BRAZILIAN MARITIME AUTHORITY
DIRECTORATE OF PORTS AND COASTS

ACCIDENT WITH FATAL VICTIM ONBOARD
MV “SHANGAI CARRIER” - IMO 8915407

85 NAUTICAL MILES FROM GUAMARÉ – RIO GRANDE DO NORTE

09 NOVEMBER 2009

MARINE SAFETY INVESTIGATION REPORT

Reference: IMO Casualty Investigation Code - MSC-MEPC.3/Circ.2 13 June 2008/ Resolution MSC.255(84)
1.0 - INTRODUCTION

For the purpose of effecting the collection and analysis of evidence, the identification of the causal factors and the elaboration of safety recommendations that should be necessary, in order to prevent that in the future occur similar maritime accidents and/or incidents, the Port Captaincy of Ceará carried out the Marine Safety Investigation, in compliance with that laid down in the Casualty Investigation Code of the International Maritime Organization (IMO), adopted by Resolution MSC. 255(84).

2.0 – SYNOPSIS

The merchant vessel SHANGHAI CARRIER, Korean flag and IMO nº 8915407, left Singapore on 12th October, 2009, without cargo, with destination the ore loading terminal of Ponta da Madeira – Maranhão – BR. On 9th November, 2009, already in Brazilian jurisdictional waters, occurred an accident with personnel onboard which injured the officer on watch in the engine room, at 07.45 hrs. local time (10.45 hrs. GMT). The referred officer suffered burns, resulting from the direct impact of live and condensed steam accumulated in the drainage tank, resulting from its rupture and, despite being rescued, died later from injuries suffered.

2.1 - SEQUENCE OF EVENTS

The merchant vessel SHANGHAI CARRIER left Singapore on 12th October, 2009, without cargo, with destination the ore loading terminal of Ponta da Madeira – Maranhão – BR. During the crossing, on 9th November, 2009, already in Brazilian jurisdictional waters, specifically the Brazilian exclusive economic zone, however outside the Brazilian territorial sea and beyond the contiguous zone, when navigating on true bearing 292°, it stopped the engines right after the occurrence of an accident with personnel onboard which injured the officer on watch in the engine room, at 07.45 hrs. local time (10.45 hrs. GMT), when passing the position of LAT. 03°40.3 S and LONG 036° 19.7 W, approximately 85 miles abeam of the city of Guamaré, on the coast of Rio Grande do Norte.

The referred officer suffered burns, resulting from the direct impact of live and condensed steam accumulated in the drainage tank, resulting from its rupture, whilst he was preparing the steam system, right after the early assuming of the watch of 08.00hrs to 12.00hrs. from the officer on the previous watch, being accompanied on the job by an Engine Room rating.
The officer of the previous watch had left an orientation for the steam pipe system to be drained, in order to proceed with the testing of the ballast pumps, as determined by the Captain of the ship.

At that moment the rating had left the engineering room and gone to the opposite side of the engine-room, in order to carry out the verification of the temperatures of the engines and of the motors, when suddenly he heard a strong noise which was also heard by the Chief Engineer in his cabin, who had already observed before a weak noise like “Tum, Tum” whilst he was in the bathroom of his cabin and he went to the engine-room, in order to verify what was it. When he perceived that the intensity of the noise increased, he ran faster to the entrance of the engine-room and at that moment heard a noise higher still. He entered then the engine-room and saw a cloud of steam close to the ballast pump.

In the sequence of events, the Chief Engineer made for the Engine Control Centre, stopped the main engine and, right then the rating returned to the Centre, making no comment regarding the accident. Moments later the officer on watch entered the Engine Control Centre dressed in individual protection equipment however all wet with hot water, burns all over his body, peeling the skin of his face and making for a position under the ventilation of the air conditioning.

