two. Conclusions drawn from such a study, although a virtual one, would be faulty and deceptive.

4.8 Flooding management support

4.8.1 Decision Support Systems

Damage Control Plan and Damage Control Booklet

The support to the ship's Officer for the actions to be undertaken in case of flooding is provided by the "Damage Control Plan" (Annex 55) and the "Damage Control Booklet" (Annex 56).

The ship was also equipped with the NAPA software along with the Stability Information to the Master. The software functions are detailed later on.

The "Damage Control Booklet" (DCB) and the "Damage Control Plan" (DCP) are supports provided by Regulation no. 23 of Chapter II-1 of SOLAS 74 (amendments 89-90).

Such regulation requires that the plan should be permanently posted, and duly acknowledged by the ship's officers in charge, clearly providing – for each deck – the boundaries of the watertight compartments of the ship, their openings and relevant closing appliances, the locations of the relevant controls and the action to be taken in case of listing due to flooding. Furthermore, booklets containing the above mentioned information must be supplied to the ship's Officers.

The "Damage Control Plan" should be prepared in accordance with IMO provisions set in the Circular MSC/Circ. 919 "Guidance for Damage Control Plans".

The IMO circular explains that the DCP and the DCB should provide, among others, information on the action to be taken to mitigate and, where possible, to recover the ship's loss of stability.

The DCP should provide information on all mechanical means to mitigate the listing due to flooding, the location of all bilge and ballast pumps with their valves and control positions.

The DCB should contain the same information as well as additional/complementary details with respect to the ones provided in the Damage Control Plan.

NAPA software should be considered a "supplement" to the above mentioned support.

The DCP and the DCB do not need the approval either of the Flag Administration or of the Organism acting on its behalf; they are anyway subject to a specific inspection at the time of the initial survey carried out for the issuance of the Passenger Ship Safety Certificate by the ship's classification company (RINA for the m/v COSTA CONCORDIA).

The latter provision is contained in the IMO Resolution A997(25) "Survey Guidelines under the Harmonized System of Survey and Certification, 2007".6.

The C/s COSTA CONCORDIA had the Damage Control Plan ANN330390 (Rev. 1) and of the Damage Control Booklet ANN330391.

After comparing the two documents with respect to the above mentioned requirements, the following critical issues would result:

The pumps to be used in case of damage and mentioned at pages 24 and 25 of the DCB are not reported into the DCP

The ship's heeling system is not described into the DCB but its use is required as, at page 22, it reads "cross-connected heeling tanks must be symmetrically filled", apart from a photo in the synoptic chart (picture 28) with no reference in the text.

It is not possible to understand in both documents which are the pumps powered by the emergency power supply

The pump marked as emergency bilge in the picture no. 29 (XA/405) is not the right one; as a matter of fact it would result in the compartment no. 5 whereas the emergency ones, YA412, is in the Compartment no. 12.

NAPA

NAPA is a software designed for ship stability calculations developed in accordance with the Stability Information to the Master.

The main aim of the software is to supply the ship's stability data at departure, producing calculations based on the information supplied by the gauges located in the tanks containing liquids and on those manually inserted by the Deck Officer (passengers, crew, provisions,

[6] **The initial survey should consist of**: .1 **an examination of the plans**, diagrams, specifications, calculations and other technical documentation to verify that the structure, machinery and equipment comply with the requirements relevant to the particular certificate; 4.1.3 ***Examination of plans and designs*** 4.1.3.1 An application for an initial survey should be accompanied **by plans** and designs referred to in sections 1, 2, 4 **and 5 of Annex 1** and in Annexes 2, 3 and 4, as appropriate, together with:……..; **5**.1.3.1 confirming that the **stability information and damage control** plans have been provided (SOLAS 74/88 Reg. II-1/22 and **23**). – La Risoluzione in questione è stata sostituita dalla Risoluzione A.1053(27) adottata il 30 Novembre 2011.

etc.). NAPA software produces the ship's stability values calculated on the basis of the Stability Information to the Master.

It is therefore necessary to underline that the system:

- Is not able to monitor water ingress
- Is not able to activate/deactivate equipment
- Is not able to simulate the ship's flooding on the basis of the breach dimensions or of the flooding time.

With reference to the latter issue, it is important to underline that the software allows to simulate a "damage condition" but in doing so it assumes the compartment full flooding and the stability calculations are accordingly done; the software allows the operator to manually insert the data relevant to compartment filling, volumes or percentages, but in this case the software calculations are based on the intact condition criteria so that the combination of areas in "damage" and "intact" condition relay stability parameters wholly divergent from a situation even hypothetically close to the progressive flooding in damage condition.

Considering what above we can affirm that:

The software cannot supply a dynamic/progressive indication on the ship's stability in damage condition as it is not able to automatically monitor the water ingress and levels into the compartments; even though had the crew sounded the flooded compartments – action not possible to undertake in the casualty we are dealing with – the information would not have been so relevant for NAPA. As a matter of fact, as already explained, the manual introduction of one compartment flooding percentage produces stability criteria wholly divergent from the reality because the compartment is considered intact.

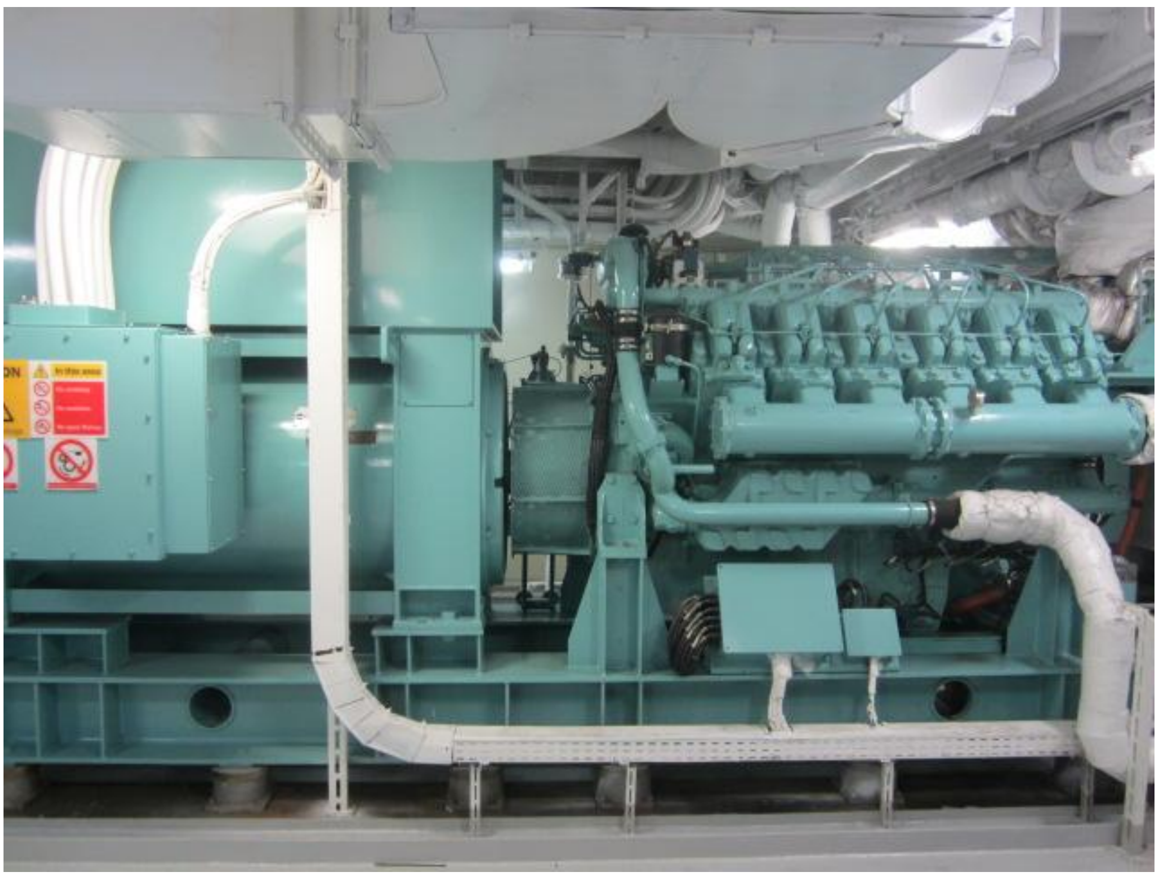
The software does not provide information on the actions to be taken in case of flooding, so that the Officer must take the actions provided in the "Damage Control Plan" and in the "Damage Control Booklet" manually inserting the data in the system in order to check the positive effects on the ship's stability.

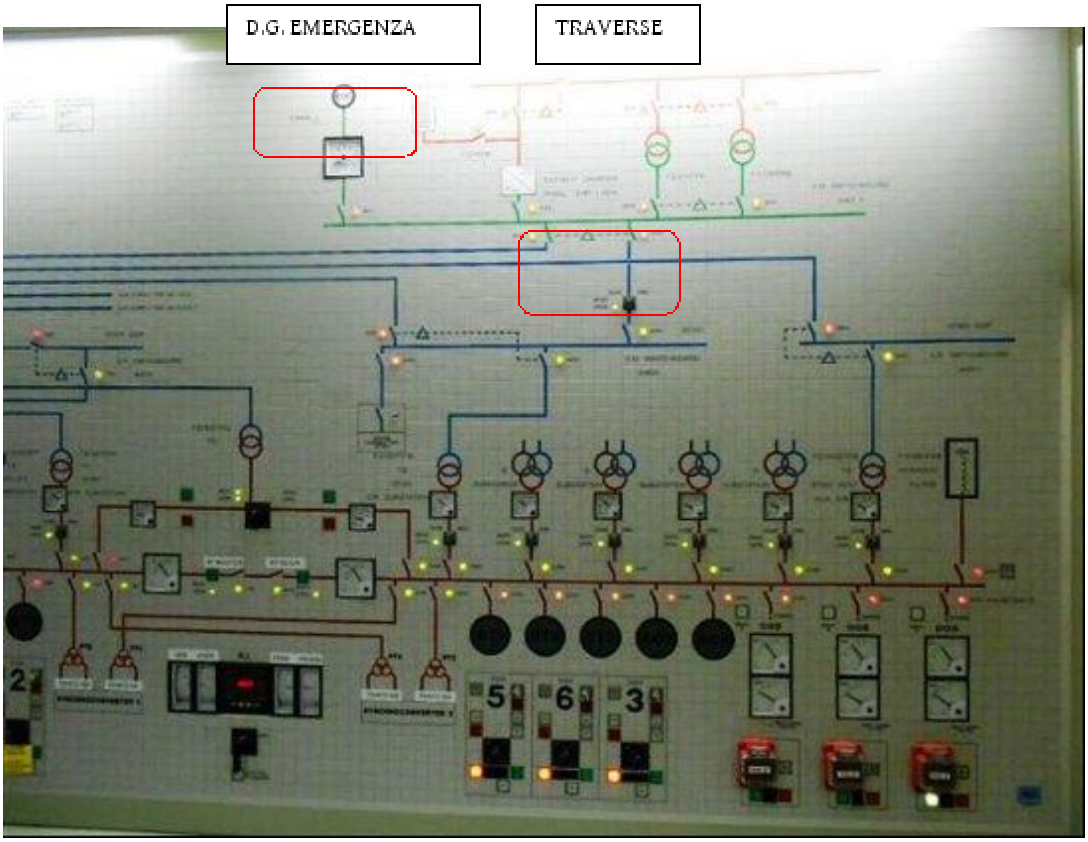
NAPA software must be exclusively considered a "supplement" with respect to the "Damage Control Plan" and the "Damage Control Booklet" as reported in MSC/Circ.919 "Guidance for damage control plans".

4.9 Emergency Diesel Generator functionality.

The ship suffered an immediate shock because of the shut down due to "short chain in" triggered by the violent entry of water in uncontrollable quantities, that in less than a minute affected the stern DG Room (WC nr. 6, where are installed the three main Generators) and the PEM room (WC nr.5). The black out, in fact, is recorded after 51 secs by the contact .
In PEM room (lower part and intermediate) are located large transformers, while in its upper part there is the electrical panel of the distribution (at the level of the Bridge A). Adjacently, therefore always at the top (at the level of the bridge A) of the stern DG room (WC nr. 6), insists the electrical distribution (or rather the double panel), to SB fed by the DG group nr 3,5,6 and at left side by the Group nr. 1,2,4.

