REPUBLIC OF LIBERIA

DECISION OF THE COMMISSIONER OF MARITIME AFFAIRS, R.L.

And the

Report of Investigation in
the Matter of Sinking of
Passenger Vessel EXPLORER (O.N. 8495)
23 November 2007
in the Bransfield Strait near the South Shetland Islands

PUBLISHED BY THE BUREAU OF MARITIME AFFAIRS

26 March 2009
Monrovia, Liberia

The Flag Administration has a mandate to promote safety of life and property at sea, and the prevention of marine pollution. This is achieved in part by conducting investigations of marine casualties involving vessels in the registry for remedial purpose in accordance with the Republic of Liberia Maritime Law and Regulations. Marine investigations, which are administrative in nature, determine the root cause of casualties, recommend means of avoiding them in the future, possible violations of law, and any faults or failures on the part of personnel, shipowners or operators which might require action in respect to any relevant licenses, certificates or documents.

It is not the purpose of the investigation nor function of the Administration, to assign fault or determine civil or criminal liability with respect to enhancing the litigation posture of any party. The Administration must report, or cause to be reported, the circumstances and proximate cause or causes of a marine casualty and any contributory factors. However, where it is determined that there exists evidence of criminal conduct under the Laws of the Republic of Liberia on the part of any seafarer holding a Liberian Certificate of Competency or other official document, the matter would be referred to the Ministry of Justice of the Republic of Liberia for appropriate action.

Disclaimer:

This Report and any appended Commissioner's Decision, sets forth certain findings, which have been ascertained or determined up to the time of its issuance, and is published to alert the shipping industry and the public of the general circumstances of the incident. While every effort has been made to ensure the accuracy of the information contained in this Report, this Administration and its representatives can accept no liability for any error or omission alleged to be contained herein.

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Decision of the Commissioner of Maritime Affairs
Republic of Liberia
Report of Investigation in
the Matter of Sinking of
Passenger Vessel EXPLORER (IMO 6924959)
23 November 2007
in the Bransfield Strait near the South Shetland Islands

AUTHORITY

This Decision is rendered pursuant to the provision of Section 258 of Liberian Maritime Law and Liberian Maritime Regulation 9.258(7).

COMMENT

Liberian Nautical Inspector, Captain Robert Ford, was appointed Investigating Officer pursuant to Liberian Maritime Regulation 9.258 (4), for the purpose of conducting an investigation into the circumstances of the sinking of the Liberian registered passenger vessel EXPLORER. The investigation was conducted in cooperation with the Chilean Navy in accordance with IMO Resolutions A.849 (20); A.884 (21) - Code for the Investigation of Marine Casualties and Incidents.

On 23 November, 2007, at about 1530 local time[1], the Liberian registered passenger vessel EXPLORER sank in a position 25 miles southeast of Penguin Island in the Bransfield Strait near the South Shetland Islands, in about 1300 meters of water. All 54 crew and 100 passengers abandoned the ship without loss of life or major injury. All of the passengers and crew were rescued by the Norwegian registered vessel NORDNORGE.

The EXPLORER was on an 18 day round trip voyage from Ushuaia, Argentina to tour areas in the Antarctic. On the evening of 22nd November the vessel entered an ice field described by the Master as "first year ice". The vessel navigated through the ice until about midnight when it hit, what was described by a passenger witness, a "wall of ice". The vessel sustained damage to a section of the hull of about 3.1 meters which led to rapid flooding.

The crew attempted to stop the flooding and pump out the water. However, based on accounts of the flooding, the sustained damage was more significant than what was initially described as a "fist sized hole" and the crew was not successful. The flooding could not be

[1] All times are in local Argentina Standard Time (ART) of UTC minus 3 using the 24 hour clock.

contained in the one-compartment that sustained the initial damage and the flooding spread to other compartments until the EXPLORER sank. The passengers and crew abandoned the EXPLORER into lifeboats and Rigid Inflatable Boats and were rescued by the Norwegian registered vessel NORDNORGE.

The decision by the Master to enter the ice field based on his knowledge and information available at the time was the primary reason why the EXPLORER suffered the casualty. He was under the mistaken impression that he was encountering first year ice when in fact, as the Chilean Navy Report indicated, was much harder land ice. The ice pilot who made the assessment of the passenger video also believed that the ice was thicker and harder than the Master's assessment. Passengers reported seeing red paint on the passing ice less than thirty minutes prior to the flooding was reported, another indication that the vessel was passing through compact and hard ice. The Master of the EXPLORER was very experienced in Baltic waters but he was unfamiliar with the type of ice he encountered in Antarctic waters. The Master should have altered course to open water and not have entered the ice field during darkness. However, once he had entered the ice field and approached the "wall of ice", there is no indication that he reduced the EXPLORER's speed as he approached and then made contact with the "wall of ice".

The Master and crew should be recognized for the actions taken to ensure the survival of the passengers under difficult conditions and circumstances that they had to deal with. The Master's decision to have the passenger abandon the vessel as well as the Engine Crews efforts to restore and maintain power so that the passengers could be successfully abandoned into lifeboats, in all likelihood, saved lives. Based on the circumstances of this accident, the Liberian Administration will do another review to determine whether some of the IMO guidelines, circulars and resolutions (such as those relating to vessels operating in Antarctic and Arctic waters, minimum safe manning, float free or quick release VDR installation) should be made mandatory.

ACTION

1. The Report of Investigation, along with the Findings of Fact, Conclusion and Recommendations, is approved.

2. It is directed that this Decision be published together with the Report of Investigation.

3. The owner, G.A. P. Shipping Co. Limited should consider the Recommendations in 4, 6, 7, 11 and others in the attached Report of Investigation, taking into account any relevant comments in this Decision.

4. In light of the importance of this Report of Investigation to the quest for improved safety of life and property at sea and the environment, the undersigned will cause a copy of this Decision and Report of Investigation will be submitted to the Secretary-General of the International Maritime Organization (IMO).

5. As a matter of comity, the undersigned will cause a copy of this Decision and Report of Investigation to be officially transmitted to the Maritime Authorities of the Government of Chile and Canada.

Done in Monrovia, Montserrado County, R. L.

This 23 day of March A.D. 2009

Binyah Kesselly
COMMISSIONER OF MARITIME AFFAIRS
REPUBLIC OF LIBERIA

Report of Investigation into
the Sinking of
Passenger Vessel EXPLORER
23 November, 2007
in the Bransfield Strait near the South Shetland Islands

FACTUAL INFORMATION

INTRODUCTION

On 23 November, 2007, at about 1530 local time[1], the EXPLORER, a Liberian - registered passenger vessel sank in a position 25 miles southeast of King George Island in about 1300 meters of water. All 54 crewmembers and 100 passengers abandoned the ship into lifeboats and rigid hull inflatable boats until the arrival and rescue by the Norwegian registered passenger vessel NORDNORGE. There were no major injuries and only one minor injury reported.

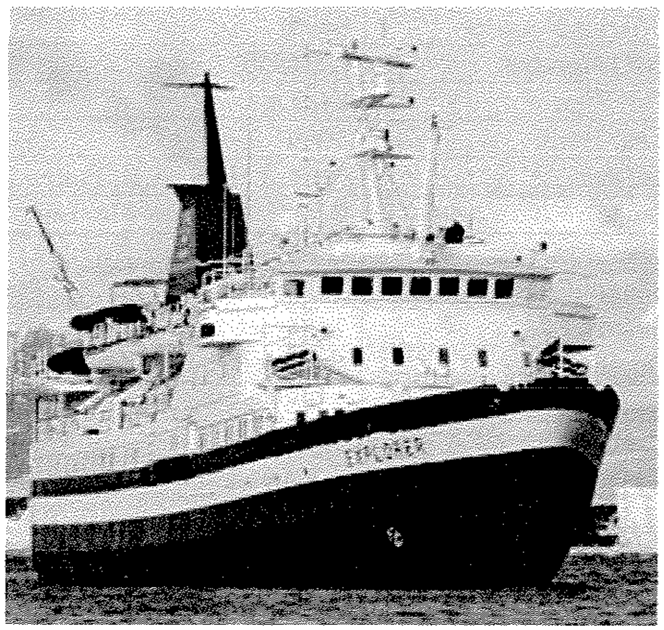


Photo 1: Photo of EXPLORER from G.A.P. Shipping Co. Limited brochure.

AUTHORITY

Liberian Nautical Inspector, Captain Robert Ford was appointed Investigating Officer by the Deputy Commissioner pursuant to Liberian Maritime Regulation 9.258 (4), for the purpose of conducting an investigation into the circumstances of the sinking of the Liberian flagged passenger vessel EXPLORER.

The Flag Administration has a mandate to promote safety of life and property at sea, and the prevention of marine pollution. This is achieved in part by conducting investigations of marine casualties involving vessels in the registry for remedial purpose in accordance with the Republic of Liberia Maritime Law and Regulations. Marine investigations, which are administrative in nature, determine the root cause of casualties, recommend means of avoiding them in the future, possible violations of law, and any

[1] All times are in local Argentina Standard Time (ART) of UTC minus 3 using the the 24 hour clock.

faults or failures on the part of personnel, shipowners or operators which might require action in respect to any relevant licenses, certificates or documents.

VESSEL PARTICULARS AND INFORMATION

The EXPLORER was classed by Det Norske Veritas (DNV) and was in compliance with the applicable requirements for a 1A1[2] Ice-A (for max draught 4.20 m) Passenger Ship. The most recent Classification Certificate was issued 30 May 2006 and was valid until 30 June 2011. (See table below for General Particulars and information)

Port of Registry	Monrovia
Official Number	8495
IMO Number	6924959
Call Sign	ELJD8
Year Built:	1969
Builder	Nystad Varv. A.B. Finland
Owner:	G.A.P. Shipping Co. Limited
Operator:	G.A.P. Shipping Sweden
Length Overall (LOA)	76.2 meter
Beam	14.0 meter
Depth	5.6 meter
Gross Tonnage	2398
Cruising Speed	13 knots
Vessel Draft	4.3 meters

NARRATIVE

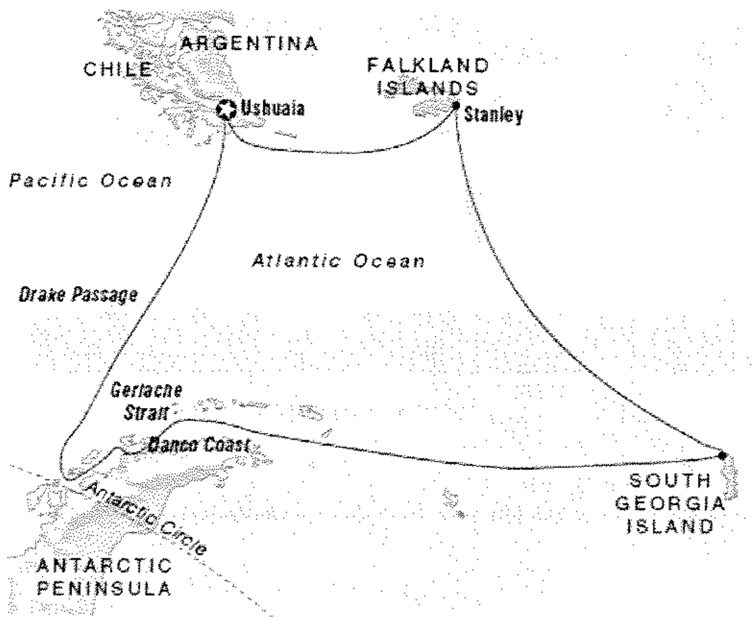
Crew Account of Events Leading Up to the Flooding

On 11 November, 2007, the EXPLORER was berthed in Ushuaia, Argentina preparing to embark on its first voyage of the season, scheduled for an 18 day round trip voyage from Ushuaia to tour areas in the Antarctic Circle (See Graphic 1). There were 54 crewmembers and 100 passengers on board. Nine of the passengers listed on the passenger manifest were employees of G.A.P. Shipping Co. Limited Shipping that provided staff and tour services to the passengers and were referred to as the Expedition Group. The Expedition Group provided services that included operating water borne passenger tours using the rigid-hull inflatable boats manufactured by Zodiac[3] and providing translations and tour information. The operators of the Zodiacs did not hold seaman documents and were not required to have any training required for seafarers.

[2] The notation 1A1 will be assigned to ships with hull, machinery, systems and equipment found to be in compliance with applicable rule requirements (DNV Rules for Ships).
[3] The crewmembers and Expedition Group referred to the rigid hulled inflatable boats by their manufacturer name, Zodiac.

Command of the EXPLORER was turned over to a new Master (see section on Crew Information) at 0800 the same day.[4] A pre-departure emergency drill was held at 1855. (See section on Pre-Departure Emergency Briefing) The EXPLORER departed Ushuaia at 2100, 11 November and headed for its first destination at West Point Island, (51-20 S, 60-40 W) in the Falkland Islands. After departing West Point Island, the EXPLORER continued on its voyage to Steeple Jason and Stanley, also in the Falkland Islands. The vessel departed Stanley on 14 November and was at sea on 15 and 16 November. On 16 November, an entry in the Bridge log book read "1030-Fire Drill for Galley Dept." No other information was included.[5]

From 17 though 19 November, the vessel anchored in various harbors in South Georgia. The first Zodiac launch and landing was on 18 November while the EXPLORER drifted in Fortuna Bay. The EXPLORER was at sea on 20 and 21 November. The first time that the vessel encountered ice, as noted in the Bridge log book, was at 0400, 20 November. The Bridge log entry read "navigating on bergy water" [6] at position 56-50.7 South and 038-50.5 West. The 1800 log entry was "Ice Navigation".[7]



Graphic 1: Route as provided in G.A.P. Shipping Co. Limited Brochure for Spirit of Shackleton Tour. (See section on Company Information)

[4] The Master that assumed command had served on the EXPLORER as Chief Officer but had not served as Master on the vessel.
[5] The Master took the Bridge Log Book and navigational chart for the area the EXPLORER was navigating in when abandoning the vessel. No other supporting documentation or records were taken from the vessel, including the Engine Log Book.
[6] WMO SEA-ICE NOMENCLATURE-Bergy water (Bergy water [fr]): An area of freely navigable water in which ice of land origin is present in concentrations less than 1/10. There may be sea ice present, although the total concentration of all ice shall not exceed 1/10. (4.2.7)
[7] "Ice Navigation" indicated that courses and speeds would be adjusted for the ice conditions encountered.

At 1000 on 21 November, the vessel was at position 57-45.7 South and 040-24.2 West. The Bridge log entry was, "Course acc to Ice Navigation". Course and speed changes were not logged. Each watch logged the distance made good for each four hour watch and the 0800 to 1200 watch indicated the vessel had made 46 miles good. The two preceding watches logged 51 miles each and the next two watches logged 47 and 50 miles. According to a few of the passengers and Expedition Group members, the vessel transited the outlying areas of an ice field but never made any transit deep into an ice field. Other passengers recalled at least one other transit though an ice field.

At 2000 on 22 November, the Safety Officer relieved the Chief Officer (also referred to as the Staff Captain) to stand his regularly assigned 2000 to 2400 watch. The vessel was on a course of 209° true and the 2000 deck lock entry read "Ice Nav". The vessel's speed, according to the Safety Officer, was about 11 knots. The Master had intended for a morning arrival at Base Esperanza on Trinity Peninsula, Antarctica. However, sometime during the evening, the Master realized he could not make the early morning arrival and changed the vessel's destination to Penguin Island, near King George Island.

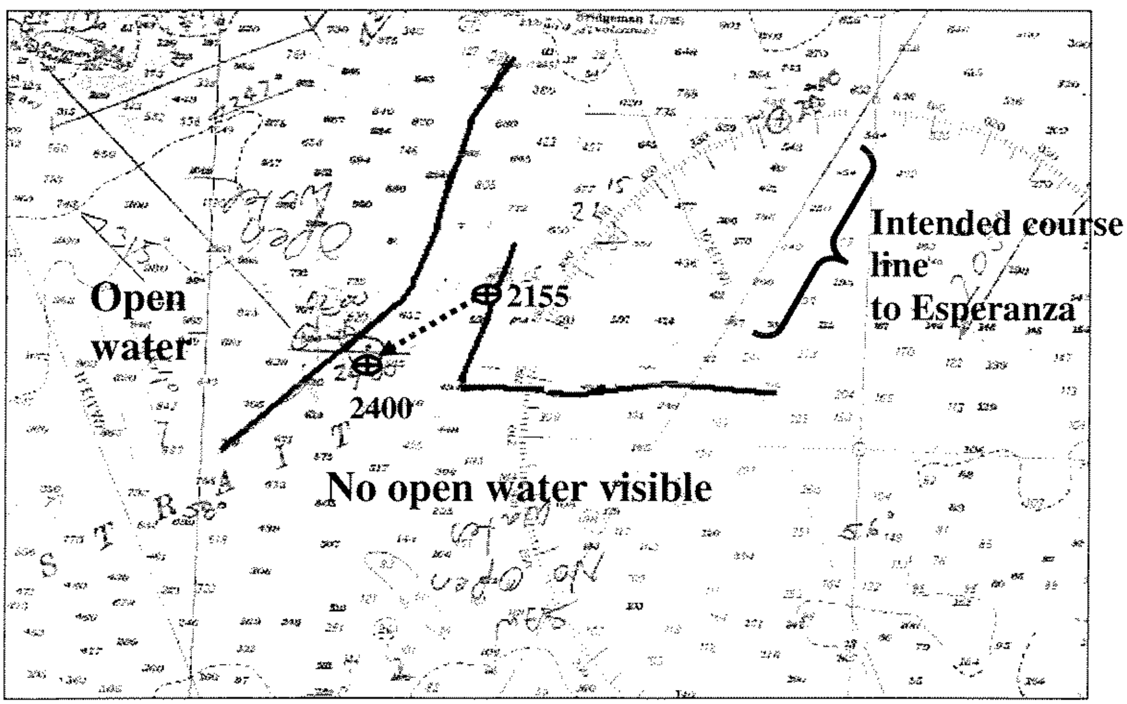


Chart 1: Navigation Chart marked by 2000-2400 Safety Officer.
Navigation track indicated by 2155 ·········➔2400 while EXPLORER was in ice field.

The Safety Officer said that at about 2125 he could see an ice field in the distance but was not certain as to the extent of the ice. He called the Master about 2200 to report the ice field. The Master said that he was already aware of the ice field because he had earlier observed the ice through his cabin window. As the vessel approached the ice field, the sun set at 2146 and searchlights mounted on flying bridge were used to illuminate the ice field.

The Safety Officer stated that he reduced the vessel's speed to about 5 knots and the Master arrived on the Bridge and assumed the conn[8] as the vessel entered the ice field at about 2200. (See Chart 1) The Master described the ice as first year ice, which is ice of not more than one winter's growth, developing from young ice; 30 cm or greater. It may be subdivided into thin first-year ice – sometimes referred to as white ice –, medium first-year ice and thick first-year ice.[9]

The Chief Officer said that he was having difficulty sleeping and had gone out on deck after hearing the sound of ice striking the vessel hull. He estimated the time to be about 2230. He said that there were no icebergs in the immediate vicinity but could see large icebergs on the horizon. He went to the Bridge and said hello to the Master and returned to his cabin to sleep at about 2245.

The Master said that as the vessel proceeded through the ice field he adjusted the vessel's course and speeds to maneuver the vessel through openings in the ice field. He was not certain of the time when he could see open water about 100 to 200 meters away.

The vessel continued through the ice field until, according to the Master, made contact with a section of ice that brought the ship to an immediate stop. The Master said at the post-accident inquiry and to the Investigating Officer that the method he used to break through the ice was to maneuver the vessel astern and ahead and would continue the process until the vessel broke through the ice.

While the Master was maneuvering the vessel as described, he was explaining the procedure to the helmsman and an alarm on the passenger cabin alarm panel sounded on the Bridge. The Master thought a passenger had inadvertently set off the alarm and expressed this to the others on the Bridge. (See section of Passenger Accounts of Events leading to and including the Flooding) The alarm panel light that was illuminated indicated that the alarm had been activated from the 300 level. The alarm lights on the panel indicated the deck that the alarm was activated from and not the specific cabin.

After the alarm sounded on the Bridge, the 0000 to 0400 Able Seaman (AS) was reporting to the Bridge to relieve the watch. The Master saw the AS and sent him to determine the reason the alarm was sounded. Within minutes after leaving the Bridge, the AS called the Bridge and informed the Master that water was flooding into passenger cabin 314.

After receiving the report from the AS, the Master sent the Safety Officer to the 300 level for an additional evaluation of the flooding. He told the Safety Officer to taste

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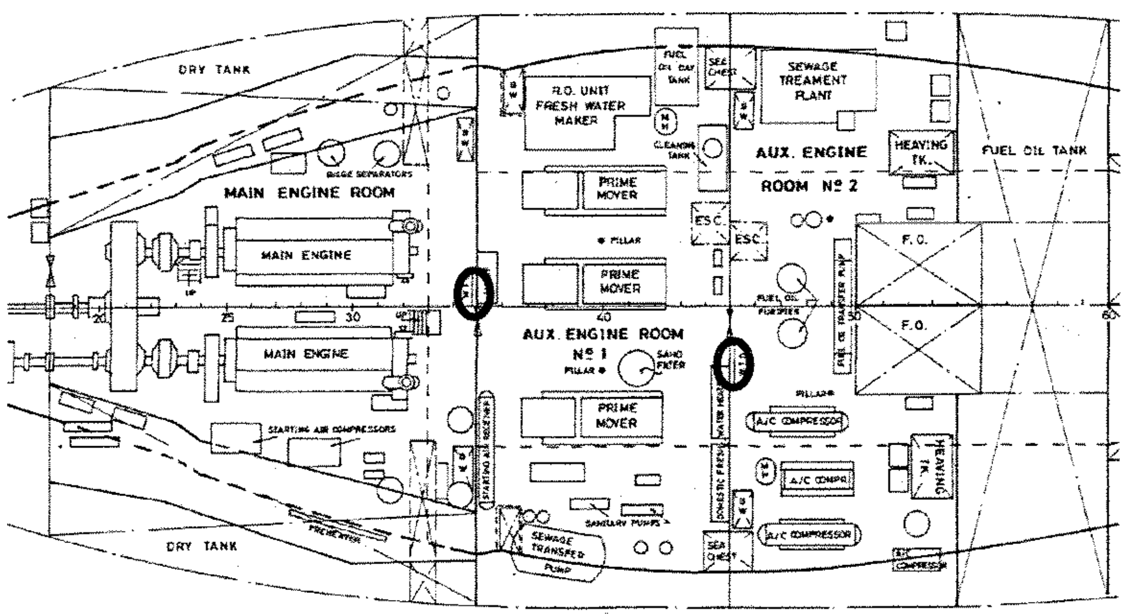
[8] To direct the course and speed of the vessel.
[9] MANUAL OF STANDARD PROCEDURES FOR OBSERVING AND REPORTING I C E CONDITIONS Issuing authority: Assistant Deputy Minister Meteorological Service of Canada Originating authority: Director, Canadian Ice Service Meteorological Service of Canada Revised Ninth Edition, June 2005.

the water to determine if the water was salty or fresh tasting. If the water was fresh tasting, it would have indicated that a fresh water pipe had burst. If the water was salty tasting, the source of water was from the sea. The Safety Officer went to the cabin and after tasting the water, radioed the Master and confirmed that salt water was flooding into one of the cabins. He said that the water level in the cabin was up to his knees.

The Master decided that he wanted to personally assess the situation and went to the area of reported flooding to determine the extent of the flooding. After observing the flooding he knew that the flooding was not from a ruptured pipe but due to damage to the hull. He announced over the Public Address, "Damage Control Team to deck 3; this is not a drill". He decided to also muster the passengers and sounded the general alarm and made an announcement over the Public Address for all passengers to muster in the Penguin Lounge in warm clothing and lifejackets. The passengers that were on the Bridge were sent to the muster station.

In the Engine Control Room, the Second Assistant Engineer was finishing up his regularly assigned 2000 to 2400 watch. While making entries into the Engine log book, he heard a loud bang. He estimated the time to be about 2350. He sent the Oiler to make an inspection round of the Engine Room spaces. The Oiler left the Control Room and when he returned he told the Second Assistant Engineer that water was entering the Separator Room. (See Graphics 2: Engine Room diagram below)



Graphic 2: Engine Room – Machinery Spaces		
Main Engine Room	Auxiliary Engine Room #1 Generator Room	Auxiliary Engine Room #2 Separator Room
O	Watertight Doors between Main Engine Room, Generator Room and Separator Room	

The Second Assistant Engineer said that not long after he sent the Oiler to make the inspection round, the Third Assistant Engineer arrived in the Control Room to relieve the Second Assistant Engineer and stand his regularly assigned 0000 to 0400 watch. While the two engineers discussed the turnover of the watch, the phone rang and the Third Assistant Engineer answered it. The Navigation Officer on the Bridge called to report the flooding in the passenger cabin on the 300 level. Both the Second Assistant Engineer and Third Assistant Engineer could only provide estimated times for the sequence of events.

After the Navigation Officer (0000-0400 watch officer) called the Engine Room and reported the flooding, the Second Assistant Engineer called the Chief Engineer and notified him of the flooding. He estimated the time to be about 0010. The Second Assistant Engineer left the Control Room and went to and banged on the cabin door of two of the fitters to inform them to report to the 300 level to assist with damage control. The Second Assistant Engineer returned to the Control Room and was told by the Oiler that had been assigned to monitor the flooding in the Separator Room that the water level in the room was increasing rapidly.

The Third Assistant Engineer said that not long after he entered the Control Room the phone rang and he answered it. The Navigation Officer was on the phone and reported that a passenger cabin on the 300 level was flooding. He said that the Second Assistant Engineer left the Control Room to assist the damage control team when he heard the alarm sound on the bilge high-level alarm panel indicating the bilges in the Separator Room were filling. The Third Assistant Engineer and Oiler went to the Separator Room and found the watertight door into the Separator Room open. The two crewmembers could see water flowing down into the Separator Room from the overhead. The Third Assistant Engineer told the Oiler to remain in the space and monitor the flooding and he returned to the main Engine Room to start the ejector pump to pump out the bilges.

After starting the pump, the Third Assistant Engineer returned to the Control Room and the Oiler that had been monitoring the Separator Room also returned behind him. The Oiler told the Third Assistant Engineer that the water level in the Separator Room was rising very quickly. The Third Assistant Engineer sent the Oiler back to close the watertight door between the Generator Room and the Separator Room.

Bridge Log Book Entries

As stated earlier, the deck log had been removed from the vessel by the Master. The 2400 entries made on 22 November consisted of the following data as indicated in below table:

Barometer 994 kpa
Wind West at force 6*
Swell ice
Entry Ice Nav
Course Steered Var
Distance made good (for watch) 37 miles
*(entry for direction not clear-interpretation is that it is a W)

The logged 2000, 2200 and 2400 positions were plotted and computed. The distances and Course Made Good (CMG) were as indicated in table below:

Time	Distance Made Good (nautical miles)	Course Made Good (in degrees)
2000 to 2200	23.6	239.4
2200 to 2400	8.1	243.6
2000 to 2400	31.7	240.5

The table below contains Bridge Log entries for 23 November:

0005	Received (passenger)cabin alarm, cabin 312 flooding
0008	C/O confirm ship's has hole in the hull
0012	General emergency alarm
0020	All pax evacuated in Lecture hall
0025	capt contact ashore
0035	Radio Off. Send msgss. To MRCC STN. Distress Call
0100	GPS L- 62 24-5 S' L- 057 16.2 W
0200	GPS L – 62-29.1 S L- 057 16.4W
0215	Power blackout
0235	Abandon Ship GPS L-62 23.6 S; L-057 16.6W [10]

[10] Time is for when the signal for passengers to Abandon Ship was given.

Passenger Accounts of Events Leading To and Including the Flooding

Passenger accounts of the events on the EXPLORER were compiled from telephone interviews, email correspondence and passenger questionnaires. The Investigating Officer provided the questionnaire to more than 30 passengers and received 25 responses. In addition, after passengers had returned to Punta Arenas, Chile, they were provided a questionnaire by representatives of the owner, G.A.P. Shipping Co. Limited. The Investigating Officer was provided responses from 34 passengers. [11]

After the evening dinner, a small group of Expedition Group staff and four passengers went to the Bridge to observe the vessel transit the ice field. The passengers consisted of one female passenger from the United Kingdom (U.K.) who was traveling with her husband and was taking photographs, a female passenger from U.K. taking video, and male passengers from Sweden and Netherlands taking photographs. The passengers provided the photos and video to the Investigating Officer for the investigation.

