

The Costa Concordia Shipwreck

Summary of Emergency Response Management



PROTEZIONE CIVILE
Presidenza del Consiglio dei Ministri
Dipartimento della Protezione Civile

“After that magic moment when my eyes opened in the sea,
I was no longer able to see, think or live as before”
(Jacques-Yves Cousteau)

“Now small fowls flew screaming over the yet yawning gulf;
a sullen white surf beat against its steep sides;
then all collapsed, and the great shroud of the sea rolled on
as it rolled five thousand years ago.”
(Herman Melville, Moby Dick)

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Head of the Department of Civil Protection

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OPENING STATEMENT

On the night of January 13, 2012, over four thousand people in life-threatening conditions, were saved and welcomed by a small community whose emergency plans did not take into account a partially sunken tilted vessel almost three hundred meters long, resting on its coastal sea bed. Relief, although activated immediately, came after several minutes, if not hours, from the peninsula: Giglio has proven to be a resilient community, capable of responding promptly to emergencies. It gave the necessary support to men, women, children and elderly who were perturbed and disbelieved what had happened to them. The population of Giglio has proven to be a positive example of a consolidated civil protection system. It is with them in mind that I like to believe that in Italy the National Service of Civil Protection can count on sixty million people. Sixty million people, contribute united and individually, each according to their recognized skills, they work side by side under one direction. Again we were able to appreciate the management of this emergency: the unique role of the Department of Civil Protection's coordination structure, which is a department of the Presidency of the Council of Ministers. Over thirty years ago, we experienced two very different disasters in terms of scale, number of victims and territories involved; yet so tied emotionally - the Irpinia earthquake and the death of Alfredino Rampi¹ - Italy in both cases witnessed a chaotic management of relief and realized how essential it had become to create a supra-ministerial coordination structure. At Giglio, on land the size of a handkerchief, where the island has its port the coordination role was fundamental. Thousands of rescuers operating in different specific fields of civil protection, each one with its own training and rescue techniques had to confront themselves with the others and work together in search operations with the sole aim to rescue those still alive and on board the Costa Crociera and find the lost. It is precisely this capacity of being a System- coordinated at different levels by the Mayor, the Prefect, the President of the Region and the National Department of Civil Protection - that represents the foremost strength of our Civil Protection, which, once again, in its management of the Costa Concordia emergency has been praised by the international community

FRANCO GABRIELLI

Head of the Department of Civil Protection

¹ Alfredino was the victim of a tragic event in the early 1980s: on Wednesday, June 10, 1981, he fell into a well, 30 centimeters wide and 80 meters deep, in the vicinity of Vermicino, Rome. Rescuers tried with their greatest efforts to save him. The drama attracted unprecedented media attention and was broadcast on television for 18 hours. A large number of the Italian population followed the development of the situation with anxiety. After many hours, Rampi's voice (relayed by a microphone) was getting weaker and he is thought to have died around 6:30am on 13 June. His body was recovered on July the 11th .

1. PREMISE

On the night of January 13, 2012, near the coast of the Island of Giglio, the cruise ship “Concordia” operated by Costa ran aground after hitting a reef, on board there were 4,229 passengers and crew members, 30 people were killed and two are still dispersed.

The main aspects of managing the consequences of the wrecked Concordia were:

- rare scenario, large and complex
- integrated approach inherent in the organizational model;
- management of critical points related to the combination of three concurrent lines of activity;
- complex SAR operations;
- the need to bond with all parties involved in the emergency;
- the deep interaction between public and private agencies;
- the urgent need to establish safeguards and environmental mitigation and to ensure the safety of the vessel;
- the need for intervention and the role at national level.

Varied and complex activities at operational level were carried out simultaneously which characterized the first two months of the emergency (recovery of missing persons in conjuncture with the activities of debunkering and implementation of technical and administrative plans to define and adopt the wreck removal plan) and that required a considerable effort in terms of coordination between the different components involved and guaranteeing the safety of the operators.

The state of emergency was declared and coordination was assigned to the National Department of Civil Protection² and a Delegate Commissioner³ was appointed and guaranteed a clear defined directive of the activities of rescue and emergency management issued through the establishment of a departmental mission structure, emanated by the CD and operating on the island

² Hereinafter indicated as DPC in the text

³ Hereinafter indicated as CD in the text

1. THE EVENT

At sea off the coast of the Island of Giglio the Costa Concordia Cruise Ship hit the “Scole” rocks and was washed up on the starboard side at Punta Gabbianara. Following the evacuation order issued by the Commander of the Ship, The Livorno Harbour Coast Guard assumed full coordination of rescue operations at sea which engaged staff of the same Coast Guard Departments as well as the Guardia di Finanza, the National Fire Brigade Corps and the Police Forces.

At the same time, the Civil Protection system was activated to provide assistance to the evacuated passengers on the island of Giglio, who were then transferred to the Harbour of St. Stefano. First assistance to the evacuees, transported to Giglio island, was provided by the Municipality itself and by citizens. The Prefect of Grosseto, as Head of the local Crisis Unit in collaboration with the provincial administration and the Mayor of the Isola del Giglio municipality, started immediately by coordinating relief efforts to respond to the health and housing needs of the evacuated people and entrusted the technical direction of Search and Rescue operations on board the ship to the Chief of the Grosseto Fire Brigade Corps. During the first 30 minutes following the evacuation order 3,000 of the total 4,228 passengers on board were rescued, this figure which includes crew and passenger members amounts to four times the resident population at the island of Giglio. The transfer of all the evacuees was guaranteed involving all the ferries connecting the island to the mainland. In Porto Santo Stefano a first welcoming shelter area was set up which was also activated thanks to the involvement of civil protection volunteers and Italian Red Cross, in order to provide blankets, hot meals and medical care and to coordinate the transfer of passengers to hotels or other temporary accommodations also with the support of the Costa cruise company. The wounded were treated immediately before being transferred to nearby hospitals. Both on the island and on land, the Police and the Carabinieri, registered the names of the passengers in order to have a clear indication with regard to the missing persons, and to provide an updated list to the Prefecture of the town of Grosseto. The transfer of passengers lasted until early afternoon of the day after the ship wreck.

Following the accident a DPC team was immediately dispatched with the task of monitoring assistance operations to the passengers and crew members of the ship and to provide support to the Region of Tuscany. The Department of Civil Protection from

then on kept in contact with the Region, the Prefecture and the province of Grosseto, as well as the Coast Guard of the Harbours of Livorno, Porto Santo Stefano and Talamone, and with the other operational structures including the civil protection volunteer associations. Contacts with the embassies and consulates were established to provide assistance to the foreign citizens. At the same time the rescue operations at sea, coordinated by the Coast Guard, the Search and Rescue on board began under the coordination of the National Fire Brigade Service. These SAR operations which lasted more than two months turned out to be one of the longest and highly sophisticated research task ever carried out at sea. Many other national specialized resources such as the Navy's expert unit diver teams – GOS -, the Fire Brigade, the Coast Guard, State Police, Guardia di Finanza as well as the National Alpine Cliff and Cave Rescue Corps and the Italian Sea Diver Federation diving units .

In light of the scale of the event and in order to coordinate the necessary SAR operations needed to rescue the missing persons and to provide assistance to the survivors of the shipwreck, which for the most part were confirmed to be of foreign nationality, and in order to facilitate oil removal operations as well as the recovery of the ship, on 20 January 2012 the Council of Ministers officially declared the National state of emergency through the **Ordinance issued by the Prime Minister n. 3998 of 20 January 2012⁴**, the Head of the Department of Civil Protection was nominated CD in charge of the following tasks:

- provide for the coordination of response operations needed to overcome the state of emergency ;
- supervise and monitor the safety and reclamation operations carried out by the ship owner for the recovery of the ship;
- ensure the safety and reclamation/clean up activities of the public areas or areas under the public administration's control ;
- monitor the implementation of safety measures during the removal operations of the shipwreck in terms of environmental protection.

3. THE ROLE OF THE CRISIS MANAGEMENT UNIT

In order to support the implementation of CD's needed measures to deal with the state of emergency in the municipality of the Island of Giglio, on Jan. 22, 2012 a

⁴ Hereinafter indicated as OPCM in the text

Crisis Management Unit⁵ was established consisting of DPC staff and organized in “Auxiliary Functions”. The CMU was coordinated by the Director of Emergency Management of the Department of Civil Protection. The CMU set up an operation centre, in order to ensure effectiveness and efficiency in its activities on the island of Giglio. In addition to the Coordination Secretariat, the following auxiliary functions were adopted:

- Technical-scientific;
- Media and Information;
- Volunteering;
- Communication;
- Contracts and Accounting;
- International Relations;
- Computer and technological resources;
- Emergency Telecommunications;
- Logistics;
- Personnel management;
- Air activities.

Auxiliary functions were defined as **operating on site** functions - permanently worked at the operational centre on the island of Giglio - and **operating HQ** functions - that permanently worked at the headquarters of the DPC in Rome.

The complexity and peculiarities of the emergency scenario, generated by the sunken Concordia, prompted the Head of the Department to develop an operational working strategy that took into account the different operational aspects.

The CMU finished its activities on June 15, 2012. Monitoring activities, specifically related to the removal project of the vessel was entrusted to the Observatory for monitoring established by the decree of the CD on 15 June 2012.

Below is the emergency management response model adopted for Concordia originating expressed in OPCM 3998 and the response organization of the national civil protection. The complexity of the model is apparent from the large number of actors required to provide a clear answer to emergency management.