Following pictures taken from C/s Costa Favolosa:





The consequences of violent water entry had irreversible effects, and therefore the ship lost propulsion immediately, and all government services.
The immediate and practical of the two protections [cross connections / isolations between the main electric panel (or rather the two panels) and the Emergency one, the so told switches nr 902 and 905], which just link the main electrical panel (QEP) with the emergency panel (limited to users in 220 and 440 Volts supplied by that system), prevented, as designed, the transmission of serious and widespread short-circuit to the emergency electricity network (therefore intervened automatic opening of the switches nr. 902 or 905, or both).
It should be noted that the plant is built and ready - always in stand by - and then once the motor of the emergency DG (DGE) starts, when there is no power from the mains, happens the link automatically between the fore mentioned DG and the Electrical Emergency panel connected (QEE), except that there are no protections for short circuit on the emergency power network, consent is given by a large thermo switch (marked by 'numeric identifier no. 901, and equipped with hand-wound spring always triggered).
It is assumed that the Electrician Officer didn't provide any details on the latest, positive load tests of the DGE, that regularly took place in Barcelona on January the 10th.
The testimonies of the crew in charge (1st Engineer, Officer Electrical engineering, and Electrical Officer), all matching, have so far allowed us to determine the alternate operation of that emergency plant, either for part of the electric panel, but also for the mechanics of DGE

(but it is unclear if they have found on their arrival in the DGE room the emergency power grid already connected).
It was necessary, however, the intervention of Electric Officer for engaging (or reengaging) manually switch 901.
When we consider that, already at 21 52 32 (after seven minutes by the impact) the Chief Engineer says Officer Electric to start the DGE, it is likely that there wasn't an automatic start of the system (would leave only the engine of DGE), and this is probable considered the immediate blackout (21 46 44) and the violence of the water on the system of production and distribution of electricity and the consequent shorts circuits simultaneously interested by an extraordinary shock (overprotecting also the emergency part of the QEE). We will show that this consideration is correct in the following paragraphs, were we give a proof about what happened really on board..
In this regard it should be noted that the primary switches powered either by the QEP and the QEE, are switched on the emergency network through individual switches located in Local DGE on QEE. Obviously, some of these switches, supplying services / facilities among those hit by the water violently, they would have disconnected in group isolating the respectively short-circuited lines . According to this logic of violent release, the shock switch nr. 901 would be so disruptive to lock / protect it at the end, although the lines remained attached to the QEE were not those short-circuited. This is demonstrated by the results of the DGE / QEE engagement / link in manual mode (or, as it is better to say, in forced manner), which proves, however, the isolation of the short circuit, otherwise the QEE would have blown electrocuting people therein.
The QEE was engaged at 22 10 52, after the arrival of the Electrician officer in DGE room. The Electrician, immediately identified the problem, gave manual winding with the handle to the spring of the switch 901, and then, noting that the system did not allow in any case the engagement of the DGE to the related electrical network, has employed a screwdriver with which, relying on the blades of mechanical interconnection inside the switch, caused the connection and engagement (hang up) of the EDG to the emergency power grid .
The operation, says the Electrician Officer, was repeated three times, and that is when the DGE stopped, it was arrested for excessive water temperature (110 C°) of the cooling circuit, due to the locking of the corresponding fan on the alternator group . The 1st Engine Officer has done every time you restart the DGE and Electrical Officer consequently after charging manually the spring, worked to manually engage (with tool) switch nr 901..
Finally, the Official Electric arranged to make a sort of chock with a cloth to avoid standing still with his hand on the screwdriver blocking the connection of the switch 901, thus stopping into the slot the screwdriver itself..
According the testimonies of the three crew members which intervened in DGE room, it appears that this activity of precarious operation, which began at 22 11 (when DGE hangs up - or snaps for the first time, still do not know), it lasted up to 22 55 when the ship continued to list more and more to starboard, after the abandon ship signal , they also had to leave the

place of destination. The 1st Engineer also, before leaving the room, said he had turned off the EDG to prevent that the excessive engine temperature degenerate into a fire that nobody could then control.

A specific investigation has been carried out to study in deep the working of the Emergency electric power system, analyzing each proper string of VDR which could be to us: - a clear evidence related with the condition of this system at the leaving from Civitavecchia; - why the black out occurred; - if after the black out the EDG automatically engaged the Emergency Switchboard (ES); - if during each forced attempt to engage the EDG with the ES, some supplied utility was really worked.

All those above mentioned questions found logical answer, as even proved, through a specific, long and complex investigation carried out by this IB, as reported in detail in the Appendix 9 and related enclosure, and we can read in the following paragraph.

4.9.1 Focusing on the Emergency electric source of power. (details in Appendix 9)

As above said, due to the breach openings caused by the impact of the ship's portside against the rocks of Le Scole a black-out occurred on board the Costa Concordia; in these circumstances the emergency electric power switches on, in order to guarantee the essential ship's services for a given period of time.

Requirements

The ship, in compliance with what provided by Rule no. 42 of Chapter II-1 of SOLAS 74 (amendments 96-98), must be equipped – apart from the main electric power – with the following power supplies:

Emergency power supply constituted either by batteries or by a diesel generator (the m/v COSTA CONCORDIA is equipped with the latter located at deck no. 11 – stbd side – frame no. 69-83).

Temporary emergency power supply constituted by batteries.

These sources must be sufficient for providing power to the ship's essential safety services when in an emergency situation.

They must be located so that a fire, or any other accident occurring in the spaces containing the main electric power supply, do not interfere with the supply, control and distribution of emergency electric power.

The emergency power supply must guarantee the emergency lighting, the GMDSS equipments, the internal communication means, the emergency bilge pump and primary machinery with relevant valves workings for a period of 36 hours; all the watertight doors driven by electrical power and the lifts for a period of 30 hours.

The temporary emergency power supply intervenes if the emergency one fails and must be able to supply the emergency lighting and the emergency internal communication means.

The life-boats and life-rafts launching appliance are able to operate even without electric power supply. The system is designed so as to allow the manual control of the outreaching telescopic arms and the survival crafts lowering by gravity.

The emergency power supply was guaranteed by a diesel generator located at Deck 11 as well as by supplementary batteries and dedicated ones (UPS) for some equipment.

According to the witnesses collected and confirmed by the VDR data it results that immediately after the impact a black-out occurred (in the narrative at 21.45.47 hours).

The emergency generator started but supplied power for just 41 seconds.

The 1st Electronic Officer, the 1st Electrician[7] and the 1st Mate witnesses are quite significant; according to these declarations we may evince that the emergency diesel generator was not able to perform the designed service notwithstanding the crew efforts to guarantee its working.

The emergency diesel generator should have supplied power, among the others, to the emergency bilge pump (YA-412) and to one of the "Heeling system" pump (YA/409A).

Due to the black-out and the emergency diesel generator failure to supply power, the UPS batteries intervened guaranteeing the internal communication means and the emergency lighting.

The Electrician and the Electronic Officer went to the Deck 11, into the emergency diesel generator room where there is also the emergency electric switchboard, verified that the emergency diesel generator was running but the main breaker was disconnected.

[7] Further to the witness collected during the Summary Enquiry there is also the one reported at page 7.469 of GROSSETO PUBLIC PROSECUTOR report where he affirms that the emergency diesel generator worked intermittently for intervals not over two minutes.

The emergency diesel generator was connected using a screwdriver that had to be manually kept into the switch so as to guarantee the electrical connection.

Once the problem was partially solved another fault occurred involving the emergency diesel generator cooling system and the intervention of the engine alarms (high temperature) and its automatic shut-down too.
The engine safety alarms were therefore switched off by the crew and, in order to avoid worse consequences (fire/explosion), the engine had to be periodically stopped to cool it down.

Due to the above, the emergency diesel generator was not able to regularly supply electrical power to the lines.

We neither have objective evidences of the time the batteries stopped supplying power nor do we know the technical reasons that determined the power supply stop.
The consequences were, among others:

- Missing power supply for emergency bilge pump working (YA-4129) and for heeling system emergency pump (YA/409A)
- NAPA not working, whose dedicated UPS, at the beginning, did not work as well
- Steering gear unavailability.

Description of the activities related to the technical investigation on the EDG and ES.

Some investigations on the reference were carried using the sister ship "Costa Favolosa". They are the direct results of a specific planning evolving through time and following the steps herein listed, all of them closely related i.e.:

- Study of the historical data of the last year of service (Enclosure no. 1 with relevant Annexes from 1 to 8 attached to the Appendix 9) relevant to the EDG/EEP and to the low tension main electric switchboard of the m/v Costa Concordia, supplied by the Fleet Manager and by the superintendent of the m/v Costa Concordia . Such data include:

  a) plant summary description and lay-out as from the departure of the m/v Costa Concordia from Civitavecchia on 13th January. 2012;

  b) periodical checks

  c) working tests

  d) ordinary overhauling

e) extraordinary overhauling/events

f) results of lube oil analysis

g) further additional information.

- Analysis of the afore mentioned EEP intermittent working, the latter taking place during a collective meeting that was attended by the ship's witness Chief Electrician too: the latter, during an interview, had given a detailed technical account of the event occurred to the EDG. Such a meeting - where detailed information were supplied to the participants, so as to allow everybody to understand what had happened – enabled Fincantieri and Schneider to draw up a preliminary technical paper (App. 9 - Enclosure no. 2) detailing the EEP working.
- Sharing of above technical paper among the parties, necessary for drawing up a testing and simulation protocol (Enclosure no. 3) that, in compliance with the ruling safety regulations for people and vessel, required another sister ship of m/v Costa Concordia (most particularly due to the similarity of plants on board) to perform a voyage without passengers (corresponding to the transfer to a dry-dock) as soon as it was feasible The m/v Costa Favolosa was selected, as she was scheduled to depart from Savona bound for Palermo in order to stop in dry-dock for works.
- Sharing of above mentioned test protocol among the crew (master and officers).
- Subsequent further meeting before the survey on board, necessary to assess the schedule of tests (being some of them decidedly onerous for the ship's conduct).
- Meeting on board the ship, on 16th November, 2012, soon after being embarked in the port of Savona, in order to directly discuss and assess the actual consequences of the planned tests on the ship with the Master and the Chief Engineer, so as to avoid any possible inconveniences, with respect both to technical issues and to the crew, considering that the technicians and crew members on board were about a thousand. After the meeting a new schedule/optimization of the tests were agreed upon (Enclosure no. 4) so as to take into consideration the Chief Engineer's requirements. I pointed out, at first to the members of the team, and later on to the crew, the need to further check – during the full blackout - the time employed by the ship's lifts (totaling 29 and including the ones employed by the crew and by the passengers) to reach the deck, in accordance with the requirements of the relevant SOLAS regulation (mentioned in the Enclosure no. 5). The above mentioned test has been required by the Flag State representative as future support of the forthcoming investigations on the accident, as this is a test not easily repeatable within the short term. Anyway, the test was exclusively functional, as it is not possible to compare its results with what

happened on the m/v Costa Concordia as we do not know how many and which lifts were working at the beginning of the emergency and during the whole emergency phase.

Scope of activities

As previously described, the planned activities had the final aim to assess the possible causes of the intermittent working of EEP of the m/v COSTA CONCORDIA. Most particularly the tests carried out aimed to assess the following conditions:

- Automatic connection, in case of black-out, between EDG and relevant ED and length of the working time in such condition
- Further possible manual connections, between EDG and ES.
- The breaker, identified with code 901 and located in the EDG room, functionality.
- EDG functionality (prime motor end)
- Functionality of EDG cooling system (electric fan with air/water heat exchanger)
- Functionality of so called "ship-to-shore" switch located in the main electric switchboard (at Deck A) whose aim is to disconnect the 440V main electric switchboard from the 11000V section during the ship's connection to shore and to avoid any possibility of working of the emergency diesel generator in parallel with shore power plant.
- Following the above mentioned tests results, proceeding with a deductive reconstruction of the events recorded by the VDR – and/or according to the witnesses – of the water progress within the different ship's watertight compartments, most particularly with respect to the nos. 5, 6 and 7, i.e. the PEM room and the two diesel generator rooms.

Methodology

In order to test the ship's plants working, a repetition of their behaviour has been simulated, in accordance with the data resulting from:

- VDR recording (signals relayed by the systems/plants fed by ES, voice recordings, etc.)
- SMS recording (recovered from the bridge and supplied by Martec) relevant to the EDG working
- Witnesses of the engine crew of the m/v Costa Concordia – Enclosures from no. 6 to no. 12).

We have not been able to recover from the m/v Costa Concordia the data contained in the SMS server and in the Automation computer, the latter monitoring all engine room machineries data (supplied by APSS Valmarine) and both located in the ECG Engine Control Room.

Sequence of the events

The reconstruction of the event has been done on the basis of the recording and direct witnesses (as far as the main issues of interest dealt with in the present report are concerned).

The sequence of the events, as here below detailed, does not represent their actual chronological progress because timing is subject to the refresh factor, the latter a variable depending on each system interfacing with the VDR and SMS. The refresh range varies from a minimum of 0'' to a maximum of 27'', so that the reported timing may be subject to a delay, from 0'' to 27'', with respect to the actual time.

For more details please see the tables containing the VDR/SMS recording in the Enclosures no. 13, 14 and relevant Abstracts (13.1, 13.2, 13.3 and 14.1).