As the EXPLORER entered the ice field, the passenger taking the video remarked, "the Captain is certainly earning his money tonight." The final remark made by the passenger while the vessel was in the ice field was, "really thick stuff that we are going through now." The video was provided to a former Master/Ice Pilot that had served on the EXPLORER to make an assessment of the transit through the ice. (See section on Ice Pilot's Assessment)

One passenger stated during his interview that he could see red paint on the ice as the vessel passed through the ice field. Another passenger indicated in response to his questionnaire that he could "hear the vessel's speed change repeatedly."

The passenger that was taking photographs said that she went to the Bridge late in the evening. She said it had been "quite bumpy". She had been in her cabin (#213) and felt movement of the vessel that was not what she had experienced during the first part of the trip. The cabin was located on the 200 level on the port side at frame 65. When she went to the Bridge, she saw ice completely around the ship. She was not certain of the time, but said times could be determined from time stamped photos that she had taken. (See Appendix A for passenger photos)

The same passenger said that "she was surprised at the speed at which the vessel was proceeding through the field". She had been on a tour in Greenland through ice and felt the Master on that tour had approached the ice more cautiously. As the vessel proceeded through the ice field, she saw a "long wall of solid ice"[12] ahead of the vessel

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[11] The Investigating Officer recognized that passengers are not trained and have limited or no experience with marine or ice navigation. The statements made by passengers are indicted in quotes and are subjective in nature. However, the passengers were witnesses to the events on the EXPLORER and their perspectives could not be omitted or ignored. One passenger was a Naval Architect and another passenger was a former marine engineer with 10 years seagoing experience.

[12] The passenger that described the "long wall of solid ice"also referred to it as, "a wall of ice", "a wall" and a "ridge". She took a photo as the vessel approached the "wall of ice" and referred to it as a "ridge".

and said "she couldn't see the ship going through it". She went to her cabin to tell her husband what she had observed and told him that he should come to the Bridge and watch. She said her husband expressed confidence in the Master's ability and he remained in the cabin. The female passenger returned to the Bridge and estimated she was gone for only about 4 to 5 minutes. After returning to the Bridge she saw that the "wall of ice" was closer and vessel was about to make contact with it. She was not certain if she took a photo at this time, but decided to "hold on to a pole". She felt two large bangs or bumps and said the EXPLORER came to a complete stop. She took her final photo from the Bridge after the vessel came to the stop.

She said that the Master did not appear concerned as he explained to the helmsman that the procedure for getting through the thick patch was to alternate between full ahead and full astern and continue until the ice is broken and the vessel can proceed. She said an alarm sounded on the Bridge while the Master was explaining the procedure.

The husband of the passenger taking the photographs stated that he decided to turn in to his bunk and estimated that sometime after 2300 he felt a bang and was almost thrown out of his bunk. He said that the bang was followed by a second but not as large bang. He estimated that about 15 minutes after the second bang, his wife returned to the cabin and tried to convince him to come to the Bridge and watch the transit through an approaching "long wall of ice". He responded that he felt that the Master knew what he was doing and decided to remain in his bunk.

The female passenger from cabin 213 said that after the passenger alarm sounded a crewmember was sent to investigate the alarm. The passenger said that the initial reaction she heard expressed by one of the crewmembers on the Bridge was that a passenger must have inadvertently set off the alarm and there was no great concern at first. She could not identify which crew member made the comment. She heard the Master send a crewmember to investigate but wasn't certain which crewmember was responding to the alarm. The Bridge phone rang and the Master answered it. The passenger heard the Master say he wanted to take a look for himself. When the Master returned to the bridge he said "Oh (expletive deleted)... This is serious." The passenger said that the Master sounded the alarm to muster the crew and then decided to muster the passengers. She could not provide the time that the Master sounded the alarm for the passengers to muster.

A couple from Canada was in their cabin (#101) on the port side. The female passenger said that sometime after 2300 the vessel experienced a very hard bump. She had been writing in her journal and was preparing to go to bed when at about 2330, while in the bathroom brushing her teeth, was thrown against the sink by "one really big and loud jolt." She looked out the porthole and was "amazed by the ice, including the height of the ice" that the vessel was transiting through. She said she had never seen ice as high as the ice the EXPLORER was passing at the time. She said that after seeing the ice she turned in for the evening and shortly after the passenger alarm sounded for the passengers

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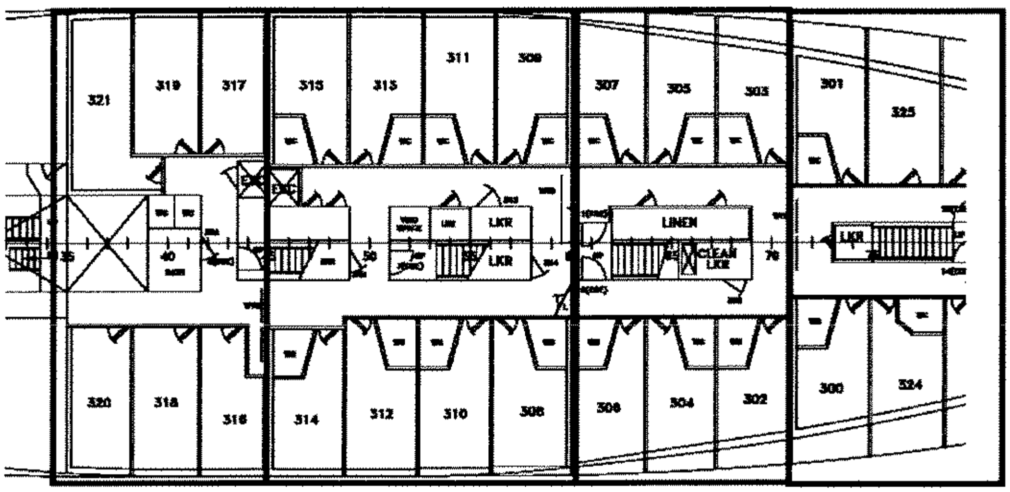
See Appendix A – bottom photo. The term used should not be considered the same as the definition of "ice wall" in the Appendix; Ice Terminology.

to report to the muster station. She said that there were only two times she looked at her watch during the emergency and this was the first time. According to her watch, the time the alarm was sounded was 0013.

A male passenger from the United States was lying in the lower bunk in cabin 314. He said that the lower bunk was below the water line and the upper bunk was above the waterline. (See Graphic 3) The passenger stated that the ship had been through ice earlier in the voyage and described the sound similar to a scraping noise. He said the passengers were informed that the EXPLORER would be transiting an ice field during the night. He said crewmembers and Expedition Group members were telling jokes and forewarned passengers about the loud noise the vessel would make when transiting through ice. He decided to wear headphones to muffle the sound.



Graphic 3: Cabins on 300 Level. The vessel bow is to the right of the page and stern is to the left of page. Port side is to top of graphic (odd numbered cabins) ; Starboard side is on bottom (even numbered cabins) Cabin 314 is where crewmember reported feeling "fist sized hole". The four compartments are indicated in the rectangles.

As the passenger lay in his bunk, his fingers were extending into a narrow gap between his bunk and bulkhead panel.[13] He felt an impact and the panel of the cabin pinched his fingers between panel and bunk. He became alarmed when he could not immediately pull his fingers loose. After a few moments, the pressure eased so that could pull his fingers free. The next sound he heard was what he thought was the sound of running water. At first he was not certain of what he was hearing and continued to lay in the bunk. It was not until the passenger in the upper bunk called his name and asked him if he also heard water running that he reached towards the deck and found that there was about "one foot" of water in the cabin. He tried to turn on his bunk reading light but

[13] The EXPLORER owner, G.A.P. Shipping Co. Limited, disputed that there was a gap between the bunk and paneling and questioned whether the passenger was referring to a gap between the mattress and paneling. The passenger that recounted the events told the Investigating Officer that there "absolutely" was a gap of about ¾ inches between bunk frame and paneling.

found it was wet and would not illuminate and then felt water running down the bulkhead paneling. Both he and the passenger in the upper bunk reached for the alarm button and pushed the passenger alarm button that was mounted within reach of the bunks. The passenger estimated the time that he pushed the button to be about midnight and that the sequence of events occurred very quickly. The passenger from the United States said the cabin began flooding very quickly and he wanted to move his camera equipment that was stowed in the second and third drawer of a dresser that was located between the bunks. However, the drawers were already flooded within moments of his pushing the alarm button and he realized the equipment was already destroyed by the water.

From the time he pushed the call button to the time he heard the alarm, he estimated that about 40 and 60 seconds had passed. The passenger went out into the passageway and he did not see anyone. Water was about one foot outside the doorway and was "pooling" in the passageway. Shortly after, the passenger from cabin 312 came out of his cabin and he saw crewmembers begin to arrive in the passageway. He said one crewmember tasted the water and said it was "salty". The passenger from the United States returned to his cabin to try and retrieve his boots but the water level was up to his knees and he could not locate the boots.

The third passenger in cabin 314 (from Peoples Republic of China) was in a single bunk on the forward end of the cabin. According to the passenger from the United States, the Chinese passenger told him later that he had been watching a movie on his laptop with the laptop set on the dresser that was beneath the port hole and between the double and single bunk. Based on the time indicated on his laptop, at 2330 the passenger heard a loud scraping noise along the hull and thought the porthole may be "smashed". He moved his laptop because he was concerned that if the porthole was damaged, it could result in damage to his laptop. When the passenger heard water flooding he tried to turn on his bunk reading light but found it wet and would not illuminate. He had closest access to the cabin overhead light and turned it on and the passengers saw water flooding into the cabin.

A couple from the United States was asleep in cabin 310 when the husband said he was awakened by "what sounded like the gang plank slapping against the hull." He then heard what he described as "the sound of gurguling water in the wall behind my head." He reached down and felt the carpet was damp and went from what he described as being "half asleep" to full awake". He said he immediately pushed the emergency button. The couple dressed and after putting on clothes the husband moved his "suitcase and laptop to the top of the bed to be away from the water." The passenger went out to the passageway where he saw a crewmember that he described as heavy set in his forties that he thought was the vessel Master.

A 70 year old male from Australia was traveling with his nephew and was asleep in his cabin (312) at about midnight. He was not sure what woke him at the time but he next heard his nephew say that he could hear water running. The nephew jumped from his bunk to the floor and said there was water on the floor. The nephew activated the passenger alarm and then left the cabin to go for assistance. The uncle heard activity outside in the passageway and saw the Master and another ship's officer come down. He said that the Master told him that the source of the water was seawater and not from an internal leak. He dressed with warm clothing but did not have time to locate socks and foot wear and went to the muster station without any shoes on.

Emergency Response and Damage Control Efforts

As the crew responded to the alarm and passengers reported to the muster station, the Master ordered the Radio Officer to transmit a distress message on the Inmarsat C-unit. The Radio Officer also contacted another vessel known to be traveling in the Antarctic region, the NATIONAL GEOGRAPHIC ENDEAVOUR, to report the emergency and request assistance. The Master of the EXPLORER knew the general location of two other passenger vessels, the NORDNORGE and ENDEAVOUR. The Master of the EXPLORER contacted the Master of the ENDEAVOUR using an Iridium satellite phone and confirmed that he was in distress and requested that the ENDEAVOUR make best speed to the EXPLORER's position to assist.

According to Maritime Rescue Coordination Centre (MRCC) Chile, the Global Maritime Distress and Safety System (GMDSS) alarm was activated at 0035 on 23 November. MRCC Chile ordered the activation of (MRCC) Punta Arenas and Maritime Rescue Sub Center (MRSC) Antarctica on distress phase at 0039 hours. By 0140 MRCC Chile had established telephone communication with the EXPLORER.

One of the Zodiac drivers was called to the Bridge to assist with the emergency communications. He spoke Spanish and made calls to the Argentine and Chilean rescue centers. He said after a number of calls to the Argentine MRCC, he was unsuccessful in communicating the seriousness of the emergency. Each time he called he provided details of the vessel and the emergency. He was told to call back and each time he did, he had to repeat the previously provided information.

The Master of the NORDNORGE said that he was called by the Master of the ENDEAVOUR and received details of the emergency on the EXPLORER. The ENDEAVOUR was 12 to 14 miles ahead of the NORDNORGE and had encountered ice fields as it proceeded towards the EXPLORER's position. The ENDEAVOUR provided the location of the ice fields to the NORDNORGE so that the NORDNORGE could maneuver through the ice fields by following the best route taken by the ENDEAVOUR.

The Master of the NORDNORGE said that he had been in contact with the Chile MRCC and they appointed him as "On Scene Commander." After the call with the Chile MRCC, the Argentine MRCC contacted him and told him to "follow their instructions, as they claimed to have jurisdiction over the area." The Master decided to work with Chile MRCC, but requested the ENDEAVOUR remain in contact with the Argentine MRCC.[14]

The Damage Control Team arrived on the 300 level bringing submersible pumps and tools. A rating from the engine department (8-12 Oiler) and ship carpenter arrived at cabin 314 and saw the passengers gathering up their gear. The passenger from cabin 314

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[14] http://www.gard.no/gard/Publications/GardNews/RecentIssues/gn190/art_2.htm M/V NORDNORGE – Antarctic rescue of M/V EXPLORER by Captain Arnvid Hansen, Master of M/V NORDNORGE

stated that as crewmembers appeared in the passageway, other passengers from the adjacent cabins were also leaving their cabins reporting that their cabins were also flooding. The crewmembers told the passengers to don warm clothes and lifejackets and to proceed to the Penguin Lounge (muster station).

The Chief Officer said that he was called by the Navigation Officer between 2340 and 2345 and informed that there was water in the passenger cabins on the 300 level and that he was to proceed to the level. The Chief Officer got dressed and went down the main staircase into the 300 level. The vessel was listing five to six degrees to starboard at this time. He saw an Able Seaman and motorman (engine rating) in one of the flooding cabins. A portable pump was being prepared to begin pumping out the water in cabin 314. The Chief Officer inspected all four cabins on the starboard side and saw water in all of the cabins (308, 310, 312 and 314). He believed that the majority of the water was coming from the aft most cabin (314). He called the Master by radio and informed him what he found. According to the Master, the Chief Officer told him that he could hear water swishing in the space between the decorative cabin panels and side shell of vessel.

After verifying that the four cabins were flooding, the Chief Officer went to the passenger spaces forward and aft of the flooded space and found the spaces dry and not flooding. He reported his findings to the Master and went to an area of the ship referred to as China Town where crew member cabins were located. (See Graphic 3: Cabins 317 through 321) He reported that there was no flooding in any of the other spaces. He returned to the flooding area to direct damage control efforts.

The Chief Engineer had been asleep in his bunk, but was aware that the vessel was in an ice field because of the noise that would occasionally awaken him. At about 2345, he heard it reported over his VHF hand-held radio (which he had inadvertently left on and in the charger) that there was water on the 300 level. Within moments of hearing the radio message, the Second Engineer called the Chief Engineer and reported the water in the 300 level. As the Chief Engineer was leaving his cabin, he heard the general alarm and first announcement notifying the Damage Control team to report to the 300 level due to flooding in one passenger cabin. Shortly after, he heard the second announcement telling all passengers to muster in the lecture hall.

After the Chief Engineer had left his cabin, he went to the 300 level to determine the extent of the flooding. After observing the damage control efforts, he went to the Engine Control Room and then to the Bridge. From the Bridge he returned to the 300 level and saw two submersible pumps were operating and saw that the water level in the cabin was decreasing.

The Third Assistant Engineer had just arrived in the Control Room to assume the watch and estimated that about 0010, the Bridge called the Engine Control Room informing the watch engineers that there was flooding in passenger cabins on the 300 level. The Second Assistant Engineer left the Engine Room and went to the 300 level while the Third Assistant Engineer decided to go to the Separator Room. Before the Third Assistant Engineer left the Control Room, the bilge level high-level alarm sounded.

The Third Assistant Engineer went to the Separator Room and saw water on the deck and water draining into the room from the deck above. He went back to the Control Room and told the Oiler to go to the Separator Room and keep watch on the water level in the space. The Chief Engineer arrived in the Control Room and the Third Assistant Engineer told the Chief Engineer about the water entering the Separator Room. The Chief Engineer told the Third Assistant Engineer to watch the water level. Not long after, the Oiler returned to the Control Room and told the Third Assistant Engineer that the water level was rising very quickly in the Separator Room. The Third Assistant Engineer ordered the Oiler to close the watertight door between the Generator Room and Separator Room.

The First Assistant Engineer was asleep in his bunk when the initial alarm sounded. While going to the Engine Control Room, he looked into the 300 level where the Damage Control team was working to control the flooding. He continued on to the Engine Room and conducted an inspection of all the engine spaces. Water was entering the Separator Room through the "flaps" (down flooding ducts) on the starboard side. He left the Separator Room and told one of the Oilers to monitor the water level. The First Assistant Engineer said he started the main fire pump and ejector pump located in the Main Engine Room to pump the water in the Separator Room directly over the side. Within 20 to 30 minutes, the Oiler reported that water was pouring into the space and there was about one half meter of water on the starboard side of the Separator Room. The First Assistant Engineer said that he closed the watertight door between Generator Room and Separator Room and went to the cabins that were flooding to assist removing the overheads and bulkhead paneling.

The two crewmembers working in cabin 314 could not locate the source of the flooding because of the decorative paneling of the cabin which covered the side plating of the vessel. There was an inspection access panel beneath the bunk bed that the men removed to determine the location of the damage. When they still could not locate the source of the flooding, they decided to remove the bunk bed which they realized would have to be removed to also remove the bulkhead paneling. Both men said that the water level was higher along the bulkhead indicating that the vessel had begun to list. To remove the bunk bed, the Oiler had to use a ratchet wrench with extension to loosen the bolts that held the bunk in place. The bolts were submerged by the cold seawater making it difficult for the crewmen to reach into the water and feel for the head of the bolts. He said that at one point his hands had become numb from working in the cold water and was not certain if he was succeeding in removing the bolts. However, after successfully removing the bolts and moving the bunk away from the bulkhead panel, the two men used a fire axe and tore out a 60 cm wide by 80 cm high section of panel.

The source of the flooding was still not visible so the Oiler reached into the hole in the paneling and felt around to try and locate the flooding. He was worried about sharp edges and because his hands were cold and numb, was not certain if his sensation of feeling could be relied on. At one point, he felt incoming water pressure from a hole he estimated to be about the size of a fist. He provided his findings to the Chief Officer who then reported this finding of the "fist sized hole" to the Master on the Bridge.

The two crewmembers in the cabin jammed pillows down into the space and inserted a sheet of plywood over the pillows. A long bar was situated in such a way that it applied pressure to the plywood which applied pressure to the pillows over the hole. Although the two crewmembers thought that they had stopped the flow of water from the incoming "fist sized hole", they believed that water was entering the vessel from additional areas adjacent to the hole because water continued to rush into the cabin.

While the two crewmembers were attempting to locate the source and stop the flooding, other crewmembers had rigged up portable pumps in the space and routed hoses overboard. After the first hour most of the crew believed they had the flooding under control because the water level in the cabins had decreased. The Chief Mate believed the flooding was under control and reported his findings to the Master. The Master was encouraged by the news and went to the muster lounge and informed the passengers. The Master's briefing of passengers was recorded by the passenger taking the video.

Within the first hour of arriving in the Engine Room, the Third Assistant Engineer saw smoke in the Control Room and could smell what he described as a "burned rubber smell". He called the Chief Engineer who was on the Bridge at the time and reported the smoke. The Chief Engineer returned to the Control Room while the Third Assistant Engineer went to determine the source of the smoke. The Third Assistant Engineer found that the smoke and smell was coming from the air conditioning air duct and believed that a belt to the air conditioning compressor was the source. He went to the air conditioning room on the Bridge deck and secured (shut off) the air conditioning system. He returned to the Control Room and the Oiler that had been watching the water level in the Generator Room returned to the Control Room and informed the Third Assistant Engineer that water was leaking into the Generator Room through the watertight door from the Separator Room. The Third Assistant Engineer went to the Generator Room and saw water streaming in around the door seals up to the top of the door.

While the Damage Control team was working in the cabins, the Master ordered the Bosun to launch one of the Zodiacs so that an external inspection of the hull damage could be made. The Bosun worked with members of the Expedition Group with a plan to place a tarp to cover the damaged area. However, the damage was not visible and the tarp could not be pulled in snug against the vessel to cover the damage. After the unsuccessful attempts to cover the damage, the Zodiac was re-stowed on board the vessel. The vessel's list had reached an angle that made visual inspection of the damage not possible. One of the Expedition Group members that was assisting on the Bridge and in contact with MRCC believed that the Master was also trying to bring the vessel to a course to put the wind on the starboard side to push the vessel to a port list, but was not successful.

The Master said that he considered reversing the list to the port side in an attempt to expose the damage above the waterline, but he did not have the time to attempt to reverse the list. The Chief Engineer was asked if any attempt was made to reverse the list to the port side by ballasting or de-ballasting. The Chief Engineer did not consider using the ballast tanks to correct the list because the tanks were too small and would have had minimal effect on the list. He also said there was no crossover between the ballast and fuel systems to fill any of the fuel tanks. The Chief Engineer suspected that Deep tank # 19B, an empty fuel tank, may have also suffered damage and was flooding. He said that he did not have time to confirm this by sounding the tank. The tank was located on the starboard side beneath the flooding cabins.

The Chief Engineer said that he had been going from the Engine Room to the Bridge to the 300 level and at one point returned to the Control Room. He said that he lost track of time and the actual sequence of events. After he was told by the Third Assistant Engineer that the Separator Room was flooding he went to the Generator Room and saw that water was seeping through the bottom corner of the watertight door at a height of about 20 cm. The Chief Engineer had suspected, and now had confirmed, that the water in the 300 level was draining down into the Separator Room through a safety device that the crew referred to as the scupper valves, but what the Trim and Stability Booklet referred to as down flooding ducts. (See General Arrangement of Vessel- Down-Flooding Ducts)

The Chief Engineer returned to the 300 level and looked into the escape trunk that provided access by vertical ladder into the Separator Room. He estimated that the water level was above the first three rungs of the ladder and was rising quickly. He had one of the pumps moved from the cabin to the escape trunk of the Separator Room to attempt to discharge the water. The Chief Engineer recognized that if the Separator Room water level continued to rise, the electrical control panel (breaker panel) in the room would short out and there would no longer be any power to the fuel transfer pumps located in the Separator Room. Once there was no power to the fuel transfer pumps, the source of fuel to two separate gravity tanks would stop. One gravity tank provided fuel to the generators and the second provided fuel to the main engines. Once the fuel supply to the gravity tanks stopped, there would have only been enough fuel in one tank to operate the generators for about 15 to 20 minutes and to the main engines for about 30 minutes. Without the generators, there would be no electrical power for any of the vessel's systems including the main engine cooling system and the engines would have to be shut down.

The Chief Engineer devised a plan for providing fuel to the generators and decided to assemble the engine crew to implement his plan. He believed that the easiest way to provide fuel to the generators was from the #1 and #2 fuel tanks located aft. Access to the tanks was through manhole plates that were located in the steering gear room. The manholes were opened and an air driven barrel pump was rigged up and pumped fuel to the gravity tanks through portable hoses. The First Assistant Engineer estimated that the engine crew began the process to provide fuel at about 1 hour 35 minutes from the time the initial alarm sounded.

Before the engine crew had time to rig up the equipment to transfer the fuel, the fuel in the gravity feed tank for the generators was completely consumed. The Chief Engineer had the Third Engineer shut down the main engine before the fuel to the generators shut down. After the generators shut down, the vessel blacked out.

During the blackout, the Master called the Chief Engineer using a hand-held radio and told the Chief that it was critical to get the generators on line and restore electrical power so the bow thruster could be energized. An iceberg was approaching the vessel and the Master wanted power to the bow thruster to maneuver the EXPLORER into the seas to launch the lifeboats. The Master stated that the blackout occurred at 0215 and by 0235, as the vessel was drifting back to the ice field, he decided to abandon the vessel as a precautionary measure. He did not want to wait until the vessel could be surrounded by ice, which would have made launching of lifeboats dangerous or not possible.

During the black out, with emergency lighting provided by the emergency generator, the engine crew continued to work to transfer fuel to the gravity tanks to restore the generators. The gravity tank to the Generators had an overflow/recirculating line on the top of the tank that was located above the Separator Room. The First Assistant Engineer and Oiler removed the overflow line by cutting the line because the securing bolts were wasted and could not be removed. Using a portable hose, the hose was alternated between the two feed tanks so that the tanks could be replenished. Once fuel was replenished in the gravity feed tank for the generators, the engineers could re-start the Generators.

The Third Assistant Engineer was responsible for the generators and started generator #2 (along the centerline of the vessel). It took him about 20 minutes to start the generator because he had to bleed air that was in the fuel line. He started generator #2 followed by #1. The main engine was re-started and generator #3 was started, which provided enough power to start the bow thruster. The Third Assistant Engineer resumed the pumping of the Engine Room bilges by re-starting the fire and ejector pumps.

After the generators were energized, the passengers abandoned the vessel in the lifeboats. The Master was still convinced that the vessel was not going to sink and believed once the responding vessels arrived with additional pumps, they would be able to pump out the water. However, water was entering the Generator Room from the leaking watertight door into the Separator Room. The First Assistant Engineer attempted to close the bilge suction to the Separator Room in order to increase the discharge from the starboard side of the Generator Room. However, he realized that the line remained open to the Separator Room because the electrical motor that operated the suction valve was in the Separator Room and would have shorted out once submerged. With the line remaining open to the Separator Room, he could not achieve the necessary suction to pump from the Generator Room and the water level continued to rise in the room.

With water beginning to flow into the Generator Room from the overhead down flooding ducts, the Chief Engineer went to the passenger and crew quarters above the Generator Room (levels 200 and Boat Deck) to determine where the water was coming from. He found water was overflowing into the cabins from the toilets and flooding the entire area. At this point, the Third Assistant said the water level in the Generator Room had reached the foundation of generator #3 and the Chief Engineer ordered the generator to be secured (shut down).

The Chief Engineer realized that the flooding could not be contained or stopped and went to Bridge and told Master that the vessel could not be saved. The Master called all engine personnel to the Bridge and conducted a head count. The personnel that had been in the Engine Room went to the Bridge and did not shut down the engines nor secure the two operating generators (#1 and #2) They also did not close the two remaining watertight doors between the Generator Room and Main Engine Room and from the Main Engine Room into the Shaft Alley. The engine crew abandoned the EXPLORER into the Zodiacs after the Master was satisfied that all of the engine crew was accounted for.

After the engine crew had departed the vessel, the Master and Expedition Group leader remained on the Bridge planning to stay on board until the rescue ships arrived. Not long after the engine crew had abandoned the vessel, the Controllable Pitch Propeller went full astern and the vessel gained sternway reaching a speed of about 8 knots. The Master said that he activated the emergency stop switch in the wheelhouse but it did not shut down the power to the main engines or generators. He contacted the Chief Engineer by radio to have the engine crew return but it would have been too dangerous to attempt to re-board the vessel. At this point, the Master and Expedition Group leader decided to abandon the vessel. With the EXPLORER moving astern and listing over 20 degrees to starboard, a Zodiac maneuvered alongside the forecastle deck[15] (see Photo 2) where the Master and Expedition Group leader boarded the Zodiac.

Mustering of Passengers and Abandoning Ship

Pre-Departure Emergency Briefing

According to the EXPLORER log entry for November 11th, a "Crew and Pax Drill" was held at 1855. There were no additional remarks regarding the drill. The next entry is at 1925 reading, "All W.T.D. Closed".[16]

The Expedition Group leader and the vessel Safety Officer provided the Emergency Briefing before the EXPLORER departed Ushuaia. Passengers were told that in the event the general alarm bells sounded, they were to don warm clothing and lifejacket and to proceed to the muster station (Penguin Lounge). Passengers were assigned to lifeboats while at the muster station. The assembled passengers were divided into four sections, and then each section was instructed to follow the Expedition Group member assigned to the division. [17] A few passengers responded in the questionnaire that they were not certain if the lifeboat assigned at the pre-departure muster was the same lifeboat that they should use in an emergency. A few passengers were not certain but thought there may have been a lifeboat assignment card in the cabins.

[15] International Maritime Dictionary- 2nd Edition by Rene de Kerchove, Copyright 1961 by D. Van Nostrand Company Inc. Forecastle deck is the term applied for the deck from the stem of the vessel over the forecastle (a short superstructure or erection situated over the bow.
[16] W.T.D. is an acronym for Watertight Doors.
[17] The Expedition Group members did not have assigned duties in the Emergency Station Muster List.