The CMU, as expression of the CD, correlated the various public and private entities

⁵ Hereinafter indicated as CMU in the text

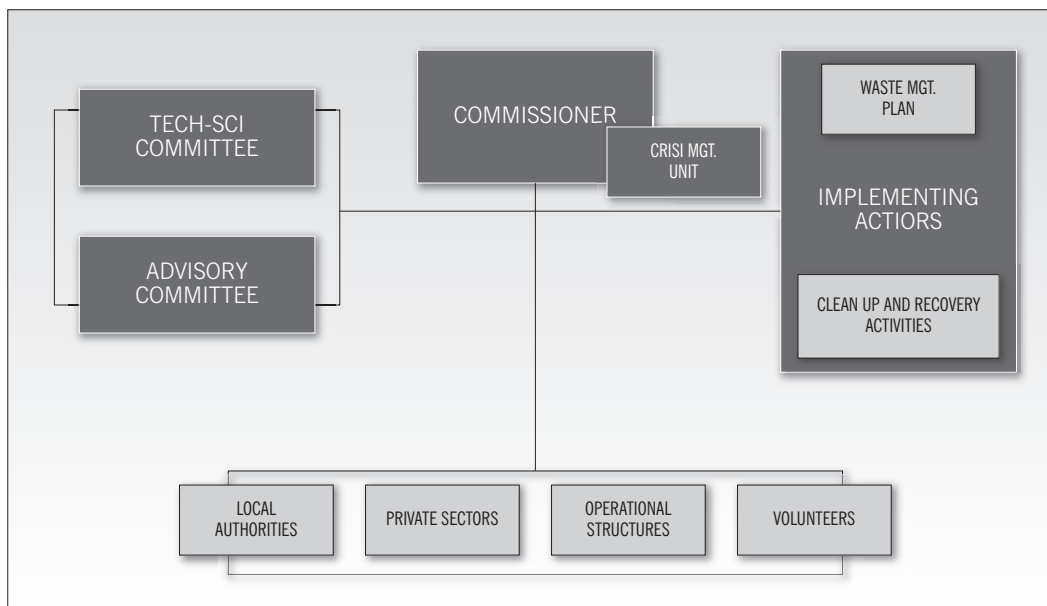


Fig 1 – Emergency response model adopted by the CD

and organizations created to provide the necessary support to the CD, in the management of the three main activities that distinguished the emergency:

1. **correlate SAR** operations;
2. **definition** of operations for environmental protection;
3. **start-up** of technical administrative procedures adopted for the rapid adoption of the ship removal project;

The specificity and central role of the CMU is evident from the number and complexity of activities to which it was committed and the management of which was maintained either directly or through auxiliary functions and activated through close collaboration with all organizations and administrations involved:

- technical operational support and documentation necessary for the CD and the coordinator of the CMU in order to pursue the overall objectives;
- liaison with government agencies and administrative components, the committees set up to link the necessary information
- monitoring of operations carried out by the operating structures involved in emergency;
- coordination and link with the scientific community technicians involved in monitoring and advisory activities and with organizations and administrations active

in the field of territorial and environmental sustainability (ISPRA, ARPAT, etc);

- press and media monitoring; management and media relations with institutions and private press offices involved in the emergency;
- definition of the emergency financial aspects and monitoring of expenditures;
- updating DPC website and monitoring of web and social networks;
- public relations: management of questions submitted to a specific mailbox and set up of the a contact centre;
- liaison with the national voluntary organizations and their role, with the Regions and with the Italian Red Cross;
- assessment and definition of logistical resources;
- coordination of DPC's air assets;
- liaison with other operational structures for coordination of available aircraft assets;
- information liaison with the Monitoring and Information Centre in Brussels;
- liaison with key international actors involved in various roles;
- information liaison with embassies and consulates for new regarding missing persons and victims;
- support to the families of the victims;
- installing and management of a radio network coordination system (data electrical cabling);

In order to ensure the necessary operational link the CMU cautiously planned sharing tasks and planned activities in a guide that outlined the work of the CMU in the first months:

Time	Activity
7.30	SAR operation briefing
8.30	Maritime operators briefing
12.00	Media Conference
15.00	Meeting with the families of the victims
18.00	SAR Debriefing
18.00	Videoconference
19.00	Meeting with all components and operational structures. Daily checks and plans for the following day
21.00	Report activities

Within the framework of cooperation and synergies taken by the CD related to emergency management activities, emphasis must be made that Costa Crociera Co. contributed in terms of professionalism and experience, and the CD never had to resort to his power to use a commissioner. This aspect characterizes his response approach, and it is due to the close bond created by private actors and the CD who played a major role in the delicate stages of recovery of fuel and the realization of assets aimed at protecting the environment.

Among the delicate activities, apart from those of a technical nature aimed at ensuring the effectiveness of SAR operations and the reduction of environmental risk, it is worth expanding on the relationship with, the island's population and the families of the victims. Weekly until the end of the CMU, the CD, in the presence of the Mayor of Giglio, met the resident citizens on the island, with the aim of referring all the information on the progress of research activities, recovery of fuel and the removal of the wreck sharing the timing, operating mode, and the difficulties of the whole operation. The meetings were attended by representatives of the Province of Grosseto, and the Region of Tuscany.

The CMU provided assistance to the families of the victims and the missing of the wreck, assisted and supported the families with all means including direct contact with their consulates and embassies. In order to provide as much information as possible, within the first hours following the disaster, a tight link was set up with the institutional bodies responsible for updating the lists of passengers rescued, editing the missing persons list and the definition of an adequate framework for the conduct of search and rescue activities already underway.

On January 18th many relatives of the missing, of Italian and foreign nationality, arrived on the island, daily briefings were given with detailed information on the operations of the ongoing research. After finding a missing person, maximum support was given to families of those still missing, a procedure was adopted where by the families were contacted before the information was released through other channels, including the press. Family consultation with local authorities was also provided, granting assistance and psychological support for the families of missing persons, as well as the period following the disaster victim identification.

Through a special mailing list, with the addresses of embassies and families of the

missing, daily updates on search operations were given, even after the families returned to their homes.

The CMU has also strove to maintain, in relation to disaster victim recognition, a close link with:

- the Prosecutor's Office of Grosseto through the Judicial Police for finding the victim and victim identification;
- the Disaster Victim Identification Team of the State Police with the Health Department of the Hospital of Grosseto where the bodies were kept and where investigations and postmortem autopsy was carried out;
- the Grosseto Health Department for psychological counseling of the relatives of the dead and missing.

It should be emphasized that on 27/28 January, a team of EU observers composed of a Liaison Officer of the Monitoring and Information Centre in Brussels, three experts in marine pollution research and rescue at sea, an expert from EMSA (European Maritime Safety Agency) and an environmental expert of the United Nations, undertook a mission to the island of Giglio to observe the activities and acquire all the possible elements related to an event so unique and share the results with the international community. The final report was submitted to the European Commission.

4. THE ADVISORY COMMITTEE, THE TECHNICAL SCIENTIFIC COMMITTEE, THE IMPLEMENTING PARTNERS, THE MONITORING OBSERVATORY

In order to ensure contact at all times with all the Bodies and Government Departments involved in the event, as well as to ensure the necessary sharing of initiatives to be undertaken in the area, the CD under OPCM 3998, engaged an **Advisory Committee**, composed by the Prefect of Grosseto, the President of the Tuscany Region and of the Province of Grosseto, the Mayor of the Municipality of the Island of Giglio, representatives from the Ministries of Environment and Protection of Land and Sea and Infrastructure and Transport. The main purpose of the Committee lying within its strategic function aimed at sharing the objectives and defining the general guidelines to follow.

For the purpose of implementing successful operations aimed at the removal of the ship and at the activities for the safety and protection of the environment, the CD recruited a **Technical Scientific Committee**⁶ formed by experts in the environment preser-

vation sector and in the removal of shipwrecks belonging to different operational structures and components of the National Service of Civil Protection. The Technical Scientific Committee was under the direction of a Chief Executive of the Ministry of Environment and Land and Sea Preservation.

On 21 January 2012 the CD chaired an introductory meeting with the Advisory and the Technical Scientific Committee as provided by OPCM 3998. On that occasion the CD defined the general governance for the emergency by subscribing three specific requests to the TSC which characterized the first two months of operations carried out by the various subjects involved and coordinated by the CMU:

1. state of the art of search and rescue operations and compatibility with the fuel removal operations from the ship.

By having acknowledged the operating modes of the two specific activities (Search and Rescue and Debunking operations) the TSC was able to draft some essential recommendations to reduce incompatibility and guarantee safety while conducting the operations with the purpose of suggesting the best possible way to conduct the two operations simultaneously. Management models of potential interferences were elaborated in reference to the positioning and mooring of the vessels employed, with respect to the necessary escape routes to ensure particularly to the SAR staff. With regard to the possible deformations of fragile structures, with particular reference to those through which access/exit gates were opened by SAR divers, the TSC recommended not to carry out operations in case of adverse weather and sea conditions.

2. Assessments of ship anchorage and its stability.

The TSC (particularly as per the Italian Naval Register) substantially stated that the ship was stable in its position and that its stability could not be affected by sea conditions with max. wave height up of 2,8 m (1,5 m significant wave height). The issue is still the object of much investigation and analysis, holding in due consideration the constant input of further data on the movement patterns both on the seabed and on the contact surface between the rock and the ship.

The movements of the ship have been constantly monitored through a specific system derived from other disciplines in collaboration with the University of Flo-

⁶ Hereinafter indicated as TSC in the text

rence under the coordination of the CMU, allowing to provide real-time alerts in case of abnormal acceleration, according to shared operating procedures. Considered that most of the vessel's movements were associated with deformation of the superstructure, and fragile structures, in order to better focus on any movements associated with the sliding of the hull on the seabed, a further monitoring system was installed positioned on the structural parts emerging from the ship and a system of markers placed on the seabed in contact with the ship whose monitoring has been entrusted to the Coast Guard and State Police divers.