Meanwhile, the fire alarm went off, making the other engine-room crewmembers go to the Engine Control Centre. The officer of the previous watch returned to the Engine Control Centre, having, also observed the existence of steam in a part of the engine-room, also seeing the Chief Engineer stopping the engines. Then he went to help the officer on watch to take off his overall, when he received the order of the Chief Engineer to close the interception valve of steam of the boiler (photos to follow).
After the accident, needing to put the engines in operation again to proceed on the voyage, the Chief Engineer ordered the officer of the previous watch to carry out the repair of the drainage tank, grinding the parts and carrying out welding, which was carried out by a crewmember specialised in welding, in the period from 08.30 to 10.30hrs, culminating with the placing of the boiler on line to carry out a test of the steam network with 16kg/cm², which did not present problems. (photos below).
Drainage tank after the accident and without the lower plate

Drainage tank after the welding of the bottom plate
At 11.55 hrs the ship proceeded to Fortaleza, in order to arrange specialised medical treatment for the injured officer. Meanwhile the Captain warned of the accident the Maritime Rescue Coordination Centre Brazil, the agency representing the ship in Brazil, the ship’s operator, and the Emergency Medical Centre of Korea, putting the injured officer in the infirmary and ministering first aid by means of the treatment indicated by the Medical Centre. At 11.55 hrs of 9th November 2009, when the ship had already drifted to the position of Latitude 03° 35’ S and Longitude 036° 29.2’ W, approximately 90 miles from Ponta do Tubarão, on the coast of Rio Grande do Norte, the Captain deviated the originally planned course, taking the true course 267°, destination the port of Fortaleza, arriving at 21.24hrs at anchorage nº 7.

After the preparations for the landing, the patient was then transported by launch at 22.25 hrs to the quayside and sent to the Centre for the Burnt of Fortaleza, located in the Instituto Dr. José Frota – municipal hospital for medical emergencies, under the responsibility of Agencia Maritima Brandão Filhos Fortship LTDA, according to official authorization of the Federal Police. The patient was attended in the Instituto Dr. José Frota and interned at 23.30 hrs the same day, with the diagnosis of “BIG BURNS” by boiler steam, with 100% consequences, by reason of “2ND AND 3RD DEGREE BURNS ON THE HEAD, NECK, BUTTOCKS, TORSO FRONT AND BACK, GENITALS, ARMS AND LEGS”.
On 11th November at 09.00hrs a Port State Control Inspection was carried out by the
Naval Inspectors of the Brazilian Navy, allotted to the Port Captaincy of Ceará. In the inspection no
deficiencies were identified, only being registered the need to embark another engineering officer to
substitute the one that had the accident. After the liberation by the Brazilian Navy, the ship sailed
on 11th November 2009 at 19.24 hrs, with destination the Ponta de Madeira Terminal – MA, to
load iron ore.

In the meantime, despite the medical treatment carried out, the injured crewmember died at
19.00 hrs of 15th November 2009 in the Instituto Dr.José Frota, due to clinical complications of
great burns. The death certificate made clear injury on 85% of the surface of the body, affecting
cranium, face, thorax, back, arms and legs and buttocks. Conclusion: “DEATH DUE TO
CLINICAL COMPLICATIONS OF BURNS”.

3.0 – GENERAL INFORMATION

3.1 – Characteristic of the Ship

Name of the ship : SHANGHAI CARRIER
IMO No : 8915407
Type : Bulk Carrier
Country, port and registry: Republic of Korea – Jeju – JJR-072115
Nr Registry Certificate : 08-0133
Flag : South Korea
Builder : Daewoo Shipbuilding & Heavy Machinery Ltd, Korea
Hull Nr : 5046
Material of the hull : Steel
Date keel laid : 29th October 1990
Date of delivery : 16th July 1991
Period of Conversion : 18/02/2008 to 27/07/2008
Call Sign : DSPRB
Length Overall : 267 m
Length between perpendiculars : 256 m
Breadth : 46.20 m
Depth : 23.83 m
Gross Tonnage : 80,994
Nett Tonnage : 44,517
Draft Loaded : 18.02 m
Displacement Loaded : 182,595 ton
Deadweight : 160,850 ton
Displacement Light : 21,737 ton
Maximum Height : 53.90 m

Capacity of the tanks
3.2 – Previous Conditions and Inspections

The accident occurred on 9th November, 2009, at 07.45 hours local time, when it was approximately 85 nautical miles abeam of the coast of the city of Guamaré –RN and 180 miles from Fortaleza, according to the course plotted on nautical chart n° 21.900 of the Directorate of Hydrography and Navigation (DHN).