Emergency Muster of Passengers

The Hotel Manager was in his bunk when, at some point, he felt a hard bump that he described as larger than normal. He estimated that less than one hour passed from the time he heard the pump until the alarm sounded. He heard the Master instruct the passengers over the Public Address to muster in the Penguin Lounge (passenger's muster station) with lifejacket and warm clothing. The Hotel Manager went to his assigned station at the muster area and took count of all passengers. His additional responsibility was to have assigned crew verify and report back that all the watertight doors in the passenger decks were closed. He said that within five minutes he had confirmation that all the doors were properly closed. After the passengers were mustered, the Hotel Manager was instructed to report to the damaged area to assist as needed. At this point, the care of passengers was taken over by the Expedition staff that had mustered with the passengers.

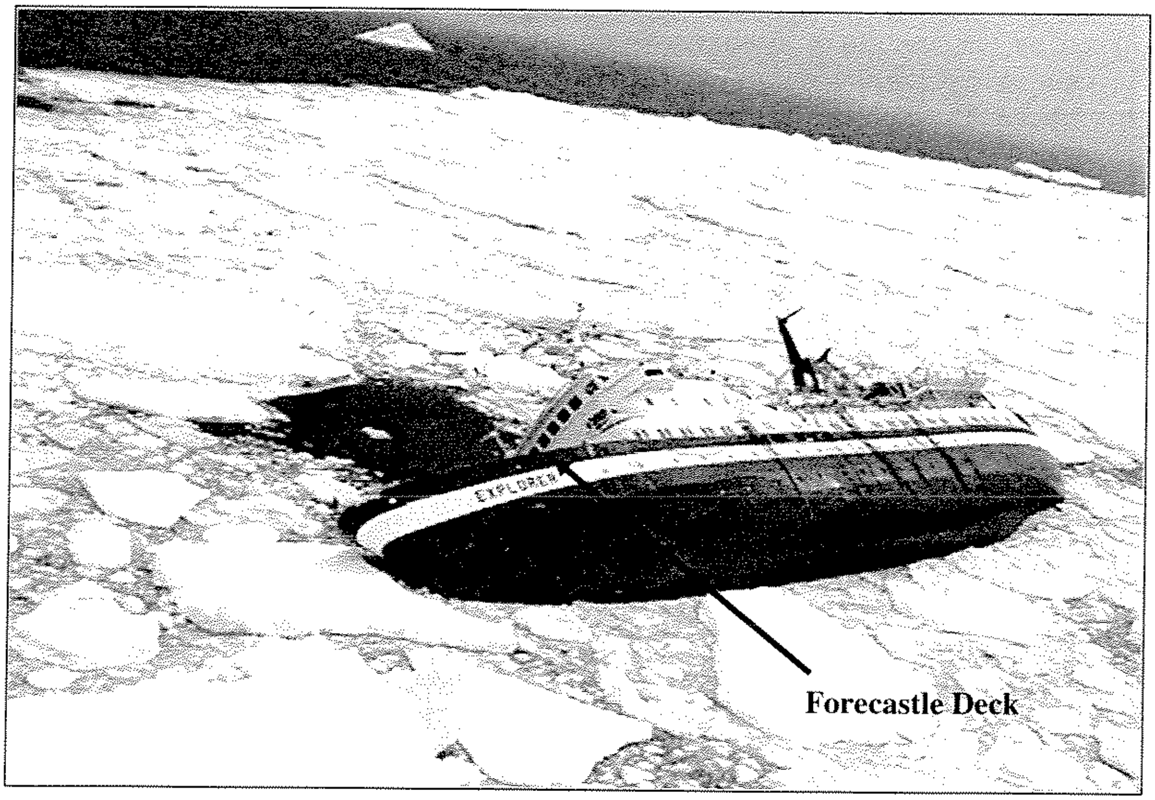

Photo 2: EXPLORER after all passengers and crew had been evacuated from vessel. Note black streak above keel - See section – Sewage Holding Tanks.

One passenger stated in her questionnaire that once the alarm sounded, she "was beyond terrified". She did not remember to put on her coat and went to the muster station without a warm coat. She asked one of the Expedition group members if she could return to her cabin to retrieve her coat and he reluctantly allowed her to return.

While the passengers waited in the Penguin Lounge, mustered in warm clothing and lifejackets, some requested to take toilet and cigarette breaks. Others asked to go out onto the aft deck to cool down from wearing the heavy gear. The Expedition Group that was with the passengers developed an escort system so that the passenger issues could be dealt with in a controlled manner.

Passengers confirmed that the Master went to the Penguin Lounge to assure the passengers that everything possible was being done for their safety. The passenger with the video-camera taped the Master's talk to the passengers. When he arrived in the lounge, one of the Expedition group members was telling a joke to the passengers. The Master told the passengers that it appeared that the flooding was under control because the level was going down. The passengers were informed by the Master and Expedition Group members while they were mustered that rescue vessels had been notified and that the nearest vessel was six hours away.

While the Expedition staff was controlling the passengers and allowing trips to the toilet, the Expedition Group leader returned and announced that the Master would allow a controlled return of passengers to cabins on the Boat Deck and 200 level to collect personal belongings. The Boat Deck was on the same level as the Penguin Lounge and none of the cabins on this level were flooding. According to passengers interviewed, the Master expected to have passengers transferred to the arriving vessels and once the situation could be stabilized, the luggage would be transferred. Passengers overheard the radio discussion between Master and Expedition Group members and many of them began to leave the lounge. One member of the Expedition group referred to the passengers exiting the lounge as an "uncontrolled rush". Other Expedition group members attempted to stop the passengers once they realized that passengers from the lower deck (300 level) were also attempting to return to their cabins. One passenger said he heard the Master on a radio shouting that passengers are going to the lower levels and must return to the muster station.

Passengers that were in their cabins packing gear said that while packing, the cabins lost lighting. All of the passengers that were in the cabins returned to the Penguin Lounge. The Emergency Generator started and emergency lighting was energized in the passageway. Some of the passengers believed the reason the cabins lost lighting was because the vessel lost power. Other passengers said that they learned after returning to the Penguin Lounge that the vessel lost power which explained why the cabins lost lighting. Not long after the passengers returned to the lounge, the Master announced that the passengers would be abandoning the ship. The deck officers and crew were directed to the lifeboats to abandon the ship with the passengers.

Passenger interviews and responses to questionnaire indicated that they were not provided any additional preparation for the abandonment of the vessel, including reminders of lifeboat assignments and the emergency gear stowed in the boat lockers. The passenger from cabin 314 said that while at the muster station, Expedition Group were telling jokes to keep the passengers calm. He said he felt the situation was more serious than they were being told and did not appreciate the jokes.

Abandoning the EXPLORER

At about 0215, after the vessel lost electrical power and power was no longer available to operate the submersible pumps, the deck crewmembers were called to assist with preparing the lifeboats for launching. The engine crew had already been called away to assist with the rigging of equipment to ensure an alternative continued supply of fuel for the generators. Without the main engines and no electrical power the Master could not maneuver the vessel. He called the Chief Engineer and told him it was vital to have power restored for the bow thruster. He saw that the vessel was drifting back towards the ice field and also saw an iceberg drifting towards the vessel. (See Photo 3) The lifeboats[18] on the starboard side had to be hoisted above the embarkation deck to avoid having the iceberg strike and possibly damage the lifeboats. The Master decided at 0235 to abandon the passengers and sounded the alarm. He made an announcement over the PA. The vessel was listing to starboard about 15 to 18 degrees and the Master stated that having the passengers abandon the vessel at the time was a precautionary measure.

Photo 3: Provided to Administration by a passenger.

After the announcement was made for the passengers to abandon ship, the passengers that were either on the open deck, in the Penguin Lounge or on the port side of the vessel smoking, were not mustered for another accountability check. One passenger said that there was an attempt to conduct a roll call, but was stopped. The passenger said that as passengers left the lounge, one of the Expedition Group members began directing passengers toward the starboard lifeboats. At one point a passenger

[18] The EXPLORER had four open lifeboats. See Section on Emergency Equipment.

heard the Expedition Group member say that that it looked like half of the passengers had been directed to the starboard side and he began directing the remaining half of passengers to the lifeboats on the port side. He said many of the passengers were confused and asking others trying to find out what lifeboat to go to.

As the passengers were being directed to the lifeboats, some passengers followed Expedition Group members and others headed to what they thought were their pre-assigned lifeboat. The Master, by Public Address, was urging to have the life boats loaded and lowered because of the approaching ice. One member of the Expedition Group stated that it was the Master's decision to have the lifeboats on the starboard side filled first. While passengers boarded the lifeboats, the engine crew worked to re-start the vessel generators and main engines. The passenger that had returned earlier to her cabin to retrieve her jacket said she did not know her assigned lifeboat. Her cabin stewardess saw her and asked her what lifeboat she was assigned to. When she said she didn't know, the stewardess told her to board lifeboat #3 (starboard side aft).

One of the passengers from the Netherlands, (in response to the questionnaire) said that he did not know which lifeboat to go to and asked a number of the other passengers from the Netherlands. None of these passengers knew their assigned lifeboat. The passenger said that some of the passengers went to the first boat they "reached, so there was the situation that some people had to go from lifeboat to lifeboat to search for a place….."

The passenger from the United States (from cabin 314) said that he was directed to the lifeboats on the port side and stood on deck while two crewmembers in lifeboat # 2 (port side forward) were attempting to start the engine. The Master came out on the Bridge wing on a few occasions and after about twenty minutes, began yelling to get the boat loaded and launched without any more delay.

Passengers waited to board lifeboat # 1 and two passengers described the scene in the boat as "chaotic" with the Philippine deck gang "yelling" at each other while the Chief Officer and a crewmember were trying to start the lifeboat engine. According to the same passengers, the Chief Officer shouted commands at the crew and restored order. He returned his attention to starting the lifeboat engine and was successful in starting the engine.

The crew attempted to start the engine in lifeboat # 3 until the Master ordered the boat loaded and lowered. Lifeboat #3 was lowered before lifeboat #1 and once in the water, the crew had difficulty pushing away from the EXPLORER. Lifeboat #1 was directly overhead with its engine operating and a number of passengers in lifeboat #3 became concerned that lifeboat #1 would be lowered onto their boat. There was some shouting and some passengers felt that panic was beginning to set in until the lifeboat drifted away from the EXPLORER. While trying to push off the EXPLORER, one of the oars broke.

Lifeboat # 2 (on the forward port side) was lowered and due to the starboard list, slid along the hull causing the boat to tip outboard. A number of passengers said that as the boat tipped, they were afraid that they were going to be thrown into the water. After the boat was waterborne, the crewmembers attempted to use the oars to push the boat away from the vessel. The crew used what a passenger described as a pole "with a metal thing" on the end. He later learned that the device was used to alert other vessels by providing a radar target. He was describing what, in all likelihood, was the radar reflector. He said the device was smashed while being used to push off the vessel.

A couple from Canada that was in lifeboat # 3 said the lifeboat was so full of passengers that "you could literally not move your feet." They recalled that three or four passengers had to stand because there was no more room to sit. The female passenger was very concerned that if the passenger standing next to her fell into the water, she would also end up in the water.

While preparing to launch the lifeboats, power had been restored to the EXPLORER. The crew launched seven Zodiacs which were used to tow the lifeboats, ease the overcrowding in the lifeboats by transferring passengers into the Zodiacs, and by distributing thermal blankets.

Events in Lifeboats

After all of the lifeboats were waterborne, the Zodiacs arrived and towed the three boats that did not have operating engines. Some passengers heard that a head count was being taken and the information was being exchanged over hand-held radios between the crew in the boats and who they believed was the Master.

The passenger that was earlier taking the video, continued to take video while in the lifeboat. The video indicated a small sea chop that caused the lifeboats to pitch. Many of the passengers said that sea spray was blowing over them causing many of them to get wet. The passengers stated that they were not aware of the equipment in the lifeboats and, according to the passengers, none of the crew informed the passengers about the equipment in the lifeboats until about one hour had passed in the boats. One of the passengers said that another passenger opened the lifeboat locker and found the Thermal Blankets and that none of the crewmembers informed them of the equipment. Some passengers reported that the zippers to the thermal blankets were rusty and did not work. Others reported that the blankets tore as they tried to use them. A few of the passengers said that the blankets provided adequate protection and others felt the blankets were ineffective and did not provide protection from the cold.

There were seasick passengers in all the lifeboats and the ship doctor was transported by Zodiac to lifeboats to assist as possible. Passengers did not realize, and were not told by the crew, that there were seasickness tablets in the lifeboat lockers.

The passengers from the Netherlands said that passengers in lifeboat # 4 had to jump into a Zodiac. Many of the passengers could not jump without help from crewmembers. Passengers and crew had to hold the lifeboat and Zodiac together making it a risky transfer.

Before the arrival of the rescue vessels, a helicopter from the Chile Navy arrived on scene. The appearance of the helicopter encouraged the passengers because it confirmed that assistance was enroute. The first indication that the rescue vessels were near was when passengers could see bright floodlights of one of the vessels on the horizon.

The NORDNORGE and ENDEAVOUR arrived on scene about 0625 and began the process of rescuing (boarding) the passengers. The NORDNORGE launched its Zodiacs to assist with the rescue. The NORDNORGE's lifeboats were lowered into the water and passengers from EXPLORER's lifeboat #1 transferred from the lifeboat to the NORDNORGE's lifeboat. (See Photo 4) Once the NORDNORGE's lifeboat was full, it was hoisted to its embarkation deck for passengers to board the NORDNORGE .

Photo 4: Transferring of Passengers to lifeboat of NORDNORGE.

The passengers that had to board the NORDNORGE from the Zodiacs had a more difficult and risky procedure. For the transfer, the Zodiac driver maneuvered the bow of the Zodiac against the NORDNORGE in the location of the NORDNORGE's sideport. Passengers had to reach from the Zodiac and grab a "rope ladder" (Jacobs ladder) that was hanging from the sideport. (See Photo 5) Some passengers were reported to be too cold to climb the ladder and other passengers and crew had to assist by pushing and pulling the passenger into the sideport.

One passenger said that the most "hair raising" and dangerous time was during the rescue of the passengers by the NORDNORGE. The wind and seas were increasing and passengers were transferring from lifeboat to lifeboat, to Zodiac or to a jacobs ladders on the NORDNORGE. He witnessed three incidents were people almost fell into the water. One of the passengers described the transfer operation as very risky. He said that two hours after boarding the NORDNORGE, the weather and seas deteriorated to gale force winds.

Photo 5 above: Zodiacs at sideport ladder of NORDNORGE.
Photo 6 below: transferring passengers from Lifeboats to Zodiacs.

A few of the passengers said that they were not certain if there was a crewmember in their lifeboat. One passenger believed the crew stopped trying to start the engine and should have continued. After the passengers and crew were rescued, one of the passengers approached the Safety Officer and asked why the crew could not get the lifeboat engines started. According to the passenger, the Safety Officer responded that the crew was too cold to get the engine started.

Repatriation

After all the passengers were safely aboard the NORDNORGE, a head count was taken. The Master of the NORDNORGE requested authorization to enter Fildes Bay on King George Island. Fildes Bay is near Presidente Frei Base of the Chilean Air Force. The passengers were taken off the NORDNORGE and were at either Frei Base or to the Uruguayan Scientific Base late on the evening of 23 November. They were taken to Punta Arenas, Chile (in two groups) in a C130 Hercules transport on 25 November.

After arriving in Punta Arenas, most of the passengers returned to Buenos Aires for flights to their respective countries. There was differing opinions by the passengers regarding the treatment of them once in Buenos Aires. Many of the passengers felt they were treated well. Other passengers were not satisfied at the treatment they received.

One passenger believed that the repatriation from the air base to Chile was done without regard to passenger needs for medication. Another passenger stated that he and another passenger were separated from the main group in Buenos Aires and lodged in a separate hotel. Other passengers felt there was a communication gap between the company and passengers regarding flight connections.

CREW INFORMATION

The Republic of Liberia issued the Minimum Safe Manning Certificate on 01 January 2004 and the EXPLORER fulfilled the requirements of the certificate. [19] The ship's crew consisted of the Master, a 15 member deck department, 11 member engine department, and a 27 member Hotel Department. There were nine passengers that were employed directly by G.A.P. Shipping Co. Limited Shipping that were referred to as the Expedition Group. Their duties included functions as tour guides, translators and operating the Zodiacs.

The crew composition of citizens consisted of 45 Filipinos, 4 Swedish, 2 New Zealanders, 1 Polish, and 2 Bulgarian. The Master, Chief Officer, Safety Officer and Ship Doctor were Swedish. The Chief Engineer was Polish. The First Assistant Engineer was Bulgarian and the Navigation Officer, 2nd Engineer and 3rd Engineer were Filipino.

The 49 year old Master held a Master's license issued by Sweden and endorsed by Liberia that was valid until April 2011. He stated that he had over 25 years experience working on vessels that operated in ice. The voyage of the accident was his first trip as Master to the Antarctic. He had served as Chief Officer on the EXPLORER on a previous trip to the Antarctic.

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[19] EXPLORER was required to carry 1 Master, 1 Chief Mate, 2 Navigational Watch Officers, 3 Able Seaman, 2 Ordinary Seamen, 1 Chief Engineer, 1 Second Assistant Engineer, 2 Engineering Watch Officers, 3 Oilers.

The 59 year old Chief Engineer held a Chief Engineer's license issued by Poland and endorsed by Liberia that was valid until April 2010. He had over 37 years at sea including time on Baltic Search and Rescue vessels. He began his sea time on the EXPLORER in 1999 as First Assistant Engineer.

COMPANY INFORMATION

Background

G.A.P. Shipping Co. Limited, Canada's largest adventure company, was formed in 1990 by Bruce Poon Tip to provide tours to developing areas of the world. The company has grown to over 500 employees worldwide.[20] The company offers "hundreds of adventures spanning the globe".[21] Ecotourism is defined by the International Ecotourism Society as "responsible travel to natural areas that conserves the environment and improves the well-being of local people."[22]

G.A.P. Shipping Co. Limited offered ten different tour packages of varying lengths and destinations. On the voyage that the EXPLORER sank, the vessel was operating on an 18 day "Spirit of Shackleton" tour. The vessel's route was from Ushuaia, to the Falkland Islands, to South Georgia Islands, Elephant Island and Antarctic Peninsula and return to Ushuaia via Drake Passage. The Spirit of Shackleton Package was an expanded expedition where, prior to the voyage on the EXPLORER, the tourists can tour Buenos Aires before flying to Ushuaia. The package includes a tour of Tierre Del Fuego National Park. The G.A.P. Shipping Co. Limited brochure refers to the possibility of making numerous possible landings in Antarctica making the selection of sites variable, time permitting. The landings were made using the Zodiacs.

VESSEL INFORMATION

History

The EXPLORER, originally named the MS LINDBLAD EXPLORER, was designed by and built for tour operator Lars-Eric Lindblad in 1969 and was nicknamed the "Little Red Ship." In Lindblad's own words, the "primary target was to bring the EXPLORER to Antarctica, where its design would enable us to penetrate farther into the ice than before."[23] According to G.A.P. Shipping Co. Limited newsletter, the EXPLORER had completed over 250 expeditions in Antarctic waters.[24]

From 1972 until her sale to G.A.P. Shipping Co. Limited in 2004, the EXPLORER was owned by various companies. She was not registered under Liberian Flag until 1989 when she was sold to EXPLORER Shipping and renamed EXPLORER.

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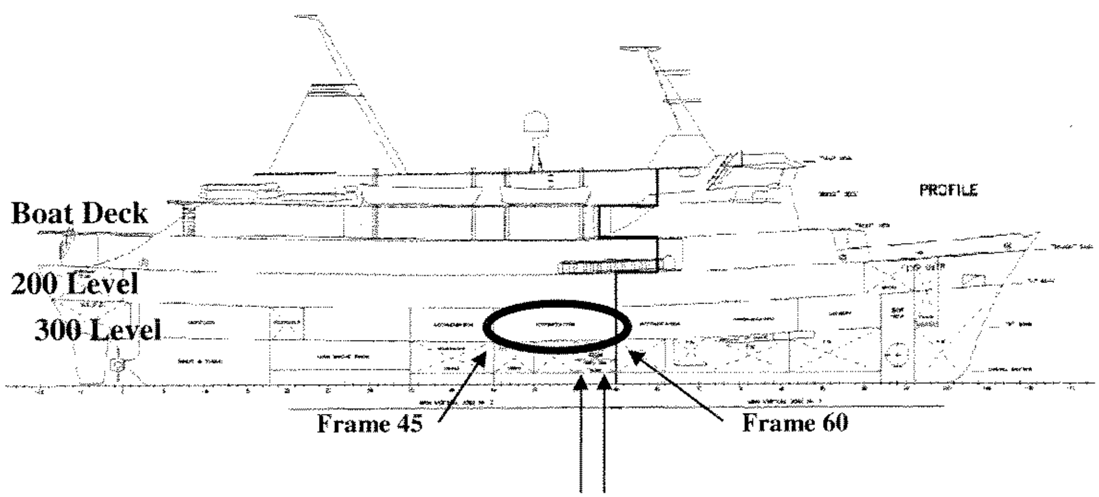
[20] http://www.matternetwork.com/2007/10/closes-Gap Adventures-eco-travel.cfm
[21] http://www.Gap Adventuresadventures.com/about_us/about_us 22 July 2008.
[22] http://www.ecotourism.org/webmodules/webarticlesnet/templates/eco_template.aspx?articleid Aug. 6, 2008
[23] Lindblad, Lars-Eric Passport to Anywhere, 1983 page. 151-152
[24] www.Gap Adventuresadventures.com/newsletters/200406-1-EXPLORER.html 23 September 2008.

General Arrangement of Vessel

The EXPLORER was a single-hulled with double bottom passenger vessel with six enclosed decks and one open deck. Passenger accommodations were located on the Boat deck (100 level), A deck (200 level) and B deck (300 level). The passenger and crew cabins on the 300 level were divided into 4 separate compartments with watertight doors between each space (See Section on Watertight Doors). The damaged stability standard was in accordance with International Convention for the Safety of Life at Sea-1960 (SOLAS 60). The compartment subdivision standard was one compartment.[25]

The Sun Deck was an open deck above the Bridge Deck. The Bridge Deck consisted of the Wheelhouse in the fore part of deck and vessel, Radio Room, staff quarters, hospital, sauna and gymnasium. When the lifeboats were in the stowed position, they were on the same level as the Bridge Deck. Two twenty-person life rafts were stowed on the forward end of the deck. Zodiacs were cradled on the aft end of the Bridge Deck. There were two cranes, mounted on the port and starboard quarter that were used for launching the Zodiacs.



Deep Tank #19B between Frame 60 and 54

Graphic 4: Profile View with Passenger Levels	
	Passenger cabins located between Frame 45 and 60 on 300 Level were flooded. Frame spacing was 600 mm between each frame.

The Boat Deck was beneath the Bridge Deck where all of the licensed officer quarters were located. Ten passenger cabins were located on the deck and the Penguin Lounge (Muster Station for passengers) was aft.

The Engine Room and machinery space consisted of four compartments starting at frame 60 and continued aft to the shaft tunnel. The forward most engine space was an

[25] http://www.imo.org/Conventions/contents.asp?topic_id=257&doc_id=647#5 The subdivision of passenger ships into watertight compartments must be such that after assumed damage to the ship's hull the vessel will remain afloat and stable.

auxiliary Engine Room that was referred to as the Separator Room. Within the space the gravity feed tanks that fed fuel to the main engines and the three generators were located. The next auxiliary engine space was the Generator Room which housed the three generators (prime movers). Generator #1 was on the starboard side, Generator #2 was off the centerline to port, and Generator #3 was located on the port side (at frame 40).

Watertight Doors

According to the Trim and Stability Booklet;

> Watertight doors are to be kept closed at sea wherever practicable. However, it is accepted that doors may need to be left open for operational or maintenance purposes. In light of this, the watertight doors carried on board this vessel are divided into three categories.

Type C watertight doors were located in the Engine Room and on the 300 level. (See Appendix F) The doors were to be opened only long enough for a person to pass through. According to the Master, Chief Engineer and First Assistant Engineer, the Type C watertight doors on the EXPLORER were closed at sea and were only opened when a crewmember needed to pass through. The crewmember that planned on opening the door would first notify the watch on the Bridge to inform him that the applicable door was to be opened. There was an indicator panel on the Bridge where the mates on watch could view the status (open or closed) of the doors. An alarm would sound on the Bridge if one of the doors was opened.

Type A	Doors which may normally be kept open.
Type B	Doors which should be kept closed. They may be open, but only when an 'Authorized Person' is working in the adjacent compartment.
Type C	Doors which should be kept closed. They may be opened by an "Authorized Person' but only for sufficient time to pass through.

On the evening of the accident, the Safety Officer that was on watch on the Bridge told the Investigating Officer that all of the watertight doors were closed. The Third Assistant Engineer that reported on watch at midnight told the Investigating Officer that the watertight door into the Separator Room was open when he went to check the status of the bilges after receiving the bilge alarm while in the Control Room.

Consumable Tanks (See Appendix B: Tank Capacity Table)

The EXPLORER was carrying Marine Gas Oil (MGO) in accordance with the Antarctic Treaty that recommended that vessels carrying heavy fuel oils not travel in Antarctic waters. (See section on Antarctic Treaty System) The estimated amount of fuel on board at the time of the sinking was 178 cubic meters (See Table Below). There was 24 tons of lube oil in Double Bottom No. 36. All of the salt water ballast tanks were full. At 0600 on 22 November, there was a total of 184 cubic meters in the fuel tanks. The consumption from 0600 until the sinking was from the double bottom tanks # 1 &2. The estimated remaining quantity at the time of the sinking was 178 cubic meters.

Estimated Fuel on Board	
Fuel Tank	Quantity (m^3)
1 & 2	56
4	13
5	13
6	23
7	23
12	16
13	16
Service Tank	10
Settling Tank	10
Auxiliary Tank	4

The salt water ballast tanks were always full to ensure adequate stability. For ballasting, the Main Engine Cooling pump was used. The Chief Engineer was asked if any consideration was given to de-ballast the vessel in order to remove the starboard list. He did not consider it because he felt the ballast tanks were too small (7-9m/3) and discharging the tanks would not have changed the list of vessel. The Chief Engineer stated that the only tank which could have been used to upright vessel was deep tank #19A (port fuel tank), but there was no cross connection between the fuel and ballast system which would have enabled him to fill the fuel tank.

All copies of the piping diagrams were on the EXPLORER and lost when the vessel sank.

Propulsion System

The EXPLORER had a Controllable Pitch Propeller (CPP) manufactured by Liaaen. Liaaen was purchased by Ulstein and then by Rolls Royce in 1999. The CPP System was the original installation from vessel construction. According to Class DNV there had been no modifications to the system.

A Controllable Pitch Propeller is "where the blades can be rotated normal to the drive shaft by additional machinery at the hub and control linkages running down the shaft. This allows the drive machinery to operate at a constant speed while the propeller loading is changed to match operating conditions. It also eliminates the need for a reversing gear and allows for more rapid change to thrust, as the revolutions are constant."[26] The hub assembly on the EXPLORER contained a hydraulically operated pitch control mechanism that adjusted the blade angle. By varying the pitch, the speed and/or direction (ahead or astern) of the vessel is controlled.

The Master reported, and photos confirmed, that while he and the EXPEDITION Group leader remained on the vessel, the vessel's propulsion went astern and the vessel reached a speed of about 8 knots astern. The Master and Chief Engineer believed that when the CPP system lost hydraulic pressure, the default mode was for the propeller blade angles to revert to astern mode. They believed that the EXPLORER lost hydraulic pressure to the CPP system and the vessel responded as designed.

According to the Senior Engineer, Marine Services, Propulsion-Norway of Rolls-Royce Marine, the system was not designed to default to astern mode. He said that they are finding that due to the various forces and pressures involved, it is the nature of the system that causes the blades to revert to astern once hydraulic pressure is lost.

Emergency Equipment

The EXPLORER had four open lifeboats that, in the stowed position, were at the Bridge Deck level. To board the boats, the boats would be lowered to the Embarkation Level on the Boat deck. Boats #1 and #3 were were located on the starboard side with #1 closest to the bow. Boats #2 and #4 were stowed on the port side with boat #2 forward. The capacity of boats #1 and #2 was 39 persons each and boats #3 and #4 had a capacity of 59 persons each. The Chief Engineer and former Chief Officer told the Administration that the engines were air-cooled.

A former Chief Officer (not the Chief Officer on the voyage that the accident occurred), through correspondence, stated that the lifeboat engines were difficult to start, especially in cold weather and that starting the engine required "a very strong manpower" that usually required two crewmembers to turn or crank the engine followed by another two to continue until the engine started.[27] The lifeboat engines complied with all relevant regulations.

