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PASSENGER SHIP SAFETY

Investigation into the Costa Concordia accident

Submitted by Italy

SUMMARY

Executive summary:	This document provides the latest information available on the investigation of the **Costa Concordia** accident
Strategic direction:	No related provisions
High-level action:	No related provisions
Planned output:	No related provisions
Action to be taken:	Paragraph 29
Related documents:	MSC 90/27/5 and MSC 91/7/5

INTRODUCTION

1 In document MSC 90/27/5 (Italy) on Investigation into the **Costa Concordia** incident, Italy provided preliminary information on the investigation into the **Costa Concordia** accident. As anticipated by document MSC 91/7/5 (Italy), this document provides an update of the aforementioned information.

RESCUE AND SEARCH OPERATION

2 In regard to the search and rescue operations, the search for two missing persons is still ongoing.

ENVIRONMENTAL AND SALVAGE ISSUES

3 There has been no change of the position of the ship since the accident was reported. The removal of the fuel and lubricating oil from the ship's 24 tanks (total quantity 2042.5 m^3) has been successfully completed. Operations for clearing up debris from the seabed are still ongoing.

4 The contract for the salvage operations was awarded to Titan Salvage together with Micoperi. Salvage activities started in the summer.

5 As far as the removal of the wreck is concerned, relevant operations can be identified in three different phases:

.1 **Securing of the wreck**: This is achieved by drilling the seabed at the shoreside of the wreck to erect rigs that, with a system of chains, will keep the wreck from sliding. This phase is expected to be completed by mid-November 2012;

.2 **Up-righting of the wreck**: Erection of eight additional rigs and installation of the complete system that will allow the wreck to be lifted to its upright position. This phase is expected to be completed by the end of 2012; and

.3 **Transfer of the wreck**: This will need the installation of floating tanks at both sides of the shell. The tanks are currently under construction; the installation of the floating tanks on the port side of the wreck will be carried out in conjunction with the second phase described above. The transfer should take place at the beginning of summer 2013.

THE INVESTIGATION

Release of relevant information

6 All of the three different types of investigation (i.e. administrative; technical and criminal) are still in progress. On 15 October 2012, a hearing was carried out where all the data retrieved from the Voyage Data Recorder (VDR) as well as other relevant documents that were under seizure, were made available to all interested parties. Data of interest for the Technical Investigation are currently under examination.

Hull damage

7 From the measurements carried out as part of the technical investigation, the extension of the damage of the hull (in terms of both deformations and breaches) extends for about 53 m, from frame 52 to frame 125, with a variable width, up to about 7.30 m.

8 The involved compartments are watertight compartments (WTC) no. 4, 5, 6, 7 and 8. These WTCs accommodated, among others, machinery and equipment vital for the propulsion and steering of the ship, such as:

.1 within WTC 4 – main thrusts bearings and hydraulic units, machinery space air conditioning compressors;

.2 within WTC 5 – propulsion electric motors, fire and bilge pumps, propulsion and engine room ventilation transformers, propulsion transformers;

.3 within WTC 6 – three main diesel generators (aft);

.4 within WTC 7 – three main diesel generators (fwd); and

.5 within WTC 8 – ballast and bilge pumps.

Computer simulation

9 A computer simulation has been developed, taking into account information from various sources, such as witness statements, survey reports and VDR recording data available, to obtain a reconstruction of the manoeuvring before the event and the ship's behavior after the event. The results of the simulation, following the first grounding up until the ship's rolls from port to starboard, correlate well with the flood water heights in various spaces provided in the statements from crew members. The outcome of the simulation shows the progression and magnitude of the heel angle following the roll to starboard until the final grounding, which does not currently match stated heel angles read from the onboard inclinometer. It is likely that this non-correlation is due to additional spaces flooding on or below the bulkhead deck which have not been considered in the model developed; also the contribution given by possible entrapped air in flooded volumes cannot be evaluated. Consequently, it is difficult to provide within the calculation the quantity and position of water that flooded the ship because there is no device able to detect such information.

Other considerations

10 The navigation phases before the impact are to be considered as a crucial aspect of the technical investigation because they relate to the causes originating from 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 mentioned under paragraph 9 above, to some extent confirmed delays in the ship's manoeuvring in that particular circumstance. The accident may lead to an overall discussion on the adequacy in terms of organization and the roles of the Bridge Team.

11 The general emergency alarm was not activated immediately after the impact. This fact has led to a delay in the management of the subsequent phases of the emergency (e.g. flooding, abandon ship process, etc.). With regard to the organization on board, the analysis of crew certification, the Muster List (ML) and the familiarization and training, highlighted some inconsistencies in the assignment of duties to some crew members.

12 In addition, the lack of direct orders from the Bridge to the crew involved in safety issues hindered the management of the general emergency and abandon ship phases and contributed to initiatives being taken by individuals. The presence of different backgrounds and basic training of crew members may also have played a role in the management of the emergency.

13 It is also necessary to emphasize the different scope of the Minimum Safe Manning (MSM) document and the Muster List (ML). In this regard, 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, as adopted by resolution A.890(21), as amended by resolution A.955(23). The Administration should, therefore, issue a MSM document appropriate with the aforementioned provisions, although it appears that the criteria for establishing the MSM should be reconsidered for large passenger ships. In additions, SOLAS regulations III/8 and III/37 provide details for the preparation and posting of the ML. In particular, regulation III/37 requires that the muster list should show the duties and tasks assigned to the crew for the management of various emergencies.

14 In respect to the above, it should also be emphasized that, as confirmed by verifications carried out by the Italian Coast Guard on more than 50 cruise ships flying different flags, 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 muster list (and not through the MSM). Thus, it would be desirable that this aspect is further considered and discussed.