Time	VDR signal	SMS signal	Remarks/Additional notes on the event
21.45.07	Contact		
21.45.15	Stop of rudder pump no. 2		
21.45.17	Shafting line alarm.		
21.45.20	UPS battery AS913QFCA alarm.		The alarm refers to UPS battery under discharge. The alarm may start when UPS is without power supply so that loads are fed by the battery. UPS is powered by the switchboard AS913QFA, both from the main source and the emergency one. We can therefore assume that the ship had a power black-out.
21.45.32	Portside rudder alarm.		
21.45.38	Propulsion electrical motors slow down.		
21.45.47	AS913QFA 220V breaker alarm.		On the switchboard AS913QFA 200V bus bar there is a tension relé detecting the power loss. Furthermore there is another signal for shutting off of 220V switches. The two signals –power loss and shutting off - are channelled into a single

			alarm. The alarm recording does not mean that there is a total loss of 440V power (total black-out). As a matter of fact the alarm might have started due to the opening of one of the switches feeding the 220V plants i.e. a short circuit due to the flooding.
21.45.47	Regular working of UPS battery AS913QFCA.		The EDG might have concurrently started. The switch 901 did not shut off because the power to the emergency switchboard was immediately guaranteed by the main switchboard sections switch over. The EDG, as expected, would keep on running, without being connected to the electric plant.
21.45.56	Rudder pumps no. 1,3 and 4 stop.		This signal is the evidence that there is an actual black-out.
21.45.57	Black-out.		The black-out is announced by word and recorded on the VDR audio section. The proximity of the two signals (1”) shows that the recorded black-out timing corresponds to the real one.
21.46.03	Rudder pump no. 1, 3 and 4 starting.		This is an evidence that the EDG is acting by the switch 901 closure and its connection to the EEP, following the black-out.
21.46.10		EDG starts.	The refresh time between SMS and VDR is 27” so that the time of the event might be included between 21.45.45 and 21.26.10.
21.46.17	Low pressure alarm for starting air circuit in WC no. 5 (PEM)		That is an instrumental data that might show the pressure switch has been affected by the flooding. The pressure switch is located on PEM stbd side at 2.80 m above the DDBB tank top plating (at 2.2 m above the keel).
21.46.57		EDG electro ventilator starts.	
21.46.44	Rudder pumps no. 1,3 and 4 stop.		This is the only alarm showing that the EDG 901 breaker did open and that the ship remained powered by the transitory source (the ship’s batteries).

21.47.08	• QFA 913 alarm • UPS AS913QFCA alarm • AS913QFA switchboard alarm		These alarms refer to the automation switchboard AS/913QFA powering the automation plant at 440V and at 220V. As previously stated at 21:45:20 hrs the UPS battery S91QFCA alarm regards the UPS battery being under discharge, when the switchboard AS913QFCA was in a total black-out condition. The other alarms might refer to the switches intervention on the 440V switchboard section; breakers intervention alarms on the 220V section, with subsequent 220V tension loss as well as to the low insulation alarm on UPS power supply. All these alarms confirm that the ship at the time was undergoing a black-out and that the switches opening was due to the flooding.
21.52.25			This is the time the water level noted by on the Chief Electrician main electric switchboard is recorded in the VDR audio data.
21.55.47		EDG electric fan stops.	
22.08-22.10	The vessel reverts her drift direction under the combined action of the NE wind and the current and starts listing to starboard.		VDR information on the ship's course and verbal information (VDR audio data) for listing.
22.15.37		EDG stops.	According to Chief Engineer witness it may be assumed that the stop has been done manually.
22.20.16		EDG starts.	It is manually started.
22.28.01		EDG stops.	According to Chief Engineer witness it may be assumed that the stop has been done manually.
22.30.04		EDG starts.	It is manually started.
22.30	The ship proceeds, pushed by the wind and current, drifting towards the south listed by 10° to the stbd side.		VDR information on the course and verbal information (VDR audio data) for listing.
22.36.45		EDG stops.	Chief Engineer witness emphasizes the EDG voluntary stop in order to avoid, according to him, a possible fire due to the cooling water system overheating. The time relayed by Chief Engineer is 22.45 about.

22.42.52		EDG stopped.	It is the same signal as before.
22.46	The ship is drifting southwards due to the wind and current action, listed by 15° to the stbd side.		VDR information on the course and verbal information (VDR audio data) for listing.
22.55	The ship runs aground the bottom listed by about 20° to the stbd side.		VDR information on the course and verbal information (VDR audio data) for listing.
23.11	The ship listing is about 30° on the stbd side.		Verbal information (VDR audio data).
23.18.56		EDG starts.	The signal is no longer reliable due to the complete failure of the ship's automation system located on the bridge 0 and now involved by the flooding. The subsequent signals of SMS system show that the latter is no longer reliable (fault).

ANALYSIS OF EVIDENCE

I.

With respect to the EDG and its switchboard working (Part Number 1Q345063 – Item mark XM/277) it would result that the crew – due to the repeated alarms of cooling water high temperature– stopped manually and repeatedly the EDG.

According to the witnesses we can evince that the crew undertook this action as they had noted that the electric ventilator(XA/277/B) was not working and, in these circumstances, they had not understood the reason why but had anyway deemed necessary to safeguard the EDG for the overheating by natural cooling (i.e. by manual shutting down the EDG at irregular intervals).

The EDG is designed in compliance with the technical rules and expected to work until "destruction" and to stop only due to over-speed (Ref. RINA Rules for Classification Edition 2003 – Part. C Chapter 1 – Section 2 – Table 3).

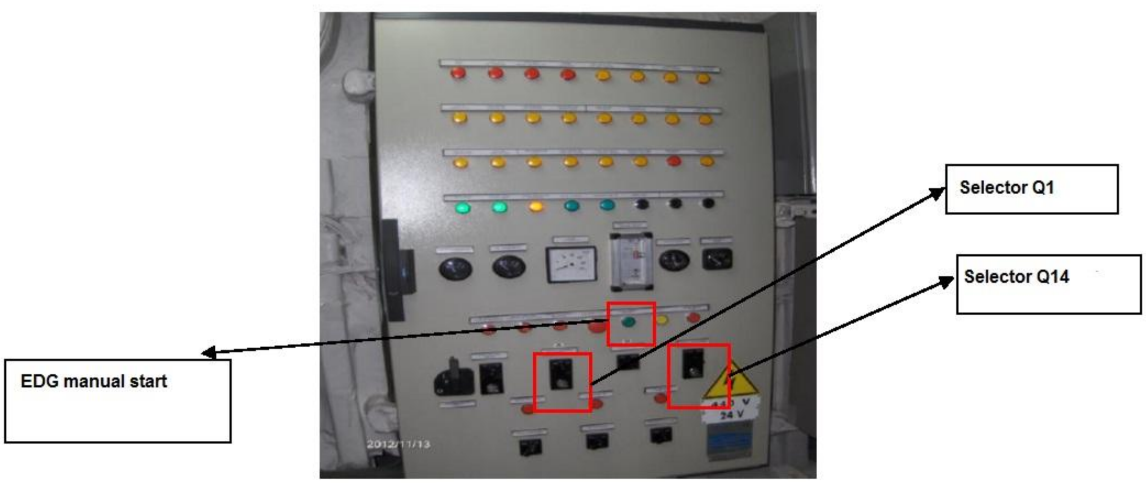
According to the events chronology until 22:36 hours the EDG was running with a stbd side listing of 10° -15°.Sometime before at about 22.10 hours the port side listing had reached its maximum value i.e. 10°.The listing did never exceed the maximum allowed value of 22,5° that – corresponding to the EDG maximum designed listing – could have led to its stop due to loss of lube oil suction from the sump (Ref. SOLAS Rule II-1/42.6).

It is available a paper (Test report – Enclosure no. 15 and 15bis) from (makers) I.F.M. that shows how such an engine is able to keep on running up to a side listing equal to 25°.

Bearing in mind what explained as far as shut down are concerned, we deem it is plainly attested that from the mechanical point of view the EDG was working correctly and in compliance with the rules and design requirements.

With reference to the above, during the simulation on board the m/v Costa Favolosa it was agreed to carry out the tests no. 1 and no. 2 as described in the Enclosure no. 4 in order to check that the EDG alarms (the highest water temperature and the lowest lub oil pressure) would lead the EDG to stop only when in manual mode and not in automatic mode too.

One more enclosure (Annex no 57) by Isotta Fraschini, forwarded on 5th March 2013, states that there is no evidence, in its standard recording, about how long is the work of the Generator in case the ventilator wouldn't run. The Company added, moreover, that no RO rules were established to test and regulate this case.
Isotta Fraschini claims, in other words, that the cause of the suddenly arrest of the related ventilator can be studied and searched only assessing the Concordia Emergency Diesel Generator.



EDG switchboard (Part Number 1Q345063 – item mark XM/277 – sister ship Costa Favolosa)

II.
As far as the breaker 901 working (connecting the EDG and its ES) is concerned, the following has been assessed in accordance with the recording and the witnesses.

Due to the above it was possible that the sudden and large flooding of the compartments may have created a critical situation for the breaker 901.

The latter, being obliged to deal with a series of contemporaneous short circuit (those of the lines feeding the compartments involved by the progressive flooding), might have shut off causing the total black-out.

What above is logically and technically explained in the description here below reported. Once there are more than one short circuit on the lines fed by the ES fault, the electrical power generated by the alternator is distributed on the lines involved by the failure. Due to the latter the value of the short circuit on each line might not be enough for the relevant safety switch on the ES (the one connected to each single service) to intervene.

On the contrary, in such circumstances, the switch 901 can detect the total fault of electrical power (the summation of all the short circuit currents on any single line) and intervene by opening, causing therefore a total black-out.

This is shown by the number of lines connected to the ES (see enclosure 16) that have been involved by the immediate flooding of the watertight compartments no. 4, 5, 6 and 7.

As per above the concurrency of a short circuit in the lines powered by the ES could be the most reasonable cause of the switch 901 improper functioning.

Switch nr. 901 (picture taken from Costa Favolosa)

III.

As far as the switch 901 (connecting the EDG and its ES) intermittent working is concerned, the following has been assessed in accordance with the recording and the witnesses:

As the EDG did not connected to the ES so the crew thought the only solution was to manually deal with the switch 901, enabling the system connection between the EDG and the ES. This operation has been carried out by employing a screwdriver recreating the working condition of the minimum voltage coil , thus enabling the power passage from EDG and ES.

Each time the crew manually intervened on the breaker 901, i.e. they succeeded in unlocking it, the latter actually closed on the ES because the current measuring instrument read, after an initial 1000A, a running current of about 400A.

There are no VDR objective evidences of such breaker closure on the ES because there were no services connected to the emergency that might have been recorded during the whole period of forced connection to the ES by way of the switch 901. Anyway, in accordance with the results of the inspections carried out on the lifts, whose doors functioning at some of the decks is monitored by the SMS system and recorded in a VDR dedicated string (Enclosure 17), it is possible to evince that between 22.03.16 and 22.04.20 the lift no. 8 (marked as H in the Enclosure 18) most presumably ran from the deck no. 6 to the deck no. 4. Bearing in mind that the ship's lifts are powered by the ES, such recording let us think that the Chief Engineer action, as here below detailed, caused for the first time the EDG connection to the system (considering that the Chief Engineer left the ECR at about 21.53 hours).

It was considered that:

1. If the switch is fitted with opening and closing coils, correctly energized, once the operator intervenes on the electrical push buttons controls he can open and close the switch.

2. If the opening and closing coils are not energized it is possible to open and close the switch only by acting on the switch mechanical pushbuttons provided that the minimum voltage coil is energized (as per test no. 6 – Enclosure no. 4).

3. If the minimum voltage coil is either not powered or is faulty, the switch cannot even be controlled by employing the mechanical closing push buttons of the breaker.

As crew intervention would have been necessary only in the third case, we cannot rule out that a failure involved the minimum voltage coil too. In our specific case, the only reasons why the breaker cannot be manually closed are a breakdown or a power failure involving the minimum voltage coil.

At this stage it is worth to point out that the above mentioned test no. 6 showed that when the minimum voltage coil is energized the switch 901 can be manually closed without using the screwdriver (as the First Electrician did), by disconnecting the 230V circuit auxiliary tension from ES 440V section and then acting on the switch mechanical closing buttons.

IV.

Some tests on the switch 901 were carried out by acting on the ship-to-shore switch, the latter located in the main switchboard room at a height of 1,20 m above the deck A level.

The aim of the ship-to-shore switch is to insulate the main switchboard 440V section from the 11000V section during the ship's connection to shore and to avoid the working in parallel of the emergency diesel generator with shore power supply.

So the test no. 5 – within the analisys of DGE -was carried out in order to ascertain that the position of the ship-to-shore switch - when in "shore mode" - is the cause of the switch 901 opening on ES.

Due to the above we cannot rule out that the submersion of the switch may have contributed to the intermittent working of the switch 901, bearing however in mind that it is not possible to definitely ascertain the actual flooding sequence also due to the fact that the main switchboard areas are surrounded by A class bulkheads, doors and deck plating (steel) i.e. fire-resistant and that, although they are not watertight to head pressure they definitely slowdown the water free flowing.

V.

With respect to the ascertainment of the time necessary for the ship's lifts (totalling 29 for crew and passengers) to reach the deck during the total black-out, as provided by SOLAS, the test no. 4 was carried out as detailed in the Enclosure no. 4.

SOLAS 74 requires Emergency Devices able to shift lift cabins at the deck level.