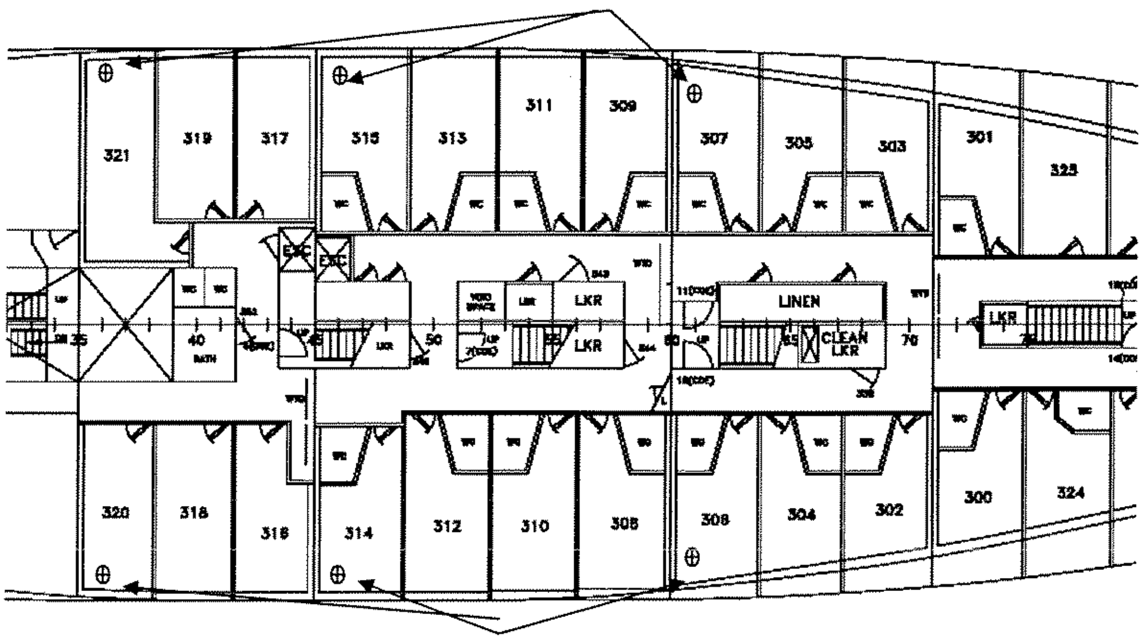
Down-Flooding Ducts (Scupper valves)

As discussed in the narrative, the vessel was equipped with self-activating down flooding ducts (scupper valves) installed on the 300 level. The purpose of the ducts was to allow water accumulating on the 300 level as a result of fire sprinkler/firefighting activity to drain down to the lower Engine Room level for overboard discharge from the Engine Room bilges. The safety devices would, in the event of fire in the passenger compartments, prevent the water from accumulating on the higher 300 level which, if

[26] http://www.answers.com/topic/propeller
[27] At the time of the accident, the owner had, on order, spring loaded starting machinery for the lifeboat engines after recognizing the difficulties in starting the engines in colder climates. The parts had been delivered and were to be installed at the next opportunity.

allowed to accumulate, would raise the center of gravity of the vessel, decrease the stability of the vessel and risk capsizing the vessel.

As indicated in Graphic 5, there were six ducts below the bunks or settees. The devices consisted of a plate with a spring-loaded hinge on one side of the plate that kept the plate in a closed position until the water level in the passenger cabin reached a certain level. The weight of the water would cause the plate to open and water would drain into the Engine Room. The Chief Engineer stated that the engine crew had to periodically perform maintenance on the hinges, usually after hearing complaints from the passengers. The sewage treatment tanks were located in the engine spaces and would vent gas and create an unpleasant atmosphere in the passenger cabins if the plate was not completely closed.



Graphic 5 : Down flooding ducts indicated by arrows.
Stern of vessel is to left of page and Bow is to the right. Even numbered cabins on the starboard side of the vessel; Odd numbered cabins on the port side of vessel

Rigid Inflatable Boats (RIB)

The EXPLORER carried 10 Rigid Hulled Inflatable Boats (RIBs) that were manufactured by Zodiac and referred to by the manufacturer name. "Zodiac is the originator and world's largest manufacturer of inflatable boats, RIBs and life rafts."[28] The Zodiacs were used to provide landings in the Antarctic region to provide passengers close-up tours of the environment.

The Zodiacs were powered by 50 horsepower outboard engines and were stowed on the Bridge Deck on the aft end. Two electro-hydraulic boom cranes located on the

[28] http://www.defender.com/inflatables/inflatable_project/zodiac/zodiac.htm

same deck (one on the port side and one on the starboard side) were used to launch the Zodiacs.

Sewage holding tanks

The EXPLORER sewage treatment plant was manufactured by FORMAT-Chemie and Apparate GmbH, with one treatment tank and two holding tanks. The treatment tank was located in the Separator Room. The vessel had a pipeline for discharging sewage ashore.

The EXPLORER had a long black streak on the section of the hull just above the keel (See photo 2). According to the Chief Engineer, before the start of every Antarctic season all sediments are washed out from the sewage treatment (all chambers). It is done in the middle of the ocean and the trace will eventually disappear. The black streak is a trace of sewage from Central Store where the sewage treatment outlet valve is located.

All copies of the diagrams and manuals for the sewage system were on the vessel and were lost when the vessel sank.

Voyage Data Recorder (VDR)

The EXPLORER was equipped with a Kelvin-Hughes NDR 2002 VDR with a Removable Storage Unit (White Box) and Crash Survival Module (CSM) mounted on the port Flying Bridge (also referred to as Monkey Island). Neither the White Box nor CSM were removed from the vessel.

According to the Kelvin-Hughes brochure, the VDR on the EXPLORER would have recorded;

GPS (Global Positioning System) – Date, time and position
Speed Log data
Gyro Compass – heading
Radar Data
Bridge Audio
VHF Communications
Rudder – order and feedback response
Engine/Propeller – Order and feedback response

The Marine Accident Investigation Branch (MAIB) of the United Kingdom learned of the accident on the EXPLORER after the distress call was received by the Maritime and Coast Guard Agency (MCA) which then informed the MAIB. According to the Chief Inspector of Marine Accidents of MAIB, "As soon as we became aware of the situation with the *Explorer* early on the morning of Friday the 23rd of November, we started making enquiries regarding the VDR on board. We spoke with (name redacted) Technical Manager Gap Adventures Ship management Sweden who was able to tell us that the vessel was equipped with a Kelvin Hughes device. We urged him to ensure that the vessel took the necessary steps to secure this evidence, pointing out that should the vessel sink, the data would be only be available through recovery of the capsule from over 1400m."

On the morning of 23 November, the Investigating Officer contacted the same technical manager and was told by the manager that he reminded the Master to remove the VDR. The Investigating Officer was also in contact with Chile MRCC and learned from the MRCC late afternoon on 23 November that the vessel had been abandoned and the VDR had not been removed from the vessel.

The Investigating Officer asked the Master at the post-accident interview why he did not remove either the White Box or Crash Module and he responded that he did not think about the VDR. He was concerned about the safety of the passengers.

During the post-accident investigation, the Investigating Officer contacted the manufacturer of the VDR to determine whether the data could be recovered from the capsule. According to the Technical Services Manager from Kelvin Hughes, "The data on the capsule should be ok for approx 2 years. The main issue with retrieving the data will be the final location of the vessel on the sea bed. The location sonar is designed to work for 30 days in normal conditions, however due to the water temperature in this area the battery life is likely to be reduced and may be as little as 10-14 days. It is also worth noting that the sonar beacon could be shielded by the vessel especially if it is lying on the port side."

The Investigating Officer contacted the company Gap Adventures and informed the company that it was the responsibility of the company to provide the VDR data for the investigation and requested the company take action to retrieve the VDR. Through its legal representative, the company declined the request stating in email;

IMO GUIDELINES ON VOYAGE DATA RECORDER (VDR) OWNERSHIP AND RECOVERY (MSC/Circ.1024 29 May 2002) "reflect the five basic issues relevant to VDR ownership and recovery, which are ownership, custody, recovery, read-out and access to the VDR information, as envisaged by the revised SOLAS chapter V." See Appendix G for the Guidelines.

Vessel Survey and Inspection 2007

The EXPLORER's most recent drydocking had been conducted at Astilleros Canarios, SA (ASTICAN) in Las Palmas, Canary Island from 08 October until 20 October 2007. The shipyard used a syncho-lift system consisting of railways and lifting devices.

While in the shipyard, a surveyor from DNV conducted the Bottom annual survey.[29] Administration investigators interviewed the Class surveyor that conducted the October 2007 survey.[30] According to the surveyor, once the vessel was on the railway

[29] The Bottom annual survey conducted in Las Palmas included Anti fouling, Sewage Pollution Prevention, some machinery items and lightship verification. All other annual surveys were completed 17 May 2007 in Glasgow.

[30] The surveyor had been conducting surveys since 1983 and estimated to have performed between 2500 and 3000 surveys during his career.

with the entire hull visible, an inspection was conducted of the entire external side-shell plating. Three indents were observed on the port side of the vessel at the 300 level.

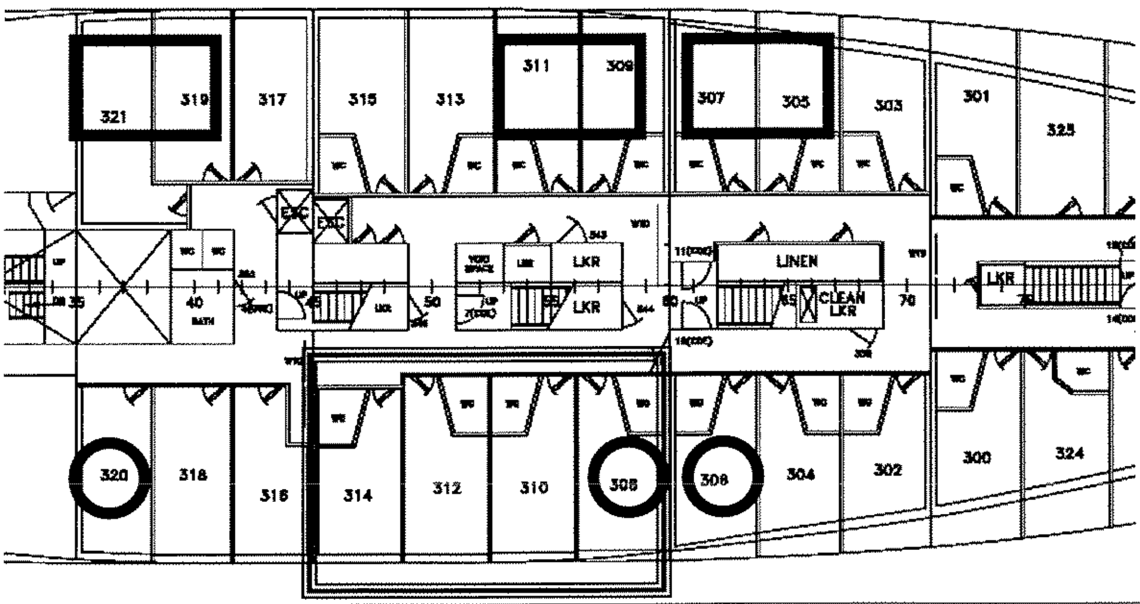
The indentations were located at cabins 305-307, 309-311 and 319-321. The false bulkheads in the cabins (decorative paneling) were removed to determine the extent of damage of the interior structure and once the steel side plating was visible, corrosion on the interior deck plating was evident. In order to ascertain the extent of replacement to the deck plates, it was decided by the surveyor and Gap Adventures representative, that gauging of the deck plate would be needed. A certified gauger performed gauging of the deck plating with the surveyor. A formal report of gauging was not created. According to DNV, the type of gauging performed was "on spot" and used for routine support to the surveyor and will not be retained as "survey records" or recorded in a formal report.

The DNV Survey Report detailed the following condition and repairs to the port side of the EXPLORER hull;

> "The portside shell plate was found indented above the B deck level, frames 35 to 38, including frames and knee brackets in way, as well as the boundary deck.
>
> *" Shell plate was cropped and renewed over 2360 x 1940 x 12 mm. Frames 36, 36 1/2, 37, 37 1/2, 38 were cropped and renewed over the distorted length. Deck plate was cropped and renewed between frames 35 to 38 over a width of 240 mm.*
> *Temporary action: The deck plate forward of the repaired area was found with corrosion scaling. It was agreed that this area should UTM gauged during next drydocking.*
>
> The shell plate portside between frames 60 to 65 was found indented, above the B deck. The set in of the plate was evaluated and found acceptable, nevertheless the frames in the way were found distorted to a different extent.
> *Repaired: Permanent repairs were carried out by cropping and renewing partly the frames 60 1/2, 61, 61 1/2 , 62, 62 1/2, 63, 63 1/2,64, including the knee brackets and the deck plating adjacent over a width of 400 mm. The bulkhead at frame 60 was partly renewed over 950 x 600 x 8 mm.*
>
> The shell plate portside between frames 54 to 60 was found indented, above the B deck. The set-in of the plate was evaluated and found acceptable, nevertheless the frames in the way were found distorted to a different extent.
> *Repaired: Permanent repairs were carried out by cropping and renewing partly the frames 53, 53 1/2, 54, 54 1/2 , 55, 55 1/2, 56, 56 1/2 , 57, 57 1/2, 58, 58 1/2, 59, including the knee brackets."*

In view of the damage and evident corrosion of the deck plate on the port side, the surveyor instructed the Gap Shipping Sweden representative that he would have to inspect specific areas on the starboard side. The decorative bulkhead paneling was removed in cabins 306, 308, 320 and additional gauging of the deck plating was conducted. There were no abnormalities to the frames and shell plating noted, but corrosion of the deck plates was visible.

Graphics 6 :Rectangles in graphic below indicate cabins adjacent to where shell indentations were found and shell plating was replaced on the port side of vessel.



Dark circles indicate where surveyor had paneling removed to inspect deck plating on starboard side.

Border indicates cabins where flooding occurred.

According to Class DNV surveyor, the original required thickness of the deck plating was 6.5mm. The minimal acceptable thickness allowed a 20% reduction from the original thickness or 5.3 mm. The readings taken for the starboard side 300 level in the 2007 shipyard were in the range of 5.5 mm. On the basis of the readings, the area was within acceptable range but near the limit of thickness. It was recommended by the surveyor and agreed to by the Gap Adventures representative to have the area addressed in one year time.

The original required thickness for the shell plating was 13mm. The minimum allowable thickness was 10.5 mm. No gauging was performed on the shell plating because there was no corrosion evident.

Astican Shipyard was contacted in order to obtain copies of the 2007 gauging. Email from the Commercial Manager Astican Shipyard;

Please note that during the 2007 drydocking only a few spots were calibrated to delimitate the perimeter of steel plate renewal and, therefore, no report was produced. This gauging was performed by yard's staff. The only report we have in our files is the one of 2006 already e-mailed to you.

ENVIRONMENTAL DAMAGE

The EXPLORER was carrying an estimated 210 cubic meters of oils, lubricants and petrol. The Chilean naval icebreaker AP ADMIRAL OSCAR VIEL arrived on scene and moved over the visible slick to "create mechanical dispersion and speed up the weathering process of the spilt fuel."[31]

During the pollution mitigation operations, scientists on board the AP ADMIRAL OSCAR VIEL did not observe any pollution to the "Antarctic flora and fauna." Chile continued to monitor the area during the southern summer and found no new spills.[32]

"The International Tanker Owners Pollution Federation (ITOPF)[33] was requested to attend on-site by the vessel's insurers to provide advice on pollution related issues. A trail of fragmented 'iridescent' or rainbow oil sheen covering approximately 2.5 km2 was observed shortly after the vessel sank during aerial surveillance sorties carried out by the Chilean Navy, INACH (Chilean Antarctic Institute) and a P&I representative using a navy helicopter. Two days later, a 5 km2 area of sheen was reported, which represents a few cubic metres of oil at most. Subsequent reports from the Chilean Navy suggest that oil sheen continues to be observed in the vicinity of the sinking location and its appearance and cover corresponds to a slow and steady release of fuel from one or more tanks onboard the vessel."[34]

[31] Report by Chile to Antarctic Treaty Consultative Meeting Kyiv, Ukraine 2-13 June "Participation of the Chilean Air and Maritime Search and Rescue Centres in the rescue of the Passenger Ship the EXPLORER and environmental mitigation of the accident in the Antarctic. Reference cannot be located.
[32] Ibid
[33] The International Tanker Owners Pollution Federation (ITOPF) is a not-for-profit organization, involved in all aspects of preparing for and responding to ship-source spills of oil, chemicals and other substances in the marine environment. http://www.itopf.com/about/
[34] http://www.itopf.com/news-and-events/archive/2007.html#EXPLORER

BACKGROUND INFORMATION

Classification Societies

Classification societies are non-governmental organizations that establish technical standards and rules for the design and construction of ships and other marine structures, and will survey the structures to ensure compliance with these rules and standards. The standards are issued by the classification society as published rules and a vessel that has been designed and built to the appropriate rules of a society may apply for a Certificate of Classification from that society. The society will issue the certificate of class upon completion of a survey by a class surveyor. [35]

The International Association of Classification Societies (IACS) was formed so that the various class societies could combine their technical knowledge and experience [36] IACS publishes the following that the member Class Societies will comply with:

Procedural Requirements
Common Structural Rules
Unified Requirements
Unified Interpretations

There are ten current members of IACS and the Liberian Registry recognizes only IACS members. Det Norse Veritas (DNV) was the Class member that performed surveys on the EXPLORER and had been Class for the EXPLORER since its construction.

The majority of ships are built and surveyed to standards that are issued by Classification Societies and are published as rules. The Classification Process will begin during the design phase of the vessel and continue through construction.

Class surveyors will ensure that the vessel is constructed in accordance with the Classification rules and once satisfied that the vessel in compliance, a Certificate of Class is issued. [37]

DNV had been the Classification Society for the EXPLORER since construction in 1969.

Class 1A1 ICE-A Vessel

"Historically, a number of ships will retain previous class notations that will not be covered under the current rules; these class notations shall remain extant under the rules in force at the time the class notations were originally assigned." [38] The EXPLORER retained the 1A1 ICE-A Class notation.

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35 http://www.eagle.org/company/classmonograph.pdf What are classification societies?
36 http://www.iacs.org.uk/document/public/explained/Class_WhatWhy&How.PDF
37 http://www.iacs.org.uk/document/public/explained/Class_WhatWhy&How.PDF
38 Det Norse Veritas Rules for Ships January 2008 Section 2 Historical Class Notations.

"Applicable rules for ice strengthening prior to 1971 were not based on design loads of ice pressure, but merely as a percentage increase of scantling above normal class rules. The contact ice pressure is a function of the crushing (compression) strength of ice. From first year to multi-year ice, as may; be encountered in polar areas, there is generally a considerable increase in the low strain rate which leads to higher crushing strength of the ice and a corresponding increase in the contact ice pressure."[39]

The DNV additional class notation ICE-A was assigned until the 1969 issue of the DNV Rules. The rule requirements for strengthening according to ICE-A covered the following main features;

- Ice belt[40] from 500 mm above winter load waterline to 500 mm below ballast waterline. The shell plating thickness in the area was increased according to a formula above the normal thickness. The thickness of the plates, however, should not be less than 12 mm.

- Strengthening of frames introduced, and particular the stem and peak frames were strengthened and supported by additional stringers.

- Scantlings[41] of plating, frames and stringers were not given as a direct function of local ice pressure, but merely as a percentage increase above normal class rules.

"The class notation ICE-A implies a certain strengthening of hull structure and machinery, but shall not be assumed to guarantee capability to transit any ice condition."[42]

Special Surveys

According to Class Rules, special surveys are to be conducted every five years from date of the vessel's delivery in order to renew the Classification Certificate. The Special Survey is to include, in addition to the requirements of the Annual Survey, examination tests and checks of sufficient extent to ensure that the hull, equipment and related piping are in satisfactory condition and fit for the intended purpose for the new period of class of five years to be assigned, subject to proper maintenance and operation and the periodical surveys being carried out at the due dates.

The examinations of the hull are to be supplemented by thickness measurements and testing. The requirements for thickness measurements at special survey are given in IACS Unified Requirement (UR) Z 7, 'Hull Classification Survey'. The minimum

[39] DNV Memo No. MGGNO856HFR1090114-1 DNV Maritime to Liberian International Ship and Corporate Registry 15 January 2009, Comments to the Draft Report., page 6..
[40] Ice belt defined; section of hull which extends above the ice load waterline and below the ice light waterline- normally summer loadline to lightest waterline the ship navigates in, respectively.
[41] Scantlings are size of the structural components.
[42] DNV Memo No. MGGNO856HFR1090114-1 DNV Maritime to Liberian International Ship and Corporate Registry 15 January 2009, Comments to the Draft Report., page 6.

requirements for thickness measurements (depending on age) at special survey are given in Table 1 of UR Z 7. These UTM[43] recordings are to be retained as records to demonstrate compliance with these requirements and to serve as reference to ensure that the structural integrity remains effective. IACS PR 19 Procedural Requirement for Thickness Measurements gives requirements for how the UTM process shall be carried out, interaction and control with the UTM operator. The aim of the examination is to discover substantial corrosion, significant deformation, fractures, damages or other structural deterioration, that may be present.

DNV provided the Administration with the most recent Special Survey conducted on the EXPLORER. The 32 page "Thickness Measurement Report" was dated 18 October 2005 and presented gauging results in column format by structural element, drawing reference, frame number, original thickness, Class minimum thickness, gauged results (port or starboard), diminution and whether the structural element was renewed.

The gaugings performed in the area of where the damage occurred (between frames 45 and 60) were for the first strake below the sheer strake, which would have been above the waterline.

The report included a Shell Expansion Plan which indicated the results of spot gauging that were taken during the survey. See Appendix E.

Guidelines for Ships Operating in Arctic Ice-Covered Waters

The Maritime Safety Committee, of the IMO, at its seventy-sixth session (2 to 13 December 2002), and the Marine Environment Protection Committee, at its forty-eighth session (7 to 11 October 2002), recognizing the need for recommendatory provisions applicable to ships operating in Arctic ice-covered waters, additional to the mandatory and recommendatory provisions contained in existing IMO instruments, approved Guidelines for ships operating in Arctic ice-covered waters, as set out in the annex.

These Guidelines for ships operating in Arctic ice-covered waters (hereinafter called "the Guidelines") are intended to address those additional provisions deemed necessary for consideration beyond existing requirements of the SOLAS Convention, in order to take into account the climatic conditions of Arctic ice-covered waters and to meet appropriate standards of maritime safety and pollution prevention.[44]

"The Sub-Committee on Ship Design and Equipment (DE), at its 50th session in March 2007, commenced work on developing amendments to the *Guidelines for ships operating in Arctic ice-covered waters* to make them applicable to ships operating in the Antarctic Treaty Area." [45]

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[43] Ultrasonic Thickness Measurements
[44] MSC/CIRC.1056 MEPC/CIRC.399 Guidelines for Ships Operating in Arctic Ice-Covered Waters.
[45] http://www.imo.org/Newsroom/mainframe.asp?topic_id=1605&doc_id=8104#polarcode

Polar Class

During the 1970s and 1980s there was an increase in polar shipping and a number of administrations made proposals to the IMO to develop a harmonized system of ice class rules. The development of Polar Rules began in 1993 and was adopted by all IACS members and became effective March 2008. The IMO developed the framework for polar classes and IACS produced detailed requirements for structural and machinery items. [46] Seven different Polar classes were established with each level representing the different levels of capability, based on environmental conditions, for vessels navigating in Arctic waters.[47]

"The IACS Polar Ship Rules have been developed over many years in cooperation with industry, academics, and Classification Societies and provide a significant step in the harmonization of Classification Society requirements. The underlying feature of scenario based pressures provides a flexible approach that can be integrated with other rule sets."[48] The IACS Polar Rules are based on the concept that ice loads can be rationally linked to the design scenario of a glancing collision with an ice floe. The extent of reinforcement is linked with the design scenario and the damage experience.

"The IACS load calculation is based on an energy based model, i.e. the kinetic energy is equated to the ice crushing energy. During this interaction it is assumed the ship penetrates the ice and glances away. Note this scenario would be equally applicable to the aft end of a double acting vessel. From this an ice force acting on the hull is obtained from theoretical formula. The pressure, area, or patch load, is then gained by assuming a rectangular ice loading applied to the ship. And also the load line pressure. These three values are then found for various locations around the bow and the largest values are selected from the ice force, patch pressure, and load line pressure. These combine to form an overall patch pressure to be applied throughout the ship. It should be noted that this may not represent the highest load that may be experience by a ship. Ramming or icebreaking operations may well generate larger forces, but the vessel is likely to be going at lower speeds and the occurrence may be limited." [49]

Regulations governing carriage of lifesaving equipment

"The International Convention for the Safety of Life at Sea (SOLAS), in its successive forms is generally regarded as the most important of all international treaties concerning the safety of merchant ships. The first version was adopted in 1914, in

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[46] http://www.sname.org/sections/texas/Meetings/2008/September%20Luncheon/SNAME-Texas%20Polar%20Class%20Rules%20-%20Han%20Yu.pdf

[47] Jensen, Oystein The IMO Guidelines for Ships Operating in Arctic Ice-covered waters; From Voluntary to Mandatory Tool for Navigation Safety and Environmental Protection? The Fridtjof Nansens Institute page 14.

[48] Lloyd's Register (LR) Helsinki University of Technology (HUT); Current Hull and Machinery Ice Class Rules Requirements And Impact of IACS Polar Rules, 16 December 2004; page 30.

[49] Ibid. pages 10-11.

response to the Titanic disaster, the second in 1929, the third in 1948, and the fourth in 1960. The 1974 Convention has been updated and amended." [50]

The International Life-Saving Appliance Code (LSA) Code was adopted by the Maritime Safety Committee (MSC) at its 66th session (June 1966) by resolution MSC.48(66) in order to provide international standards for the life-saving appliances required by chapter III of the 1974 SOLAS Convention. The Code was made mandatory by the MSC at the same session by resolution MSC..47(66) and entered into force on 1 July 1998.[51]

Marine Notices issued by the Office of the Deputy Commissioner of Maritime Affairs are the mechanism used to promulgate Administration policy and National requirements on marine safety issues and other related matters not otherwise specifically addressed by the Liberian Maritime Law or Regulations.

Marine Safety Notice SAF-001, subject title Lifesaving Equipment, specifically addressed the requirements regarding carriage of Immersion Suits and Thermal Protective Aids. According to SAF-001;

> *The three (3) immersion suits per lifeboat required by SOLAS, Regulation III/32.3.2 for cargo ships and Regulation III/22.4.1 for passenger vessels are intended for use by the designated and/or certified persons in charge of the lifeboat. They may be kept in the staterooms of the assigned personnel.*

In accordance with SOLAS Regulations, the EXPLORER carried 12 immersion suits but thermal blankets were on board for all passengers and crew. The thermal blankets were stowed in the lifeboat lockers and immersion suits were stowed in lockers adjacent to the lifeboats.

Antarctic Treaty System

The Antarctic Treaty System (ATS) is the entire group of arrangements made for the purpose of coordinating relations among states with respect to Antarctica and includes the Antarctic Treaty itself. [52] The Antarctic Treaty was signed in Washington, D.C. on December 1, 1959 with the main purpose to ensure "in the interest of all mankind that Antarctica shall continue for ever to be used exclusively for peaceful purposes and shall not become the scene or object of international discord." The Treaty was to deal with the problem posed by various countries' claims of sovereignty and establish Antarctica as a zone of peace and cooperation. There are a number of related agreements which, together with the measures adopted by the Antarctic Treaty Consultative Meeting (ATCM) and the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) are often called the Antarctic Treaty system. [53]

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50 http://www.imo.org/Conventions/contents.asp?topic_id=257&doc_id=647 August 7, 2008
51 Life-Saving Appliance Code (LSA) IMO Publication Foreward pg.iii.
52 http://www.state.gov/documents/organization/15272.pdf
53 http://www.ats.aq/index_e.htm Secretariat of the Antarctic Treaty System.