3. Plan to contain the spillage of hydrocarbons.

In order to guarantee safety while conducting fuel removal operations also in order to avoid the spillage and to contain any potential spills a containment plan has been approved by the TSC and immediately entered into force.

In chapter 5.3 (definition of environmental protection measures) are discussed in more detail the other activities in which the TSC was involved and whose assessments and recommendations were crucial for the start-up and progress of activities mainly related to the different activities mainly linked to environmental protection issues.

The CD in order to carry out his tasks as best as possible identified two **implementing partners with the following respective duties**:

- oversee the drafting and testing of the plans, developed by the private sector aimed at the safety, recovery and reclamation of the ship in conformity with environmental protection regulations;
- oversee the preparation and testing of the plan, developed by the private sector, of management of hazardous and non-hazardous materials and waste, as well as the implementation of the same plan in reference to environmental protection , revealing any potential negligence on behalf of the responsible actors.

By Decree issued by the CD dated 14 June 2012, the **Monitoring Observatory was established**, formed by the representative of the Region of Tuscany, acting as President, the Ministry of the environment and protection of land and sea, the DPC under the Presidency of the Council of Ministers, the ARPAT, of the province of Grosseto, of the municipality of the Island of Giglio, of the Ministry of Interior , the Ministry of Infrastructures and Transport, of ISPRA, of the Coast Guard, of the Ministry of Health and

the Superior Institute of Health. After the establishment of the Observatory the TSC ended its activities.

The Observatory's main task is to constantly follow the shipwreck removal operations, in order to ensure full compliance with the Environmental Report submitted by Costa Crociere Inc.

As founding act, the monitoring center supervises project activities in order to verify the consistency with the general project examined in the daily services of the Conference on May 15 and the correct and timely implementation of the requirements set out following the conference and any further activities derived from the implementation of the project in principle. The Observatory supports, if required, the private company/body and / or the Implementing Partners as per the identification of any need for additional licenses and / or exemptions that will be submitted, upon duly motivation, to the CD.

Moreover the Observatory is responsible for:

- Monitoring the implementation of the operational stages of the project;
- Supervising the schedule of the project and referring it to the CD in compliance with the terms provided therein ;
- Operating in compliance with the specific regulations established by the CD;
- Relating to the CD the outcome of each meeting, closed session or plenary;
- Submitting to the CD, by the end of its mandate, a final report on the activities carried out.

5. MAIN ACTIVITIES

The coordination of the Costa Concordia emergency focused mainly on a threefold direction of activities:

- SAR operations (salvage at sea and search of the missing);
- definition of environmental protection operations;
- ship removal plan.

These aspects are examined below to allow for a deeper analysis of the different challenges faced by the National civil protection system.

5.1 SAR OPERATIONS: SALVAGE AT SEA

The S.A.R. acronym (Search And Rescue) encompasses a wide range of rescue operations, carried out by experts trained in saving human lives threatened by situations of danger, often in hostile environments and by use of special equipment.

The above definition is of course just a general definition, which is subject from time to time to change according to the scenario of reference, ready to operate at high altitude in the mountains as well as under sea level as expert personnel trained in diving departments. The S.A.R. operations resulting from the Costa Concordia Ship's impact against the Sciole Rocks, on 13 January 2012. can be classified as typically and at all stages a maritime S.A.R. emergency, falling within the scope of the International Convention of Hamburg of 1979 implemented in Italy by Law of 1989, which was followed by the enactment in 1994 of the implementing regulation, which identifies the Minister of Infrastructure and Transport as the national authority responsible for the implementation of the concession agreement and the Coast Guard, as the national body that ensures the overall coordination of maritime rescue services (I.M.R.C.C.: Italian Maritime Rescue coordination Center).

The above regulation provides the following:

- in Maritime Headquarters, maritime rescue centers (M.R.S.C. Maritime Rescue Sub Center), with identification of the respective jurisdiction areas, which joined together represent the entire region of national and international maritime interest, under the responsibility of I.M.R.C.C.;
- in the Harbour Command Headquarters the Coast Guard units;
- in naval units and aircraft of the Coast Guard, specially set up units of rescue at sea.

Italy has also provided an operational tool, that is the National Plan for Search and Rescue at Sea, issued in 1996 by the Minister of Transport, with responsibility for implementation consistently assigned to the General Headquarters of Coast Guard. This document consists in a preliminary part, referring to the general organization and function of the SAR service, and a second section, made up of the plans drafted by the 15 MRSC, which lists the totality of available resources in terms of vessels and aircraft belonging to government or private departments, as well as the local operational connections.

Thus according to the hereby briefly outlined regulatory framework, the international and Italian law on the activity of rescue at sea, in every case and circumstance, regardless of the connotation and the extent assumed by the individual cases, remains an exclusive duty of the Maritime Authority, including SAR operations of exceptional nature, such as the case hereof, which clearly enters the category as provided for of any emergency at sea.

In the case of maritime incidents such as the one in question, the Coast Guard Headquarter of Livorno, home to 2nd MRSC, with responsibility over an area corresponding to the surface of the Region of Tuscany, received reports from relatives of passengers on board, several minutes after the ship's collision against the rocks of Scole, in the course of these communications, Costa Concordia reported that a sudden loud noise was heard during dinner, which was followed by the fall of crockery and part of the ceiling of the dining hall, with a subsequent order, by the Commander of the Ship for the passengers and crew members to wear the life jackets provided on board.

The Coast Guard Headquarter, through the Operations Room of Livorno, established a first contact with the Concordia, which was followed by many others, always coming from the 2nd MRSC via radio, on VHF channel 16, in which the operators of the Coast Guard received misleading information from aboard the ship, apparently intended to minimize the risk on board as well as the true scale of the emergency, which in fact corresponded to a 70 meters wide gash reported on the port side of the hull of the ship below the water line.

Nevertheless, as soon as the major scale of the emergency became apparent, the SAR chain was immediately activated, under the coordination of the 2nd MRSC Operations Room, which responded to the emergency according to the duly provided regulations by ordering the de-routing of merchant ships in transit, also identified by AIS (Automatic Identification System), and the alert and dispatch of vessels of the Coast Guard and other governmental departments, as well as rescue aircraft and rescue tugs, until reaching the final maximum deployment as listed below:

- 14 merchant vessels (diverted in the course of navigation or sent out of the nearby harbours);
- 4 tug boats;
- 26 patrol boats;
- 8 helicopters.

Given the impressive amount of means employed in such a restricted area, from the first minutes the 2nd M.R.S.C., appointed an On Scene Commander (O.S.C.), more specifically the G 104 Guardia di Finanza's Patrol boat, subsequently joined by an Air Traffic Coordinator, the Coast Guard helicopter AB 412 KOALA 9-09, with the task of coordinating the area, respectively, the naval units and the aircraft present in the area, following orders given by the Livorno Operations Room. Although this was to be considered a large scale event in terms of numbers according to the National S.A.R. plan, as the number of affected persons exceeded 30 and as such was assigned to I.M.R.C.C for coordination purposes. The General Command of the Harbour Authority ordered that the coordination remain at M.R.S.C. level, due to the better and more direct communication with the area of operations, providing the necessary information exchange and coordination at central level with the other Administrations and Armed Forces involved, including the deployment of resources and means. This decision proved absolutely effective in light of the overall outcome of rescue operations.

The order to abandon ship was given by the command on board whilst the ship resting on a rocky bottom, near the shore in front of the port of Giglio, and skidding on the starboard side, initially to a small extent, so that evacuation operations in the first phase proceeded quickly and in an orderly fashion, based on the dispositions provided by the Maritime Authority of Livorno, and carried out on the field by the OSC; the rescue survival craft on its way to the Island of Giglio, while the inflatable life-rafts were being towed by the patrol boats toward the rescue units, and in many cases, the patrol boats also proceeded to the direct rescue of survivors at sea upon their descent from the shipwrecked vessel.

However an hour after the beginning of evacuation, the situation suddenly changed dramatically: the ship in fact capsized on its right flank and the resulting inclination made it extremely complicated to embark the passengers on survival craft from the left side.

In view of the presence of survivors at sea and the severe inclination of the ship and the need to proceed in search and rescue operations on the already submerged part of the hull, the 2nd M.R.S.C. gave the following orders:

- All naval means ready to operate in SAR operations, including the rescue forces letting their rafts at sea as well as boats and fast rescue boats to salvage the survivors at sea ;
- Deployment of divers from the Fire Brigade, duly equipped with thermal instruments for the extraction of passengers trapped inside the cruise-liner cabins (the first team reached the shipwreck 4 hours after the first response operations began

on a Coast Guard patrol boat), and informed the I.M.R.C.C. to order the intervention by the Coast Guard Diving Units.

- Inform the Ministry of Environment on the accident, requesting the deployment of special means needed to conduct clean up operations, equipped with floating booms to contain and circumscribe the spill of toxic substances.

Moreover, after realizing, upon contact via phone with the Commander, the premature abandonment of ship on behalf of the entire general staff, the Livorno Operations station ordered the dispatch of aircraft rescue means over the unit to rescue the passengers trapped in areas made inaccessible by the strong inclination of the ship while supervising evacuation operations and considering the absence of coordination on behalf of the staff on board the passengers were led to the mount ship rope ladder lowered in the stern area in order to allow a more rapid and massive recovery by the patrol rescue boats.

Meanwhile, the same passengers were ferried to Porto Santo Stefano where, under the coordination of the apparatus of the provincial civil defence, including the local military and Maritime Office of the Coast Guard Headquarters of Livorno, purposely sent there, a duly welcoming area was set up.