The ship was surveyed on 11/11/2009 at anchorage n° 7 of the Port of Mucuripe, Fortaleza – CE (photo below), concomitantly with the carrying out, at 09.00 hrs, of an inspection of “Port State Control” by the Group of Surveys and Inspections of the Port Captaincy of Ceará. In the inspection deficiencies were not identified, being registered only the necessity of embarking another engineering officer to substitute the crewmember who suffered the accident.
The expert Naval inspectors found the ship in good condition, with the steam pipeline for the turbines of the ballast pumps working normally and with the drainage tank already repaired onboard, by the means of welding the bottom of the tank to the body of the cylinder and a new section of the pipeline to the mentioned bottom plate, duly wrapped with thermic insulation, as shown in the photos presented to follow:
It was verified that the drainage tank presented an integral aspect, without signs of wear, corrosion or structural damages and the surface from where the bottom of the drainage tank loosened, was smooth and uniform, not indicating that there had occurred any wear on its surface or structural damage, appearing more that it was a separation of the bottom, exactly in the place where should be the welding of the joining of the respective parts of the tank (photos below)
Also were examined the localization of the drainage valve, right below the referred tank, from which the engineering officer had suffered the impact of the discharge of steam, from the rupture of the bottom of the tank, besides the region where the drain of the tank is discharged into the scuppers and the place where are installed the turbines of the ballast pumps (photos below).
The following documentation, presented by the ship and related to the accident, was verified by the investigators:

a) Note of Protest of the Captain of the Ship;

b) Ship’s Logbook, referring to the period 06 to 11/11/2009;

c) Engine Room Logbook, referring to the period 06 to 11/11/2009;

d) Diagram of the Steam pipeline for the Ballast Pumps;

e) Report on Class Survey n° SHIS0052-06, referring to the inspections carried out in the period 18/02/2008 to 27/07/2008, when docked in the shipyard situated in the city of Jiang Yin – China, by the Classification Society KOREAN REGISTER OF SHIPPING (KRS), including also the Intermediary Inspection, the Continuous Inspection of the Engines, the Docking Inspection, Inspection of the Auxiliary Boilers 1 and 2 and the Extraordinary (Occasional) Inspection of Conversion, referring to the alterations made to the ship in the referred period;

f) Report of Inspection and Measurement. Issued in July of 2008, carried out in the shipyard “CHENGXI SHIPYARD CO. LTD” on the safety valves of the boilers and on some pipelines of the systems of heating coils, ballast, drainage, hydraulics of the hatch-covers, cooling of the main engine and drain of the fuel oil tank of the ship;
g) Report of the Port State Control Inspection carried out when the ship was at anchorage nr 7, in the port of Fortaleza, on 11/11/2009, by the Naval Inspectors of the Port Captaincy of Ceará;

h) Sheet with ship’s particulars;

i) IMO Crew List, issued on 10/11/2009;

j) Guidance instructions, affixed in the Engine Room about procedures and safety precautions for operation of the steam systems and of the boilers;

k) Nautical chart of the DHN, n° 21900 in form of a sketch; and

l) A number of Certificates, such as: SAFETY CERTIFICATE OF BUILDING A CARGO SHIP; SAFETY CERTIFICATE OF EQUIPMENT OF A CARGO SHIP; SAFETY CERTIFICATE OF THE RADIO OF A CARGO SHIP; INTERNATIONAL CERTIFICATE OF PREVENTION OF POLLUTION BY OIL; DOCUMENT OF CONFORMITY OF THE COMPANY (DOC-ISM); CERTIFICATE OF SAFETY MANAGEMENT (SMC-ISM); CERTIFICATE OF CONFORMITY WITH THE SAFE PRACTICE CODE FOR THE TRANSPORT OF SOLID CARGOES IN BULK; MINIMUM SAFE MANNING DOCUMENT; INTERNATIONAL CERTIFICATE OF TONNAGE MEASUREMENT; INTERNATIONAL CERTIFICATE OF PROTECTION FOR SHIPS; INTERNATIONAL CERTIFICATE OF PREVENTION OF POLLUTION BY DRAINS; CERTIFICATE OF REGISTRY; CLASS CERTIFICATE; and INTERNATIONAL FREEBOARD CERTIFICATE.