"According to Article IX of the Treaty, every year (before 1994 every two years) the original twelve Parties to the Treaty and those Parties that demonstrate their interest in Antarctica by conducting substantial research activity there - together called the Consultative Parties - meet *"for the purpose of exchanging information, consulting together on matters of common interest pertaining to Antarctica, and formulating and considering and recommending to their Governments measures in furtherance of the principles and objectives of the Treaty"*. This is the Antarctic Treaty Consultative Meeting (ATCM). The measures, often called "Recommendations", include a large number of documents in which the principles of the Antarctic Treaty and the Environmental Protocol are translated into specific regulations and guidelines." [54]

At the Twenty-eighth Antarctic Treaty Consultative Meeting – Eighth Committee on Environmental Protection Meeting held at Stockholm, Sweden from 06 to 17 June 2005, it was decided to "address a request through the Chair of ATCM XXVIII to the International Maritime Organization to examine mechanisms for restricting the use of Heavy Fuel Oil (defining HFO in accordance to MARPOL Regulation 13 H definition of Heavy Grade Oil as all fuels of higher number than Intermediate Fuel Oil 180 (IFO-180)) in Antarctic waters, taking into account:

- the relatively high risk of fuel release in the Antarctic Treaty area due to conditions such as icebergs, sea-ice, and uncharted waters; and
- - the high potential of environmental impacts associated with a spill and emission of HFO in the Antarctic Treaty area." [55]

International Association of Antarctic Operators (IAATO) [56]

Founded by seven private tour operators in 1991, the International Association of Antarctica Tour Operators (IAATO) has grown to include over 81 member companies from Argentina, Australia, Belgium, Canada, Chile, France, Germany, Italy, Japan, the Netherlands, New Zealand, Norway, Sweden, United Kingdom, and United States. IAATO is an industry group that currently has more than 100 Antarctica-bound voluntary members. IAATO is dedicated to appropriate, safe and environmentally sound private-sector travel to the Antarctic.

The objective of IAATO are:

- To represent Antarctic tour operators and others organizing and conducting travel to the Antarctic to the Antarctic Treaty Parties, the international conservation community and the public at large.
- To advocate, promote and practice safe and environmentally responsible travel to the Antarctic.
- To circulate, promote and follow the Guidance for Visitors to the Antarctic and Guidance for Those Organizing and Conducting Tourism and Non-governmental Activities in the Antarctic, as adopted by the Antarctic Treaty System (Recommendation XVIII-1).

[54] Ibid.
[55] Ibid.
[56] http://www.iaato.org The International Association of Antarctica Tour Operators (IAATO).

- To operate within the parameters of the Antarctic Treaty System, including the Antarctic Treaty and the Protocol on the Environment and Annexes, along with MARPOL, SOLAS and similar international and national laws and agreements.
- To foster continued cooperation among its members and to monitor IAATO programs, including the pattern and frequency of visits to specific sites within the Antarctic. And to coordinate itineraries so that no more than 100 people are ashore at any one time in any one place.
- To provide a forum for the international, private-sector travel industry to share expertise and opinions and to uphold the highest standards among members.
- To enhance public awareness and concern for the conservation of the Antarctic environment and its associated ecosystems and to better inform the media, governments and environmental organizations about private-sector travel to these regions.
- To create a corps of ambassadors for the continued protection of Antarctica by offering the opportunity to experience the continent first hand.
- To support science in Antarctica through cooperation with national Antarctic programs, including logistical support and research.
- To foster cooperation between private-sector travel and the international scientific community in the Antarctic.
- To ensure that the best qualified staff and field personnel are employed by IAATO members through continued training and education. And to encourage and develop international acceptance of evaluation, certification and accreditation programs for Antarctic personnel.

Arriving vessels (for tourism and other Non-Governmental Activities) are requested to submit an advance notification to IAATO in compliance with Antarctic Treaty Recommendation XVIII-1 and Resolution XIX. The owner of the EXPLORER, G.A.P. Shipping Co. Limited, was a member of IAATO and had submitted an advance notification to IAATO.

IAATO has no jurisdiction over ships that travel to the Antarctic that refuse to comply with guidelines followed by IAATO members. The only recourse IAATO has to deal with these vessels is to register a complaint with the vessel's Administration.

Entering the Ice [57]

The Canadian Coast Guard has published recommendations for vessels conducting ice navigation in Canadian waters, The route recommended by the Ice Operations Officer through the appropriate reporting system i.e. ECAREG, is based on

[57] Ice Navigation in Canadian Waters Published by:Icebreaking Program, Navigational Services Directorate Fisheries and Oceans Canada Canadian Coast Guard Ottawa, Ontario K1A 0E6 ©Department of Public Works and Government Services Canada 1999 Cat. No. T31-73/199E ISBN 0-660-17873-7 Revised September 1999 pg.24-25

the latest available information and Masters are advised to adjust their course accordingly. The following notes on ship-handling in ice have proven helpful:

(a) Do not enter ice if an alternative, although longer, route is available.

(b) It is very easy and extremely dangerous to underestimate the hardness of the ice.

(c) Enter the ice at low speed to receive the initial impact; once into the pack, increase speed to maintain headway and control of the ship.

(d) Be prepared to go "Full Astern" at any time.

(e) Navigation in pack ice after dark should not be attempted without high-power searchlights which can be controlled easily from the bridge; if poor visibility precludes progress, heave to and keep the propeller turning slowly as it is less susceptible to ice damage than if it were completely stopped.

(f) Propellers and rudders are the most vulnerable parts of the ship; ships should go astern in ice with extreme care - always with the rudder amidships.

(g) All forms of glacial ice (icebergs, bergy bits, growlers) in the pack should be given a wide berth, as they are current-driven whereas the pack is wind-driven.

(h) Wherever possible, pressure ridges should be avoided and a passage through pack ice under pressure should not be attempted.

(i) When a ship navigating independently becomes beset, it usually requires icebreaker assistance to free it. However, ships in ballast can sometimes free themselves by pumping and transferring ballast from side to side, and it may require very little change in trim or list to release the ship.The Master may wish to engage the services of an Ice Pilot, Ice Advisor or Ice Navigator in the Arctic.

Ice Terminology

"While the importance of sea ice in the global climate system has received increasing attention during the latter half of this century, the sea-ice cover has long been of significance for navigation and other human activities in the polar and sub-polar oceans. Out of these long traditions in polar travel, sea-ice nomenclature systems have evolved in different languages and cultures. Sea Ice Nomenclature of the WMO (World Meteorological Organization: WMO sea-ice nomenclature, terminology, codes and illustrated glossary, WMO/DMM/BMO 259-TP-145, Secretariat of the WMO, Geneva, 1985) represents a synthesis of such existing systems and has become the international standard nomenclature."[58]

The Ice Terminology terms that has been established by the World Meteorological Organization (WMO) can be found in Appendix C)[59]

[58] http://www.gi.alaska.edu/~eicken/he_teach/GEOS615icenom/icenom_intro.htm

[59] The World Meteorological Organization (WMO) is a specialized agency of the United Nations. It is the UN system's authoritative voice on the state and behaviour of the Earth's atmosphere, its interaction with the oceans, the climate it produces and the resulting distribution of water resources.

Geography and Ice Characteristics

The Arctic and Antarctic differ from each other, primarily because of their different geography. The Arctic ice is not as mobile as the ice formed in the Antarctic because the Arctic is almost completely surrounded by land making it a semi-enclosed ocean. The sea ice tends to stay in the cold Arctic waters. The Floes are more prone to converge, or bump into each other, and pile up into thick ridges. These converging floes make Arctic ice thicker.

The Antarctic is a land mass surrounded by an ocean. As the sea ice is formed, the open ocean allows sea ice to move more freely, resulting in sea ice that is highly deformed due to high drift speeds. The Antarctic sea ice will not form ridges as often as the sea ice in the Arctic. [60]

"The outstanding difference between Arctic and Antarctic ice, which becomes soon apparent to the navigator, is the softer texture of the latter. While Arctic sea ice appears to be formed primarily through surface freezing of sea water, Antarctic sea ice apparently includes substantial amounts of infiltrated snow ice and underwater ice. Infiltrated snow ice is formed by the flooding and refreezing of extensive fields of snow lying on existing floes. Underwater ice results from the growth and consolidation of a cloud of ice crystals in the cold water column beneath existing ice." [61]

Land ice forms when any part of the earth's seasonal or perennial ice cover has formed over land as the result, principally, of the freezing of precipitation; opposed to sea ice formed by the freezing of seawater.

> Thus, an iceberg or tabular iceberg is land ice as well as its parent glacier, ice sheet, or ice shelf. The two major concentrations of land ice are the ice sheets of Greenland and Antarctica. Glaciers and ice caps are the other important forms. [62]

Chile Navy Preliminary Report No. 1/2007

The Chilean Navy, Directorate General of the Maritime Territory and Merchant Marine, Investigation of Marine Incidents Division provided to the Administration its Preliminary Marine Casualty Report into the sinking of the EXPLORER.

According to the Report, the Chilean Navy icebreaker- AP 46 ADMIRAL OSCAR VIEL arrived on scene and conducted an assessment of the ice field that the EXPLORER encountered. After reviewing the report, the Investigating Officer requested supplemental information to clarify certain segments of the report. In correspondence to the Administration, the Directorate General provided excerpts of the quoted message sent by the AP 46 Admiral Oscar Viel.

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[60] http://nsidc.org/seaice/characteristics/difference.html National Snow and Ice Data Center 3 July 2008

[61] PUB. 200 SAILING DIRECTIONS (Planning Guide & Enroute)2007 Prepared and published by the National Geospatial-Intelligence Agency Bethesda Maryland Copyright 2007 by the United States Government.

[62] http://amsglossary.allenpress.com/glossary/search?id=land-ice1

The observations of the vessel were as follows;

1. Ice types and their dimensions as found at the place of the accident were: first year sea ice and land ice, coming from coastal detachment, and described as consolidated pack ice. It was composed of:

   - Small floe, 10 to 20 meters in diameter and 1 to 1.5 meters thick
   - Bergy bits, 3 to 30 meters in diameter and 2 to 5 meters high.
   - Growlers, 1 to 8 meters in diameter.
   - Brash-ice.
   - Pancake ice.
   - Weathered ice, 3 to 10 meters in diameter and 2 to 5 meters high.
   - There were no tabular bergs near the place of the accident.

2. A large number of bergy bits had rams of 1 to 15 meters long.

The report stated "The Bridge team made a mistaken assessment of the relative ice. While under dusk conditions, they classified it as first year ice and therefore of low risk, when in fact among the young ice there were bergy bits and growlers, some having long underwater rams (1 to 15 meters long), posing great danger due to its hardness."

The Chilean report quotes Derrotero Antartico Chileno (Chilean Sailing Directions for the Antarctic, which states that the risk posed by growlers is:

> "Ice bits, smaller than bergy bits, that barely surpass the sea surface; they are hard to sight as they have a greenish or blackish coloration. Their height above water surface is 30 cm. to 1 meter, but they hide several tons of extremely hard and compact ice under the surface. They are considered the principal enemy of seafarers sailing Antarctic waters, and are hardly detected by radar. They are land ice coming from a glacier. Quite often they crackle due to the effect of the sun over small spaces existing between the ice crystals which form them."

Ice Pilot (Navigator) [63]

According to the International Maritime Organization's Guidelines for Ships Operating in Ice –Covered Waters, (See Section below) an "Ice Navigator" means any individual who, in addition to being qualified under the STCW Convention, is specially trained and otherwise qualified to direct the movement of a ship in ice covered waters.

The Ice Navigator should have documentary evidence of having satisfactorily completed an approved training program in ice navigation. Such a training program should provide knowledge, understanding and proficiency required for operating a ship in Arctic ice-covered waters, including recognition of ice formation and characteristics; ice indications; ice manoeuvring; use of ice forecasts, atlases and codes; hull stress caused by

[63] http://www.imo.org/includes/blastDataOnly.asp/data_id%3D6629/1056-MEPC-Circ399.pdf

ice; ice escort operations; ice-breaking operations and effect of ice accretion on vessel stability.

The 1978 STCW Convention

"The 1978 STCW Convention was the first to establish basic requirements on training, certification and watchkeeping for seafarers on an international level. Previously the standards of training, certification and watchkeeping of officers and ratings were established by individual governments, usually without reference to practices in other countries. As a result standards and procedures varied widely, even though shipping is the most international of all industries. The Convention prescribes minimum standards relating to training, certification and watchkeeping for seafarers which countries are obliged to meet or exceed. The Convention did not deal with manning levels: IMO provisions in this area are covered by a regulation in Chapter V of the International Convention for the Safety of Life at Sea (SOLAS), 1974, whose requirements are backed up by resolution A.890(21) Principles of safe manning, adopted by the IMO Assembly in 1999, as amended by Resolution A.955(23) Amendments to the Principles of Safe Manning (Resolution A.890(21))." [64]

Ice Pilot (Navigator) Background and Assessment of Passenger Video

The Administration contacted a former Master of the EXPLORER that also served as an ice pilot. The Master/Ice Pilot had ten consecutive years experience operating in Antarctica. His career as an ice navigator began in 1998 as a junior officer on board the British Antarctic survey ice-breaking research/supply vessels. He served on the EXPLORER as Chief Officer (Staff Captain) from 2000 until 2003, when the vessel was sold. He transferred as Chief Officer to the MS EXPLORER II and served on board for the 2003/2004 season. In 2004, he was appointed as Master to the EXPLORER and served until August 2006 when his service was terminated. He continued as Master and/or ice pilot on various vessels for Arctic and Antarctic voyages. According to the ice pilot contacted, there are no formal requirements or certification to qualify as an ice pilot in Antarctica.

The video recorded by the passenger was provided to the former Master/Ice Pilot of the EXPLORER. By observing the company house flag hoisted on the gaff, the ice pilot determined that the wind was from the southerly quarter and the EXPLORER was entering the ice field on the leeward side of the ice field. He estimated the ice at 9/10th with "at least one multi-year ice floe readily apparent. He "would have been wary of committing to this particular patch under these circumstances, especially given the relatively poor light, wind speed and likelihood for alternative open-water routes nearby." He remarked that "the ice at the leeward edge will always tend to be less concentrated, and under less pressure that the ice at the windward edge."

In the video, between time 00m 30s to 01m 18s, the vessel appears to move bodily to starboard, and capsized a piece of ice to starboard. The ice pilot believed the

[64] http://www.imo.org/Conventions/contents.asp?doc_id=651&topic_id=257#intro

sequence in the video indicated the thickness of ice, "probably only 2nd year ice, but still, very thick and definitely very hard."

The ice pilot referred to a maneuver which began at 1m 32s as "ill-judged". "There is an "otherwise" ordinary floe just under the bow (i.e. the vessel is already drifting downwind of it) but instead of being left to clear it to starboard, the vessel is brought back to port so as to pass upwind of it, and as she passes it she undoubtedly leans on it with some force. From experience, to move any vessel a substantial distance laterally, in a tight space like this, against significant wind, requires a considerable burst of engine power and a substantial turning moment, and carries the distinct risk of making a fulcrum out of a section of the hull which is not adequately strengthened for that purpose. In any event, with this floe being downwind of the vessel, the starboard shoulder and flat-side will be forced against the flow, which is undesirable." At this point, the ice pilot said he would have stopped the vessel and let it fall back.

Near the end of the portion of the video taken while the passenger was on the bridge, at (02m 33s) and the open water visible in the distance, the vessel seemed to be proceeding at a "fairly high rate of passage through the ice at this stage given the 10/10 concentration, arguably close to 5 knots." At this point, when nearing the end of the ice field, the most amount of caution needed to be exercised. The Master of the EXPLORER was nearing the edge of the ice field and may have been impatient and not taken the "fastest and safest route through the ice."

Workshop Towards Improved Search and Rescue Coordination and Response in the Antarctic [65]

A workshop, hosted by the Chilean Navy's Directorate General of the Maritime Territory and Merchant Marine (DIRECTEMAR) was held in Valparaiso Chile 12 to 14 August 2008. It was in collaboration with the Council of Managers of National Antarctic Programs (COMNAP). The workshop was attended by people assembled from the five nations with search and rescue regions (SRR) extending to the South Pole, plus representatives from UK, France and USA, COMNAP and IAATO.

The workshop was designed to:

- Improve understanding of the nature and activities of RCCs and National Antarctic Programs, and how they can work together;
- Review the nature of maritime, aeronautical and land traffic in the Antarctic region and the challenges it poses for Search and Rescue; and
- Explore options for improved Search and Rescue coordination and response in the Antarctic.

[65] http://www.amsa.gov.au/about_amsa/corporate_information/Recent_Events/workshopsarcantarctic.asp

Investigation

The Investigating Officer was informed of the accident to the EXPLORER at 0600 on 23 November, 2007 (U.S. East Coast time). The Investigating Officer began the on-scene portion of the investigation at Punta Arenas, Chile on 26 November 2007. Most of the passengers had been repatriated or were in the process of being repatriated from Buenos Aires so the Investigating Officer could not conduct face to face interviews with most of the passengers. Two passengers remained in Punta Arenas and were invaluable in making subsequent contact with other passengers. Without the assistance of these two passengers that made contact with other passengers that came forward with information, photographs and videos, the Investigating Officer would have had difficulty getting the necessary information to conduct an investigation because of varying national privacy rules.

The other interested parties to the investigation consisted of the G.A.P. Shipping Co. Limited (owner of EXPLORER), Chile , Det Norske Veritas (Classification Society), Transportation Safety Board Canada.

The owners of the EXPLORER believed, and the Investigating Officer disagreed, that the Master of the vessel should have been an interested party. However, the Master was provided the opportunity to review the video made by the passenger. He responded by email as follows;

> "I have seen the film before. BBC1 made a TV program in Nov, -08 about the same film.
>
> The film is NOT showing the reality. It looks much more as it was on the film. I was chocked myself when I saw the film as it looks like. But I know how it was in the reality and comments from a passenger who never have seen Ice is not to rely on .
>
> I was called to the bridge around 22:00 because there was Ice ahead. We could see the open water behind the drift ice and the ice was partly open and not frozen together. [Expedition Group leader] and I discussed and decided to change destination and go to the Penguine Island and changed course accordingly. I took the decision to go through the ice and it was approximately 4 to 4.5 nautical miles to reach open water. I was of course aware that I had a fully Ice classed vessel in my hand. But at the end of the ice belt it started to get windy,(see the flag in the film) and the ice was drifting together, however we had still no problems to move forward through the ice.
>
> I have been taught by older and more experienced Captains to use one big ice flow as a shield and then push ahead through the ice and that was exactly what I did.
>
> My comments are: Check the flag and see how much wind it was! I had no other choice than to continue through the thicker belt of ice, which at this moment was approximately of a length of about 100 to 150meters. It must have been a piece of glazier ice which was frozen in to the one year ice which caused the penetration in the hull.

During my more than 20 years experience from ice navigation I didn't feel any danger to pass this ice belt, especially as I was on an Ice classed vessel. According to the Navigation Officers who was onboard the vessel during her Svalbard cruises, they had forced much heavier ice than what we now experienced. The ship had recently renewed all certificates and some steel plates were replaced in dry dock a few weeks earlier.

Personally I am surprised that no one has brought up and questioned why the submersible emergency bilge pump, with a capacity of 0.7 m3 per minute, did not manage to keep the water out of the ship. Even if the Chief Engineer confirmed that this pump had been started and was running, I strongly question if this answer was accurate. I canÂ´t believe that we initially took in more than, at the most 100 ? 200 liters per minute. At the moment I have no more comments."

ANALYSIS

INVESTIGATION PROCESS

Voyage Data Recorder (VDR)

IMO Guidelines on VDR Ownership and Recovery (MSC/Circ.1024-29 May 2002) is very clear that "in the case of abandonment of a vessel during an emergency, masters should, where time and other responsibilities permit, take the necessary steps to preserve the VDR information until it can be passed to the investigator."

The Master of the EXPLORER did not recover and remove the VDR before abandoning the vessel. When asked why he did not remove the VDR, he said he did not think of it because he was concerned with the safety of the passengers. The Master removed the Bridge Log Book and the navigational chart that was in use.

The Investigating Officer recognized that the Master was under considerable stress from the time of the initial alarm until all passengers were safely aboard the NORDNORGE. His primary concern throughout the emergency was the safety of the passengers and the passengers credited the actions of the Master for the successful rescue.

However, the technical representative from the operator, G.A.P. Shipping Sweden, was in contact with the Master and reminded the Master to remove the VDR. When the Master ordered the passengers to abandon the vessel, he could have had a crewmember retrieve the VDR and remove it from the vessel in a lifeboat.

Because the Master did not remove the VDR when he ordered the passengers to abandon the vessel, the owner, G.A.P. Shipping Co. Limited, had the obligation to take action to remove the VDR from the sunken vessel. The owner disputed that it was their responsibility and believed it was the responsibility of the Flag Administration. Given the ice environment of the EXPLORER and the abandonment of the vessel, the Master should have thought of, and attempted to remove the VDR. Failure to do so, the owner should have taken action to remove the VDR to ensure the timely preservation of this evidence.

Although the Investigating Officer is satisfied with information collected and believes the sequence of events is accurate, the recovery of the VDR would have removed all doubt as to events on the Bridge during the time leading up to the casualty and actions taken to save the vessel. The VDR would have provided the courses and speeds used during the ice transit. The conversations of the Bridge team from the time the vessel entered the ice until the time the Master ordered the passengers to evacuate the vessel would have provided factual confirmation of events.

Without the VDR the Investigating Officer had to rely on what may be considered subjective interpretations and observations of crewmembers and passengers. Although the Investigating Officer believes there was consistency in the interpretations and observations, recovery of VDR would have removed all doubt.

The Investigating Officer concluded that because the Master did not remove the VDR from the EXPLORER, the owner should have taken action to recover the VDR from the vessel.

The party responsible for recovery of the VDR should not be in doubt. In view of the disagreement between the Investigating Officer and owner of the EXPLORER, there should be clear guidelines designating responsibility for recovery of the VDR. The IMO should review the Guidelines for Ownership and Recovery of VDR to clarify the responsibility of Flag Administration and owner regarding recovery of the VDR.

The VDR is a new investigative tool for the marine industry that, post-accident, should be available to investigators so that all possible lessons can be learned from an accident. Operating companies must have a procedure in place for recovering the device with clear instructions through its on-board standing orders to ensure the timely preservation of this evidence. Procedures should include action the vessel personnel should take while time is available for recovery as well as company procedures for recovery in the event of catastrophic loss of vessel.

The VDR may have been retrieved had the capsule been stowed on the Flying Bridge and secured with a hydrostatic release. It is also possible that had the VDR capsule been secured by a hydrostatic release, the capsule may have floated beneath the ice field and never recovered. As in the EXPLORER, if the VDR is not recovered before the sinking, efforts to recover the unit later will be much more difficult. With the locator beacon (pinger), the chances of recovering the capsule is more likely if the capsule is released while the vessel is sinking rather than to be recovered from the sunken vessel.

The Investigating Officer concluded that given the Investigating Officer's experience during this investigation in attempting to convince the company G.A.P. Shipping Co. Limited to take action to retrieve the VDR and the reluctance of G.A.P. Shipping Co. Limited to pursue retrieval, the IMO should consider requiring VDR capsules be secured by hydrostatic release.

Passenger Contact Information

The investigating officer recognized that the passengers had just suffered a traumatic experience and would expect that most of them would want to be repatriated as quickly as possible. The Investigating Officer also recognized that G.A.P. Shipping Co. Limited could not prevent the repatriation of passengers before the arrival of the Investigation Officer. However, once the passengers were repatriated, their right to privacy prevented other Administrations from providing the passengers contact information to the Investigating Officer.

The Investigating Officer would have had difficulty contacting passengers without the assistance of two passengers from the United Kingdom. In addition, other passengers were proactive in contacting other passengers to provide as much information as possible to the Administration. There should be a procedure that focuses on cooperation between Administrations that provides the investigating Administration a mechanism for contacting passengers.

The Investigating Officer concluded that national privacy rules could prevent an investigator from obtaining critical passenger contact information during an investigation.

Passenger Repatriation

The Investigating Officer recognized that the owner of the EXPLORER had to address numerous logistical problems in arranging the repatriation of the passengers from the Naval Base in Chile to their homes. The passengers lost their personal belongings including change of clothing. Lodging and return flights had to be arranged for crewmembers and passengers. Providing the needs of the passengers and crewmembers on short notice required the owner/operator to have company representatives travel on short notice and make the necessary arrangements for the passengers and crewmembers.

Many of the passengers were satisfied, based on the circumstances, with the treatment that they received. However, a number of passengers felt the treatment was not satisfactory and felt they were subjected to additional injury from the treatment.

The determination as to whether the owner had provided to the needs of the passengers and did not inflict additional injury to the passengers should not be weighed by comparing those passengers that were satisfied with those that were dissatisfied. The owner should be concerned that any passenger that felt mistreated may have a valid reason. Any additional trauma suffered by a passenger should not be acceptable. In this regard, the owner/operator did not address the needs of all the passengers.

Crisis Management Plans should address the overall response to a crisis, including treatment of the passengers so that they do not suffer additional trauma.

The Investigating Officer concluded that the owner, G.A.P. Shipping Co. Limited was not adequately prepared for the post casualty treatment of passengers and should review and revise their Crisis Management Plan.

ACCIDENT ANALYSIS

Time of Damage

The vessel entered the ice field at about 2200 and maneuvered through various concentrations of ice and types of ice (See Section on Type of Ice Field). To determine the time of the damage to the EXPLORER, the Investigating Officer made the determination based on the statements by crew, passengers and Expedition Group members (manifested passengers) and supported by photos and video. The time of damage occurred sometime between 2315 and 0015 on 22 - 23 November. The Chief Officer and Second Engineer believed that the alarm to report to the muster stations was between 2340 and 2400. However, witnesses on the Bridge and the log entries do not support the times provided by the two.

The estimated time that the hull sustained damage that resulted in the flooding was determined by linking the events that occurred in the passenger cabins (308, 310, 312 and 314) to events on the Bridge. Passengers in cabins 310, 312 and 314 reported that they heard a large bang on the hull and also experienced immediate flooding in their cabins. The passenger in cabin 314 had his fingers pinched between his bunk and bulkhead when the side plating of the vessel was pushed in and almost immediately his cabin began flooding. He immediately activated the alarm. The passenger on the Bridge that was taking photographs said that after making contact with the "wall of ice" she observed the Master begin to maneuver the vessel by going ahead and astern on the engines to break up the ice. At nearly the same time the passenger alarm sounded in the Bridge. Although the times provided by the crew and passengers can vary by about fifteen minutes, the passenger on the Bridge that was taking photographs provided time stamped photos that link the flooding of the cabins to the time the EXPLORER struck the "wall of ice" and came to a stop. The time stamped photos taken about the time the vessel struck this "wall of ice" was 0002, 23 November, 2007

The Investigating Officer concluded that the EXPLORER sustained the damage to the hull at the time the vessel struck the "wall of ice" and came to a stop at about 0002, 23 November, 2007.

Extent of Damage

The initial assessment made on scene indicated that the EXPLORER sustained damage estimated to be a "fist sized hole". The Oiler that had reached in to feel the shell plating through the small opening made in the decorative paneling could not be certain if the damage was limited to the hole. His hands were cold and numb from working in the cold water and he was worried about cutting his hands on jagged edges. The limited size of the opening prevented him from getting an unobstructed view of the hull beyond cabin 314. After the Oiler and the AB believed they had plugged the hole, the Oiler said that he could see water continue to flow into the cabin. The water was flooding from forward (the locations of cabins 308, 310 and 312) and along the space between the decorative paneling and shell plating. The Chief Mate was on scene and also reported that it appeared that based on the amount of water flooding the space, there had to have been more extensive damage than just the "fist sized hole."

The Chief Officer stated that the four cabins 308, 310, 312 and 314 were flooding. Passengers in cabins 310, 312 and 314 reported that the water level in each cabin rose very quickly and the list appeared almost immediately after they knew their cabins were flooding. A fist size hole would not have caused all four cabins to flood at the rate described. The Chief Engineer believed that the empty fuel tank (19B), which was below the flooding cabins also had been "punctured" by the ice field. If the tank was punctured, it would explain as reported by passengers and crew, why the vessel listed to starboard as soon as the vessel began to flood.

The described scenario of four cabins flooding simultaneously followed by an immediate starboard list could not have been caused by a "fist sized hole". The damage sustained had to have extended along the length of the vessel from cabins 308 to 314 for at least a distance of 3.6 meters and, in all likelihood, had punctured and sliced holes along the shell plating.

The Investigating Officer concluded that the EXPLORER sustained puncture and slice holes that extended from cabins 308 through 314 and in all likelihood punctured #19B Deep Tank.

Type of Ice Field

Although the Master believed the EXPLORER was transiting an ice field consisting of softer first year ice, the type of ice was existence of hard ice was identified by the Chilean ice breaker as land ice. The video footage and still photos show that the EXPLORER entered an ice field with open areas until about midnight when the vessel came to an area of compact ice and a ridge, which a passenger referred to as a "wall of ice". Consistent statements by the Master and passengers reported that when the EXPLORER made contact with the "wall", the vessel came to an abrupt stop.