The test (Enclosure 17 to the Appendix 9) carried out allowed to ascertain what provided in the project i.e. that the ship's lifts cars (both for passengers and crew) are brought back to the expected deck level (as planned in the system) concurrently with the opening of the doors and therefore ensuring the safety of the people inside in accordance with a sequence of "re-start after black-out" spread over time with respect to the starting point "zero" and EDG connection to the electric system.

This modality is due to the need of spreading the electrical loads over time according to a logical priority and without overloading the EDG.

According to the above logical priority it is therefore admissible to assume that – had all the lifts cars been running and we cannot demonstrate that – in the lapse of time of about 40" during which the EDG actually worked and powered the emergency lines, not all the ship's lifts cars would have been able to be brought back to the deck level. The examination of the recorded data relevant to the lifts doors status (just the fire-proof ones) located on some of the decks, previously described at item III, makes us suppose that the sequence was successively completed (during attempts to force the breaker for connecting the EDG to the electric system)

With regard to, the three Electricians (Annex 58) that verified all the lifts which served the passengers, testified that, as happened in the simulation on Costa Favolosa, reached their scheduled deck after the black out. The fact that one elevator of the Concordia was found by the speleologist divers with the doors opened, and some decedents were found on the bottom of the related trunk means that those doors:

- were moved and opened, when the emergency switchboard was connected in the forced mode at around 22.15. The VDR showed, in fact that
- one elevator gave properly a moving signal , and the possible moving part, considered those conditions, could have been only the door, rather than the cabin.

It is then also reasonable to think that, as per the First Electrician witness, each time he forced the breaker 901, i.e. when he succeeded in blocking it, the latter materially closed on the ES because the instrument measuring the current displayed at first about 1000A and then about 400A. These mechanical actions causing the breaker 901 forced closure would have therefore allowed to power the lifts cars, actually bringing them, according to their logical running time sequence, to the deck level and opening the doors.

The above could furthermore be confirmed by the electric power intensity of 400 Ampere that the First Electrician declared he always saw on the breaker 901 display when forcing its closure, i.e. he referred that there were some electric loads powering the ES such as, hypothetically speaking, the lifts cars and the emergency lights (even though, as far as the lights are concerned, there is no evidence on the recording). Other services usually connected to the emergency were clearly not powered at the time, because they were either submerged or not working.

VI.

With respect to the visual check – during the total black-out – of the lights level in the internal accommodation areas, the escape ways and the muster point for passengers embarking on the lifeboats/liferafts, the results were definitely in compliance with the rules showing that the lights were quite the same as when the ship is in normal operation.

VII.

The steering gear failure is the only signal recorded in the VDR that allowed to establish the exactly time (21.46.44) when the EDG interrupted its connection with the related switchboard, due the reason that will be outlined in the chapter "conclusion". In those moments the three steering pumps (1-3-4) connected with the emergency power stopped their working and never restarted, despite the EDG - as proved - was after connected, for three more times, with the related switchboard thanks the forced mode.

At the time of the contact, and till the engine staff crewmembers remained in the flooding areas, the WTC - where is located the steering station - was dry.

For this reason the only, logic cause of the steering failure, can be considered the breakage of the cable connected with the emergency power grid, or the breakage of some electronic connectors, due to the impact, despite this failure happened not immediately but a couple of minute after the impact. No others reasons can be reasonably taken into consideration

Description of tests carried out on the sister ship m/v Costa Favolosa

Test no. 1 – Check of EDG protection devices when in manual mode

Test no. 2 – Check EDG alarms and protection devices when in manual mode

Test no. 3 – Black-out test and check of proper working of ES

Test no. 4 – Check of lifts positioning sequence at deck level

Test no. 5 - Check of breaker 901 automatic opening conditions

Test no. 6 – Check of breaker 901 manual closing

Test no. 7 – Check of breaker 901 automatic opening

Tests results

Test no. 1 – it has been successfully checked that the EDG, when in manual mode and in OVERRIDE, does not shut down due to the action of water high-high temperature alarms and lube oil low-low pressure alarm.

Test no. 2 – it has been successfully checked that the EDG, when in manual mode and safety devices in ENABLE position, does stop due to the action of water high-high temperature alarms and lube oil low-low pressure.

Test no. 3 – we have checked, following a black-out, the EDG automatic starting, the electro ventilator louvers opening, the electro ventilator starting and the breaker 901 closure.

Test no. 4 – it has been successfully checked the ship's lifts positioning sequence at deck level (see summary table – Enclosure 5, relevant to the running time and arrival position of each lift).

Test no. 5 – it has been successfully checked that the "ship-to-shore" commutator, when in shore mode, induces the breaker 901 opening on ES.

Test no. 6 – it has been successfully checked that the auxiliary power failure to ES allows the manual closing of the breaker 901 through its mechanical push-buttons.

Test no. 7 – the opposite sequences in order to restore the ship's normal power supply after the emergency situation has been carried out successfully.

Note: all above tests are supported by the relevant ship's records (VDR, automation computer by APSS Valmarine and SMS safety computer by MARTEC) herewith enclosed (Enclosures 18, 19 and relevant Abstracts 18.1, 18.2 and 18.3).

The enclosure no. 19 is only format in digital way .

It should be emphasized the following elements:

- the above mentioned analysis, carried out by the time of May, had been finalized during the three months after the Costa Favolosa simulations, to set each finding and process with the related assumptions;
- the analysis was developed taking into account one year of the ship's history (maintenance in particularly), focusing on the two main parts of the "Emergency power equipment" interested by the failure on 13th January 2012. On the reference there is even an evidence related to a special maintenance intervention on the emergency diesel generator (made on November 2011), and the record of the several works made during the previous dry dock, which includes even the periodical check on the emergency switch-board.
- The Appendix 10 is composed by 19 special Enclosures, all the above mentioned issues are examined in detail into Annexes from 1 to 8 belonging to its Enclosure 1.

Remarks on flooding sequence

The flooding sequence has been reconstructed by matching the available VDR records (both audio and on track) and SMS with the crew witnesses.

Granted that it is not possible to exactly assess the actual flooding sequence, the only information we have with respect to the water level into the main electric switchboard room on deck A are the two engine crew members declarations.

According to the two inspections carried out by them within a short period of time (about one minute) it is possible to note that between 21.52 and 21.53, the water level at deck A (within the main electric switchboard room) resulted between 7,25m and 8,25m above the DDBB tank top plating. That means that at the time the main switchboards were quite totally submerged.

At this point the only objective data relevant to the flooding, and to the connection between the effects of the water and the failures subsequently recorded on the ship, are these witnesses.

Any other possible connection between these failures (alarms, power loss to lines connected to the emergency system, etc.) and the actual water level within the flooded compartments (adjusted by external factors such as listing and drifting due to wind/current) must be considered simply inferential, therefore supposed and not necessarily reflecting what actually happened.

However the first objective data, connected with flooding, must be considered the event recorded at 21.46.17, when the VDR system recorded the starting air circuit low pressure ascribable to the flooding of its relevant sensor.

The VDR does not record the working bilge pump and the related failure alarm.

In the Appendices are gathered all the VDR data extracted, reported in a DVD.

5. CONCLUSIONS

Foreword

It is worth to summarize that the human element is the root cause in the Costa Concordia casualty, both for the first phase of it, which means the unconventional action which caused the contact with the rocks, and for the general emergency management.
It should be also noted that the Costa Concordia is, first of all, a tragedy, and that the 32 dead people and the 157 injured, depended only by the above mentioned human element, which shows poor proficiency by key crewmembers.
According with the evidences found at the end of the present investigation, it is necessary to put in evidence that Costa Concordia resulted in full compliance with all the SOLAS applicable regulations, matching therefore all the related requirements once she left the Civitavecchia Port on the evening of the 13 January 2013.

5.1 Navigation before the impact phase

This is the phase of the incident is to be considered crucial to the investigation, as it is the cause of action originated the serious Concordia casualty, and in that sense is due firstly to highlight the conduct of the Master geared wilfully to pass the ship in restricted waters and then in a small space, by a route parallel to and perpendicular to an excessively close to the shore, intervening in a very light way on the course (then with bows which gave the helmsman faculty of self-management) to generate a sweet turn, but at the same time very wide.
It is worth to highlight also the following problems in terms of organization: - in the meantime, although the ship was proceeding quickly toward the shore , taking command well in advance, still in time to correct the dangerous route, represents for the Master an aggravating in his nautical behaviour; - the difficulties of the Master in reading the radar screen (according to 1st Deck Officer, was without glasses for near vision); - the use of cartography totally inadequate - an inappropriate application of systems navigation (Ecdis and Radar in appropriate scale of approaching); - however, the distraction of the Master by the conduct due both to the people in the hotel business department that were already on the bridge when he arrived, and to the call engaged by one of them with a colleague on the ground; - the orders of the Master to the helmsman given by assigning the bow to follow, rather than ordering the rudder angle.
Regarding the specific directives collected within the ISM procedures, emerge precise criticality that can be found in watch-keeping on the bridge, both with regard to the distraction of service personnel due to the presence of strangers, but also about the verification of the ship position, which in this case has never been (at least from audio recordings) ascertained. And in this context it is clear the arbitrary attitude of the Master in reviewing the original

navigation plan (already bad because of the passage to 0.5 miles using a chart totally inadequate) and go beyond the planned turn point without verifying (even though it was supported by the team) the actual distance from the shore.
Audio recordings, together with the evidence collected (2nd and 3rd Deck Officer, as that of 1st Deck Officer, does not become the likely outcome on the same recordings), show how lack the bridge team compared to the government of the ship.
The passive attitude of the staff (team) on the bridge is just as reprehensible, and neither the most authoritative of the Officers (1st Deck Officer,) resulted from the records to have ever urged the Master to tighten / speed up the turn, nor gave him information about the imminent danger despite before the arrival of the Master had strongly criticized the bridge the decision to follow a route so close to the shore, calling it a true madness.
It can be criticized also, the missed employment of the bridge staff (3 officers) both during the phase in which the watch was kept by the 1st Deck Officer, both when the Master took command. Even if, In this second juncture the 1st Deck Officer, could have used the staff of the bridge for warning about the dangerous approaching), rather than simply repeat the orders of the Master to the helmsman or changing the speed.

As said above, the navigation phases before the impact are to be considered as a crucial aspect, because they relate with the causes originating the accident. In particular, the focus is on the behaviour of the Master and his decision to make that hazardous passage in shallow waters. The computer simulation somewhat confirmed delays in the ship's manoeuvring in that particular circumstance. In this respect, the following critical points can be preliminarily indicated as contributing factors to the accident:

- shifting from a perpendicular to a parallel course extremely close to the coast by intervening softly for accomplishing a smooth and broad turn;
- instead of choosing, as reference point for turning, the most extreme landmark (Scole reef, close to Giglio town lights) the ship proceeded toward the inner coastline (Punta del Faro, southern and almost uninhabited area, with scarce illumination);
- keeping a high speed (16 kts) in night conditions is too close to the shore line (breakers/reef);
- using an inappropriate cartography, i.e. use of Italian Hydrographical Institute. chart nr. 6 (1/100.000 size scale), instead of at least nr. 122 (1/50.000 size scale) and failing to use nautical publications;
- handover between the Master and the Chief Mate did not concretely occur;
- bridge (full closed by glass windows) did not allow verifying physically outside, a clears outlook in night-time (which instead could have made easier the Master

eyes adaptation towards the dark scenario), catching moreover noise by sea slamming to the rocks/beach;

- Master's inattention/distraction due to the presence of persons extraneous to Bridge watch and a phone call not related to the navigation operations;
- Master's orders to the helmsman aimed at providing the compass course to be followed instead of the rudder angle.
- Bridge Team, although more than suitable in terms of number of crewmembers, not paying the required attention (e.g. ship steering, acquisition of the ship position, lookout);
- Master's arbitrary attitude in reviewing the initial navigation plan (making it quite hazardous in including a passage 0,5 mile off the coast by using an inappropriate nautical chart), disregarding to properly consider the distance from the coast and not relying on the support of the Bridge Team;
- overall passive attitude of the Bridge Staff. Nobody seemed to have urged the Master to accelerate the turn or to give warning on the looming danger.

The present case demonstrates the inadequacy, in terms of organization and then about "who does what" of the Bridge Team. This incident can be useful as a warning for a revision of the guidelines now taken by the various Conventions (SOLAS, STCW, ISM Code), and included with the ISM procedures on board. This in particular to explore the areas where intervening in order to ensure that the management structure of the bridge respond to each situation and condition (ordinary, critical, emergency) that may occur at sea, providing also instruments for adaptation to different types of vessels / sailing / quantity and quality of the crew (among the others a correct adoption of the traditional navigation tools and related criteria, the adaptation of the outlook and radio-navigation).

One particular area can be, of course, the division of duties of everyone which is in service, together with the consultation for sharing of data and risk analysis (in Concordia nobody has verified exactly how the ship was proceeding regard to the danger, with the exact position in relation to the seabed and the coast and with the kinematics it was taking while sailing).These tasks, if coded, can be (regardless who was the watch-keeper) a model of support to avoid risks in the event conditions:

- close navigation;
- narrow passages;
- possible dangers.