In order to subsidise an analysis of the causal factors that may have influenced in the occurred accident we will present some directives foreseen in the INTERNATIONAL CONVENTION FOR SAFETY OF LIFE AT SEA (SOLAS 1974/1988):

**SOLAS, CAP. I – Part B**

*Regulation 10*

**Surveys of structure, machinery and equipment of cargo ships**

(a) The structure, machinery and equipment (other than items in respect of which a Cargo Ship Safety Equipment Certificate and a Cargo Ship Safety Radio Certificate are issued) of a cargo ship as referred to in paragraph (b)(i) shall be subject to the surveys and inspections specified below:
(i) an initial survey including an inspection of the outside of the ship's bottom before the ship is put in service;*

(ii) a renewal survey at intervals specified by the Administration but not exceeding 5 years, except where regulation 14(b), (e), (f) and (g) is applicable;

(iii) an intermediate survey within three months before or after the second anniversary date or within three months before or after the third anniversary date of the Cargo Ship Safety Construction Certificate, which shall take the place of one of the annual surveys specified in paragraph (a)(iv);

(iv) an annual survey within 3 months before or after each anniversary date of the Cargo Ship Safety Construction Certificate;

(v) a minimum of two inspections of the outside of the ship's bottom during any five year period, except where regulation 14(e) or (f) is applicable. Where regulation 14(e) or (f) is applicable, this five year period may be extended to coincide with the extended period of validity of the certificate. In all cases the interval between any two such inspections shall not exceed 36 months;

(vi) an additional survey as prescribed for passenger ships in regulation 7(b)(iii).

(b) The surveys and inspections referred to in paragraph (a) shall be carried out as follows::

(i) the initial survey shall include a complete inspection of the structure, machinery and equipment. This survey shall be such as to ensure that the arrangements, materials, scantlings and workmanship of the structure, boilers and other pressure vessels, their appurtenances, main and auxiliary machinery including steering gear and associated control systems, electrical installation and other equipment comply with the requirements of the present regulations, are in satisfactory condition and are fit for the service for which the ship is intended and that the required stability information is provided. In the case of tankers such a survey shall also include an inspection of the pump-rooms, cargo, bunker and ventilation piping systems and associated safety devices;

(ii) the renewal survey shall include an inspection of the structure, machinery and equipment as referred to in paragraph (b)(i) to ensure that they comply with the requirements of the present regulations, are in satisfactory condition and are fit for the service for which the ship is intended;

(iii) the intermediate survey shall include an inspection of the structure, boilers and other pressure vessels, machinery and equipment, the steering gear and the associated control systems and electrical installations to ensure that they remain satisfactory for the service for which the ship is intended. In the case of tankers, the survey shall also include an inspection of the pumprooms, cargo, bunker and ventilation piping systems and associated safety devices and the testing of insulation resistance of electrical installations in dangerous zones;

(iv) the annual survey shall include a general inspection of the structure, machinery and equipment referred to in paragraph (b)(i), to ensure that they have been maintained in accordance with regulation 11(a) and that they remain satisfactory for the service for which the ship is intended;
(v) the inspection of the outside of the ship's bottom and the survey of related items inspected at the same time shall be such as to ensure that they remain satisfactory for the service for which the ship is intended.

(c) The intermediate and annual surveys and the inspections of the outside of the ship's bottom referred to in paragraphs (a)(iii), (a)(iv) and (a)(v) shall be endorsed on the Cargo Ship Safety Construction Certificate.