The Investigating Officer concluded that the EXPLORER transited an ice field that consisted of land ice and first year ice.

Assessment and Actions of Master

The Master of the EXPLORER was making his first trip as Master into Antarctic waters, and more specifically Antarctic ice. Although he was very experienced in ice navigation for Baltic waters, and had been in Antarctic waters, he was not familiar with the difference and potential for a different type of ice in these types of waters. As previously stated, the Chilean icebreaker that made a post-accident assessment contradicted the Master's claim that it was first year, soft ice and when in fact among the young ice there were, according to the Chilean assessment, "bergy bits and growlers, some having long underwater rams (1 to 15 meters long), posing great danger due to its hardness."

The Investigating Officer concluded that the Master of the EXPLORER was not familiar with Antarctic ice and made an assessment of the type of ice the vessel encountered based on his limited knowledge and understanding of Antarctic ice.

The decision to transit the ice field may have been made because the Master believed the ice was softer first year ice. When he entered the leeward side of the ice field there were openings in the ice field for the EXPLORER to pass through. The Investigating Officer was provided a copy of the Bridge log entries and charted positions for the 2000 to 2400 period. According to the copy of the nautical chart, a position was plotted at 2155 and 2400. Log entries indicated GPS positions for 2200 and 2400. The logged speeds indicated that the vessel made 8.1 nautical miles good from 2200 to 2400 which would indicate an overall average speed of 4 knots. However, the actual speed of the vessel could have varied and may have exceeded the four knots during the two hour period and been less than 4 knots at other times to average out to the 4 knots. Some passengers reported that they could hear the vessel change speeds from the sounds of the engine during the period.

Neither the Master nor Safety Officer could provide the speed of the vessel at the time the vessel encountered the "wall of ice". The video assessment made by a former ice pilot indicated that the vessel was traveling at "arguably five knots." Without the VDR data, and without the Master's recollection of the vessel speed at the time the vessel made contact with the "wall of ice" any conclusions made regarding the speed of the EXPLORER at the time the vessel sustained the hull damage is subjective. However, the Master's own written statement that "I was of course aware that I had a fully Ice classed vessel in my hand". This could indicate that the Master was overconfident in the capabilities of the EXPLORER to transit the ice field. At the time the EXPLORER made contact with the "wall of ice", open water was visible. The Master's decisions regarding speed of the vessel may have also been influenced by his desire to exit the ice field as soon as possible.

The Investigating Officer concluded that the Master transited the ice field with an overconfident attitude regarding the capabilities of the EXPLORER and, in all likelihood, struck the "wall of ice" at a rate of speed that was excessive to the type and concentration of the ice.

Final Capsizing of the EXPLORER

The EXPLORER was operating in an ice field and according to the Master, Chief Engineer, First Assistant Engineer and Safety Officer on watch, the watertight doors in the Engine Room and on the 300 level were closed. However, the Third Assistant Engineer told the Investigating Officer that the watertight door into the Separator Room was open when he went to assess the flooding in the room. An Oiler had just been sent to the Separator Room before the Third Assistant Engineer had assumed the watch. In all likelihood, he opened the door and did not close the door before returning to the Control Room to report his findings. Additionally, the status of the watertight doors did not have any bearing initially on the spread of the flooding. The watch officers on the Bridge and in the Engine Room said that it was a standing order that the watertight doors were to be closed when operating in ice fields.

The Investigating Officer concluded that the Type C watertight doors were closed up to the time when the EXPLORER sustained damage to the hull.

After the vessel began to flood, a chain of events hindered the crew's damage control efforts. About thirty minutes after the Damage Control team was on scene they believed the flooding on the 300 level was under control because the water level was dropping. The Master was informed that the flooding was under control and he went and briefed the passengers on the situation. As the Damage Control team worked to pump out the cabin spaces, they did not realize that the water was continuing to flood into the Separator Room via the down flooding ducts. The ducts operated as intended and routed the water from the passenger space down into the Engine Room. The Third Assistant Engineer began pumping the Separator Room bilges as soon as the flooding began. Once water drained into the Separator Room the bilge system was designed to pump out the accumulating water. However, the rate of flooding was too great for the bilge system and the level of water entering the space continued to rise. Had the Damage Control Team known that the water was flooding into the Separator Room, it is doubtful that it would have impacted their decision making and efforts. They were using the only two available portable submersible pumps.

The Chief Engineer stated that had he foreseen this scenario where the flooding from the 300 level would flood the Separator Room at such a rapid rate, he would have developed and installed a method to isolate the ducts. However, the water flooding into the Separator Space would have increased the stability of the vessel. Had the ducts been secured, the water may have remained on the 300 level and would have reduced the stability of the vessel which may have led to the vessel capsizing earlier and without warning.

Once the Separator Room began to flood, the crew faced additional problems. The electrical panel which provided power to the fuel oil pumps that supplied the fuel to the gravity tanks for the main engine and generators was in the Separator Room. Without power to the fuel oil pumps, there would be no fuel supplied to the gravity tanks and the generators would have less than thirty minutes of power. The Chief Engineer recognized that if there was any chance to save the vessel the crew would need generator power. He devised a plan for an alternate arrangement to fill the gravity feed tanks in order to supply fuel oil for the generators. The entire engine staff was taken from damage control efforts and sent to work on the alternate arrangements.

As the Separator Room flooded, the watertight door between the Separator Room and Generator Room did not maintain a watertight seal and water streamed into the Generator Room. The engine crew had to monitor the water entering the Generator Room as the water neared the foundation of the starboard generator. Without the third generator there would not have been enough power to operate the Bow Thruster.

The reason the watertight door between Generator and Separator Room leaked can be due to a number of reasons. It is possible that during the emergency, the door was not completely closed. However, the First Assistant Engineer stated he had closed it. It is possible that the gasket seal was damaged or not properly maintained. Without more information, the reason the door leaked cannot be determined. However, crewmembers need to be aware of the importance of watertight doors and the integrity of the gaskets that create the seal.

The Investigating Officer concluded that the reason the watertight door between Generator and Separator Room leaked could not be determined.

Before the engine staff could complete work on an alternate source of fuel to the generators, the fuel in the gravity tanks that fed the generators was consumed and the vessel lost power and lighting. Without power, the submersible pumps and ejector pumps could not operate. Also critical to the survivability of the passengers, without the generators there would have been no power to operate the ship cranes used to launch the Zodiacs.

At the time the EXPLORER lost power, the vessel was drifting back towards the ice field and an iceberg was drifting towards the vessel. The Master decided to evacuate the passengers from the vessel as a precautionary measure. The deck crew went to their lifeboat stations to abandon the ship while the engine crew continued to work to supply fuel to the generators.

The flooding continued into the Separator Room until the sewage (sanitary) tank was submerged. The water backed up through vent and toilet piping into all of the passenger cabins. As the water flooded from the toilets into the passenger cabins above the Generator Room, the water drained down into the Generator Room via the down flooding ducts in the same manner as what occurred with the Separator Room. Once the Chief Engineer verified the source of flooding into the Generator Room was from the toilets overflowing, he realized the vessel could not be saved and went to the Bridge and told the Master. When the engine crew was called to the Bridge for a muster, the watch engineers that left the Engine Control Room did not shut the watertight door between the Generator Room and Main Engine Room and did not shut down the main engines.

The passenger and crew cabins on the 300 level were divided into 4 separate compartments with watertight doors between each space. The one compartment standard meant that one compartment could flood and the EXPLORER would remain afloat. If the flooding could have been isolated to the Separator Room and cabin spaces above the Separator Room (from frames 45 to 60) the vessel should not have sunk. However, the flooding progressed into the passenger spaces above the Generator Room through the sewage system and entered the Generator Room through the down flooding ducts. The flooding progressed into the Main Engine Room because the watertight doors had not been closed. The vessel's list increased to starboard until the main deck was awash at the bow and stern (referred to as deck edge immersion). Water would have continued to flood into A deck and the list continued to increase until the Saloon deck was awash and water entered the Saloon Deck spaces.

Had the engine crew closed the watertight door between the Generator Room and Main Engine Room and shut down the engines it may have halted the progressive flooding. However, there were cabins above the Main Engine Room that were, in all likelihood, also flooding from the sewage system. There was no inspection of these cabins.

The leaking watertight door between the Separator Room and Generator Room allowed the flooding to spread. However, more critical to the outcome was that the back flooding from the sewage system was the primary reason the water could enter passenger cabins and other spaces as described allowing the progressive flooding to occur. The EXPLORER remained on the surface listing to starboard until about 1530 on 23 November when the vessel sank.

The Investigating Officer concluded that the EXPLORER sank because the watertight boundary could not be maintained in the one compartment (frames 45 to 60) and the adjacent compartments.

The Master and Chief Engineer considered other actions to take to save the vessel. The Master said he considered maneuvering the vessel to place the wind on the starboard side to create a port list. If he could have created a large enough port list, the damaged area may have been exposed and above the waterline. However, there was reportedly little wind at the time that could have aided to reverse the list. More important, a decision to attempt to reverse the list would have been risky because of the free surface effect from the water in the passenger cabins and Separator Room. While reversing the list and causing the vessel to heel to the port side, water would have shifted starboard to port and the free surface may have led to an immediate capsizing, depending on the amount and location of the water at the time.

The Chief Engineer dismissed the option of de-ballasting the ballast tanks. He said the tanks were too small to offset the list. In addition, there was no cross connection between ballast system and fuel tanks to fill any fuel tanks. De-ballasting the double bottoms would have decreased the vessel's stability and may have caused a capsizing before passengers and crew had abandoned the vessel.

The Investigating Officer concluded that the damage control efforts of the crew were appropriate based on the information and circumstances at the time.

Condition of Shell Plating

The EXPLORER was built in 1969 and had made over 250 trips to Antarctic waters during its 38 year history. Although the standards for ice class vessels have been revised throughout the EXPLORER's history, the EXPLORER was designed and built to international standards, SOLAS 1960 and did not have to comply with the revised standards.

As discussed, the EXPLORER sustained damage to the starboard side shell plating, but not to the port side shell plating. The Investigating Officer had to consider whether the condition of the damaged starboard shell plating and frames was inadequate and could withstand the ice pressures the vessel was subjected to.

According to DNV (see Factual Section Class 1A1 ICE-A Vessel), "the shell plating thickness of the ice belt was increased according to a formula above the normal thickness. Scantlings of platings, frames and stringers were not given as a direct function of local ice pressure but merely as a percentage increase above the normal class rules."

The EXPLORER was required to have thickness measurements (gauging) performed every five years during the Special Survey. The most recent Special Survey was conducted in 2005 and the results were provided to the Administration. According to DNV, the gauging results indicated that the vessel was within the standards of 1969. The gaugings of the starboard shell plating on the wind and water strake between frames 40 to 60 varied from 11.4 to 13.6 mm respectively. According to the gauging report, the measurements were within the class minimum required thickness of 9.6 to 10.4 mm respectively.

The Investigating Officer concluded that the EXPLORER met the minimum shell plating thickness requirements in place in 1969.

Shell plating, deck plating and frames on the port side were replaced during the October 2007 shipyard period. The Investigating Officer had to consider whether the reason the starboard side suffered damage while the port side did not was due to the newly replaced plating on the port side made is possible that the port side could withstand greater ice pressures than the starboard side. Based on the statement of the passenger in cabin 314 that had his fingers pinched, the frames on the starboard side were compressed inboard at the time of impact. One passenger was certain that he had seen red hull paint on the passing ice which would indicate that the vessel was transiting a field of compact ice. However, there was no way of determining if the ice pressures were equal on the port and starboard sides up to and at the time of contact with the "wall of ice".

The Investigating Officer concluded that it could not be determined if the reason that the EXPLORER sustained damage on the starboard side and not the port side was related to the condition of the frames, shell plating and deck plating on each side or due to the nature of the ice pressures the vessel was subjected to at the time of impact with the "wall of ice".

Although the EXPLORER met the standards set in 1969, the standards were revised and Polar Classes were established using "scenario based pressures". The standards of 1969 permit diminution to a minimum thickness and the diminution may be excessive for the vessels that operate under the older standards. The EXPLORER sank which made it impossible to determine if the shell plating, frames and deck plating on the starboard side were inadequate. However, there are other ships operating in polar waters that are classed according to the older standards. There should be an assessment of existing ships that are classed under the pre-polar class rules using "scenario based pressures" to determine if the allowable diminution should be decreased.

The Investigating Officer concluded that there should be a review of diminution of shell plating using "scenario based pressures" to determine if the allowable diminution under the older rules provides a necessary margin of safety.

The Investigating Officer requested historical gauging records (Special Survey Reports) from DNV and G.A.P. Shipping Co. Limited. Initially, DNV only provided the 2005 Special Survey report. [66] The previous manager and owner of the company were contacted by the Administration and they stated that all the records were turned over to G.A.P. Shipping Co. Limited on change of ownership. In addition, repair records and

[66] Gap Adventures, DNV, Canada TSB and Chile MRCC were interested parties to the investigation and were provided the opportunity to comment on the draft report. DNV objected to the statement that only the most recent gauging report was available and that the Investigating Officer only requested the most recent gauging report. The Investigating Officer disagrees. Requests for the historical record of surveys were made by email and phone calls. DNV included the 6th Special Survey (conducted September 2000 in Falmouth, Cornwall) with the comments to the draft report. DNV also stated that "records of previous measurements are generally summarized as part of relevant hull survey reports." However, DNV did not have detailed gauging records prior to September 2000 6th Special Survey.

invoices for shell plating renewal were also requested. With the exception of the repair to the port side shell plating performed in October 2007, no other records were provided.

The Investigating Officer concluded that the shell plating on the starboard side was the original plating from vessel construction.

The Investigating Officer concluded that the historical records dating back to vessel construction were not available; therefore an assessment could not be made to determine if there was a trend in the diminution of the shell plating.

Cause of the Accident

The decision by the Master to enter the ice field based on his knowledge and information available at the type was the primary reason why the EXPLORER suffered the casualty. He was under the mistaken impression that he was encountering first year ice when in fact, as the Chilean Navy Report indicated, was much harder land ice. The ice pilot that made the assessment of the passenger video also believed that the ice was thicker and harder than the Master's assessment. Passengers reported seeing red paint on the passing ice less than thirty minutes prior to the flooding was reported, another indication that the vessel was passing through compact and hard ice. The Master of the EXPLORER was very experienced in Baltic waters but he was unfamiliar with the type of ice he encountered in Antarctic waters. The Master should have altered course to open water and not have entered the ice field during darkness. However, once he had entered the ice field and approached the "wall of ice", there is no indication that he reduced the EXPLORER's speed as he approached and then made contact with the "wall of ice".

There are no competency training requirements for STCW 1978 As Amended for ice pilots (navigators). Although Guidelines are provided by the IMO, the term "ice pilot (navigator)" is subjective. This accident points to the need for establishing competency training requirements to qualify as an ice pilot.

The Investigating Officer concluded that had the Master been trained for the ice conditions in the Antarctic region, in all likelihood he either would have taken action to avoid the hard ice or maneuvered the EXPLORER with greater attention to the vessel's speed.

RESPONSE TO THE EMERGENCY

Emergency Response

The EXPLORER crew and Expedition Group should be recognized for their response to an emergency that could have led to large loss of life. Although the vessel was lost, there were no fatalities or any major injuries.

The Master's decision to evacuate the passengers was a precautionary measure. However, if he had waited until the Chief Engineer informed him that the vessel could not be saved the crew would probably have still been launching the lifeboats with the passengers when the EXPLORER was moving full speed astern. If the Master had waited, as the vessel's list increased, it would have prevented the use of the lifeboats on the port side leading to more overcrowding of the lifeboats on the starboard side. The potential for loss of life would have been very high if the Master had delayed his decision to order the passengers to abandon the ship.

The Investigating Officer concluded that the Master's decision to evacuate the passengers as a precautionary measure, in all likelihood, saved lives.

The Engine Crew in particular, at the direction of the Chief Engineer, demonstrated ingenuity and bravery to the point where they remained behind on the vessel to keep engine plant operating while the passengers were evacuated from the vessel. The Chief Engineer recognized that a flooded Separator Room would lead to a power loss to the feed pumps and fuel to the generators would not be provided. He devised and implemented a plan that provided an alternate source of fuel to the generators that, in all likelihood, saved lives. Because power was restored to the generators, the Master could maneuver the vessel into the sea and launch the lifeboats. The restored power made it possible for the crew to operate the cranes for the launching of the Zodiacs.

The Investigating Officer concluded that the Engine crew of the EXPLORER should be recognized for their actions to restore power to the vessel which, in all likelihood, saved passengers lives.

The Master of the EXPLORER contacted the Master of the ENDEAVOUR by cell phone early in the accident. The vessels in the Antarctic region that were members of IAATO maintained contact and were aware of the locations of other vessels because of recommended procedures used by IAATO vessels. By directly calling the ENDEAVOUR, the Master of the EXPLORER gained valuable time by calling for assistance before the MRCC had taken action.

The sea conditions that existed from the time the vessel sustained the damage until the passengers and crew were safely aboard the NORDNORGE contributed to the successful rescue. Within two hours after the passengers and crew were aboard the NORDNORGE, the weather conditions deteriorated with gale force winds. The responding vessels NORDNORGE and NATIONAL GEOGRAPHIC ENDEAVOR were able to make best speed to arrive at the scene. If the NORDNORGE's speed to the scene had been reduced due to rough sea conditions, there may have been fatalities from hypothermia.

In addition, if the seas had increased before the arrival of the NORDNORGE the overloaded lifeboats without operating engines would have been vulnerable to capsizing. Rougher sea conditions would have affected the Zodiacs ability to tow the lifeboats. The Zodiacs are not designed for towing other vessels. The lifeboats are heavy vessels that, under the best of circumstances, are not considered highly maneuverable. Under the existing sea conditions the Zodiacs could tow and keep the lifeboat's bow headed into the seas. In heavier sea conditions, and without the Zodiac towing the lifeboat, a lifeboat may have broached (broadside or beam to seas) and capsized.

The Investigating Officer concluded that the fair weather conditions contributed to the successful rescue of the passengers.

Although the rescue of the passengers was successful due to the actions of the crew and because of favorable weather conditions, the outcome may have been different under different circumstances and there are lessons to be learned from the accident.

Many of the passengers did not know which lifeboat to report to when the order to abandon the ship had been given. Although they were assigned to the lifeboats at the initial muster and briefing, some were not certain if they were supposed to use the same boats during an emergency. When the emergency announcement to abandon the vessel was given, some passengers went to the originally assigned lifeboats while some passengers went to the boats on the port side. Some of the passengers followed other passengers. One passenger said that the Expedition Group leader directed passengers to lifeboats as they exited the muster station. The Expedition Group leader directed the first half of the group to the starboard lifeboats. After he estimated half of the passengers had exited, he sent the second group to the port side lifeboats. Passengers in two of the lifeboats described how their boats were overloaded and in one of the boats, passengers had to stand because there was no room to sit. They were in danger of falling overboard until they were transferred to a Zodiac.

One passenger said that the passengers were not permitted to board the lifeboat while crewmembers attempted to start the lifeboat engine because the boarding passengers would have interfered with the crew attempting to start the engine. The passengers did not board for about 20 minutes until the Master came out of the Bridge and ordered the boat to be loaded and lowered. When the boats were waterborne but still alongside the ship, they used oars and other lifeboat equipment to push off the vessel. In another circumstance, the delay in boarding the lifeboat could have been critical. If the EXPLORER was not headed into the sea or seas were rough, the lifeboats could have capsized as soon as they were waterborne. As discussed earlier, failure to start three of four lifeboat engines could have resulted in a lifeboat capsizing.

The crewmembers stated that the reason they could not have started the engines was because they were already wet and cold from their damage control efforts. A former Chief Officer of the EXPLORER stated that the engines were difficult to start because of the required strength needed to crank the engine. However, the Chief Engineer believed it was an issue of training and that usually the engine department was assigned the task of starting the engines and the deck crew did not know how to start the engines.

The Investigating Officer concluded that the failure of the crew to start three of the four lifeboat engines endangered the passengers and it was only due to the Zodiacs ability to tow the lifeboats in the existing sea conditions that prevented loss of life.

All four lifeboats were open and exposed to the elements. The lifeboats were equipped with canopy covers that were never used. During interviews and included in a few of the passenger questionnaires some of the passengers believed that enclosed lifeboats should be required for passenger vessels. Other passengers believed that had they been in enclosed lifeboats, there may have been problems within the lifeboats because of the seasick passengers and being in an enclosed environment. Other passengers believed the most dangerous and risky time was when they had to transfer from their lifeboat to either the NORDNORGE's lifeboat or Zodiac. The motion of the smaller vessels in the sea made transfer risky. The transfer from the hatch of a totally enclosed lifeboat to another hatch of a lifeboat would have been much more difficult and risky with the motion of the vessels in the sea.

The passengers were in the lifeboats for about one hour before they learned there were thermal blankets and seasickness tablets in the lifeboats. One passenger stated that they learned of the emergency equipment when one of the passengers opened one of the lifeboat lockers and found the equipment. The passengers could not recall hearing any of the boat commanders tell them about the available equipment. Some of the passengers claimed that the blankets kept them warm while others said the blankets were ineffective. However, some of the passengers were already wet and very cold by the time they learned of and were provided a thermal blanket.

There were twelve immersion suits stowed in lockers adjacent to the lifeboats that should have been used. The decision as to who should get a survival suit may have led to resentment and anger from passengers and crew that did not get a suit. However, the suits should have been provided to the key personnel operating the lifeboats, attempting to start the engines and making the decisions in the lifeboats. Key personnel must focus on the emergency and making decisions to respond to the emergency and if the boat commanders and crew attempting to operate the engines had donned immersion suits, they may have reacted more effectively during the accident. Had seas deteriorated earlier, key personnel would not have been prepared to respond because they would have been focusing on keeping themselves warm and not on command of the boat.

The Investigating Officer concluded that the failure of the key personnel to don immersion suits may have endangered the passengers had sea conditions been more severe while passengers and crew were in the lifeboats.

The EXPLORER had open lifeboats and was traveling to polar waters on a regular basis. The trip to the Antarctic was not a unique tour. Although SOLAS requirements did not require immersion suits for all passengers on board, it should be recognized that immersion suits are critical to the survivability of passengers. Had any passengers fallen in the water while in the lifeboats or while transferring to Zodiacs or to the NORDNORGE, survival time would have been limited. Had the passengers remained in the lifeboats for another one or two hours, there may have been fatalities due to hypothermia. Passenger vessels with routes operating in polar waters should carry enough immersion suits for all on board.

The Investigating Officer concluded that vessels traveling to polar waters should carry immersion suits for all the passengers and crew on board to enhance the survivability of passengers and crew in the event of an emergency.

The Investigating Officer recognized that while the EXPLORER crew was involved in damage control efforts the Expedition Group was assigned the task of tending to the passengers. The Expedition Group were prepared to operate the Zodiacs but were not prepared or trained to prepare the passengers for abandoning the vessel. During the time the passengers were mustered, the passengers should have been reminded of lifeboat assignments and prepared for abandoning the vessel. Instead, passengers were not controlled to the point where some were allowed to return to their cabins to pack their luggage. The time the passengers were mustered should have been used to prepare for a possible evacuation of the vessel.

The Investigating Officer concluded that the passengers were not adequately prepared for the evacuation of the vessel and the time in the lifeboats while they were assembled at the muster station.

Throughout the emergency, the Expedition Group members served in the capacity of crew yet were not assigned as crew. Once the Zodiacs were launched and took the lifeboats in tow, the Zodiacs in effect, were in control of the lifeboats. The situation can lead to confusion when the Expedition Group leader is making decisions for the passengers. Although he is always under the direct orders of the Master as a "passenger" the chain of command may become blurred when the Expedition Group leader is a direct employee of company.

The actions by the Expedition Group probably saved lives. However, it was clear that the Expedition Group was responding to the emergency as crewmembers and should not be carried as passengers. In an emergency it is appropriate to use all resources available and in this case, the crew was occupied with damage control duties. However, to expect that the Expedition Group would not be involved in tending to the passengers in an emergency is unrealistic. They were on board the vessel for the specific purpose of tending to the passengers. The passengers reported that they were familiar with all of the Expedition Group members and turned to them for information and instructions during the emergency. The Expedition Group served the function of crew members and should have the required safety training and documents as seafarers. If listed in the crew, they would have had designated assignments on the Emergency Station Bill.

The Investigating Officer concluded that the Expedition Group acted as crew in that they were apparently assigned functions that are normally the duties of the crew. The function and responsibility of the Expedition Group should have been clearly established since they are not part of the vessel's navigation crew.

The Investigating Officer recognized that each emergency situation will be different and that crews must adapt to the circumstances at the time. In this case, the deck crew was involved with damage control efforts while the engine crew was involved with providing fuel for the generators and main engines. The Expedition Group was not assigned duties on the Emergency Station Bill and may not have been fully aware of all the Emergency Procedures. However, the procedures for emergency muster, assignment of lifeboats and abandonment of vessel should be followed or confusion and panic may occur.

The crew did not seem aware of the emergency supplies in the lifeboat or did not think to distribute items such as the thermal blankets or seasickness tablets. The crew did not use the immersion suits, passengers were unsure of lifeboat assignments and the crew could not start three of four lifeboats. All of these factors point to a weakness in emergency preparation. Procedures that existed for abandoning the vessel were not followed indicating that the drills to prepare for the actual emergency were not effective.

"The emergency response demonstrates the "importance of preparations before abandoning a vessel. The earlier (preparatory) phase of evacuation – muster and clear away – is a critical element of a passenger vessel's abandonment process. It is essential that all passengers be accounted for and that they board survival craft in an organized, and efficient manner. Crew members must therefore be familiar with mustering and crowd- control procedures, as well as passenger counting methods and measures to reconcile any discrepancies in those counts." [67]

The Investigating Officer concluded that the crew failed to follow Abandon Ship procedures which indicated a weakness in drilling and training.

Rescue Coordination

It was clear that the Argentine Maritime Rescue Coordination Center was not prepared for responding to the emergency on the EXPLORER. The Expedition Group member that was assigned the task of communicating with Chilean and Argentine MRCCs discontinued his attempts to request assistance from the Argentine MRCC when he was told after three attempts to call back. In addition, according to the Master of the NORDNORGE, the Argentine MRCC instructed him to follow the orders of their MRCC even though they were not responding to the accident site. Fortunately, the Master had been in contact with the Chile MRCC and had already been assigned the "On scene Commander" and to coordinate action to rescue the passengers. He made the decision to follow the orders of Chile MRCC which proved to be the correct decision.

Procedures for responding to emergencies in Antarctic waters should be addressed by the nations that are members of the Antarctic Treaty System (ATS). When lives are at stake, jurisdictional issues or concerns should not impact an emergency response. Rapid response to an emergency may save lives and prevent damage to the environment. There should be procedures designating which MRCC will coordinate the rescue and a plan for the sharing of assets during the rescue.

The Investigating Officer concluded that jurisdictional issues between regional MRCCs could have adversely impacted the rescue of the passengers and there needs to be clear procedures for the coordination of search and rescue operations in the Antarctic region.

[67] Transportation Safety Board of Canada; Memo, dated 16 January 2009, Party Comment to draft report.

CONCLUSIONS

On the basis of the findings, the Investigating Officer reached the following conclusions:

1. The EXPLORER transited an ice field that consisted of land ice and first year ice.

2. The Master of the EXPLORER was not familiar with Antarctic ice and made an assessment of the type of ice the vessel encountered based on his limited knowledge and understanding of Antarctic ice.

3. The Master transited the ice field with an overconfident attitude regarding the capabilities of the EXPLORER and, in all likelihood, struck the "wall of ice" at a rate of speed that was excessive to the type and concentration of the ice.

4. Had the Master been trained for the ice conditions in the Antarctic region, in all likelihood, he either would have taken action to avoid the hard ice or maneuvered the EXPLORER with greater attention to the vessel's speed.

5. The EXPLORER sustained the damage to the hull at the time the vessel struck the "wall of ice" and came to a stop at about 0002, 23 November, 2007.

6. The EXPLORER sustained puncture and slice holes that extended from cabins 308 through 314 and in all likelihood punctured #19B Deep Tank.

7. The EXPLORER sank because the watertight boundary could not be maintained in the one compartment (frames 45 to 60) and the adjacent compartments.

8. It could not be determined if the reason that the EXPLORER sustained damage on the starboard side and not the port side was related to the condition of the frames, shell plating and deck plating on each side or due to the nature of the ice pressures the vessel was subjected to at the time of impact with the "wall of ice".