With the arrival on location of rescue patrol boat CP 305, departed from Civitavecchia, due to the greater width and height of the patrol boat an unusual but very effective rescue technique was devised, consisting of the thrust of the same "packet" unit on the left side of the cruiser by another patrol boat in order to allow the easier descent of those passengers to be evacuated through the mount ship rope ladder lowered in the stern, thus avoiding the risk of passengers falling off. Once they reached the CP 305, the rescued passengers were transferred on the unit flanking the cruise-liner, immediately replaced by another boat which by thrusting the CP 305 sailed off to the port or to heavier vessels to board the rescued passengers. This masterful seafaring maneuver allowed for, in less than three hours of hard and relentless work, the rescue of about 700 passengers at risk.

At dawn the rescuers stopped research operations which resumed soon after with patrols at sea on always larger areas according to the drift calculations. These operations coordinated from the 2nd M.R.S.C., continued as such until January 25th to be picked up in the field of regular institutional activities. The search for the missing persons in the ship wreck was coordinated by the Fire Department until February 21st and consequently by the Maritime Director of the region of Tuscany as implementing partner in the Costa Concordia Accident appointed by the CD of the emergency.

The crew members of naval and air craft means operating during the night between 13 and 14 January, under the coordination of 2nd M.R.S.C., found themselves working in a extreme emergency response scenario, further complicated by the following factors:

- poor visibility, due to night time operating conditions;
- high number of passengers to be rescued, of different age groups and nationality, in a panic state and psychologically vulnerable;
- the particular complexity of operations due to the position of the shipwreck, the absence of lighting on board, the lack of the unit's construction planning information;
- the high concentration in the immediate whereabouts of the shipwreck of several rescue boats and self inflatable rafts furled from the sides, to which many more means are to be added dispatched by the 2nd M.R.S.C., for maritime rescue purposes;
- the short distance from the coast of the ship stranded in a sea characterized by the presence of many rocks;
- the congested area of the Giglio Island port, with consequent maneuvering difficulties for all naval units.

Due to all of the above the S.A.R. operations, related to the 4229 passengers on board the ship, were fully completed with a death toll of 30 deceased, 2 missing and 4197 survivors in the first hours, of which 1270 following direct intervention by naval and air rescue means coordinated by the Coast Guard operational station of Livorno. In particular 18 people were rescued by air rescue S.A.R. aircraft that intervened by use of pulleys/winches with immediate transfer to the Hospital of Grosseto.

5.2 SAR OPERATIONS: SEARCH AND RESCUE ON BOARD

Research activities of missing persons in the wreck were entrusted by the Prefect of Grosseto to the Provincial Commander of the Fire Department appointed as Incident Commander⁷. To ensure the connection of the different departments a scuba divers multi-agency coordination centre (CCSI) composed of experts from the various operational units deployed on the scene was set up. The research was extended to the depths of the sea surrounding the shipwreck to about 18 square kilometers, using the most so-

⁷ Hereinafter indicated as IC in the text

phisticated equipment for research on instrumental grounds. On the day of February 16, the Technical Director of Rescue operations IC, with a detailed report, completed the closing of the relief efforts. Following that note, the CD on February 21 formally requested the Regional Director of the Maritime Region of Tuscany to coordinate activities for the search and recovery of bodies still missing, making use of the public facilities which guaranteed their activities during the research phase and rescue operations. Research was completed at the beginning of May.

Two are still missing while 30 are the bodies that have been identified. The full chronological order of rescues and findings is provided below:

- January 14, three male bodies were found
- January 15, two elderly passengers were found on the ship's stern
- January 15, 3 survivors were rescued, two of which of Korean nationality both 29 years old , a man and a woman, on their honeymoon and another missing person the ship's paymaster
- January 16, a dead male body was found
- January 17, discovery of five dead bodies. Four males and a female, in the submerged stern of the cruise-liner
- January 21, a female body was found in the stern area near the deposit of lifeboats
- January 22, a female body was found on deck 7, in the submerged stern part of the ship
- January 23, two female bodies were found on deck 4 near the internet café
- January 24, a female body was found in the submerged part of the ship
- January 29, the body of a Peruvian woman was found
- February 22, eight bodies were found
- March 22, five bodies were found

The Costa Concordia disaster at sea, given the exceptional nature of the scenario, the Prefect of Grosseto, as responsible for the coordination of all the activities aimed at the search of missing persons appointed the Provincial Commander of the Grosseto Fire Brigade as Incident Commander.

The scenario faced was unique in the history of recent disasters at sea. In fact, for the first time in the history of disaster response, the difficult task of SAR activities had to be ensured aboard a cruise ship of nearly 290 meters, 114.000 if gross tonnage, about

2,400 t. of fuel, half sunken and tilted on itself; with portions of some decks and cabins at depths greater than 40 m with an inclination of almost 70%, the ship set on a granite bottom with a slope of more than 22% and increasing bathymetry that in the case of movement could have caused the complete sinking of the ship. In the early stages there was no information available on the stability of the ship, which was later assessed though the TSC activities coordinated by the CMU.

The response coordination of this complex scenario was handed over to the SAF⁸ of the Fire Brigade for the search and rescue operations carried out in the submerged part of the cruise ship. The slope of the hull and slippery conditions of the wet floor plates and lack of any support surfaces called for the use of speleological or alpine rescue techniques. Hence the decision to assign the task of Incident Commander – IC - to the Head of the Fire Brigade whose specific training could ensure the most appropriate SAR operations in the submerged part as well as the emerged part of the shipwreck.

5.2.1 THE INCIDENT COMMANDER'S PRIORITIES

The first problem was how to respond to this type of disaster; to this end all the information gathered at the earliest stages of response by the diver rescue teams of the S.A.F. units was analyzed.

The main problem was to determine the position of the shipwreck and to work on the stabilization of the hull. The organizational reference was based on the Incident Command System by defining the operational functions and the responsible experts in charge of the specific tasks required. One of the first operations performed “the day after” was an aerial survey of the shipwreck; an AB 412 helicopter performed a low altitude flight over the wreck with a significant amount of photos taken for identification of the main access ways.

The second operation involved an assessment inside the hull with the purpose of estimating the access difficulties and identifying the escape routes and an estimate of the necessary evacuation time, definition of the reference points, exit ways and transfer/passage difficulties.

During the night the Local Command Unit (Fire Department Mobile Command Vehicle) was called on the island, its operability proved to be vital from the earliest stages of emergency response operations, allowing the immediate coordination, the use of

⁸ A specialized unit inside the Fire Brigade performing rescue operations in alpine, cave and river environment

radio frequencies, the recording on the SO115 system.

In the course of time, responsible experts in the field were identified as well as an outline of a the response operations plan. Through the Costa company the cruise ship's plans were retrieved which recorded, initially on paper and after a few days in CAD, thanks to TAS teams (Rescue Applied Topography), the references identified on the ship, the decisions and the information gained, the possible routes, the critical points, the internal references.

From January 14th until January 17th, information on the movement of the shipwreck was provided by use of a pitched topographic system ensured by skilled professionals deployed on the scene on the first hours following disaster by the Prefecture upon request made by the IC.

The readings were made on two measuring points, one at the bow and one at the stern of the shipwreck and provided crucial information to assess the scene and ensure the operators' safety . The system will be considered very robust and effective by experts called by the CMU on the island and guaranteed in the early days, through the activation of a specific procedure, alert and alarm, leading, on two separate occasions to emergency evacuation of the relief operators.

The results of inspections carried out on board the ship have revealed the following scenario: the entire ship was completely dark, the doors blocked by furnishings that have piled up against the windows, the geometries are totally reversed as well as the passage ways: stairs, hallways, corridors are impracticable and many are mostly flooded. The corridors transformed into vertical wells, the doors of the cabins have become floors or ceilings and opening them is extremely complex placing severe risks to rescuers.

The submerged parts posing even greater risks to the S.A.R. (Search and Rescue) operators: all kinds of material and objects such as fragments of floating detached carpet, the absolute lack of light, the furniture piled up creating blocks and traps and the impossibility to communicate within the hull, particularly in the submerged part.

5.2.2 OPERATION STRATEGY

Given the framework that was taking shape, the strategies to pick, appeared almost mandatory. On the one hand the SAR operations in the emerged part of the hull assigned to the National Fire Brigade Corp. The evacuation routes were provided by the two ladders fact placed at the bow and stern of the ship at the sea side, the use of which was quite hazardous in the event of adverse sea conditions, and in a third ladder placed at

the stern on the other side, installed by the Fire Brigade SAF units, which was necessary to ensure a safety aerial passage to bridge the gaps of the decks that ended up almost in a horizontal position creating gradients of about 10 meters , and other areas were highlighted with paint for evacuation by AB 412 helicopter .

On the other hand, it was useful to channel the entire rescue system into a single shared direction for operations in the submerged part. The C.C.S.I. was therefore established as a single coordinating structure to bring together the most skillful professional divers that the country's system could provide. The CCSI, operating within the CMU, assumed a key role in the coordination of SAR operations, as it was possible to share experiences, techniques, strategies, and above all the decisions, by all divers, creating a rare atmosphere of synergy and understanding between all the relief operators. This enabled the IC to dictate the guidelines and manage information of technical nature at best, with a continuous series of debriefings, without interfering with the sequences and operational choices implemented by the single departments, called to plan and coordinate their manpower's operability without changing the procedures and ordinary operational codes.

The strategy that characterized the coordination of search and rescue of the missing coordination by the IC was to chronologically coordinate the different search activities according to the available definite information that was constantly being collected defining the scenario ever more clearly.

The first rescue operations were in fact characterized by a great amount of uncertainty:

1. there was no definite information regarding the stability of the shipwreck;
2. there was no clarity with regard to the number of missing persons and their identification;
3. the environments of the shipwreck and specific operational complexities became more evident with the passing of time and days.