15 A combination of factors caused the immediate and irreversible flooding of the ship beyond any manageable level. The scenario of two contiguous compartments (WTCs 5 and 6) being rapidly flooded in a very short period of time after the collision (for WTC 5 the time for its complete flooding was only a few minutes) placed a limit on the time available, as far as buoyancy, trim and list are concerned, to give an order for ship's abandon to allow for a safe and orderly evacuation.

16 The ship stability was further hampered by the simultaneous flooding of three other 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. In addition, 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 the deck to Deck C. Forty-five (45) minutes after the collision, the heeling to starboard reached 10°, and just before it grounded 1 hour and 09 min after the impact, it was almost 20°. Then, 15 min after it grounded, the heeling was more than 30°.

17 Another critical factor, caused by the severe and rapid ingress of water, was the immediate loss of propulsion and general services located in WTCs 5 and 6. One of the consequences of this was that the various high capacity sea-water service pumps (capacity between 500 to 1300 m^3/h, fed by the main switchboard only), which were fitted with a direct suction in the space where they were located, became unavailable.

18 It is noted that the rules applicable to the **Costa Concordia** did not require the installation of a flood detection system in watertight compartments.

19 It also noted 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, this 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.

20 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) warrants an in-depth consideration, taking into account the high complexity of the electric production/distribution network and bearing in mind that the violent impact and the enormous quantity of water that invaded the vital parts of the ship are critical aspects that generated uncontrollable consequences and damage, even invisible, rightly so imponderable (see also paragraph 28).

Navigation

21 In respect to the navigation phases before the impact, the following critical points can be preliminarily indicated as contributing factors to the accident:

.1 Master's arbitrary attitude in reviewing the initial voyage 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;

.2 Master's inattention/distraction due to the presence of persons extraneous to Bridge watch and a phone call not related to the navigation operations;

.3 shifting from a perpendicular to a parallel course extremely close to the coast by intervening softly for accomplishing a smooth and broad turn;

.4 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);

.5 keeping a high speed (16 kts) in night conditions is too close to the shoreline (breakers/reef);

.6 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;

.7 Master's orders to the helmsman aimed at providing the compass course to be followed instead of the rudder angle;

.8 Bridge Team, although more than suitable in terms of number of crew members, not paying the required attention (e.g. ship steering, acquisition of the ship position, lookout, etc.); and

.9 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 above critical points were confirmed by a sailing simulation carried out in September.

22 Another factor that may have impaired the exchange of communication among those key persons in the emergency was the unavailability of the wireless telephone system.

PRELIMINARY OBSERVATIONS

23 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 measures which could provide some useful indications for possible future improvements of the current regulations. Some identified measures are already taken into account by the SOLAS Convention for new buildings or existing ships, through various amendments to the Convention include:

.1 requirements for segregation and redundancy of vital equipment for propulsion, steering and navigation (SOLAS regulations II-1/8-1, II-2/21 and II-2/22 on the safe return to port);

.2 onboard stability computer;

.3 flooding detection system; and

.4 use of Electronic Chart Display System (ECDIS).

24 As regards the other identified measures, which are listed below, their appropriateness should be evaluated also in the light of the new safe return to port requirements and principles:

.1 double-skin for protecting the WTCs containing equipment vital for the propulsion and electrical production;

.2 more partitioning and sub-partitioning of each watertight compartment to limit the effects of free surfaces;

.3 discontinuity between compartments containing ship's essential systems, in order to preserve their functional integrity;

.4 more detailed criteria for the distribution, along the length of the ship, of bilge pumps and possible arrangement of at least of one high capacity pump to drain huge quantities of water from an isolated compartment;

.5 relocation of the main voltage propulsion transformers to a higher position;

.6 relocation of the main switchboard rooms above the bulkhead deck;

.7 distribution of electrical power through a main electrical switchboard for each generator room;

.8 interface between the flooding detection and monitoring system, on board stability computer and ballast/bilge systems; and

.9 adequate emergency generator capacity to support all essential services, including those meant to manage flooding conditions.

25 In respect to the functionality of the emergency diesel generator, the following should be considered:

.1 the availability of essential systems in case of emergencies, in particular redundant steering of the ship and systems to counteract flooding and heeling;

.2 the suitable energy production and distribution system, e.g., 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;

.3 the possibility of supplying the bow-thrusters to help maintaining the bow at sea, even in case of loss of propulsion, to be used as the main steering system; and

.4 the availability of the wireless telephone system.

26 It must be pointed out that the above-mentioned observations, which could be pertinent to the construction of new vessels only, 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.

27 In respect to the navigation phase before the impact and the subsequent management of the emergency, the accident may be referred to for verifying the actuality of provisions contained in international instruments, such as SOLAS, COLREG, 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, "thinking aloud" attitude;

.2 *Principles of Minimum Safe Manning* (resolution A.1047(27)) should be updated to better suited to large passenger ships. A mandatory application of these principles is also considered desirable;

.3 muster list, showing the proper certification/documentary evidence necessary for crew members having safety tasks;

.4 quality of training provided certified by competent authorities worldwide;

.5 inclusion of the inclinometer measurements in the VDR; and

.6 need for an evacuation analysis to be carried out at the early stage of a project.

ADDITIONAL ONGOING ACTIVITIES

28 A program of tests simulating emergency conditions is scheduled to be carried out by the end of November 2012 on the sister ship **Costa Favolosa** to check the sequence of the functioning of the emergency diesel generator.

ACTION REQUESTED OF THE COMMITTEE

29 The Committee is invited to consider the information provided and take action as appropriate.