9. The historical records dating back to vessel construction were not available; therefore an assessment could not be made to determine if there was a trend in the diminution of the shell plating.

10. There should be a review of diminution of shell plating using "scenario based pressures" to determine if the allowable diminution under the older rules provides a necessary margin of safety.

11. The shell plating on the starboard side was the original plating from vessel construction.

12. The EXPLORER met the minimum shell plating thickness requirements in place at the time of its construction in 1969.

13. The fair weather conditions contributed to the successful rescue of the passengers.

14. The Master's decision to evacuate the passengers as a precautionary measure, in all likelihood, saved lives.

15. The Engine crew of the EXPLORER should be recognized for their actions to restore power to the vessel which, in all likelihood, saved passengers lives.

16. The damage control efforts of the crew were appropriate based on the information and circumstances at the time.

17. The Type C watertight doors were closed up to the time when the EXPLORER sustained damage to the hull.

18. The reason the watertight door between Generator and Separator Room leaked could not be determined.

19. The passengers were not adequately prepared for the evacuation of the vessel and the time in the lifeboats while assembled at the muster station.

20. The failure of the crew to start three of the four lifeboat engines endangered the passengers and it was only due to the Zodiacs ability to tow the lifeboats in the existing sea conditions that prevented loss of life.

21. The failure of the key personnel to don immersion suits may have endangered the passengers had sea conditions been more severe while passengers and crew were in the lifeboats.

22. The crew failed to follow Abandon Ship procedures which indicated a weakness in drilling and training.

23. Vessels traveling to polar waters should carry immersion suits for all the passengers and crew on board to enhance the survivability of passengers and crew in the event of an emergency.

24. The Expedition Group acted as crew in that they were apparently assigned functions that are normally the duties of the crew. The function and responsibility of the Expedition Group should have been clearly established since they are not part of the vessel's navigation crew.

25. The owner should have taken action to recover the VDR from the EXPLORER because the Master failed to remove the VDR from the EXPLORER.

26. Given the Investigating Officer's experience during this investigation in attempting to convince the company G.A.P. Shipping Co. Limited to take action to retrieve the

VDR and the reluctance of G.A.P. Shipping Co. Limited to pursue retrieval, the IMO should consider requiring VDR capsules be secured by hydrostatic release.

27. National privacy rules could prevent an investigator from obtaining critical passenger contact information during an investigation.

28. The owner, G.A.P. Shipping Co. Limited was not adequately prepared for the post casualty treatment of passengers and should review and revise their Crisis Management Plan.

29. Jurisdictional issues between regional MRCCs could have adversely impacted the rescue of the passengers and there needs to be clear procedures for the coordination of search and rescue operations in the Antarctic region.

RECOMMENDATIONS

1. The Office of the Deputy Commissioner should take administrative action against the certificate of competency issued to the Master of the EXPLORER in view of the Master's lack of knowledge which contributed to the cause of the casualty. The Master failed to recognize the type of ice field and, in all likelihood, failed to make appropriate decision as to speed when he in navigated the vessel in the ice field.

2. The Republic of Liberia should use its influence at the IMO to recommend that the IMO establish competency training requirements for ice navigators pursuant to STCW 1978 As Amended.

3. The Republic of Liberia should use its influence at the IMO to recommend VDR capsules be secured with hydrostatic releases.

4. The Liberian Administration should require that Liberian flag passenger vessels traveling to polar regions carry immersion suits for all passengers and crew on board and should use its influence at the IMO to recommend that all vessels be required.

5. The Liberian Administration should require Liberian flag vessels traveling to polar regions must have, as minimum, partially enclosed lifeboats and should use its influence at the IMO to recommend that all vessels be required.

6. The Liberian Administration should require G.A.P. Shipping Co. Limited sign on the Expedition Group as documented/trained crew members and should use its influence at the IMO to recommend that all vessels be required.

7. The Liberian Administration should require Liberian flag vessels traveling to Antarctic Region be members of IAATO and comply with all IAATO procedures and should use its influence at the IMO to recommend that all vessels be required.

8. The Liberian Administration should inform DNV that their procedures be revised so that vessels gauging records are maintained and available throughout the life of any vessel.

9. The Liberian Administration should inform DNV that they review the minimum requirements for deck and shell plating thickness for all ice class vessels for the consideration of updating the current standards.

10. The Liberian Administration should inform DNV that they review their survey procedures focusing on the lessons learned from this investigation so that the surveyors review flooding boundaries to determine if vessel systems and components such as the sewage system and down flooding ducts can compromise the vessel's watertight boundary in the event of damage and flooding.

11. The Liberian Administration should inform G.A.P. Shipping Co. Limited that they reassess their procedures for review of:
    - Abandon Ship Procedures including the assignment of crew and passengers to lifeboats,
    - Crowd Control Procedures,
    - Drilling and training in lifeboat engines,
    - Procedures for Emergency Briefings including discussion of equipment in lifeboats,
    - Develop procedure for VDR recovery,
    - Develop Crisis Management Plans.

Michael Davies-Sekle, Esq.
Head, Investigation Department

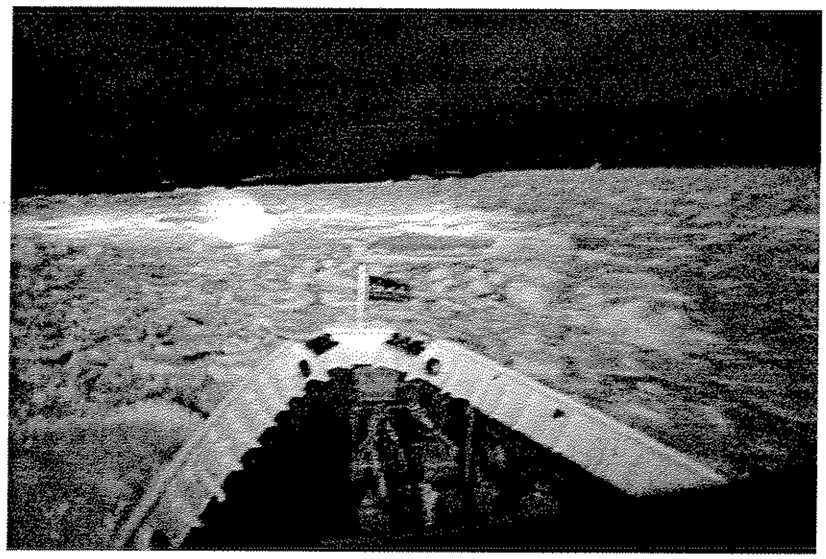
Robert Ford
Investigating Officer

12th day of March 2009

APPENDIX

Appendix A: Photos taken by passenger on Bridge

Date 23/1107 Time: 3:27Taken from the Bridge. First picture of ice flow.



23/11/07 Time: 4:02 Taken from the Bridge. I felt uneasy as the ridge was getting nearer so did not take this picture very well. I was going to take another photo but we were up to the ridge and I held on to a pole in front of me. The ship hit the ridge hard and it felt like it came to a stop. It was very shortly after this that the passenger alarm went off, the Captain checked the damage, sounded the muster alarms it was then I left the Bridge

Two photos taken by passenger on Bridge. Top photo as vessel enters ice and bottom photo about same time vessel nears wall of ice and comes to a stop. The camera times in photo were set to British Standard Time or one hour ahead of GMT in May 2007. Subtract four hours for local time on EXPLORER.

Appendix B: Tank Capacity Tables

9. TANK CAPACITY TABLES

Derived from new NAPA computer model.

9.1 FUEL OIL (Specific Gravity = 0.850) Total 273.3 tonnes

Tank Name	Frames	Capacity 100% (m³)	Capacity 100% (tonnes)	LCG (m)	VCG (m)	FSM (t.m)
No. 01&02 Aft Peak Tank P&S *	-9 – 1	57.8	49.1	-1.34	5.17	144
No. 03 D.B. Tank C	9 – 18	13.9	11.8	9.00	0.53	19
No. 04 D.B. Tank P	35 – 45	16.0	13.6	24.30	0.47	14
No. 05 D.B. Tank S	35 – 45	16.0	13.6	24.30	0.47	14
No. 06 D.B. Tank P	45 – 60	23.1	19.6	31.88	0.48	20
No. 07 D.B. Tank S	45 – 60	23.1	19.6	31.88	0.48	20
No. 08 Deep Tank P	50 – 55	13.6	11.6	31.80	2.06	2
No. 09 Deep Tank S	50 – 55	13.6	11.6	31.80	2.06	2
No.11 Deep Tank S	60 – 66	29.5	25.1	38.11	2.10	11
No.12 D.B. Tank P	60 – 71	13.9	11.8	39.31	0.47	9
No.13 D.B. Tank S	60 – 71	13.9	11.8	39.31	0.47	9
No.19A Deep Tank P *	54 – 60	39.7	33.8	34.51	1.96	68
No.19B Deep Tank S *	54 – 60	39.7	33.8	34.51	1.96	68
No.28 F.O. Overflow Tank P	25 – 29	4.0	3.4	16.57	0.63	1
No.33 D.B. Sludge Tank C	48 – 50	1.7	1.4	29.70	0.46	0
No.38 Aux. Day Tank P	42 – 44	2.7	2.3	26.10	1.76	1

9.2 LUBE OIL (Specific Gravity = 0.900) Total 47.3 tonnes

Tank Name	Frames	Capacity 100% (m³)	Capacity 100% (tonnes)	LCG (m)	VCG (m)	FSM (t.m)
No.23 D. B. Storage Tank C	24 – 29	5.2	4.7	16.20	0.55	1
No.24 D. B. Used Tank C	29 – 33	4.1	3.7	18.90	0.55	1
No.26 D. B. Gear Oil Tank S	26 – 28	3.3	3.0	16.51	0.61	2
No.27 D. B. PRP Oil Tank P	30 – 31	1.3	1.2	18.60	0.58	0
No.29 D. B. PRP Oil Tank P	30 – 31	0.6	0.6	18.61	0.66	0
No.30 D. B. Cir. Oil Tank P	31 – 33	3.4	3.1	19.46	0.60	3
No.31 D. B. Sludge Tank S	28 – 31	5.6	5.0	18.02	0.61	5
No.32 D. B. Cir. Oil Tank S	31 – 33	3.5	3.2	19.45	0.60	3
No.36 D. B. Storage Tank C *	71 – 81	24.8	22.3	45.69	0.52	132

9.3 POTABLE WATER (Specific Gravity = 1.000) Total 20.8 tonnes

Tank Name	Frames	Capacity 100% (m³)	Capacity 100% (tonnes)	LCG (m)	VCG (m)	FSM (t.m)
No.14 Deep Tank C	67 – 71	19.0	19.0	41.71	2.36	13
No.25 D.B. Cool Tank S	23 – 25	1.8	1.8	14.72	0.63	0

9.4 FRESH WATER BALLAST (Specific Gravity = 1.000) Total 182.4 tonnes

Tank Name	Frames	Capacity 100% (m³)	Capacity 100% (tonnes)	LCG (m)	VCG (m)	FSM (t.m)
No.15 Deep Tank C	71 – 79	57.4	57.4	45.89	2.13	32
No.16 Deep Tank P	81 – 92	37.2	37.2	51.97	2.60	12
No.17 Deep Tank S	81 – 92	37.2	37.2	51.97	2.60	12
No.18 Fore Peak Tank	96 – FE	50.6	50.6	60.42	4.37	16

9.5 WATER BALLAST (Specific Gravity = 1.025) Total 66.3 tonnes

Tank Name	Frames	Capacity 100% (m³)	Capacity 100% (tonnes)	LCG (m)	VCG (m)	FSM (t.m)
No.20 D. B. Tank P	35 – 45	8.3	8.56	24.44	0.59	10
No.20 D. B. Tank S	35 – 45	8.3	8.5	24.44	0.59	10
No.21 D. B. Tank P	45 – 60	11.4	11.7	31.36	0.60	14
No.21 D. B. Tank S	45 – 60	11.4	11.7	31.36	0.60	14
No.22 D. B. Tank P	60 – 71	5.5	5.6	39.63	0.63	7
No.22 D. B. Tank S	60 – 71	5.5	5.6	39.63	0.63	7
No.37 D. B. Tank C	81 – 92	14.8	15.2	51.76	0.55	41

Note: VCG measured from moulded baseline
LCG measured from aft perpendicular
FSM calculated as maximum at zero heel

Appendix C: Ice Terms

The following glossary provides definitions in general use for the many kinds of ice encountered at sea. The terms are based on the nomenclature established by the World Meteorological Organization (WMO).

Aged ridge.—A ridge which has undergone considerable weathering. These ridges are best described as undulations.
Anchor ice.—Submerged ice attached or anchored to the bottom, irrespective of its formation.
Area of weakness.—A satellite-observed area in which either the ice concentration or the ice thickness is significantly less than that in the surrounding areas. Because the condition is satellite observed, a precise quantitative analysis is not always possible, but navigation conditions are significantly easier than in surrounding areas.
Bare ice.—Ice without snow cover.
Belt.—A large feature of ice arrangement; longer than it is wide; from 1 km to more than 100 km in width.
Bergy bit.—A large piece of floating ice generally showing between 1 and 5m above sea level and normally about 100 to 300m2 in area.
Bergy water.—An area of freely navigable water in which ice of land origin is present in concentrations of less than onetenth There may be sea ice present, although the total concentration of all ice should not exceed one-tenth.
Beset.—Situation of a vessel surrounded by ice and unable to move.
Big floe.—See Floe.
Bight.—Extensive crescent-shaped indentation in the ice edge formed by either wind or current.
Brash ice.—Accumulations of floating ice made up of fragments not more than 2m wide.
Bummock.—From the point of view of the submariner, a downward projection from the underside of the ice canopy, the counterpart of a hummock.
Calving.—The breaking away of a mass of ice from an ice wall, ice front, glacier, or iceberg.
Close pack ice.—Pack ice in which the concentration is seven-tenths to eight-tenths, composed of floes mostly in contact.
Compacted ice edge.—A ridge which has undergone considerable Close, clear-cut ice edge compacted by wind or current, usually on the windward side of an area of pack ice.
Compacting.—Pieces of floating ice are said to be compacting when they are subjected to a converging motion, which increases ice concentration and/or produces stresses that may result in ice deformation.
Compact pack ice.—Pack ice in which the concentration is ten-tenths and no water is visible.
Concentration.—The ratio expressed in tenths describing the amount of the sea surface covered by floating ice as a fraction of the whole area being considered. Total concentration includes all stages of development that are present. Partial concentration may refer to the amount of a particular stage or of a particular form of ice and represents only a part of the total.
Concentration boundary.—A line approximating to the transition between two areas of pack ice with distinctly different concentrations.
Consolidated pack ice.—Pack ice in which the concentration is ten-tenths and the floes are frozen together.
Consolidated ridge.—A ridge in which the base has frozen together.
Crack.—Any fracture of fast ice, consolidated ice, or a single floe which has been followed by a separation ranging from a few centimeters to 1m.
Dark nilas.—Nilas which is under 5cm in thickness and is very dark in color.
Deformed ice.—A general term for ice which has been squeezed together and in places forced upwards (and downwards). Subdivisions are rafted ice, ridged ice, and hummocked ice.
Difficult area.—A general qualitative expression to indicate, in a relative manner, that the severity of ice conditions prevailing in an area is such that navigation in it is difficult.
Diffused ice edge.—Poorly defined ice edge limiting an area of dispersed ice; usually on the leeward side of ice.
Diverging.—Ice fields or floes in an area are subjected to diverging or dispersive motion; hence, reducing ice concentration and/or relieving stresses in the ice.

Dried ice.—Sea ice from the surface of which melt water has disappeared after the formation of cracks and thaw holes. During the period of drying, the surface whitens.

Drift ice.—Term used in a wide sense to include any area of sea ice other than fast ice no matter what form it takes or how it is dispersed. When concentrations are high, i.e. seven-tenths or more, drift ice may be replaced by the term pack ice.

Easy area.—A general qualitative expression to indicate, in a relative manner, that ice conditions prevailing in an area are such that navigation is not difficult.

Fast ice.—Sea ice which forms and remains fast along the coast, where it is attached to the shore, to an ice wall, to an ice front, between shoals or grounded icebergs. Vertical fluctuations may be observed during changes of sea level. Fast ice may be formed in situ (in its original place) from sea water or by the freezing of drift ice of any stage to the shore. It may extend a few meters or several hundred kilometers from the coast. Fast ice may be more than 1 year old and may then be prefixed with the appropriate age category (second-year or multi-year). If it is thicker than about 2m above sea level, it is called an ice shelf.

Fast ice boundary.—The ice boundary at any given time between fast ice and drift ice.

Fast ice edge.—The demarcation at any given time between fast ice and open water.

Finger rafted ice.—Type of rafted ice in which floes thrust "fingers" alternately over and under the other.

Finger rafting.—Type of rafting whereby interlocking thrusts are formed, each floe thrusting "fingers" alternately
over and under the other. Common in nilas and gray ice.

Firn.—Old snow which has recrystallized into a dense material. Unlike snow, the particles are to some extent joined together. However, unlike ice, the air spaces in it still connect with each other.

First-year ice.—Sea ice of not more than one winter's growth developing from young ice. It has a thickness of from 30cm to 2m and may be subdivided into thin first-year ice/white ice, medium first-year ice, or thick first-year ice.

Flaw.—A narrow separation zone between pack ice and fast ice, where the pieces of ice are in a chaotic state; it forms when pack ice shears under the effect of a strong wind or current along the fast ice boundary.

Flaw lead.—A passageway between (pack) drift ice and fast ice which is navigable by surface vessels.

Flaw polynya.—A polynya between pack ice and fast ice.

Floating ice.—Any form of ice found floating in water. The principal kinds of floating ice are lake ice, river ice, and sea ice, which form by the freezing of water at the surface, and glacier ice (ice of land origin), which is formed on land or in an ice shelf. The concept includes ice that is stranded or grounded.

Floe.—Any relatively flat piece of sea ice 20m or more wide. Floes are subdivided according to horizontal extent, as follows:

1. Giant—over 10 km wide
2. Vast—2 to 10 km wide
3. Big—500 to 2,000m wide
4. Medium—100 to 500m wide
5. Small—20 to 100m wide

Floeberg.—A massive piece of sea ice composed of a hummock, or a group of hummocks, frozen together and separated from any ice surroundings. It may protrude up to 5m above sea level.

Flooded ice.—Sea ice which has been flooded by meltwater or river water and is heavily loaded by water and wet snow.

Fracture.—Any break or rupture through very close ice, compact ice, consolidated ice, fast ice, or a single floe resulting from deformation processes. Fractures may contain brash ice and/or be covered with nilas and/or young ice. Their length may vary from a few meters to many kilometers.

Fracture zone.—An area which has a great number of fractures.

Fracturing.—Pressure process whereby ice is permanently deformed and rupture occurs. Most commonly used to describe breaking across very close ice, compact ice, or consolidated ice.

Frazil ice.—Fine spicules or plates of ice suspended in water.

Friendly ice.—From the point of view of the submariner, an ice canopy containing many large skylights or other features which permit a submarine to surface. There must be more than ten such features per 30 nautical miles (56 km) along the submarine's track.

Frost smoke.—Fog-like clouds due to the contact of cold air with relatively warm water, which can appear over openings in the ice, or to leeward of the ice edge, and which may persist while ice is forming.

Giant floe.—See Floe.

Glacier.—A mass of snow and ice continuously moving from higher to lower ground or, if afloat, continuously spreading. The principal forms of glacier are inland ice sheets, ice shelves, ice streams, ice caps, ice piedmonts, cirque glaciers, and various types of mountain (valley) glaciers.

Glacier berg.—An irregularly-shaped iceberg.

Glacier ice.—Ice in, or originating from, a glacier, whether on land or floating in the sea as icebergs, bergy bits, or growlers.

Glacier tongue.—Projecting seaward extension of a glacier, usually afloat. In the Antarctic, glacier tongues may extend for over many tens of kilometers.

Grease ice.—A later stage of freezing than frazil ice when the crystals have coagulated to form a soupy layer on the surface. Grease ice reflects little light, giving the sea a matte appearance.

Grey (gray) ice.—Young ice 10 to 15cm thick. Less elastic than nilas and breaks on swell. Usually rafts under pressure.

Grey (gray)-white ice.—Young ice 15 to 30cm thick. Under pressure more likely to ridge than to raft.

Grounded hummock.—Hummocked grounded ice formation. There are single grounded hummocks and lines (or chains) of grounded hummocks.

Grounded ice.—Floating ice which is aground in shoal water (See Stranded ice).

Growler.—Smaller piece of ice than a bergy bit or floeberg, often transparent but appearing green or almost black in color, extending less than 1m above the sea surface and normally occupying an area of about $20m^2$.

Hostile ice.—From the point of view of the submariner, an ice canopy containing no large skylights or other features which permit a submarine to surface.

Hummock.—A hillock of broken ice which has been forced upwards by pressure. May be fresh or weathered. The submerged volume of broken ice under the hummock, forced downwards by pressure, is termed a bummock.

Hummocked ice.—Sea ice piled haphazardly one piece over another to form an uneven surface. When weathered, it has the appearance of smooth hillocks.

Hummocking.—The pressure process by which sea ice is forced into hummocks. When the floes rotate in the process it is termed screwing.

Iceberg.—A massive piece of ice of greatly varying shape, protruding more than 5m above sea level, which has broken away from a glacier. May be afloat or aground. Icebergs may be described as tabular, dome-shaped, sloping, pinnacled, weathered, or glacier bergs.

Iceberg tongue.—A major accumulation of icebergs projecting from the coast, held in place by grounding and joined together by fast ice.

Ice blink.—A whitish glare on low clouds above an accumulation of distant ice.

Ice bound.—A harbor, inlet, etc. is said to be ice bound when navigation by ships is prevented on account of ice, except possibly with the assistance of an icebreaker.

Ice boundary.—The demarcation at any given time between fast ice and drift ice or between areas of drift ice of different concentrations (See Ice edge).

Ice breccia.—Ice of different stages of development frozen together.

Ice cake.—Any relatively flat piece of sea ice less than 20m wide.

Ice canopy.—Drift ice from the point of view of the submariner.

Ice cover.—The ratio of an area of ice of any concentration to the total area of sea surface within some large geographic locale; this locale may be global, hemispheric, or prescribed by a specific oceanographic entity such as Baffin Bay or the Barents Sea.

Ice edge.—The demarcation at any given time between the open sea and sea ice of any kind, whether fast or drifting. It may be termed compacted or diffuse (See Ice boundary).

Ice field.—Area of floating ice consisting of any size of floes, which is greater than 10km wide (See ice patch).

Ice foot.—A narrow fringe of ice attached to the coast, unmoved by tides and remaining after the fast ice has moved away.

Ice free.—No sea ice present. There may be some ice of land origin present (See Open water).

Ice front.—The vertical cliff forming the seaward face of an ice shelf or other floating glacier varying in height from 2 to 50m or more above sea level (See Ice wall).

Ice island.—A large piece of floating ice protruding about 5m above the sea level which has broken away from an Antarctic ice shelf, having a thickness of from 30 to 50m, and an area of from a few thousand square meters to 500km2 or more. Usually characterized by a regularly undulating surface

Ice jam.—An accumulation of broken river ice or sea ice caught in a narrow channel.

Ice keel.—From the point of view of the submariner, a downward-projecting ridge on the underside of the ice canopy; the counterpart of a ridge. Ice keels may extend as much as 50m below the sea level.

Ice limit.—Climatological term referring to the extreme minimum or maximum extent of the ice edge in any given month or period based on observations over a number of years. Term should be preceded by minimum and maximum (See Mean ice edge).

Ice massif.—A variable accumulation of close or very close drift ice (pack ice) covering hundreds of square kilometers which is found in the same regions every summer.

Ice of land origin.—Ice formed on land or in an ice shelf, found floating in water. The concept includes ice that is stranded or grounded.

Ice patch.—An area of pack ice less than 10km wide.

Ice port.—An embayment (indentation) in an ice front, often of a temporary nature, where ships can moor alongside and unload directly onto the ice shelf.

Ice rind.—A brittle shiny crust of ice formed on a quiet surface by direct freezing or formation of grease ice, usually in water of low salinity. Thickness to about 5cm. Easily broken by wind or swell, commonly breaking in rectangular pieces.

Ice shelf.—A floating ice sheet of considerable thickness showing 2 to 50m or more above sea level, attached to the coast. Usually of great horizontal extent and with a level or gently undulating surface. Nourished by annual snow accumulation and often also by the seaward extension of land glaciers. Limited areas may be aground. The seaward edge is termed an ice front.

Ice stream.—Part of an inland ice sheet in which the ice flows more rapidly and not necessarily in the same direction as the surrounding ice. The margins are sometimes clearly marked by a change in the direction of the surface slope, but may be indistinct.

Ice under pressure.—Ice in which deformation processes are actively occurring and therefore a potential impediment or danger to shipping.

Ice wall.—An ice cliff forming the seaward margin of a glacier which is not afloat. An ice wall is aground, the rock basement being at or below sea level (See Ice front).

Jammed brash barrier.—A strip or narrow belt of new, young, or brash ice (usually 100 to 5,000m wide), formed at the edge of either drift or fast ice or at the shore. It is heavily compacted mostly due to wind action and may extend from 2 to 20m below the surface but does not normally have appreciable topography. Jammed brash barriers may disperse with changing winds but can also consolidate to form a strip of unusually thick ice as compared to the surrounding drift ice.

Lake ice.—Ice formed on a lake, regardless of observed location.

Large fracture.—Fracture more than 500m wide.

Large ice field.—An ice field over 20km wide.

Lead. Any fracture or passageway through sea ice which is navigable by surface vessels.

Level ice.—Sea ice which is unaffected by deformation.

Light nilas.—Nilas which is more than 5 centimeters in thickness and rather lighter in color than a dark nilas.

Mean ice edge.—Average position of the ice edge in any given month or period based on observations over a number of years. Other terms which may be used are mean maximum ice edge and mean minimum ice edge (See Ice limit).

Medium first-year ice.—First-year ice 70 to 120cm thick.

Medium floe.—See Floe.

Medium fracture.—Fracture 200 to 500m wide.

Medium ice field.—An ice field 15 to 20km wide.

Multi-year ice.—Old ice up to 3m or more thick which has survived at least two summers' melt. Hummocks even smoother than in second-year ice, and the ice is almost saltfree. Color, where bare, is usually blue. Melt pattern consists of large interconnecting irregular puddles and a well-developed drainage system.

New ice.—A general term for recently formed ice which includes frazil ice, grease ice, slush, and shuga. These types of ice are composed of ice crystals which are only weakly frozen together (if at all) and have a definite form only while they are afloat.

New ridge.—Ridge newly formed with sharp peaks and slope of sides usually 40°. Fragments are visible from the air at low altitude.

Nilas.—A thin elastic crust of ice, easily bending on waves and swell under pressure, thrusting in a pattern of interlocking "fingers" (finger rafting). Has a matte surface and is up to 10 centimeters in thickness. May be subdivided into dark nilas and light nilas.

Nip.—Ice is said to nip when it forcibly presses against a ship. A ship so caught, though undamaged, is said to have been nipped.

Old ice.—Sea ice which has survived at least one summer's melt, thickness up to 3m or more. Most topographic features are smoother than on first-year ice. May be subdivided into second-year ice and multi-year ice.

Open ice.—Floating ice in which the concentration is four-tenths to six-tenths with many leads and polynyas, and the floes are generally not in contact with one another.

Open water.—A large area of freely navigable water in which sea ice is present in concentrations less than one-tenth. When there is no sea ice present, the area should be termed ice free.

Pack ice.—Concentration of seven-tenths or more of drift ice (See Drift ice). (The term was formally used for all ranges of concentration.)

Pancake ice.—Predominantly circular pieces of ice from 30cm to 3m in diameter. Up to about 10m in thickness with raised rims due to the pieces striking up against one another. It may be formed on a slight swell from grease ice, shuga, or slush or as a result of the breaking of ice rind, nilas, or under severe conditions of swell or waves, of gray ice. It also sometimes forms at some depth, at an interface between water bodies of different physical characteristics, from where it floats to the surface. Its appearance may rapidly cover wide areas of water.

Polynya.—Any non-linear shaped opening enclosed in ice. Polynyas may contain brash ice and/or be covered with new ice, nilas, or young ice. Submariners refer to these as skylights. Sometimes the polynya is limited on one side by the coast and is called a shore polynya or by fast ice and is called a flaw polynya. If it recurs in the same position every year, it is called a recurring polynya.

Puddle.—An accumulation of meltwater on ice, mainly due to the melting of snow, but in the more advanced stages also to the melting of the ice. Initial stage consists of patches of melted snow.