Finally, it could be also coded in a better way a complete ban of the presence on the bridge during the voyage and manoeuvres of personnel which is not part of the commanding/conducting staff (Deck Officers and sailors / lookouts), and the resulting penalties [see on the reference the related chapter titled recommendations (operational matters)].

On the whole, the accident may lead to an overall discussion on the adequacy, in terms of organization and roles of Bridge Teams.

5.2 Breach and management of dynamic stability during flooding

A critical factor concurrent to the flooding, caused also by the violent and sudden flooding and very decisive, was the immediate loss of propulsion and services in general, short circuits occurring in the chain of the two WC more violently affected, i.e. the same PEM room (No. 5) and the WC 6 (aft DD.GG.), where vertically - but under the Bridge 0 - insist respectively the electric production panel and the distribution one (in PEM are present, below the production panel, even the transformers).The black-out was recorded only 50 seconds after the contact.
Although the protections present before the power distribution have intervened to prevent the transmission of short-circuits on the electrical panel from emergency DG, loss of propulsion due to the collapse of the six main DD.GG. and the consequent loss of production and distribution of electricity hit, crucially, production facilities and overall governance of the ship.
Once lost the production of electrical power, the consequent criticality was, in fact, the inability to have available the pumps of exhaustion large masses (approximately 1,000 m3 per hour flow rate, requiring a large power consumption which is insurable only by the network production / primary distribution), as only adequate aids to control (3 pumps should have operated at the same time), depleting them, the free liquid surfaces immediately produced in WC 4, 7 and 8.
The emergency pump (250 mc flow / h) has not been activated, also for the discontinuous operation of emergency utilities evidently (especially in the crucial phase of failure, i.e. from 3 mins to 20 mins). It, however, could not provide any significant contribution to the reduction of free liquid surfaces.
A further electrical line supplying the emergency, and then affected by the same problems of continuity in operating, is the balancing pump. Regardless, and taking into account the severity of the list, the use of that pump, possible only in tanks at the extreme bow, could not surely have an impact on the improvement of conditions of stability.
Taking into account the exceptionality and the rapidity of the event, the Solas rules referable to Concordia do not establish that the ship is equipped with an automated system of water detection in the free compartments and, consequently of a computerized failure control system by direct information necessary to calculate the residual dynamic stability.

With regard it should be noted, in fact, the mere function of support performed by the computerized stability system (i.e. NAPA) , which responds to Rule 8 of Chapter II / 1 of Solas to provide, before and after failure, the parameters of static stability and the condition of final flooding determined with the help of the operator who manually enter the necessary data. The NAPA is powered by one of the battery groups (UPS) on board, and after some initial technical difficulties, appears to have been used regularly employed by the Officers in charge.

The stability of the vessel resulting at the 10 steps analyzed in the flooding sequence have been determined using NAPA, as the software used for the flooding simulation does not perform stability calculations; the stability results are available in Annex 1b App 3.

The stability of the vessel is found satisfactory in terms of GM at equilibrium heeling angle, range and area under righting lever curve (representing the residual righting energy of the vessel) from step 1 (representing the vessel situation at 9.45 p.m. of 13 January 2013) to step 9 (representing the vessel situation at 10.31 p.m),whereas at step 10 (representing the vessel situation at 10.54 p.m) the righting lever curve is almost neglectable meaning that the vessel has lost her capability of opposing to healing causes

Furthermore, starting from step 8 (representing the vessel situation at 10.26 p.m) irreversible progressive flooding of the intact spaces afterward the breach occurs causing the progressive loss of stability and the loss of the ship herself.

For the related diagram, see the pictures reported in the Annex 1b attached to the main Appendix No. 3 (however the related technical graphs are reported at page no. 117 and 119).

Based on the sequence of events, even in the absence at the time of a complete picture of the evidence - and given the exceptional nature of the event [it refers to an extreme case of a contact for high speed while sailing at short distance from the coast and for the incident route (could be qualified as boarding) followed till a few minutes before impact] – it can be assumed that an integrated system of defence (passive and active) can handle a similar case in the future, reducing:

- the consequences and;
- ship's flooding reaction even in terms of resistance against sinking,

should be based on criteria of safety / construction / arrangements of different systems, other than those existing today.

Excluding in the long-term the replication of an event so dramatic and severe as that which occurred to the Costa Concordia, should be considered in the future a similar incident (consequential damages) the eventual contact between two ships at high speed, with acute /

obtuse angle of impact that would affect, therefore, more than two adjacent watertight compartments.

The above matters are examined later in the corresponding recommendations chapter, both in terms of vital equipment and redundancy.

5.3 Functionality of the Emergency Diesel Generator.

The operation of the EDG showed significant criticalities, which require prudent considerations in the round.

It 's a critical issue both the violent impact, the consequently collapse and the massive amount of water that flooded the vital parts of the ship, causing uncontrollable consequences and damage, even invisible, properly imponderable .

We point out that the power emergency grid went into automatic operation, despite the fast path followed by the water within the complex system of production / distribution of electricity, particularly in the WTC 6 (stern DDGG room and Electrical Panel of the main distribution). It is however known, as showed by this IB, that the related equipments were then invested by a collapse, and the grid worked only in a forcing way.

Being understood, the conclusion of the deep technical investigation drafted in the following sentences, some critical elements can be found in the aspects below mentioned:

- limited availability of emergency lines in case of failure for flooding and direct consequences on management of residual dynamic stability;
- absolute absence of redundancy in the production of emergency power ;
- lack of lines available in emergency, in particular those also that could be used for an alternative government of the ship.

In view of the afore mentioned results, carried out with the aid of board Costa Favolosa sister ship activities , the conclusions are here below submitted:

- The statement in Enclosure no. 1 to the main Enclosure nr. (….) provides evidence of EEP efficiency conditions at the departure of the m/v Costa Concordia from Civitavecchia on 13th January, 2012 (it is to emphasize the positive results – with the breaker 901 closure – during the monthly test with no load, carried out in the port of Toulon on 8th January, 2012).

- As it can be noted from the events chronology reported in the narrative of this report, the contact occurred at 21.45.07 and the black-out was recorded at 21.45.57. At 21.46.03 the EEP automatically started, as shown by the steering gear pumps power signal.

- The large and sudden flooding of the compartments led to a critical situation for the breaker 901 that at 21.46.44 tripped causing a power loss to the ES. As the breaker 901 was supporting a situation of contemporaneous short circuits (those of the lines powering the compartments involved in the progressive flooding) its tripping may have caused the total black-out. Due to the above the concurrency of the short circuits occurring to the lines powered by the ES would seem the most probable cause of the breaker 901 malfunctioning.

- We cannot rule out that the "ship-to-shore" commutator submersion may have contributed to the breaker 901 malfunctioning, still bearing in mind that it is not possible to actually ascertain the flooding real sequence, also due to the fact that the main switchboard rooms were bounded by class A (steel) bulkheads, doors and deck plating, i.e. fire-resistant and although the latter were not waterproof to head pressure they were anyway an obstacle to the flooding progress.

- On the other hand, should we consider the sudden flooding of the main switchboard room feasible, the latter circumstance could not be considered as a contributory cause to the EEP malfunctioning (breaker 901). As a matter of fact, the EDG still kept on working automatically supplying power to the ship's electric plant up to 21.46.44.

- The test no. 6 showed that it is possible to manually close the breaker 901, manually disconnecting the auxiliary tension to the closing/opening coil without employing a screwdriver, provided that the minimum tension coil is powered. Should the minimum tension coil not be powered or resulting faulty the switch cannot be operated, even manually operating the mechanical closure push buttons. That means that we cannot rule out that a fault or a power loss may have involved the minimum tension coil of the breaker 901, therefore justifying the First Electrician forced intervention.

- Later on the EEP resumed working, as declared by the First Electrician , and as resulting from the VDR records relevant to the lifts doors.

Summarizing, the EEP discontinuous working depended on the breaker 901 intermittent functioning, the latter caused by the exceptional event in progress and by the unexpected consequences occurring due to the heavy water progressive flooding.

In fact the evidences resulting from the witnesses and the records relevant to the m/v Costa Concordia casualty - as verified during the checks carried out on board the sister ship m/v Costa Favolosa - demonstrated the EEP adequate intervention when the black-out occurred and its full compliance with the applicable rules.

Redundancy of electric power is one the main target drafted in the following chapter titled recommendations (emergency power generation), as suggested by the present lessons learnt.

5.4 On board organization – emergency management

The General Emergency Alarm was not activated immediately after the impact. This fact has led to a delay in the organization of the subsequent phases of emergency (flooding-abandon ship process). With regard to the organization on board, the analysis of crew certification, of the Muster List (ML) and of the procedures of familiarization and training on board highlighted some inconsistencies in the assignment of duties to some members of the crew.
The procedures implemented for the familiarization and training of the crew, required for their inclusion in the ML, were not fully responsive to the need. Some communication problems between the crew members and between them and the passengers somehow hindered the management of the general emergency-abandon ship phase and contributed to initiatives being taken by individuals. It is deemed that such flaws are attributable also to the different backgrounds and training of crews. It appears, therefore, that the recruitment of crew members, carried out by external agencies worldwide, plays a fundamental role in the management of emergencies.
It is also necessary to emphasize the different scope of the Minimum Safe Manning (MSM) document and the Muster List (ML). SOLAS regulation V/14.1 requires that the ship shall be sufficiently and efficiently manned, from the point of view of the protection of the safety of life at sea. This regulation makes reference, but not in a mandatory way, to the Principles of Safe Manning adopted by the Organization by Resolution A. 1047 (27). The Administration should, therefore, issue a MSM document appropriate with the above mentioned provisions. SOLAS regulations III/8 and 37 provide details for the preparation and posting of the ML. In particular, regulation III/37 requires that the crew should be organized in a ML showing their assigned tasks in the management of various emergencies.
In the light of the above, it should be underlined that, in our experience, too often the scope of the ML is confused with that of the MSM (and this was also found out on passenger ships flying a Flag other than the Italian one).
In fact, the crew indicated in the MSM document shall be properly trained, be in possession of the certificates and training provided in accordance with the STCW Convention and then holding the "minimum standard" required. However, persons on board who are assigned to

safety duties, as per the M.L., sometimes lack the necessary skill or simply are unfamiliar with the ship lay-out and procedures. It is believed that this aspect merits a focused attention and discussion.
The general emergency and the abandon ship signals were activated with delay in respect to the moment when the awareness that at least three contiguous WTC of the ship were flooded; this meant that the seriousness was evident, and this information reached the bridge at 22.01 but the first lifeboats were lowered in the sea only at 22.55.
The Master, whose last voice in the bridge was recorded at 23 19 30, first of all abandoned very soon the bridge (leaving of there the Staff Master, who remained till the 23 32 30) and left the ship before her evacuation was completed; at 01.11(contacted by the SAR telephone number 1530). The Master declared to be on shore, while several passengers and crewmembers were still on board; and however, most of the Officers were already on shore, together their Master.

It is evident that the Master of the Concordia:

- not promptly declaring the general emergency, despite the premises occurred; thus seriously delaying the gathering of the passengers and crew in the Muster Stations;
- not activating the Muster List;
- abandoning the ship while passengers and crew were still on board,

could have caused as a consequence of the above findings the 32 decedents in the casualty, as already showed in detail by the statement reported in the previous chapter 4, according with the finding which reconstructs the dynamic of the causality and the only practicable alternative way to avoid those victims, which was, instead, ignored by the Master.

Within the ship reports (Annexes 59 - 60) regarding the two last general drills carried out on board during December 2011, although simulating an abandon ship after a serious fire on board, it was pointed out - despite the Master was the same – a correct approach of the both emergencies. In particular within the 14th December one, the Master, just after the awareness that passengers were in danger, launched immediately the general emergency alarm and just after 25 minutes, when the Hotel Director confirmed to the Master that all passengers had been evacuated from the living spaces, he raised the abandon ship order.

Therefore the above mentioned delaying played the main root cause on the reference, because mostly of those persons (at least 18 on the whole as passengers and crewmembers) delayed, desperately attempted to cross the ship from starboard to left, slipping to the starboard side when the ship listed because the heeling gradually increased from 30° to 80°. This is confirmed by the analysis carried out according to the position where those victims were been found. Meanwhile, the others desperate people were thrown into the sea.

It is clear, according with the analysis already drafted, that several Officers belong to the deck staff contributed to cause the casualty. Moreover, some of the deck staff officers and the hotel director, since they failed their duty during the management of the emergency, could have contributed to cause the dead persons. The DPA, indirectly, could have contributed to cause of the dead persons as well (at least in terms of moral obligation, taking into account that he realized the serious danger too late).