Regulation 11

Maintenance of conditions after survey

(a) The condition of the ship and its equipment shall be maintained to conform with the provisions of the present regulations to ensure that the ship in all respects will remain fit to proceed to sea without danger to the ship or persons on board.

(b) After any survey of the ship under regulations 7, 8, 9 or 10 has been completed, no change shall be made in the structural arrangements, machinery, equipment and other items covered by the survey, without the sanction of the Administration.

(c) Whenever an accident occurs to a ship or a defect is discovered, either of which affects the safety of the ship or the efficiency or completeness of its life-saving appliances or other equipment, the master or owner of the ship shall report at the earliest opportunity to the Administration, the nominated surveyor or recognized organization responsible for issuing the relevant certificate, who shall cause investigations to be initiated to determine whether a survey, as required by regulations 7, 8, 9 or 10, is necessary. If the ship is in a port of another Contracting Government, the master or owner shall also report immediately to the appropriate authorities of the port State and the nominated surveyor or recognized organization shall ascertain that such a report has been made.

SOLAS, Cap. II-1 – Part C – Regulation 26

General

1 The machinery, boilers and other pressure vessels, associated piping systems and fittings shall be of a design and construction adequate for the service for which they are intended and shall be so installed and protected as to reduce to a minimum any danger to persons on board, due regard being paid to moving parts, hot surfaces and other hazards. The design shall have regard to materials used in construction, the purpose for which the equipment is intended, the working conditions to which it will be subjected and the environmental conditions on board.

... 

5 All boilers, all parts of machinery, all steam, hydraulic, pneumatic and other systems and their associated fittings which are under internal pressure shall be subjected to appropriate tests including a pressure test before being put into service for the first time.

Regulation 33

Steam pipe systems
1. Every steam pipe and every fitting connected thereto through which steam may pass shall be so designed, constructed and installed as to withstand the maximum working stresses to which it may be subjected.

2. Means shall be provided for draining every steam pipe in which dangerous water hammer action might otherwise occur.

3. If a steam pipe or fitting may receive steam from any source at a higher pressure than that for which it is designed a suitable reducing valve, relief valve and pressure gauge shall be fitted.

It was verified that the procedures followed by the ship show that the steam pipe systems are inspected, normally, on the occasion of the docking, for during the operation of the ship the pipeline stays permanently pressurized with steam, it not being viable the carrying out of hydrostatic tests.

The last dry-docking of the ship occurred in the period from 18th of February 2008 to 27th July 2008, in accordance with the contents of the following documents:

a) Certificate of Construction of a Cargo Ship issued by the Classification Society of the ship – “KOREAN REGISTER OF SHIPPING” (KRS). On this document it was verified that the last annual inspection was made in Tianjin – China, on 2nd October 2009;

b) Report on Class Survey nº SHI – S0052-08, referring to the inspections carried out in the same period previously described, when the ship was dry-docked in the shipyard situated in the city of Jiang Yin – China, by the same KRS;

c) Report on Inspection and Measurement carried out on 5th June 2008 in the shipyard “CHENGXI SHIPYARD CO. LTD”.

These documents present corroboration of the carrying out of the intermediary inspection during the dry-docking, and the continuous inspection of engines, the inspection of the dry-docking, the inspection of the boilers and an extraordinary inspection due to the conversion carries out on the ship completed on 27th July 2008, in accordance with that registered in the Supplement of the Certificate IOPP (FORM A – RECORD OF CONSTRUCTION AND EQUIPMENT FOR SHIPS OTHER THAN TANKERS), besides the test of the safety valves of the boilers and hydraulic tests and tests of resistance of some systems onboard.

According to the reports and registers obtained onboard, it was verified that the majority of leakages of steam are originating in the gaskets of the flanges of the pipelines and not from their welding of joining and that all the pressures and temperatures are checked by the engine-room crewmembers during the watches. After the accident the system was all inspected by the engineers
onboard, nothing being found that compromised the structure of the steam pipe system, a situation also observed by the expert Naval Inspectors when they were onboard the ship and found the engine installations in perfect working condition and the ship in good conditions of maintenance and operation, within the standards demanded by the international conventions of the International Maritime Organisation (IMO).