In light of all of the above the choice was to address the rescue means to an extended research by evaluating carefully all the areas that could be accessed and investigated keeping in mind the evacuation routes identified between decks 3 and 4. This procedure that in the emerged part of the shipwreck entailed initial immediate search operations subsequently allowing for the rescue of three survivors, while 17 bodies were found in the submerged part.

The second response mode saw a change in strategy dictated by the following considerations:

1. in the first weeks it was possible to clearly identify the number and names of the missing. From this time a meticulous job on the part of the intelligence was initiated allowing for the reconstruction of the last movements of the missing on board the ship;
2. the deformation of the ship, monitored with precision instruments, did not allow access to flooded areas from outside;
3. extensive activities in the emerged part of the ship were in fact coming to an end;
4. after more than four weeks following the accident, there was no realistic hope of finding any survivors.

The choice, therefore, was to abandon the extensive research operations and to devote response to specific goals defined as "shot on target". Clearly this different approach led to a total change in terms of operating mode. The choice proved to be effective, allowing to find the bodies of missing persons by focusing research on areas of the ship where the presence of the victims would most likely be concentrated and avoid exposing the rescuers to risks that were no longer compatible with the objectives of the research. In this new phase operators proceeded to inspect the wells of the decks turned into evacuation passages and interface areas outside the hull. These two operations allowed for the discovery of 13 missing bodies, raising the number of recovered victims to 30, getting closer to the total number of ascertained missing persons.

5.2.3 SAFETY

Another important aspect under the responsibility of the IC was the one concerning the safety of operations. To achieve this objective, the key points were:

- informing and sharing all decisions with the heads of operating units;
- an effective communications management; a marine band radio exclusively dedicated to emergency communications reporting any abnormal movement of the hull of the ship;
- an access to the areas of intervention restricted to authorized vehicles ,
- presence of two hyperbaric chambers for the treatment of any injury to the diver rescue teams;
- presence in the day time of a helicopter for evacuation purposes;
- reduction of resources at night due to the impossibility of helicopters to operate

at night time. Night time emergency health care was however guaranteed by SUEM 118 at USL 9 of Grosseto;

- presence on the Island of Giglio of health facilities guaranteed by 118;
- monitoring of movement of the hull. On the days between 17 and 22 January of the monitoring system, based on different technologies whose data were analysed by the best experts from the University of Florence under CMU coordination, has been implemented. This activity which continued to grow during the hours and days following the disaster was the basis for an entire alert system created by a new and very accurate procedure (7/24 hours) based on alerting via radio on a dedicated channel, submitted to the researchers connected with the Local Fire Brigade Command in charge of issuing the alert and coordinating response operations;
- coordinated and shared evacuation plans; constantly updated according to the evolving situation. In particular the following risks have been highlighted with their respective response plan: rapid sinking of the shipwreck, fall at sea of the rescue operators with heavy equipment, sliding on board with violent impact, fall at sea within the wreck, balance disorders, physical exhaustion, chemical and/or biological contamination , injuries to the divers, use of explosive material, movement of floats/vessels during diving missions
- presence of Fire Brigade vehicle of the Local Command Unit U.C.L. has allowed a unified tactical direction of all S.A.R. operations among all the resources and actors conducting response operations;

5.2.4 RESCUE OPERATIONS

In both the emerged and submerged parts of the shipwreck, different operating modes can be referred to the bordering conditions which upon analysis have in fact influenced and determined the choices and decisions made. The search and rescue activities carried out can be subdivided in five different phases:

The **first phase** refers to the immediate rescue operations that began on 13 January at about 11:00 pm and ended on 14 January at 1.00 pm.

The **second phase, characterized by an increase in** response coordination, began on the morning of 14 January, still without any accurate information regarding the stability of the ship, concentrated on the number of missing persons and their identity and on the definition of the probable search areas. The problem of the ship's stability was faced by defining an evacuation plan to ensure the safety of the disaster victims on board and

around the shipwreck. As per the submerged part of the vessel this phase was characterized by search operations through the “call out” method which proved to be effective for the finding of three survivors, a married couple of Philippine nationality and the ship commissioner. This response phase was concluded after 72 hours.

During this phase with the support of the Fire Brigades for the emerging part of the hull and the CCSI for the submerged part, intervention strategies aimed at the rescue of survivors and to the identification of dead bodies as well as the protection of the rescue teams were defined. The main issues of interest in terms of response to this disaster for the rescue teams were the following:

- The scenario analysis: carried out despite lack of information; lack of specific procedures; lack of historical reference, relying mostly on environmental parameters (temperature, air , water), survival curve and stability of shipwreck;
- Available human resources: according to the demand and to the specific operations both airborne, under water and mixed;
- Operation modes: this is one of the more complex issues of this emergency as these can be identified into three separate modes: fast response, aimed at specific objectives and systematic (shot on target missions);
- Intervention time: as most national emergencies this one as well required a progressively decreasing deployment demand. During the first and second phases permanence on the Island amounted to a maximum of 36 hours and in the third phase to 72 hours;
- Risks for the rescue operators and safety protection: the issue of safety for the relief operators was identified as among the objectives of response coordination as it was considered a top priority in the framework of the planned rescue operations, considering the series of macro risks previously described;
- Emergency plans: each specific risk implied a consequent response plan, extremely detailed and under constant monitoring through a series of updated briefings at the end of each mission with the single teams and joint forces implemented at the end of the day,
- Definition of a strategy for each single mission

As per the numbers of the relief operators we can state that in the emerging part of the hull during the first 48 hours after the morning of Saturday 14 January two SAF teams composed of eight units took 6 hour shifts in the 24 hour period. Subsequently from January 16th with an increase of available personnel and therefore available for

the entire second and third phases, three teams composed of 12 units each were deployed to operate according to specific 24 hour operation tasks with shifts of personnel every 4/6 hours with respect to the operational demand. Higher numbers would not have been compatible with emergency evacuation procedures.

With regard to the submerged (underwater) scenario in the following table the data related to all activities carried out by the diver staff during SAR operations performed in the first 12 days when immersions were characterized by access from outside to the interior of the shipwreck. In reference to this it is important to stress how access capacity to the vessel differed for the various diver teams. The Fire Brigades and Coast Guard corps guaranteed also speleological and under water deep immersions, the national Navy Gos divers managed to the opening of blocked areas by use of explosive material, the Guardia di Finanza and the CNSAS (National Alpine Cliff and Cave Rescue Corps) ensured the inspection of the different parts of the shipwreck and subsequently the co-ordination of the monitoring markers supervised by the Coast Guard and the Police Forces.

Body	Deployed Units	Diving missions	Total diving time
Fire Brigades	37	93	94h 39'
Navy GOS	13	86	71 h 39'
Coast Guard	19	101	55 h 15'
State Police	13	65	43 h 10'
Guardia di Finanza	8	38	26 h 50'
CNSAS	16	8	8 h 00'
Total	93	391	300 h

The **third phase** mainly regards the SAF units of the Fire Brigades and marks the passage from the “call out” phase to the assessment of all the emerging areas. During this phase all search modes were implemented, particularly the use of micro-cameras used for inspecting some cabins as well as geophones, attempts with search dog units were also made. In approximately two weeks this activity was concluded ending precisely on January 31st.

The **fourth phase** which in fact began on 1 February refers to the accurate identification of all the missing persons. The second operations mode is entered which distinguishes

the first three from the next three phases. For each of the missing persons an investigation file was opened with the personal details, the cabin occupied and the last sightings witnessed and possible movement on board. To this end both films taken on board by the Company and private recordings are analyzed . So from a general research plan we passed to a “shot on target” approach both for the emerging and underwater part of the hull. This strategy led to the definition of some specific areas of the ship with evident less risk exposure for the rescue operators. In this context the need to focus search operations in correspondence of the cross section corridors of decks 3 and 4 which due to the inclination of the hull appeared like submerged wells with a depth of about 26 meters. This type of scenario which has never been dealt with before, was managed by the SAF units, the National Fire Brigade and Navy divers, operating in two different working area.

In this phase the flooded areas of the shipwreck were reached from the inside of the vessel. In consideration of the fact that the access ways for hyperbaric activities presented high risks of contamination, as proven by the samples analyzed by ARPAT and by the competent Health Authority, operations were performed by use of systems supplied and controlled on the surface (Surface Supplied) and wetsuits. These systems in addition to avoiding the contact of water with the airways through the use of helmets in overpressure, ensured high safety standards by the unlimited reserve of air and by the audio- video integrated systems.

The **fifth phase** which began at the end of February and ended in early May is when the coordination of research operations was assigned to the Maritime Regional Director of Tuscany and when operations were transferred outside the vessel to the bottom interface areas- the hull.

The search and rescue situation, at the beginning of this phase presented the following scenario: 32 missing persons and 25 rescued and the complete inspection, that is 100 % of the reachable areas of the submerged part of the shipwreck. In addition to the necessary response steps specific missions were carried out to check all the cabins of the missing persons; a number of partially flooded cabins were inspected by joint teams of SAF units and Fire Brigade diver with the use of high definition underwater cameras. As per the submerged part of the vessel, in addition to the reconnaissance missions conducted internally and externally, missions were carried out within the vessel both in the cabins of the missing passengers and in correspondence of the flooded cross-section corridors of decks 3 and 4.

About 65 % of the fully submerged part of the vessel was inspected with great tech-

nical complexities due to the total absence of light and the presence of floating heavy waste material of mixed type, which included heavy furnishings, carpet and other materials. The deepest deck areas, particularly 1 and 2, are referred to as the black areas, where fortunately there is no evidence or witness of any presence of missing persons. For safety reasons a number of ROV (Remote Operating Vehicle) were used for the inspection of cavities, which allowed to reach unexplored areas in order to identify and recuperate the bodies of the last 5 to 7 victims which were missing on the list, hence reaching the total of 30 bodies found.