5.5 Summary Of The Human Factors Analysis And Related Final Conclusions

On the whole, human factors characterized this casualty, as already stated in detail both in the previous analysis and in the present conclusions.
Now, however, it is worthwhile to put in evidence in what terms this main element can be stated, matching it with each of the single actions, or with the respective crewmembers who committed the action.
First of all, analyzing the background of the crewmembers (Officers mainly) involved in all the different phases of the event (even before the contact), this IB excludes that the casualty and the consequent handling of the emergency is due, in terms of human performance, to the lack of competency.
It is likewise evident - also because we have no elements to say the opposite - that the casualty and the related failure in terms of emergency handling was characterized by the lack of alertness. In reference to this, this IB excludes, in accordance with the previous analysis, that there were problems related to fatigue and related rest and the health of the crewmembers (they had certificates of fitness). Instead with reference to stress, while most factors which could have influenced this element, it has to be excluded as well. This IB cannot say the same for the individual factors such as: personally, health problems occurred during the seagoing service on Concordia, personal relationships, motivation, sense of danger. This IB has not elements to establish, for each crewmember involved, if he/she felt “optimum performance” (linking it to the stress level) on the day 13th January 2012 and exactly during the occurrence of the casualty.
Therefore, distractions, errors and violations can be established as the elements which characterized the human factors as root causes in the Costa Concordia casualty.
Both distractions and errors (in all terms of slips, lapses and mistakes) had been made during the Master’s performance before the contact, according to the previous detailed analysis.
Distractions and errors (in all terms as slips, lapses and mistakes, as well) had been made during the Bridge Team performance (all the Bridge Team involved) before the contact, according to the previous detailed analysis.
Notwithstanding the above preamble, regarding the competency, not having attended a training course on Bridge Resources Management course - BRM, (not mandatory at this stage) could have represented a weakness in terms of competency (human factor as bad

human performance) in this casualty. In fact none of those deck Officers on duty before the contact (Master and all the Bridge Team) had attend a BRM course.

Regarding the actions carried out by the Master during the navigation before the contact, some errors and violations occurred (as this IB supposes), respectively due to:

- about errors, as “false hypothesis” [according with his convincement to operate in a familiar surroundings, despite the external environment changed (ship was not in maneuvering but she sailed like in an usually navigation like in high sea, darkness)], “pressure” (promise to a crewmember for sailing too close), “decision” (insisting to change the original voyage plan), “mistake” (he applied a bad rule to maneuver), “lapse” (he omitted the handover);
- about violations, as “short cuts” [two ISM procedures were, in fact, not applied, the first in order the scheduled handover and the consequent watch-keeping, the second regards the watch-keeping in case of close sailing with others ships (keep a distance not less than 1 mile – see Annex 25). In this reference, despite it is applicable for other ships approaching, the related criteria should be extended as well, by the Master, to the Giglio approaching, considering the external environment and the speed], “optimizing” (he tried to match the pleasure towards a crewmember with the only purpose of the sailing, which was to proceed in safety manner for approaching the next scheduled port).

It is worth to point out that the above error (the lapse) and violations (the two short cuts) regard also the First Mate (in duty before the contact). While all the Bridge Team carried out both lapse and mistake/failure of attention, respectively not making the look out and the adequate support/warning to the Master during the most dangerous phase of approaching (not anticipating the maneuvers to correct the wrong course).

About the emergency, the performance of the Master was affected by errors. These can stated in terms of lapses (omissions of procedures such as, mainly, the Decision Support System; moreover, he left the bridge as first and after left the ship very soon), failure of attention (he seemed such as absent by the context of the emergency and disoriented both his Staff and DPA), mistake (lack of knowledge about the vital equipments located in each compartment below the bulkhead).

Once again about the emergency, it is worth to point out the following: - both delay and mistake regarding the Hotel Director (he did not cover his duty scheduled by the procedures, omitting firstly his fundamental role on board); - delay and mistake by some Deck Officers belonging to the emergency Staff after the contact (they did not cover their exactly role, despite they were active in supporting the emergency handling; however, their actions/reactions were influenced by the absence of the Master who, carrying out the above errors, did not coordinate and governed - at all as resulted by the VDR conversations - the emergency).

5.6 SAR Operations

Summarizing, SAR Authority which intervened to coordinate the rescue operations was, of course, not informed in a suitable way respect to the real scenario occurred on board, both by the Master/Bridge staff and the Company. Fortunately, the incident happened near the shoreline (the area, however, is still not covered by the VTS system), and that's way the delay caused by the Ship, first of all, didn't compromise the rescue operation. Just 15 minutes after the event, thanks to some passengers, Leghorn MRSC was warned about some failure on board, and after few minutes (22 14), the vessel track was found by Leghorn AIS. The Patrol Boat in the area was tasked, at 22 16, to reach the Concordia position, approaching her at 22 39. The main lesson learnt is, therefore, the delay and the missing information by the ship.
SAR operations can be considered overall successful, taking into account that in few hours all the persons on board had been evacuated. It is need to take into account that, after 5 hours by the abandon ship, remained only 40/50 persons on board. 1.270 persons (a third of the total) were, at the end, saved by the shore SAR resources, while the others were saved by the ship, who were been supported by the same SAR resources by the time when the first lifeboat touched the sea. Despite the casualty is a tragedy, the number of victims was constricted, and all of them dead mainly for the delaying of the on board emergency procedures.

The abovementioned success was achieved also with the contribution of two significant elements:

- special patrol boats deployed by the Coast Guard (22 meters length and able to load more than 100 passengers) provided with a special fender, known as "*balmoral*", which allowed to approach the hull and the lifeboats without creating any damage to both ships and people to rescue;
- special rescuers, who were divers with a proficiency as speleologist, able to climb and break the structures, to rescue, even in dark condition, persons standing in the ravines.

6. SAFETY RECOMMENDATIONS

FOREWORD

The following recommendations have been made, despite the human element is the root cause in the Costa Concordia casualty.

Here is why, after this investigation, we would like to delivery in the hands of the International Maritime Community our suggestions regarding as the naval gigantism, represented by the Very Large Cruise Ships, to face this actually and rising wonder.
We believe that we can only investigate to:

- mitigate the human contribution factor with education, training and technology;
- improve day by day the building, through the modern technology;
- stress all the maritime field cluster to make the maximum contribute for the related study and consequent technical research.

The following recommendations must be considered the starting point of the actions taken consequently to this extraordinary tragedy, since we believe that many other issues could be risen, reflecting on the deep and taking time to react more, among others, with the three suggestions fore mentioned.

6.1 Actions taken

6.1.1 What Flag Administration already made:

It should be recalled that in the interim period from the beginning of the investigation and the publication of this report, some of the issues identified by this Investigation Body, and already implemented on Italian Flying Flag ships, was brought by the Flag Administration to the IMO (refer to documents MSC 90/Inf. 19, MSC 91/7/7) and taken on board by such an Organization (refer to MSC.1/Circ 1446/rev 1, Long-term action plan on passenger ship safety and amendments to SOLAS convention as set out in MSC 91/22 Annex 14).

The proposals originally made are summarized in the following:

1. Information on passengers: the information required by SOLAS regulation III/27 and European Directive 98/41/EC should be integrated with the indication of the nationality of each passenger. This would help communications, in case of accident, between SAR Centres and Administrations whose citizens are on board;

2. Voyage plan: the voyage plan requested by SOLAS regulation V/34 should be made available by the master to the Company prior to the ship's departure and be kept available until the next DOC audit;
3. Instructions to passengers: the following measures should be implemented:

   a) at their embarkation, passengers are to be provided with a brochure containing all the essential emergency information; these brochures are to be available in the Flag language and in the languages spoken by the passengers on board;

   b) in addition to what is prescribed by SOLAS regulation III/19.2.2, safety information is to be available through the ship's TV system, both in cabins and in conspicuous points in the public areas, at the embarkation and throughout the voyage;

4. muster of passengers: the muster of passengers as per SOLAS regulation III/19.2.2, is carried out at the ship's departure from the home port; where embarkation takes place in different ports, separate and dedicated musters are to be performed for passengers embarking in those ports.

6.1.2 How the MLC Convention (in the final rush to enter in force) could contribute, in terms of recruitment, placement and manning towards the human factor:

- assessment necessary to recognize the private Manning Agency which manage in the maritime field to recruit and find employment for seafarers and other personnel who supply the ships sail under the Italian flag should be taken;
- periodic controls on the activities of such Agencies should be established;
- a more detailed criteria for employing Recruitment and Job Agencies. Organize procedures, through the SMS Manual, to carry out systematic audits of the above mentioned Agencies should be established;
- the regulation pertaining to the MLC 2006 ILO Convention even to the Countries which are not Member States of the related Organizations/Agencies should be extended;
- improving the guidelines to control the activity carried out by the Manning Agencies for the recruitment and find employment could be delivered within the MLC working group.

6.1.3 What the Company already did (before and after the March 2012 audit by the Flag State)

1. Company Audit follow-up as a consequence of the casualty:

   Following the Costa Concordia event and after the evaluation of initial information and elements of investigation acquired, the Flag Administration considered necessary to perform an audit related to the safety management system of the Company "Costa Crociere SpA".

   In this regard, the Flag Administration provided a DOC additional verification that was performed on 6 and 7 March 2012 by four ITCG Officers and a Recognized Organization auditor (Rina Services SpA). 7 "Non Conformities" and 5 "Observations" were found.

   Notwithstanding the need to conduct an additional audit, within 6 months, the Company DOC certificate was endorsed.

   The non conformities control and corrective actions were monitored by the Flag State Administration and definitively closed on 5 June 2012.

   On 3 October 2012 the above mentioned DOC additional audit was carried out by ITCG personnel in conjunction with Recognized Organization auditors (Rina Services SpA) without any finding.

2. Regarding the organizational changes implemented by the Company following the Costa Concordia case, the most relevant with the subject are:

a. Amending P12.04 IO 01 SMS Procedure "Management of the Emergency Instruction for Passengers (Annex 61):

   - Forwarding the Circular Letter GEN. SER. N°97/2012 – implementation of actions in favour of cruise ships identified in response to the accident of "Cost Concordia", which amended the above procedure establishing a new policy on passenger emergency instructions, by the 1st of February 2012 (this should be adopted one week before that the same policy was adopted by the rest of the whole Cruise Industry). According with this new policy, the above procedure (Annex 62) points out that guest's safety drill is performed now before the departure of the ship from the embarkation port, and those guests identified as not participants are re-invited to another event organized on-purpose.

b. Amending P12.04 IO 02 SMS Procedure “Decision Support System for Master” (Annex 63):

- Reviewing, by the 2nd of June 2012, the related fundamental rule, implementing each action to be taken in case of emergency. The related workflow is amended for:

  - Contact/Leaking, enforcing the assessment of the WTC and the linked, consequent, actions, also related to the Damage control Plan;
  - Aground, implementing the procedure for the VDR discharge;
  - Fire in Engine Room, enforcing the assessment and the confinement of the related vertical zone, and implementing the procedure for the VDR discharge;
  - Fire outside Engine Room, implementing the procedure for the VDR discharge;
  - Emergencies related with Pollution, stressing the action of the Master already established, to emphasize that he is obliged to follow the related plan for fighting the pollution.

c. It results, moreover that the Company made:

- Creating a new Maritime Development & Compliance Dept, which reports directly to the CEO and manages all the HESS [Health - Environmental - Safety - Security] matters related with the COSTA-IBERO-AIDA brands (Annex 64).

- Implementing an advanced system to manage and monitor fleet route the "High Tech Safety Monitoring System" (HT-SMS), involving both on board and ground staff. The system enables the Company to monitor position and course of the entire fleet in real time (Annex 65), to verify:

  - The safety level of route plans, comparing the route planned by the Master (Passage Voyage Plan or VPP) with the standard route;
  - Actual position of each vessel compared with the route planned by the Master (VPP) and the standard route;
  - quickly and automatically identify unexpected changes of direction.

- Creating a dedicated "F.O.C." Fleet Operations Centre in Genoa HQ to monitor and manage any alarm generated by the system (the related procedure is attached);

- Is about to be officially replaced the P15.6 IO 01 “Crisis Management Preparedness Plan Operational & Reporting Procedure” by a brand new E.S.U. [Emergency Support Unit] Manual, prepared by a working team leaded by another new role created: the Crisis Management Director, reporting directly to the President. The Crisis Management Director’s organization is about to be fully deployed whenever crisis levels are such as to pose risks for passengers, crew and corporate structures in general and involves new and dedicated Genoa HQ infrastructures.

d. Implementing the training towards the Deck Officers, through a mandatory policy adopted by Carnival Corporation on 1st September 2012 (see Annex 50), which establishes, as drafted in the previous chapter 4, the following action taken about such the following summarized mandatory courses, which amended in concrete the procedure P5.03 SMS (Annex 66):

- Bridge Resources Management (BRM - two levels);
- ECDIS-NACOS (two levels);
- Ship Handling;
- Stability.

Furthermore:

- Master and Staff Master have to attend all the above courses;
- Senior Officer on Watch the two levels of both BRM and ECDIS;
- Junior Officer on watch BRM and ECDIS 1st Level;
- Course for Instructor is recommended for the Master;
- The Carnival Corporation new Safety Standard addresses the proficiency in details as well.

6.2 RECOMMENDATIONS

PREAMBLE

The immediate flooding of five watertight compartments, where most of the vital equipment of the ship was located, makes the Costa Concordia casualty quite a unique event. The extent

of damage is well beyond the survivability standard applicable to the ship according to her keel laying date.
However, the investigation has allowed the identification of some recommendations the adoption of which could constitute an improvement of the current requirements.