Rafted ice.—Type of deformed ice formed by one piece of ice overriding another (See Finger rafting).

Rafting.—Pressure processes whereby one piece of ice overrides another. Most common in the new and young ice
(See Finger rafting).

Ram.—An underwater ice projection extending from an ice wall, ice front, iceberg, or floe. Its formation is usually due to a more intensive melting and erosion of the unsubmerged part.

Recurring polynya.—A polynya which recurs in the same position every year.

Ridge.—A line or wall of broken ice forced up by pressure. May be fresh or weathered. The submerged volume of broken ice under a ridge, forced downwards by pressure, is termed an ice keel.

Ridged ice.—Ice piled haphazardly one piece over another in the form of ridges or walls. Usually found in first-year ice (See Ridging).

Ridged ice zone.—An area in which much ridged ice with similar characteristics has formed.

Ridging.—The pressure process by which sea ice is forced into ridges.

River ice.—Ice formed on a river, regardless of observed location.

Rotten ice.—Sea ice which has become honeycombed and which is in an advanced state of disintegration.

Sastrugi.—Sharp, irregular ridges formed on a snow surface by wind erosion and deposition. On mobile floating ice, the ridges are parallel to the direction of the prevailing wind at the time they were formed.

Sea ice.—Any form of ice found at sea which has originated from the freezing sea water.

Second-year ice.—Old ice which has survived only one summer's melt. Thickness up to 2.5m and sometimes more. Because it is thicker than first-year ice, it stands higher out of the water. In contrast to multi-year ice, summer melting produces a regular pattern of numerous small puddles. Bare patches and puddles are usually greenish-blue.

Shearing.—An area of ice is subject to shear when the ice motion varies significantly in the direction normal to the motion, subjecting the ice to rotational forces. These forces may result in phenomena similar to flaw.

Shear ridge.—An ice ridge formation which develops when one ice feature is grinding past another. This type of ridge is more linear than those caused by pressure alone.

Shear ridge field.—Many shear ridges side by side.

Shore lead.—A lead between drift ice and the shore, or between drift ice and an ice front.

Shore melt.—Open water between the shore and the fast ice, formed by melting and/or due to river discharge.

Shore polynya.—A polynya between drift ice and the coast, or between drift ice and an ice front.

Shore ice ride-up.—A process by which ice is pushed ashore as a slab.

Shuga.—An accumulation of spongy white ice lumps, a few centimeters wide; they are formed from grease ice or slush and sometimes from anchor ice rising to the surface.

Skylight.—From the point of view of the submariner, thin places in the ice canopy, usually less than 1m thick and appearing from below as relatively light, translucent patches in dark surroundings. The undersurface of a skylight is normally flat. Skylights are called large if big enough for a submarine to attempt to surface through them (120m), or small if not.

Slush.—Snow that is saturated and mixed with water on land or ice surfaces, or as a viscous floating mass in water after a heavy snowfall.

Small floe.—See Floe.

Small fracture.—Fracture 50 to 200m wide.

Small ice cake.—An ice cake less than 2m wide.

Small ice field.—An ice field 10 to 15km wide.

Snow-covered ice.—Ice covered with snow.

Snow drift.—An accumulation of wind-blown snow deposited in the lee of obstructions or heaped by wind eddies. A crescent-shaped snow drift, with ends pointing downwind, is known as snow barchan.

Standing floe.—A separate floe standing vertically or inclined and enclosed by rather smooth ice.

Stranded ice.—Ice which has been floating and has been deposited on the shore by retreating high water.

Strip.—Long and narrow area of pack ice, about 1km or less wide. Usually composed of small fragments detached from the main mass of ice which have run together under the influence of wind, swell, or current.

Tabular berg.—A flat-topped iceberg. Most tabular bergs form by calving from an ice shelf and show horizontal banding (See Ice island).

Thaw holes.—Vertical holes in sea ice formed when surface puddles melt through to the underlying water.

Thin first-year ice/white ice.—First-year ice 30 to 70cm thick. May sometimes be subdivided into first stage (30 to 50cm thick) and second stage (50 to 70cm thick).

Tide crack.—Crack at the line of junction between an immovable ice foot or ice wall and fast ice, the latter subject to rise and fall of the tide.

Tongue.—A projection of the ice edge up to several kilometers in length, caused by wind or current.

Vast floe.—See Floe.

Very close pack ice.—Pack ice in which the concentration is nine-tenths to less than ten-tenths.

Very open pack ice.—Pack ice in which the concentration is one-tenth to three-tenths and water preponderates over ice.

Very small fracture.—Fracture 1 to 50m wide.

Very weathered ridge.—Ridge with peaks very rounded, slope of sides usually 20° to 30°.

Water sky.—Dark streaks on the underside of low clouds, indicating the presence of water features in the vicinity of sea ice.

Weathered ridge.—Ridge with peaks slightly rounded and slope of sides usually 30° to 40°. Individual fragments are not discernible.

Weathering.—Processes of ablation and accumulation which gradually eliminate irregularities in an ice surface.

White ice.—(See Thin first-year ice/white ice).

Young coastal ice.—The initial stage of fast ice formation consisting of nilas or young ice. Its width varies from a few meters up to 200m from the shoreline.

Young ice.—Ice in the transition stage between nilas and first-year ice, 10 to 30cm thick. May be subdivided into gray ice and gray-white ice

Appendix C: Z7 Table 1 – Minimum Requirements For Thickness Measurements At Special Survey

Special Survey No.1 Age ≤ 5	Special Survey No.2 5 < Age ≤ 10	Special Survey No.3 10 < Age ≤ 15	Special Survey No.4 and Subsequent 15 < Age
1) Suspect areas throughout the vessel.	1) Suspect areas throughout the vessel.	1) Suspect areas throughout the vessel.	1) Suspect areas throughout the vessel.
	2) One transverse section of deck plating in way of a cargo space within the amidships 0.5L	2) Two transverse sections within the amidships 0.5L in way of two different cargo spaces.	2) A minimum of three transverse sections in way of cargo spaces within the amidships 0.5L.
		3) All cargo hold hatch covers and coamings (plating and stiffeners).	3) All cargo hold hatch covers and coamings (plating and stiffeners).
		4) Internals in forepeak and afterpeak tanks.	4) Internals in forepeak and after tanks.
			5) All exposed main deck plating full length.
			6) Representative exposed superstructure deck plating((poop, bridge, and forecastle deck).
			7) Lowest strake and strakes in way of 'tween decks of all transverse bulkheads in cargo spaces together with internals in way.
			8) All wind – and water strakes, port and starboard, full length.
			9) All keel plates full length. Also, additional bottom plates in way of cofferdams, machinery space, and aft end of tanks.
			10) Plating of seachests. Shell plating in way of overboard discharges as considered necessary by the attending surveyor

Notes:

1. Thickness measurement locations are to be selected to provide the best representative sampling of areas likely to be most exposed to corrosion, considering cargo and ballast history and arrangement and condition of protective coatings.

2. Thickness measurements of internals may be specially considered by the Surveyor if the hard protective coating is in GOOD condition.

3. For ships less than 100 meters in length, the number of transverse sections required at Special Survey No. 3 may be reduced to one (1), and the number of transverse sections required at Subsequent Special Surveys may be reduced to two (2).

4. For ships more than 100 meters in length, at Special Survey No. 3, thickness measurements of exposed deck plating within amidship 0.5 L may be required.

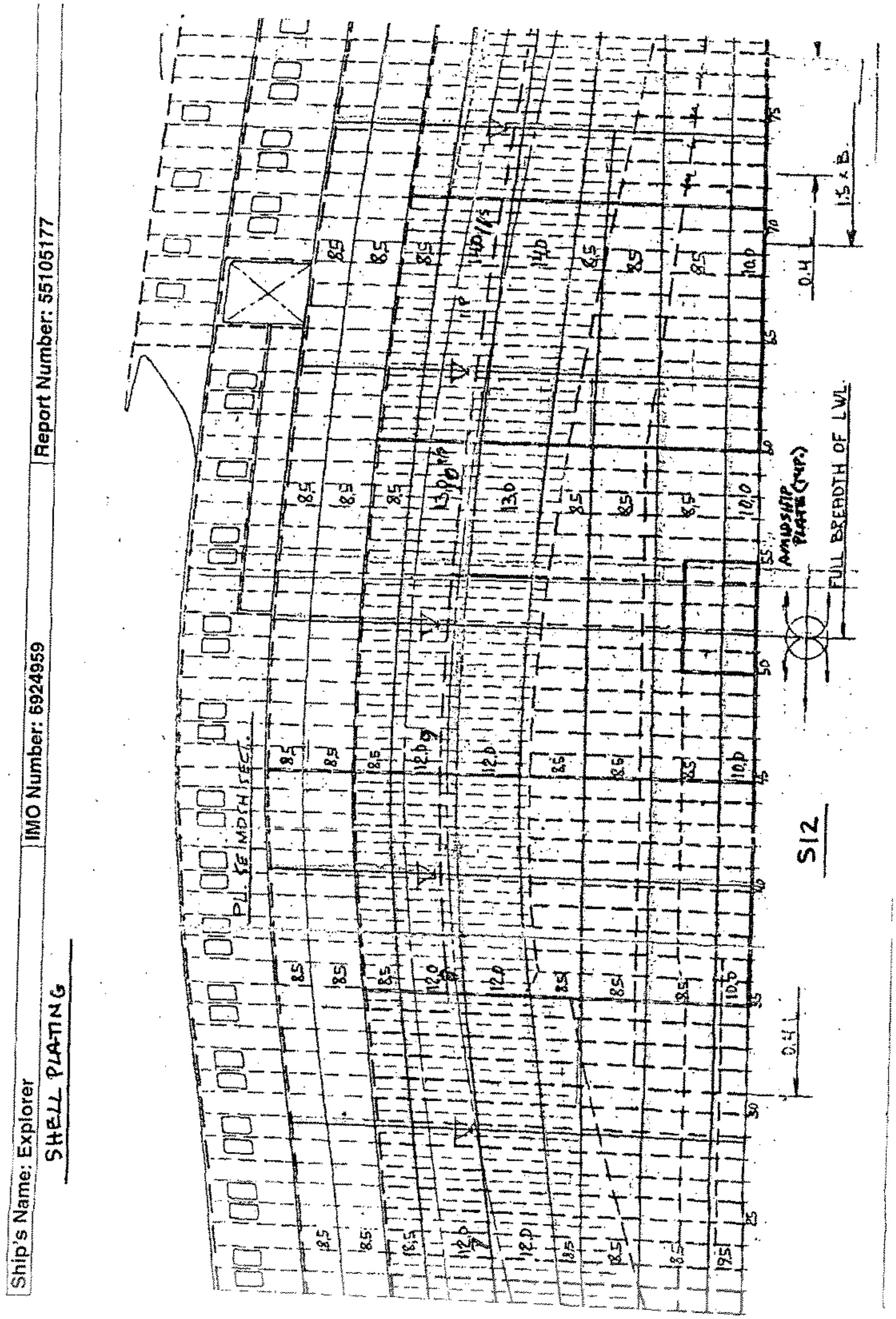
Appendix D: 2005 Gauging Results between frames 45 – 60

THICKNESS MEASUREMENT REPORT

Ship's Name: Explorer Id.No: ELJD8 Report No: 55105177 Legend: Substantial corr

External structure	Tank/Space Reverse side	Structural Element	Element / Frame No.	Draw ref.	Orig thk.	Class min thk.	Gauged Port	Gauged Stbd	Diminution Port		Diminution Starboard		Renewed Port	Renewed Stbd	Comments, Defects found
					mm	mm	mm	mm	mm	%	mm	%	mm	mm	
		Wind and Water Strakes Side Shell Plating								-		-			
Ship Side	Aft Peak/	Stern Plate-Plate 1	I-F	S11-1	16.00	12.80	15.70	15.70	0.30	1.9%	0.30	1.9%			
	Tank 1/2	-Plate 1		S11-2	16.00	12.80	15.70	15.80	0.30	1.9%	0.20	1.3%			
		-Plate 1		S11-3	16.00	12.80	15.80	16.00	0.20	1.3%	0.00	0.0%			
		-Plate 2	F-E	S11-1	12.00	9.60	12.40	12.20	0.00	0.0%	0.00	0.0%			
		-Plate 2		S11-2	12.00	9.60	12.10	12.00	0.00	0.0%	0.00	0.0%			
		-Plate 2		S11-3	12.00	9.60	12.10	11.90	0.00	0.0%	0.10	0.8%			
		2nd Below Strake-Plate 3	G-1	S11-1	12.00	9.60	12.40	11.50	0.00	0.0%	0.50	4.2%			
		-Plate 3		S11-2	12.00	9.60	12.30	11.30	0.00	0.0%	0.70	5.8%			
		-Plate 3		S11-3	12.00	9.60	12.40	11.30	0.00	0.0%	0.70	5.8%			
		3rd Below Strake-Plate 4	E-1	S11-1	12.00	9.60	11.50	12.10	0.50	4.2%	0.00	0.0%			
		-Plate 4		S11-2	12.00	9.60	11.40	11.80	0.60	5.0%	0.20	1.7%			
		-Plate 4		S11-3	12.00	9.60	11.40	11.70	0.60	5.0%	0.30	2.5%			
Ship Side	Provision	2nd Below Strake-Plate 5	1-7	S11-1	12.00	9.60	11.70	11.70	0.30	2.5%	0.30	2.5%			
		-Plate 5		S11-2	12.00	9.60	12.00	11.80	0.00	0.0%	0.20	1.7%			
		-Plate 5		S11-3	12.00	9.60	12.20	11.70	0.00	0.0%	0.30	2.5%			
		1st Below Strake-Plate 6	7-18	S11-1	12.00	9.60	11.50	11.80	0.50	4.2%	0.20	1.7%			
		-Plate 6		S11-2	12.00	9.60	11.40	11.60	0.60	5.0%	0.40	3.3%			
		-Plate 6		S11-3	12.00	9.60	11.40	11.30	0.60	5.0%	0.70	5.8%			
Ship Side	Workshop	1st Below Strake-Plate 7	18-29	S11-1	12.00	9.60	11.70	12.00	0.30	2.5%	0.00	0.0%			
		-Plate 7		S11-2	12.00	9.60	11.50	11.90	0.50	4.2%	0.10	0.8%			
		-Plate 7		S11-3	12.00	9.60	11.30	12.00	0.70	5.8%	0.00	0.0%			
		1st Below Strake-Plate 8	29-33	S12-1	12.00	9.60	11.20	-	0.80	6.7%		-			
		-Plate 8		S12-2	12.00	9.60	11.20	-	0.80	6.7%		-			
		-Plate 8		S12-3	12.00	9.60	11.30	-	0.70	5.8%		-			
		-Plate 8	33-35	S12-1	12.00	9.60	11.80	-	0.20	1.7%		-			
		-Plate 8		S12-2	12.00	9.60	11.90	-	0.10	0.8%		-			
		-Plate 8		S12-3	12.00	9.60	12.10	-	0.00	0.0%		-			
Ship Side	Accommodation	1st Below Strake-Plate 8	35-40	S12-1	12.00	9.60	11.80	-	0.20	1.7%		-			
		-Plate 8		S12-2	12.00	9.60	11.80	-	0.20	1.7%		-			
		-Plate 8		S12-3	12.00	9.60	11.90	-	0.10	0.8%		-			
		-Plate 8	29-40	S12-1	12.00	9.60	-	12.00		-	0.00	0.0%			
		-Plate 8		S12-2	12.00	9.60	-	11.80		-	0.20	1.7%			
		-Plate 8		S12-3	12.00	9.60	-	11.80		-	0.20	1.7%			
		1st Below Strake-Plate 9	40-46	S12-1	12.00	9.60	12.10	-	0.00	0.0%		-			
		-Plate 9		S12-2	12.00	9.60	12.00	-	0.00	0.0%		-			
		-Plate 9		S12-3	12.00	9.60	11.90	-	0.10	0.8%		-			
		-Plate 9	46-52	S12-1	12.00	9.60	14.00	-	0.00	0.0%		-			
		-Plate 9		S12-2	12.00	9.60	13.60	-	0.00	0.0%		-			
		-Plate 9		S12-3	12.00	9.60	13.20	-	0.00	0.0%		-			
		-Plate 9	40-52	S12-1	12.00	9.60	-	11.40		-	0.60	5.0%			
		-Plate 9		S12-2	12.00	9.60	-	11.60		-	0.40	3.3%			
		-Plate 9		S12-3	12.00	9.60	-	11.90		-	0.10	0.8%			
		1st Below Strake-Plate 10	52-57	S12-1	13.00	10.40	13.60	-	0.00	0.0%		-			
		-Plate 10		S12-2	13.00	10.40	13.60	-	0.00	0.0%		-			
		-Plate 10		S12-3	13.00	10.40	13.70	-	0.00	0.0%		-			
		-Plate 10	57-63	S12-1	13.00	10.40	13.40	-	0.00	0.0%		-			
		-Plate 10		S12-2	13.00	10.40	13.30	-	0.00	0.0%		-			
		-Plate 10		S12-3	13.00	10.40	13.40	-	0.00	0.0%		-			
		-Plate 10	52-63	S12-1	13.00	10.40	-	13.60		-	0.00	0.0%			
		-Plate 10		S12-2	13.00	10.40	-	12.80		-	0.20	1.5%			
		-Plate 10		S12-3	13.00	10.40	-	12.20		-	0.80	6.2%			

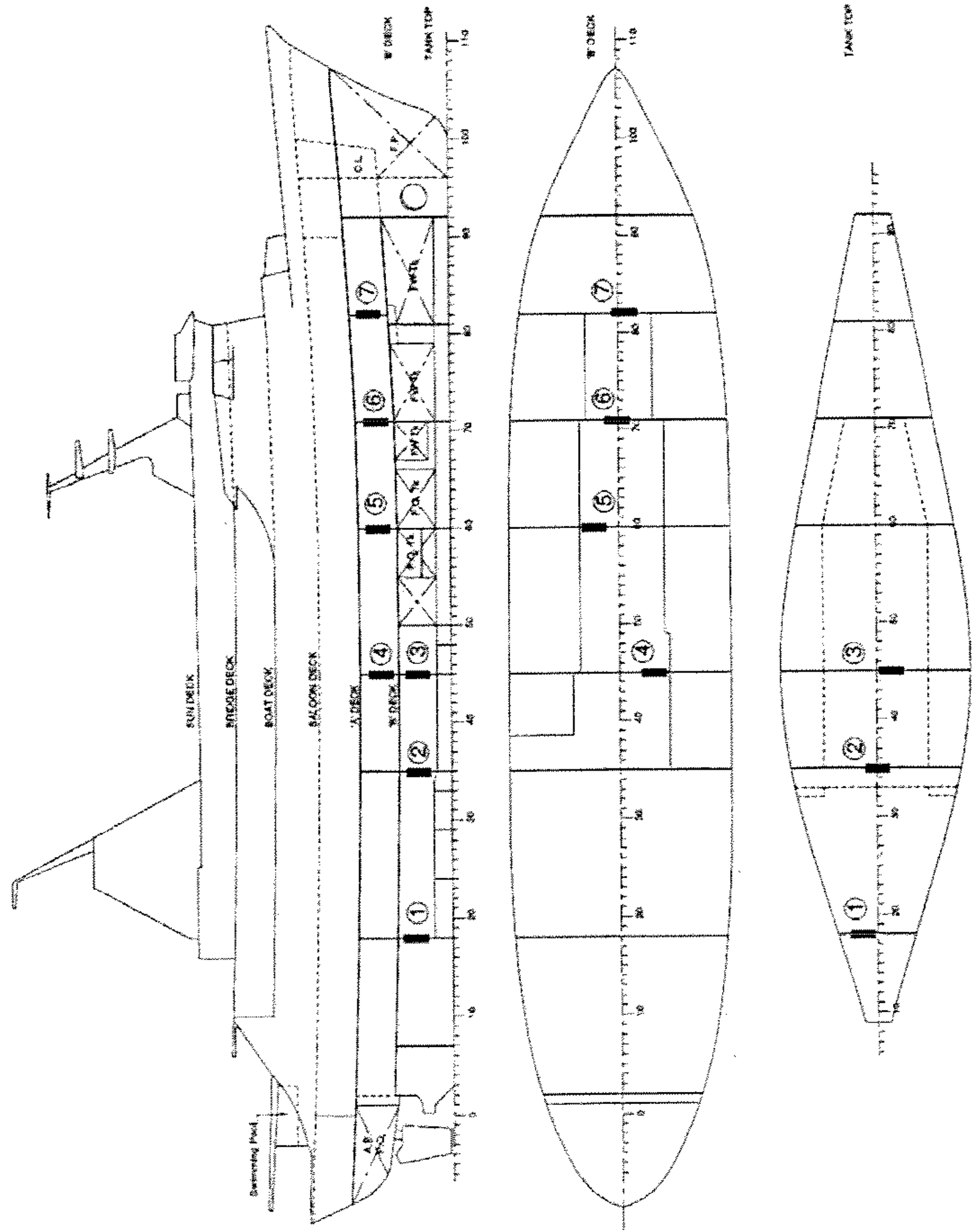
Appendix E. Shell Expansion Plan with gauging results for frames 45 to 60



Appendix F : Location of Type C Watertight Doors

The watertight doors are indicated by circled numbers 1 through 7.

Figure 4.1 ARRANGEMENT OF WATERTIGHT DOORS



Appendix G: Owner Representative email regarding VDR recovery

1. You are no doubt aware that the ship owners' obligations under the Liberian Maritime Regulations are to co-operate with the Commissioner or Deputy Commissioner and produce witnesses and documents *in their possession*. VDR data attached to a sunken ship cannot be said to be within the ship owners' possession.

2. Having further considered the IMO Guidelines on Voyage Data Recorder Ownership and Recovery (as incorporated into SOLAS), we cannot find anything which would compel the ship owner to retrieve inaccessible VDR data or fund such an operation. Paragraph 2(3) of the Guidelines specifically places the decision to recover the data and the responsibility for co-ordinating the recovery operation firmly on the Flag State. The ship owner is not even referred to, except in the final sentence, where it is stated that the co-operation of the owners, insurers and VDR manufacturers *may* be required.

3. Our view (to the extent it is relevant given the foregoing) is that it would not be cost effective to recover the VDR. We have spoken with Dronik as have our technical advisors. Dronik informally advised that they would be looking at a minimum of a 20 day operation, comprising of 7 days mobilisation and demobilisation and 6 days for weather down time. Our own technical advisor advises that the mob-demob time from the US Gulf would be considerably longer. To this would need to be factored in the time it might take to locate the wreck-as you know no one knows where she is with any degree of accuracy. There are also concerns over an ROV pilot being willing to fly such a beast in close proximity to debris, of course no one knows how the wreck is lying on the sea bed. In short, we are looking at a significant investment (probably in excess of US$2 or on what our own adviser has told us, in excess of 3 million) with no measure of whether such an exercise would be successful. There are good reasons for taking a conservative view on the likely prospects of success given the location, depth etc. Looking at the potential benefits, this is a casualty where thankfully everyone survived. The primary witnesses have all been interviewed by you at length. For our purposes, we are satisfied that we have sufficient knowledge of what happened and what took place to reach conclusions and learn lessons. Whilst obtaining VDR data might ultimately prove to offer some additional benefit (equally it might not), it is not as if this is a case with no survivors and no evidence. Far from it.

4. There is also a very important point concerning the wreck/vessel and the local authorities. Our clients went to considerable effort in the days and weeks following the incident to assess the potential damage to the environment resulting from the loss, and happily no claims or serious issues ever arose. Matters have now stabilised, the authorities are calm, interest in the wreck/vessel has waned, because there have been no developments in this regard, and none are expected. If the vessel is disturbed in any way it could result in the escape of oil. This could have significant political and financial implications not least for those performing or directing the operations. Clients therefore have concerns over disturbing the wreck/vessel, and indeed concerns over there being an operation in the area which will almost certainly reinvigorate interest in the vessel/wreck from other authorities. If ultimately Flag State decides to go ahead with the recovery operation, owners will require the Flag State to formally confirm that they take on the operation at their risk and hold our clients harmless and indemnify them for any losses arising from the physical operation of removing the VDR, including but not limited to pollution, environmental damage, equipment damage, injury to any personnel. As an aside, when we spoke to Dronik they indicated that they had already thought about such issues (having discussed things with their lawyers) and in any contract they enter in to they too would be seeking hold harmless and indemnity provisions.

5. In summary therefore, whilst our clients are willing to co-operate with the Liberian authorities, as has already been demonstrated, we feel it is important to view the proposed operation from a practical, and cost perspective - and of course the likely value of such an operation. In our view the risks are too great, the prospects for success too vague and the costs, although tentative (and although not for owners account) cast serious doubt on the advisability and value of such an operation. We cannot find anything which would compel our clients to carry out the operation themselves or to fund it. In these circumstances, we must decline your invitation to owners to recover the VDR. For the avoidance of doubt, owners will not be responsible for any costs involved in such an operation or plans.

Please keep us updated as to how you intend to proceed and whether our co-operation as outlined above is required.

Kind regards

Appendix H: IMO Guidelines, VDR Ownership and Recovery

IMO

MSC/Circ.1024
Page:1/3

29 May 2002

**GUIDELINES ON VOYAGE DATA RECORDER (VDR)
OWNERSHIP AND RECOVERY**

1 The Maritime Safety Committee, at its seventy-fifth session (15 to 24 May 2002), approved the annexed Guidelines on voyage data recorder (VDR) ownership and recovery which have been developed to support provisions of the revised SOLAS regulation V/15, as amended by resolution MSC.99(73), and, in particular, to support the carriage requirements for voyage data recorders contained in the revised SOLAS regulation V/20, which are expected to enter into force on 1 July 2002.

2 These Guidelines reflect the five basic issues relevant to VDR ownership and recovery, which are ownership, custody, recovery, read-out and access to the VDR information, as envisaged by the revised SOLAS chapter V.

3 In view of the complexity of the matter, close co-ordination and co-operation among interested parties, as appropriate, in any recovery operation of a VDR is encouraged.

4 Member Governments are invited to bring the annexed Guidelines to the attention of all parties concerned.

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ANNEX

GUIDELINES ON VOYAGE DATA RECORDER (VDR) OWNERSHIP AND RECOVERY

Ownership of VDR information

1 The ship owner will, in all circumstances and at all times, own the VDR and its information. However, in the event of an accident the following guidelines would apply. The owner of the ship should make available and maintain all decoding instructions necessary to recover the recorded information.

Recovery of VDR and relevant information

2 Recovery of the VDR is conditional on the accessibility of the VDR or the information contained therein.

.1 Recovery of the VDR information should be undertaken as soon as possible after an accident to best preserve the relevant evidence for use by both the investigator[1] and the ship owner. As the investigator is very unlikely to be in a position to instigate this action soon enough after the accident, the owner must be responsible, through its on-board standing orders, for ensuring the timely preservation of this evidence.

.2 In the case of abandonment of a vessel during an emergency, masters should, where time and other responsibilities permit, take the necessary steps to preserve the VDR information until it can be passed to the investigator.

.3 Where the VDR is inaccessible and the information has not been retrieved prior to abandonment, a decision will need to be taken by the flag State in co-operation with any other substantially interested States[2] on the viability and cost of recovering the VDR balanced against the potential use of the information. If it is decided to recover the VDR the investigator should be responsible for co-ordinating its recovery. The possibility of the capsule having sustained damage must be considered and specialist expertise will be required to ensure the best chance of recovering and preserving the evidence. In addition, the assistance and co-operation of the owners, insurers and the manufacturers of the VDR and those of the protective capsule may be required.

Custody of VDR information:

3 In all circumstances, during the course of an investigation, the investigator should have custody of the original VDR information in the same way that the investigator would have custody of other records or evidence under the Code for the Investigation of Marine Casualties and Incidents.

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[1] The term investigator refers to the Marine Casualty Investigator as per the terms of the Code for Investigation of Marine Casualties and Incidents.

[2] Refer to paragraph 4.11 of the Code for the Investigation of Marine Casualties and Incidents, as adopted by resolution A.84 0).

Read-out of VDR information:

4 In all circumstances the investigator is responsible to arrange down loading and read-out of the information and should keep the ship owner fully informed. In some cases, the assistance of specialist expertise may be required.

Access to the VDR information:

5 A copy of the VDR information must be provided to the ship owner at an early stage in all circumstances.

6 Further access to the information will be governed by the applicable domestic legislation of the flag State, coastal State and other substantially interested States as appropriate and the guidelines given in the Code for the Investigation of Marine Casualties and Incidents.

7 Any disclosure of VDR information should be in accordance with section 10 of the Code for the Investigation of Marine Casualties and Incidents.