5.2.5 CONSIDERATIONS

Search and rescue operations were concluded in early May with the latest research efforts of bodies made in the interstices between the rocks and the hull of the shipwreck, conducted by the Coast Guard and the Fire Brigade using instrumental techniques. In two weeks the entire topside was fully inspected. Thirty of the thirty-two missing bodies were returned to their families thanks to the efforts of specialized diver departments of the National Fire Brigade, the Coast Guard, the State Police, the Navy, the Guardia di Finanza, the National Corps of Mountain Rescue and Italian Federation of Underwater Activities.

Below are some considerations shared with the heads of rescue diver departments who worked in the Costa Concordia emergency and related activities carried out by the diver departments belonging to the civil and military authorities who participated in SAR operations. In order to improve the effectiveness of SAR operations, as mentioned earlier, a Coordination Centre for Underwater Command (CCSI) was set up. The main actions carried out by the CCSI are listed below:

- analysis of the plan of the cruise-ship made available by the Costa spa Company;
- identification of the macro-areas (decks) areas of underwater exploration;
- identification of the natural or artificial passage ways to optimize the underwater routes for rescue operations;
- collection of information (testimonies, emergency plans, gathering areas) for the elaboration of response strategies.

In order to avoid interferences and conflict in reference to the procedures adopted

by each diver/underwater component the vessel was split in specific sectors of operational responsibility, duly assigned to the various authorities according to the technical skills of the diver units. To this regard different operational set ups were established :

1. EOD (Explosive Ordnance Disposal)
2. underwater cave diving
3. ordinary
4. mixed
5. instrumental research

The type 1 unit of (EOD) divers involved the GOS diver units of the Navy who carried out numerous reconnaissance missions across the submerged part of the ship to secure life rafts and ensure the opening of passage ways , both natural and artificial ,by special explosive micro-bursts in specific sections of the ship. Blasting operations were carried out according to specific security protocol that has provided the total absence of operators within the ship and the interdiction of the access to a predetermined area of protection regulations which provided for the total clearing of rescue operators inside the vessel and the closing off of a specific area calculated with respect to the center of the hull.

During the entire SAR activities passage ways either natural and artificial were opened and marked with alphanumerical signs and placed in the various decks. The realization of the openings was necessary to optimize underwater research routes for the cave diver units that operated inside the hull in bridges 3, 4 and 5 in order to allow the best and most complete possible exploration of environments, compatibly with the reserve supply of air and operating procedures.

The type 2 set up (underwater cave diver units) regarded the Fire brigade divers, the Coast Guard and the CNSAS, trained to operate in hostile environments or similar locations.

It should be mentioned that the cave diver units surveys were characterized by a high degree of risk due to the adverse surrounding conditions which deeply affected visibility which was very low or null due to the abundance of floating waste material and also impaired by the lack of orientation caused by the inclination of the ship.

Each immersion was in fact planned in consideration of the acceptable risk condi-

tions for the rescue diver units according to the following parameters:

- total diving time according to diving decompression curve (U.S. Navy tables) ;
- exploration distances from the opening access compatible with the air supply reserve provided by the operational procedures;
- presence of divers in stand by both on surface (on diving vertical) and in depth in proximity of the inlet access;
- presence of hyperbaric chamber and of health /medical staff at the base camp;
- alert of hyperbaric facility in the Hospital of Grosseto and available transfer via sea or helicopter in case of decompression accident.

The speleological rescue diving missions allowed for the exploration of decks 3, 4, and 5 of the ship as well as the finding of several bodies.

The type 3 set up (ordinary) was deployed for the following:

- exploration outside the vessel
- systematic inspection in the exterior cabins
- exploration of the environments at stern

In particular, the activities referred to in point b) allowed the inspection of all the cabins of the submerged decks 6, 7, 8, 9 and 10 with the exception of those (few units) whose access was blocked by the presence of rock masses or furnishings against the sliding doors. For this operation, the Fire Brigades, State Police and Finance Police diving units were deployed .

To increase the safety of divers and expand the areas of exploration, systems powered and controlled from the surface (surface supplied) by the Fire Brigade divers were implemented.

The operational tactics adopted for this type of operation involved the division of the starboard side of the vessel in areas with underwater trails from the lower deck to the upper ones.

The type 4 set up (mixed) involved the SAF divers and Fire Brigade diving units for the first time in joint activities in order to explore the flooded corridors of the ship which had become wells as a result of the vessel's inclination.

The composition of the teams which planned for n. 4 SAF + n. 3 divers + n. 1 speleo sub-divers, allowed for the access and progression to the surfaced part of the vessel with

the assistance of SAF staff and the subsequent inspection of the flooded wells with dives in the speleo underwater set up.

This system was also deployed to carry out “shot on target” missions with the objective of exploring well defined submerged areas identified on the basis of recent sightings reported by witnesses at the time of the sinking.

Inspection of the flooded wells at greater access risk was conducted with the use of underwater cameras.

The type 5 set up (instrumental research) involved diver units from the Fire Brigades, the Navy Institute of Hydrography and the Coast Guard.

It has been a “multi-agency” type of operation aimed at the search and rescue of possible missing persons/bodies at the seabed within an area of 18 km² around the shipwreck.

For this purpose, areas of research were defined within which the above organizations operated jointly with the use of sonar and robotic systems embarked aboard pilot boat (Fire Brigade), patrol (CP) and the Navy ship Galatea (Hydrographic Institute). The above operation was carried out in two stages: mapping of seabed and geo-referencing of possible targets and visual inspection of acoustic targets by ROV.

Rescue operations were concluded in less than two months. Despite the extraordinary operational scenario, the extreme conditions during the winter months characterized by adverse weather and sea conditions, the need to operate in a multi agency type of set up with capacities and operational procedures and methods differing among the various implementing bodies, the entire job was conducted without any reported injuries to the rescue operators.

While the rescue operations were still on going, an open discussion table took place with expert divers from France, England, Sweden and Switzerland activated within the European Civil Protection Mechanism. In emphasizing the extraordinary commitment of Italian divers, foreign participants did not identify alternative solutions to those adopted by highlighting the exceptional work done.

During all the different phases of response to this complex emergency there has been a strong and full participation and collaboration of the relief authorities and operators with the families and relatives of the victims ensuring a continuous flow of information with regard to the research activities in progress, the operational procedures adopted and the achieved results as well as the objectives of each mission.

5.3 ENVIRONMENTAL PROTECTION

Environmental protection has always played a crucial aspect in management of the various emergency activities in which priority was ensured to safety of the workers involved in the recovery of missing persons and in the reduction of environmental risks as well as in ensuring the safe removal of the wreck.

Several measures were implemented by the CD through the various parties, organizations and administrations involved that targeted both monitoring the movements of the vessel and preparation of measures to contain spillage of chemicals or other material produced from the ship.

For this purpose actions were implemented to prevent pollution events, fuel recovery from tanks, waste management originated from the various operations carried out within the ship, matrix environmental monitoring, ensured health protection of the workers, implementation of a movement monitoring instrumental system for the vessel and provided meteorological support operations.

The synthesis proposed here does not aim to fully describe the complexity and the number of activities that characterized the environmental protection, but grants an overview of the different points that constituted the system of measures aimed at ensuring environmental protection.

5.3.1 ANTI-POLLUTION PLAN

The operational plan for local pollution, approved by the Maritime Directorate of the Tuscan Region, was immediately, activated after the vessel sunk; it involved, among other things, floating oil absorbent booms positioned around the ship to protect parts of the coast in the vicinity of the hull from oil spill. An oil recovery plan prepared by the company chosen by Costa Cruise Company was also approved and immediately enforced. The shipping company's plan, to contain accidental spills, was also approved and immediately enforced which worked side by side with the local antipollution plans. The plan foresaw recovery of spills, by floating oil absorbent booms, floating booms and coastal cleanup. Floating booms were the primary response to spills.

To add to the above measures the CMU together with the Province of Grosseto rose coastal municipalities' awareness and adopted and implemented a contingency plan in case of spills at sea and oil on shores. Simultaneously, ISPRA, the Coast Guard,

After the sinking of the vessel, the Costa Cruise Company verified the stability of

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Fig 2 – Individual tank capacity's estimates

5. MAIN ACTIVITIES © [39]

The following chart shows the final debunkering activities which officially ended March 24:

Tank	Status	Estimated quantity m ³	Pumped quantity m ³	Date Completed
HFO wing tank 1 PS	Completed	130	131,0	17-02 1527Lt
HFO DB tank 1 PS	Completed	410	429,0	17-02 1532Lt
HFO DB tank 1 SB	Completed	410	297,0	17-02 1535Lt
HFO wing tank 1 SB	Completed	130	95,0	17-02 1515Lt
HFO DB tank 1 CN	Completed	270	224,0	19-02 1517Lt
HFO DB tank 2 CN	Completed	168	132,6	19-02 1515Lt
HFO DB tank 3 PS	Completed	30	20,0	28-02 1430Lt
HFO DB tank 3 SB	Completed	30	13,0	28-02 1430Lt
HFO overflow DB tank 1 CN	Completed	9	0,0	28-02 1430Lt
HFO DB tank 4 PS	Completed	75	64,0	02-03 1516Lt
HFO DB tank 4 SB	Completed	75	91,0	02-03 1515Lt
HFO DB tank 5 CN	Completed	0	0,0	02-03 1540Lt
HFO settling tank 1 PS	Completed	120	87,0	21-03 1600Lt
HFO settling tank 1 CN	Completed	90	45,6	21-03 0806Lt
HFO service tank 2 SB	Completed	75	21	23-03 0845Lt
HFO service tank 3 SB	Completed	0	47,7	24-03 0730Lt
HFO pumped/skimmed from engine room	Completed	0	90,6	//
Total HFO		2022	1788,5	