The aim of some recommendations is already taken into account by the SOLAS Convention for new buildings or existing ships, through various amendments to the Convention including:

1. requirements for segregation and redundancy of vital equipment for propulsion, steering and navigation, i.e. SOLAS regulations II-1/8-1, II-2/21 and II-2/22 on the safe return to port, applicable to ships built on or after 1 July 2010;

2. onboard stability computer (or shore-based support), applicable to passenger ships subject to the safe return to port requirements and built on or after 1 January 2014, i.e regulation II-1/8-1.3 as contained in resolution MSC.325(90);

3. flooding detection system, for ships built on or after 1 July 2010 as per SOLAS regulation II-1/22-1; and

4. use of Electronic Chart Display System (ECDIS), SOLAS regulation V/19.2.2.3.2 applicable to all passenger ships (for those constructed before 1 July 2011, the requirement shall be met not later than the first survey* after 1 July 2012).

However, the recommendations given below may emphasize the necessity for having some of the above requirements reconsidered.

It must be pointed out that the adoption of these recommendations may permit an improvement in the ship's survivability during a casualty as the one involving the Costa Concordia; although they may not be sufficient to render the ship unsinkable when more than two watertight compartments are flooded.

6.2.1 STABILITY

For what concern the stability related issues, it is recommended that the following items are considered with the aim of improving the existing requirements:

1. double-skin for protecting the WTCs containing equipment vital for the propulsion and electrical production;

2. limiting of the down flooding points on the bulkhead deck to be discussed in the light of Part B-2 of Chapter II-1of SOLAS 74, as amended

3. provision of a computerized stability support for the master in case of flooding; and
4. interface between the flooding detection and monitoring system and the on board stability computer, taking into consideration regulations II-1/8-1 and 22-1 of Chapter II-1of SOLAS 74 as amended.

Initiatives in 1. and 2., above, are meant to be addressed to new ships while the discussion on the content of 3. and 4. should be extended to both new and existing ships.

6.2.2 VITAL EQUIPMENT AND ELECTRIC DISTRIBUTION

The following issues need to be discussed for possible improvements of the existing requirements:

1. discontinuity between compartments containing ship's essential systems (such as propulsion sets or main generators sets) in order to preserve their functional integrity (reference should be done to regulation II-2/21, SOLAS 74 as amended);
2. more detailed criteria for the distribution, along the length of the ship, of bilge pumps and requirement for the availability of at least one pump having the capacity to drain huge quantities of water (reference should be done to regulation II-1/35-1, SOLAS 74 as amended);
3. relocation of the main switchboard rooms above the bulkhead deck (reference should be done to regulation II-1/41, SOLAS 74 as amended);

The above mentioned recommendations number 1, 2 and 3 are meant to be addressed to new ships only.

4. relocation of the UHF radio switchboard above the bulkhead deck, for all existent ships which are provided with this equipment below this deck, and for the new ships, it should be located above the bulkhead deck.

6.2.3 EMERGENCY POWER GENERATION

Regarding the emergency source of electrical power (ref. regulation II-1/42, SOLAS 74 as amended), the following should be considered:

1. increasing the emergency generator capacity to feed also the high capacity pump(s) mentioned in the previous paragraph "*VITAL EQUIPMENT AND ELECTRIC DISTRIBUTION*";

2. provision of a second emergency diesel generator located in another main vertical zone in respect to the first emergency generator and above the most continuous deck. In this respect, the definition of "most continuous deck" in the light of SOLAS regulation II-1/42.1.2 seems to be necessary. This second generator could be dimensioned on the basis of selected services. The related manufacturing and handling should be as follows:.

    a) new emergency diesel generators are made according to aimed and specific building techniques in order to guarantee a unfailing and long-lasting functioning;
    b) regulate in an optimal way the functioning tests, planning them once a week, under a significant load (at least 50%) and of at least two hours duration for both the emergency diesel generators.

3. provision of an emergency light (both by UPS and emergency generator) in all cabins in order to directly highlight the life jacket location.

Although the above recommendations are meant to address new ships, considerations on the applicability of items 2. and 3. also to existing ships is suggested.

6.3.4 OPERATIONAL MATTERS

The event demonstrated that there is the need for verifying the actuality of provisions contained in international instruments, such as SOLAS, STCW and ISM Code related to different issues such as:

1. bridge management, considering aspects such as the definition of a more flexible use of the resources (that may be tailored for responding to ordinary, critical, emergency conditions), an enhanced collective decision making process and "thinking aloud" attitude;

2. Bridge Team Management course for certifications renewal should be mandatory by the 1st January 2015;

3. *Principles of Minimum Safe Manning* (resolution A.1047(27) as amended by resolution A.955(23)) that should be updated to better suit to large passenger ships. A mandatory application of these principles is also considered desirable;

4. muster list, showing the proper certification/documentary evidence necessary for crew members having safety tasks;

5. inclusion of the inclinometer measurements in the VDR.

The above items could be applicable to both new and existing ships.

6.3.4 EVACUATION ANALYSIS

1. For new ships, it would be useful to require an evacuation analysis to be carried out at the early stage of a project (ref. regulation II-2/13-7.4, SOLAS 74 as amended), extending in mandatory way the above regulation, actually limited to ro-ro passenger ships.

2. Regarding the embarkation ladders: with the ship listed at an angle exceeding 20°, it was demonstrated that traditional embarkation ladders were more useful. Therefore, in the light of the above mentioned details drafted in Para 4.6.1.4, it may be necessary to consider whether the minimum number of embarkation ladders (one) on each side should be increased (SOLAS 74 as amended reg. III/11.7)

6.3.5 SAR

This casualty gives us special lessons also in terms of SAR experience.

Despite the main, unbelievable lesson learnt is, the delay and the missing information by the ship, we would warn the IMO about other issues, to recommend each SAR Organization for providing its resources by the following tools:

- SAR patrol boat supplied with fix fenders, blocked in the upper side of the hull, to approach safe other ships/boats in case of extraordinary evacuation of persons. This should be able to load at least 100 passengers in their deck;

- Divers speleologist, able to rescue, even in dark condition, persons standing into the ravines of ships/wrecks.

All the lessons learned and the consequent above mentioned recommendations have been shared with the relevant Flag State Office.

7. ACKNOWLEDGMENT AND FURTHER INTENTIONS

This IB would like to thank all the SISs, and particularly the USA IB, who close cooperated with us to address, in the best way, the analysis outlined within this report.

It is intention of this IB to get the further opportunity for analyzing the Costa Concordia wreck, asking in advance the clearance to the Judicial Authorities, to verify the on board scenario, as first among equal with the criminal inquirers, such as to avoid any pollution of it. Among the finding to better assess we would point out, in this moment, the main following:

- ventilator of the Emergency diesel generator;
- steering pumps and related electric connections;
- position of the elevators and the condition of the related steel cables and supports;
- openings upper the bulkhead deck in the WTC 3, 2 and 1;
- conditions of the WTC nr. 8 and the other main leaked WTC (7,6,5 and 4);
- conditions of the watertight bulkheads and the related watertight doors following the impact (first of all the number 6);
- operating conditions of switch no. 901 located in the emergency switchboard;
- operating conditions of liferafts/lifeboats gears (for the bending due to exaggerate heeling).

Notwithstanding the above, the present document, however, represents the final report of Costa Concordia casualty investigation and, even if the wreck could be available for an eventual residual investigation (and provided that the scenario would not be compromised), this report should be updated only by the Italy – nevertheless - under an exceptional authorization issued by IMO, taking into account the uniqueness of the event.

This hypothesis will be submitted to EC by a special request for a formal approval also to be used in similar exceptional cases through i.e. a specific resolution amending the EU Directive 2009/18/EC[8].

[8] EC DG MOVE regarding this matter replied officially with note MOVE/D2/JPB ON 30 APRIL 2013 enclosed to the present document (Appendix 13)

8. APPENDICES

8.1 Annexes and appendices related to the report

ANNEX	TITLE
1	Meteo Data 225-D
2	Data Meteo LIQO Monte Argentario
3	Weather bulletin 13 - 14 January 2012
4	Meteomar Notes
5	Decedents
6	P5.01.02.01 IO 01 SMS - Deck & Engine recruiting and selection
7	P5.03.03 Man 1 SMS - Safety - Crew Training
8	Enc 01 Man 01 SMS - Company process map
9	P 12.04 IO 06 SMS – Muster list compiling
10	P 5. 05.01 IO2 - Rest hours
11	P 5.2 IO 9 - Application form for hotel department personnel recruitment
12	Minimum Safe Manning
13	Crew List
14	Civitavecchia Port Arrival and departure clearance on 13 January 2013
15	Man 01 SMS - Company Management Manual
16	Statement regarding the simulation of the contact with the rocks
17	P 5.05.01 IO 02 – Crew Rest hours monitoring
18	Circular letter P5 - 121.11 (internal communication) 20.04.2011
19	SAFPASS
20	CLASS Certificate
21	Operating Limits as per Rule V/30 Solas 74 as amended
22	Interim survey endorsement sheet
23	PSC - Inspection Summary
24	P 14 - Man 1 MO 5 SMS / Navigation management - Voyage and passage planning (berth to berth)
25	P 14 - Man 01 SMS - Bridge procedures -
26	Chart Inventory Costa Concordia
27	Ares Manual Ed. 2002
28	Ares Communications
29	ECDIS
30	P5.03.03 Man 1 MO8 SMS COP – Deck Officers training Check list
31	Manoeuvring booklet Costa Concordia
32	P 14 MAN1 SMS MO 12. 10 Navigation manag -Standard ordrs for the watch officer on the bridge
33	P 14 IO2 SMS - Operating instructions - Bridge Team Behaviour rules
34	P 14 Mn1 - M O1 Navigation management - Departure preparation checklist
35	P12.05 IO 06 SMS -Guidelines for the usage of watertight doors during navigation

36	Stability Certificate and NAPA software
37	E-mail on 28 may 2012 of the RINA
38	P12.04 IO 14 SMS - on board safety management - in formations about passengers on board
39	On board Recording system - Ministry approval
40	Note no. 02/01/12/3137 on 29 FEB 2012 - Civitavecchia Harbour Master
41	P12.04 IO 01 SMS - Safety management on board- emergency instructions for passengers
42	Technical Consultant paper - Question no. 27 (manoeuvring before collision)
43	P12.04 IO 02 SMS - On board safety management - Decision support system for master
44	P15.6 IO 01 - Crisis management preparedness plan operational & reporting procedure
45	Manning agencies list
46	Embarkations MAMS plan
47	MAMS liferatfs plan
48	Master's Curriculum
49	Procedures regarding filling up muster list (P12.904-IO06SMS) and PMR, Voips devices (P2.09.08IO02)
50	Bridge resource management: training and assessment
51	Crew list details
52	Passenger list
53	Kinetic energy release calculation
54	Bildge pumps position
55	Damage control plan
56	Damage control booklet
57	Analysis integration DGE by Isotta Fraschini
58	Electrician testimony regarding lifts functionality
59	P05.03.903 MAN 1 MO 4 SMS date 22/4/2010 (Drill report on 14*/12/2011)
60	P5.03.03 MAN 1 MO 4 SMS date 22/04/2010 REV 1 (Drill report on 30/12/2011)
61	P12.04 IO 01 SMS "Management of the emergency extraction for passenger" (Circular letter 97/2012
62	Circular Letter Gen. SER. 97/2012
63	P12.04 IO 02 SMS “Decision support system for Master”
64	Maritime Development and compliance (workflow)
65	Image HT-SMS (High Tech Safety Monitoring System) Costa Luminosa
66	P5.03. SMS training management - Rev 4 21/09/2009

APPENDIX	TITLE
1	Leghorn Operations room logbook
2	VDR Transcription
3	Excerpt of testimony 1st Deck Officer
4	CSMART video simulation
5	Testimony of electrician department personal
6	Watertight doors activity - VDR
7	Splash tight doors
8	Interviews
9	Dossier Emergency Electric plant
10	Stability dossier
11	Complete VDR data (available on request due to large file size)
12	SIS comments and MCIB answers
13	EC DG MOVE NOTE MOVE/D2/JPB ON 30 APRIL 2013

[1] This report is not written for the purpose of litigation and will not be eligible for use in any judicial proceedings whose purpose, or one of whose purposes is to assign responsibility or accusation.

Appendix 2

Introduction

- Short introduction of the research topic and why the informant is chosen.
- Presentation of the case of the foundering of COSTA CONCORDIA.
- Short introduction about interview procedures (tapes, notes, transcription, confidentiality, time, language).
- Presentation of the informed consent form.
- This interview will focus on the decision to evacuate a passenger ship. How to go about such a decision and the problems associated with that decision. Furthermore, I am interested on the formal and informal power structures on board – specifically power relations between the master and crewmembers, and between the master and the shore organisation.
- During the interview I will ask your opinion about subjects related to the evacuation of the ship. The interview is not a test of knowledge, but rather about gaining your personal view and perception about the subject of evacuation.
- Questions from the informant.