Tank	Status	Estimated quantity m ³	Pumped quantity m ³	Date Completed
DO DB tank 1 CN	Completed	130	142,0	24-03 2200Lt
DO DB tank 3 CN	Completed	10	31,0	25-03 2315Lt
SLUDGE DB tank 1 CN	Completed	18	0,0	26-03 0955Lt
Emergency D/G DO tank 1 SB	Completed	10	11,0	09-03 1640Lt
Emergency lifeboat DO tank 2 SB	Completed	4	5,0	09-03 1640Lt
DO service tank 1 PS	Completed	49	49,0	21-03 0813Lt
Total DO/Sludge		221	238	

Tank	Status	Estimated quantity m ³	Pumped quantity m ³	Date Completed
Oily Bilge clean/dirty side tanks 1 PS	Completed	37	10,0	23-03 0850Lt

Total quantity of hydrocarbons estimated on board as per oil removal plan	2280 m ³
Total quantity of hydrocarbons removed from the Ship	2036,5 m ³
Total estimated quantity of hydrocarbons to be removed	0 m ³
Total estimated not pumpable on estimates	243,5 m ³
Total quantity removed by using a "skimmer" in the damaged area	6,0 m ³
Total hydrocarbons removed	2042,5 m³

Tank	Status	Estimated quantity m ³	Pumped m ³	Date Completed
Holding black water DB tank 5 PS	Completed	120	120	12-03
Holding black water DB tank 5 SB	Completed	120	120	13-03
Total black water		240	240	

Table 1 – summary of fuel removal activities

With regard to waste water, 240 m³ of waste water was removed. This figure represents only the waste water removed from the accessible sewage coffer. This activity began on March 12 and ended on March 13.

5.3.3 WASTE MANAGEMENT PLAN

Costa Crociere S.p.A. prepared a descriptive removal waste plan for the vessel. It described procedures for: collection, transport, recycling or disposal, which depended on, characteristics and classification of material floating on the water. It also described disposal, after characterization and classification was performed of waste water (sewage) present in coffer on the vessel, as well as chemical products and hydrocarbons stored separately. The plan also included collection of debris deposited on the seabed near the ship.

The TSC expressed its opinion on the waste removal and approved only the parts relating to: removal of floating material, removal of waste water (sewage) and debris, deposited on the seabed adjacent to the accident. It did not authorize the removal of chemicals and hydrocarbons stored separately and for waste water coffer positioned in high risk areas for operators.

The CMU guaranteed a flow of information between the shipping company and the organizations supporting the CD (TSC and Implementing Partners), appointed to provide advice, feedback on products and plans on issues raised, including the CD himself and the Offices of the DPC.

5.3.4 ENVIRONMENTAL MONITORING AND HEALTH

ARPAT¹⁰ is normally responsible, at regional level, of environment and health monitoring of marine waters at Giglio. After the Costa Concordia vessel sank it was deemed necessary to perform special audits on the water, with respect to possible spills from the vessel.

The monitoring plan of water quality and marine environment surrounding the Costa Concordia was set out by Arpat in collaboration with the Institute for Protection and Research (ISPRA) and was forwarded to the CD for its approval. Prior to transmission of the plan, the ARPAT took daily samples in the vicinity of the vessel and the desalination plant following the assessments of the TSC and commissioner provisions. The

¹⁰ Regional Agency for Environmental Protection of the Tuscan Region.

information gathered was published on its website. It also guaranteed a manned monitoring motorboat on the island working around the clock as of 26/01/2012.

The TSC examined the plan and considered it "adequately, balanced and appropriate for the purpose for which it was responsible." Starting in March, ISPRA and ARPAT continued their monitoring campaign of the surrounding waters the Concordia vessel, with variable frequency on a monthly basis. Monitoring was articulated in three levels which continues to this day (level 1 - monitoring 5 points in close proximity to the vessel; level 2 - evaluation monitoring for short and medium-term environmental damage, with chemical toxicological, hydro-morphological and biological characteristics of the water column, sediment and biota investigations; level 3 - long-term monitoring for assessments at a sufficient distance from the sunken vessel area at regional monitoring stations in the network).

On July 2, 2012 a special Agreement was signed between the CD and ISPRA. This agreement determined the content, method of research and environmental monitoring to be carried out by ISPRA, according to the implementation of the above specified monitoring plan in order to assess the effects of possible pollutant spillage from the Concordia vessel in the eastern area of the island of Giglio, in the institutional framework of the parties and pursuit of public interest of the civil protection. The Agreement, went into immediate effect from the date it was signed, with a deadline of 31/01/2013. A similar agreement was signed between the commissioner and ARPA Toscana on August 2, 2012.

5.3.5 SHIP MONITORING

Monitoring of the vessel was coordinated, through the DPC, from a scientific point of view by the Department of Earth Sciences of the University Florence (UNIFI - DST), who installed an advanced laser scanner on the topside of the Concordia vessel and controlled its stability.

Monitoring activities were carried out in close coordination with the CMU, with the Monitoring and Surveillance Centre of DPC and the Region of Tuscany, with other Centres of Excellencies¹¹ (CNR-IRPI, ASI) and other research institutes (EC-JRCIPSC, OGS, Prato research Foundation, Polytechnic - University of Milan) and specialized companies appointed by other partners in the first phase of the emergency or requested

¹¹ Technical and Scientific Institution working with the DPC on ordinary basis

by the Centres of Excellencies (SMIT, NERI, SIRI, Marine Remote Sensing Europe, HORTUS, HERA, LEICA).

The monitoring system (still operating) was installed and operational on January 18, 2012, which is the same day the request for assistance arrived at the DPC, and it was fully operational the following day. The system is comprised of different independent technologies, so as to increase control and reliability of the data of movement:

- Accelerometers SIRI-Marine System installed and operated by Neri/Smiti, SIRI-Marine,
- Robotic total stations installed and operated by CNR-IRPI;
- Synthetic aperture radar interferometer (MIMO-SAR) installed and operated by EC-JRC;
- Three-dimensional laser scans installed and operated by UNIFI;
- Thermographic Surveys, installed and operated by UNIFI;
- Microseismic network, installed and maintained by FPR-INGV;
- Analysis COSMO-SkyMed satellite interferometric radar, installed and managed by ASI, TRE, POLIMI;
- Global Positioning Systems GPS, installed and operated by HERA;
- Gage wire anchored underwater, installed and operated by UNIFI, Hortus;
- Monitoring of underwater markers installed and operated by the VVFF, C.P, P.S.

This set of techniques and monitoring networks has allowed the measurement of deformations of the wreck, in real time, highly precise and accurate (in the order of 10-3 m) and Broadband (sensitivity extended over 10 orders of magnitude : from 10-8 to 102 Hz). In order to minimize the influence of daily changes and periodic atmospheric parameters (temperature, pressure, index of refraction of air, etc..) That can reduce the overall accuracy of certain measures, a series of reference points were installed on the mainland to compensation the measurements.

Most of the systems provided a remote data transmission via radio or via Internet, data was displayed on computer monitor, smartphone and iPad. This set of techniques used for monitoring constituted an early alert system which also aided search and rescue activities carried out on the vessel, and during fuel recovery operations. The data collected and interpretations were made available via daily and weekly bulletins, to the CMU and then released to third parties that contributed to emergency management and reported on a daily basis, in the report addressed to the various components involved.

5.3.6 METEOROLOGICAL SUPPORT

As part of the CMU a weather forecast station was set up, which provided the necessary weather data to conduct operations safely, with particular reference in regards to wind intensity and sea conditions in the area.

Since 19 January 2012, the Monitoring and Surveillance Centre of DPC produced weather forecast bulletin for the island of Giglio, in close collaboration with the consortium LAMMA of the Tuscany Region. The weather forecast proved to be a useful tool for supporting the operations during the de-bunkering and during search and rescue operations.

5.4 SHIP REMOVAL

In order to select the best project for the removal of the Costa Concordia the Costa Crociere Company established a technical committee comprised of Fincantieri, RINA Group, Carnival Corporation, London Offshore Consultants on behalf of insurers and academics as well as the Costa Crociere itself. The committee set out the technical specifications for the removal of the hull which on 1 February 2012 were sent to ten specialized companies. These companies presented their proposals by no later than March 3, and respected the three major elements required by the CD:

- the removal activities must have as little environmental impact as possible without resorting to the cutting of the vessel;
- the removal activities will cause minimal disruption to the ordinary life of the people of the island of Giglio;
- operators must be guaranteed safety working conditions.

The technical committee set up by Costa Cruises assessed the various projects presented and chose, at the end of the preliminary investigation, the joint venture Titan Salvage / Micoperi which respected most of the requirements: entire removal of the wreck, little risk as possible, less environmental impact, safeguard of tourist and economic activities of the island of Giglio and maximum safety of operations.

The project evaluation was carried out on the basis of a matrix comprising of over 200 items divided into groups with the following percentages:

• Enviromental and territorial impact	30%
• Reliability of the proposed technical solution	25%
• Risks	25%
• Timeframe	10%
• Costs	10%

The winning project is based on refloating the vessel restoring its buoyancy capacity through installing parbuckling strand jacks on the casualty itself and to pull against subsea piles; external sponsoons gives it the necessary buoyancy for subsequent transfer to an Italian port where it will be completely dismantled. Particular attention will be paid to recovery of the site once the ship is transferred.

Of particular importance in the removal project context, is the hold back system of the ship which operates via steel cables, jacks and pylons driven into the seabed along the coast, in order to ensure that the operation proceeds safely for ship operators and to ensure the stability of the vessel even in adverse weather conditions.

Fig 5 describes hold back, parbuckling and buoyancy system.

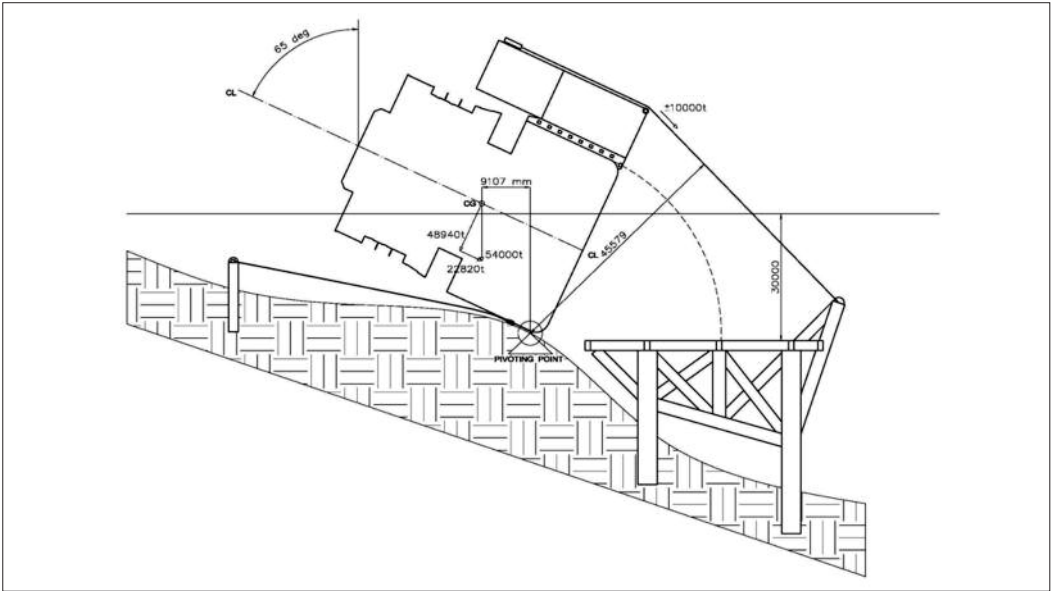


Fig 5 - Configuration of the hold back, parbuckling and buoyancy system

The CD, for the sole purpose of verifying that the wreck removal Project selected is carried out in full compliance with the appropriate environmental protection measures and that the project would be handled by experts both operationally and organizationally, appointed a representative who participated in the Technical Committee.

In order to ensure a quick removal of the wreck from the Island of Giglio, and bearing in mind the preservation of its natural environment, under OPCM n. 4023/12, two investigative Service Sessions meetings, with the purpose of improving the proposed Costa Crociera project, as well as a subsequent decision Services-Session meeting to examine, opine, approve, grant licenses and permits and evaluate the environmental impact assessment, as provided by law and regulating the project.

The decision-Service Sessions ended with a positive general overview, subject to the requirements of the different partners.

With the establishment of a control centre for monitoring, an institutional centre that constantly checked the removal procedures has been established, in order to ensure full compliance with the Environmental Report submitted by Costa Crociere S. p. A. and requests made at the Services Sessions.

6. CONCLUSIONS

In the premise we introduced the elements that characterized the management of issues related to the consequences of the grounded Concordia. It seems appropriate at this point to comprehend better after what has been described so far.

General aspects

The peculiarity of the emergency management generated after the sinking of the Concordia, resides in a series of features almost unique in the scenario generated by man-made disasters, which confirmed the efficiency of the civil protection organization as a well-established emergency response system and its adaptability which became evident in the lack of an ad hoc strategy; nevertheless during first days of the emergency, the response model was based on the operation strategy set out by the provisions of the Directive of the Head of the Department of Civil Protection on April 6, 2006 which granted indications for operational coordination of different types of emergencies namely, accidents at sea that involve a large number of people. The flexibility of the civil protection system, with the intent to be "the ability of a system affected by an event that hits the country, and its ability to organize, adapt and start the regional recovery

following the effects of an event in an effective and timely manner, including conservation and restoration of its basic structures and functions “in short, the added value of the civil protection as it is structured in Italy. A system capable of implementing, organizationally well-established and tested, capable of adapting to achieve the complex connection needed to deal with the consequences of this event in a coordinated manner and organize the work of a large number of specialized operators, of applied research centers, of well structured volunteers civil protection organizations and of the Institutions involved.

The dominant feature of emergency management resides in the possibility, given by the norms of civil protection, to the Head of the Civil Protection Department to ensure a unified response management and the ability to use the entire national civil protection system. It therefore guarantees a unique direction to the whole system on technical and administrative activities which are necessary in order to overcome an emergency. A system that, through sharing exercise drill sessions and by the accrued experience of many emergency events that have characterized our country, tested its internal procedures and its ability to connect with the entire system.

The role of the CMU

The CMU, played a leading role in creating a bond among the partners involved, which is not always immediate, due to its strong internal organization, resolving of all aspects, often critical, related to the flow of information, management of meetings, communications with the outside world and public relations with institutions pursuant to the directives issued by the CD.

The strong bond made and the great efforts not only emerge from the numerous activities but also from the list of the many partners involved in the crisis: the Ministry of Interior, the Ministry for the Environment, Land and Sea, the Ministry of Infrastructure and Transport, the Public Prosecutor's Office of Grosseto, the Tuscany Region with its joint technical and administrative sections, the Prefecture - UTG of Grosseto, the Province

¹² **Directive of 2 May 2006: indications for coordinated operations in the event of accidents – published in the Italian Official Journal n. 101 of 3 May 2006.** As foreseen by the directive of the President of the Council of Ministers on 6 April 2006, published in the Gazzetta Ufficiale n. 87 of 13 April 2006, the Head of the Civil Protection Department issued indications for operational coordination for accidents on: roads, rail, aircraft and at sea, explosions and collapsed structures and accidents with dangerous substances addressed to the Components and to the Operative Structures of the National Civil Protection Service.

¹³ This capacity is determined by the system's capacity to organise itself before and during the event and its resources.

of Grosseto, the Municipality of Isola del Giglio, the State Police, the Carabinieri, the Guardia di Finanza, the State Forestry Corp, the National Fire Brigade, the Coast Guard, the Navy, the Provincial Police, the Provincial Volunteers Coordination, the Italian Red Cross, the CNSAS (National Alpine Cliff and Cave Rescue Corps), the Misericordie Volunteers Association, the FIAS (Italian Federation of Underwater Activities), the health emergency service 118, the Grosseto Department for Health, the Municipal Police of the Island of Giglio, the Scientific Community, Costa Crociere SpA, the joint venture Neri-Smit and Titan - Micoperi and not least the citizens of Giglio.

The operation scenario

In operational terms, the scenario was immediately constituted as complex and the immediate short-term goals were search and rescue of the missing persons and protection of the environment.

A scenario made operationally complicated and difficult to approach because of the position of the vessel (inclined by 60 degrees on the left side). A cruise ship of nearly 300 m, and weighing more than 50,000 t, of which about 2,400 t was fuel, partially sunken and tilted to one side. Portions of some decks and cabins were submerged in more than 40 m of sea water and with an inclination of almost 70%; the vessel was unstable, on a granite bottom sloped at more than 22% and characterized by a growing bathymetry.

As for rescue operations at sea, timeliness and immediacy with which the 2nd MRSC, despite the lack of adequate information reported by the staff on board the Costa cruise-liner, took all appropriate measures, and achieved the best results operationally possible, thus avoiding disastrous consequences, especially in terms of loss of human lives.

In regards to the operations of search and rescue of the missing, these were conducted in a closed, semi-submerged environment, with modified reference points that caused difficulties in communications between operators, visibility was reduced to almost zero and necessitated stringent safety procedures and health protection, which limited in some respects the operations. The breadth and complexity of the SAR operations, followed by a long period of search for the missing gave rise to new methodological approaches and procedures which are to be considered one of the greatest achievements in terms of SAR operations.

The establishment of the C.C.S.I. (scuba divers multi-agency coordination centre) as the only coordination structure of different highly skilled divers, forced the entire rescue

system into a single shared direction for recovery operations which proved to be an appropriate choice, shared by all.

This is the set of elements that gave rise to the creation of a deep interoperability between the different components involved (the role of the Coast Guard involved in the maritime SAR in the first moments of the emergency, the CMU and, for the general link of all operations and coordination between organizations managed by the National Fire Brigade and Coast Guard regarding the search of the missing) which ensured resolution of significant problems related to operational difficulties inherent to activities of this nature, which, incurred within a territory of great naturalistic interest.

The high profile in terms of media and press produced by this disaster, certainly increased public attention on search operations of the missing and safety of the wreck which were considered unique. In this sense, a communication strategy and public relations with the press exclusively managed by the CD proved to be successful.

The Scientific Community

The scientific community, engaged in monitoring the vessel, operated in connection with the CMU. Their significant contribution guaranteed that the various operations on the ship were carried out with the support of technology instrumentation that enabled activation of an immediate alarm network system which guaranteed the safety of maritime operators. The last point that must be stressed is the adaptability of the system which encompassed the monitoring system of the Costa Concordia which is to be considered innovative in that it was designed for other purposes but adapted to this unique context.

The connection between private and public sectors

In the final analysis, what emerges is the synergy that was established between the CMU (as representative of the entire National system) and the private sector strongly implicated in the emergency management (the Costa Crociere Company, the consultant companies, the Insurers and the joint ventures Neri-Smit before and Titan-Micoperi then). An interaction that had to match different timescale routines and different interests (public interest and corporate goals), different sanctions and different organizational structures.

The CMU was able to add a value across the different partners or associations, acting as a pivot to facilitate operational and administrative activities. The various partners were totally willing to work together for the benefit of the primary public interest.