Topics and questions

A. Bibliography

Please tell me your name, age, position on board and a short description of your professional experience.

B. Presentation of case study. After being presented with the key elements of the report, what is your view of the events described?

C. Formal power structures

Please tell me about the formal hierarchy on board.
Please tell me about the formal relationship between the shore organisation and the master.
In case of an evacuation who decides to evacuate the ship?
Is the shore organisation involved in that decision - if so, how?
Where do your think this way of designing the structure comes from – have you experience from other structures?
What would happen if you were somehow incapacitated in an emergency?
Where does your power come from?
What happens to that power if the ship is not working as a system anymore? E.g. it is foundering etc.?

D. Informal power structures

How are these hierarchy structures seen in everyday operations?
Do you think they change during emergencies?
What would challenge your position as master on board the ship?
What do you think the passengers view is on your role on board?
Why do you think the company made you master of the ship?
What could challenge your position in the hierarchy?
Why do the crewmembers see you as a superior?
How do you secure the compliance of the subordinated officers?
How are the subordinated officers expressing their disagreement and how do they try to change your mind?

E. Decision support system and the decision to evacuate the ship

Do you have a decision support system on board?
How does it work?
Do you use it in drills?
Do you think it would be useful in deciding to evacuate the ship? – If so, how? If not, why?
What would be your concerns in an evacuation situation?
If the ship in an emergency situation was listing more than 15-20 degrees - what would you imagine happened?

F. Other remarks

Do you have anything to add to the subject of the decision to evacuate the ship?

Concluding remarks - Thank you for your participation.

Appendix 3

Informed consent form

Research Project Title

This thesis sets out to assess the validity of the normative view of the shipmaster in the context of the decision to evacuate a passenger ship.

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Purpose

This thesis research aims to gain an understanding of how the decision to evacuate a passenger ship challenges the decision-making capabilities of shipmaster. Furthermore, how the formal hierarchal structures shape the existing design of decision support systems and influence the actual decision-making.

This understanding not only effects how the role of the master is constructed in the public in general, but has also adverse effects on safety – specifically when the master has to decide whether to evacuate a ship or not.

By conducting interviews, I hope to gain an understanding of how the practitioners are meeting the challenges of making decisions in a complex socio-technical system, where there is imperfect knowledge about the interactions within the system and constant trade-offs and conflicting goals; and in emergency situations even more so.

The research will be conducted in fulfillment of the requirements for a master's degree.

Risks and Rights

There are no known risks in participating in this research. You are participating on a voluntary basis and have the right to withdraw from taking part in the study at any moment without stating a reason.

As a participant in the research you can elect to receive a copy of the thesis.

Confidentiality

The research involves the collection of your personal information, which will not be disclosed to third parties without your consent, except to meet the requirements of the University of Lund. Recordings will be transcribed

Appendix 3

and stored electronically and password protected within a secure governmental server. The records will be stored for three years.

Consent

Your participation in this research is entirely voluntary. You may refuse to participate or withdraw from the research at any time. Your signature indicates that you have received a copy of this consent form for your own records and that you consent to participate in this research.

I, ____ agree to participate as outlined above.

My participation is voluntary and I understand that I can withdraw at any time.

____

Participant's signature | Date

____

Investigator's signature | Date

Appendix 4

Short summary of the case and timeline of the main events

The main events are illustrated on figure 2 below. A picture of the bridge where the shipmaster was located is seen on figure 3.

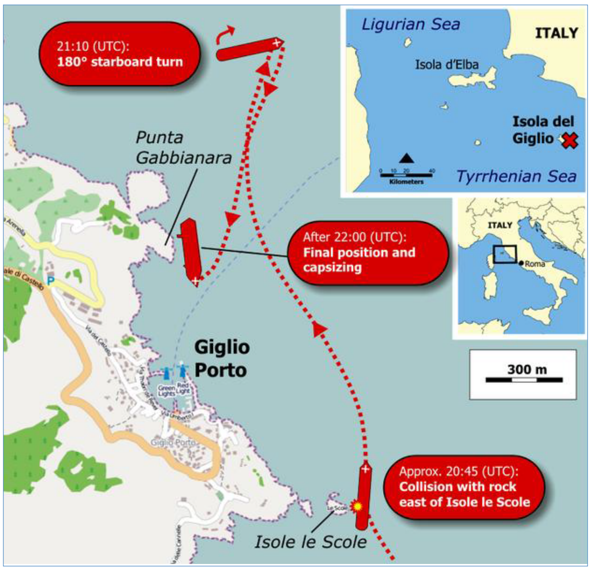

Figure 2: Main events before the foundering
Source: MIT (2013)

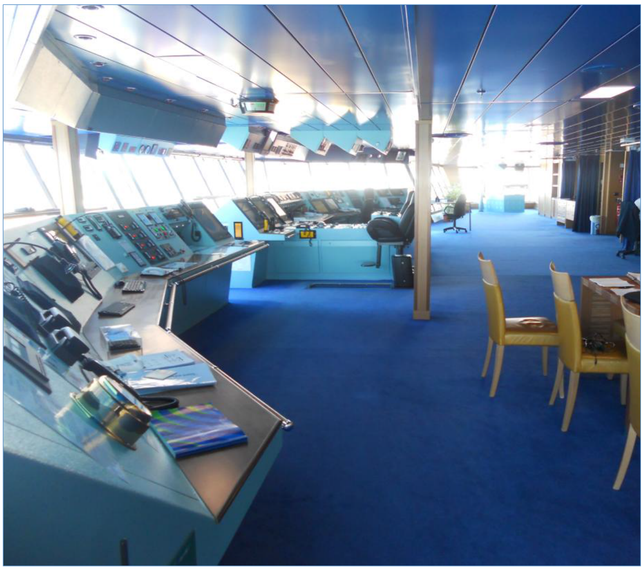

Figure 3: Conning station in the centre of the picture (sister ship).
Source: MIT (2013)

On 13 January 2012 at 2134, the passenger ship Costa Concordia was en route to the port of Savona, Italy, with 4229 persons on board. The bridge team consisted of the senior officer of the watch (1st officer), the junior officer of the watch (3rd officer), one cadet, one able seaman and the shipmaster who had just arrived on the bridge. The hotel manager and the 2nd officer were also present in the vicinity of the conning station (figure 3, middle of the picture).

The shipmaster was on the bridge to conduct a course change intended to bring the ship closer to the shore of the Island of Giglio - closer than the pre-approved passage plan had intended. The course change was not part of the initial voyage plan and large scaled charts (providing detailed information) were not available. The manoeuvres were not pre-programmed in the electronic chart system or other navigation aids, but the deviation had been discussed between the 2nd officer, responsible for passage

Appendix 4

planning, and the shipmaster before departing from the last port, thereafter it was put in a small-scale (providing little detail) paper sea chart. It is unclear what the motivation for bringing the ship close to the shoreline was. Many suggestions have been presented in the media that were not derived from the formal report, but presumably it was, among other things, to give the passengers a scenic evening view, which was not unusual[1].

As the ship approached the Island of Giglio, the shipmaster established a safety margin on the radar of 0.5 nautical miles (about 1 kilometre) from the furthermost point of a group of small rocks (Le Scole), just south of the main port (Giglio Porto) of Giglio Island. During the turning manoeuvre, where the shipmaster was to align the ship on a northerly course (figure 1), the Costa Concordia got closer than the intended 0.5 nautical miles, and at 2145 the ship had contact with underwater rocks.

After the ship had been in contact with the rocks, the ship vibrated and the speed was suddenly reduced. The bridge team immediately realized that the ship had been aground. Shortly after, the ship lost propulsion and was consequently affected by a complete loss of power. The emergency diesel generator automatically switched on as expected, but was unable to continuously supply power to the equipment that was designed for emergency situations (bilge/fire pumps, communication, lighting etc.). The UPS[2] also failed disabling the computer systems that were designed to calculate the stability of the ship in a case of water ingress (damage stability calculations). There were no indications that the shipmaster after the grounding used any decision support tool for e.g. grounding, flooding etc.

At 2154, the shipmaster announced via the public address system to the passengers that a loss of power had occurred and that the ship's crew were working to restore the power.

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[1] In August the previous year the ship had made a close approach for the giving the passenger opportunity to take photographs (MIT, 2013, p. 46).

[2] Uninterruptible Power Supply

Appendix 4

Initially, there was a difference in the understanding of the extent of the damages, because there were discrepancies in the information given from the engine room to the bridge that was later passed on to the shore based fleet crises coordinator whom the shipmaster was in continuous contact with. As time passed the information about the situation was communicated from the engine room to the bridge, and the bridge crew and the shipmaster realized the seriousness of the situation. At 2227, the water ingress had reached a critical level and the officers on bridge realized that it would not be possible to recover from the situation.

At 2254 abandon ship was announced on the public address system and the first lifeboats were lowered at 2255.

The rudder was blocked in a starboard (right) position making the ship drift uncontrollably in a southerly direction by the wind and current, resulting in the ship grounding at approximately 2300, close to the shore line and approximately 300 meters from the Port of Giglio (see figure 1). As a result of the grounding and the extensive ingress of water into the engine room compartments, it immediately started to list heavily to starboard (at least 15°) and the list increased slowly.

Several crewmembers including the shipmaster left the bridge at about 2320. At about 2400 the ship listed to 40° increasing to 80° during the rescue operation. The immediate rescue operation was concluded at 0617 the following morning, where 4.194 lives had been saved.

The accident resulted in the total loss of the ship and 32 fatalities (27 passengers and 5 crew members). Below is a time line of the chosen events that occurred before and after the grounding and breech of the hull.

Appendix 4

Timeline of the main events:

Time	Event
2134	Shipmaster arrived on the bridge. Orders helmsman to use manual steering.
2137	Shipmaster on the phone receiving advice about safe distance to the island (0.3-0.4 nautical miles from shore).
2139	Shipmaster took command.
2139	Shipmaster ordered increase of speed and change of course.
2140	Misunderstanding in rudder orders between shipmaster and helmsman.
2140	Distance to shore: 0.5 nautical miles.
2142	2nd officer sent to bridge wing.
2143	Misunderstanding between shipmaster and helmsman – shipmaster expresses concerns about the possibility of grounding.
2144	Distance to shore is 0.3 nautical miles and shipmaster gave a series of rudder orders and not course orders to helmsman.
21:45	Grounding.
21:45	Shipmaster ordered all watertight doors to be closed.
2145	Black out (power disrupted which stops steering gear pumps).
21:49	Anchors were ordered to be lowered
21:54	Announcement to passengers about loss of power.
22:07	Search and rescue centre contacted ship. Ship only described the power loss and that they were trying resolve the situation.
22:11	Ship adrift towards the shore.
22.12	Announcement that the passengers should move towards the lounges.
22:22	Request for two tugs is communicated from ship to search and rescue centre Livorno. Shipmaster only mentions the power loss.
22:30 22:31	Chief engineer suggested to the shipmaster to abandon ship. Engineers leave engine control room against shipmaster's orders to stay a while longer.
22:30	Some passengers entered life boats on their own initiative
22:36	Passengers ordered to muster stations.
22:36	Shipmaster declared "distress" to Leghorn Coast Guard.
22:40	Ship grounded again and was resting on the side with increasing list.
22:50	Shipmaster ordered first four lifeboats to be lowered and uses the phrase *"let passengers ashore"*.
23:11	Abandon ship in progress (ship list more than 25°-30° which exceeded designed parameter for launching the life boats). Evacuation became disorderly.
23:19	Shipmaster ordered the persons on the bridge to go to the external bridge (list now in the excess of 40°).
00:36	The shipmaster had left the ship.

Table 2: Time line of the main events

Appendix 5

Questions	Informant 1	Informant 2	Informant 3	Informant 4	Informant 5
A. Formal power structures					
Please tell me about the formal hierarchy on board.					
Please tell me about the formal relationship between the shore organisation and the master.					
In case of an evacuation who decides to evacuate the ship?					
Is the shore organisation involved in that decision - if so, how?					
Where do your think this way of designing the structure comes from – have you experience from other structures?					
What would happen if you were somehow incapacitated in an emergency?					
Where does your power come from?					
What happens to that power if the ship is not working as a system anymore? E.g. it is foundering etc.?					
B. Informal power structures					
How are these hierarchy structures seen in everyday operations?					
Do you think they change during emergencies?					
What would challenge your position as master on board the ship?					
What do you think the passengers view is on your role on board?					
Why do you think the company made you master of the ship?					
What could challenge your position in the hierarchy?					
Why do the crewmembers see you as a superior?					
How do you secure the compliance of the subordinated officers?					
How are the subordinated officers expressing their disagreement and how do they try to change your mind?					
C. Decision support system and the decision to evacuate the ship					
Do you have a decision support system on board?					
How does it work?					
Do you use it in drills?					
Do you think it would be useful in deciding to evacuate the ship? – If so, how? If not, why?					
What would be your concerns in an evacuation situation?					
If the ship in an emergency situation was listing more than 15-20 degrees - what would you imagine happened?					
D. Other remarks					