4.0 – CREW

The crew foreseen in the Safe Manning Certificate issued by the flag country on 28th July 2008 with validity undetermined was composed of 13 crewmembers, distributed thus:

a) one Captain certified as a First Class Nautical Officer and Radio Officer with GMDSS (Rules II/2 and IV/2 of the STCW);

b) one First Officer certified as a Second Class Nautical Officer, Deck Watch Officer and Radio Officer with GMDSS (Rules II/2, II/1 and IV/2 of the STCW);

c) two deck officers certified respectively as Third and Fourth Class Nautical Officers (Rule II/3 of the STCW), Officer of the Deck Watch (Rule II/1 of the STCW) and course of the GMDSS (Rule IV/2 of the STCW);

d) one Chief Engineer certified as First Class Engineering Officer (Rule III/2 of the STCW);

e) one Sub-chief Engineer (First Engineer Officer) certified as a Second Class Engineering officer and Officer of the Engine-room watch (Rule III/2 and III/1 of the STCW);

f) one Second Engineer certified as a Third Class Engineering Officer and Officer of the Engine-room Watch (Rules III/3 III/1 of the STCW);

g) one Third Engineer with certification of Fourth Class Engineering Officer and Officer of the Engine-room Watch (Rules III/3 and III/1 of the STCW);

h) three Deck Ratings (Rule II-4 of the STCW);

i) one Engine-room rating (Rule II1-4 of the STCW); and

j) One Chief of the Galley.
Besides this, there is a requirement of nine crewmembers with special qualifications, one being with the duty of medical care (Rule VI/4.2) and eight with proficiency in lifesaving craft and rescue (Rule VI/2.1), besides demanding that all the deck officers possess the GMDSS course (Rule IV/2 of the STCW).

The ship is not automatized, so the Engine-room should be permanently manned.

It was verified that the ship attended entirely that demanded in the Minimum Safe Manning Document. The officers are all Korean besides the quartermaster, the machinist’s mate and the cook, all the other crewmember are Philippines, making a total of 21 crewmembers, well above that demanded by the referred document (thirteen).

The work language onboard is English, Korean also being used. The Captain, the first officer and the other officers speak Korean amongst themselves and English with the crew to transmit manoeuvring orders and in general tasks. The Captain had four months onboard, the first officer one month, the deck officers had four and eight months respectively onboard, the Chief Engineer four months the Sub-Chief engineer one month and the other engine-room officers six and eleven months respectively, the last one being the victim of the accident. The other ranks had in the majority, eight months onboard (quartermaster, ordinary seaman, engine-room sailor and ordinary seaman) whilst two sailors were embarked five months before (one from the engine-room), two were two months onboard and three sailors had one month onboard (one from the engine-room), besides the machinist’s mate who was already eleven months on the ship.

The work routine was normal, three watches of four hours each on the bridge and the engine-room, possessing, furthermore, personnel for supervision, maintenance and repairs necessary so that to guarantee the continuity of the services and due resting of the crewmembers, even on long journeys.

5.0 – CAUSAL FACTORS

According to the Expert’s Report elaborated by the Expert Naval Inspectors of the Brazilian Navy, the determinant causal factor of the accident investigated that victimised an engine-room crewmember was “a fortuitous case, connected with the deficiency of the project of the means available for effecting a safe and efficient draining of the steam system, permitting the formation of a “hydraulic hammer” in the steam system for the turbines of the ballast pumps, during
the realization of the heating and draining of the mentioned network, when preparing the installation of steam for the test of the functioning the ballast pumps.

This dangerous formation had started in the steam pipeline and extended itself up to the drainage tank, at the moment that the Officer on Watch alleviated the drainage valve and did not perceive the sound of the beating provoked in the steam network by the “hydraulic hammer” in formation, due to the presence in the area of other noisy machines and motors which must have smothered the sound of the “hydraulic hammer” and thus, did not have time and action to take the emergency measures to stop the evolution of the referred effect, which are: *rapidly close the steam valves and wait until the sound disappears for only then re-start the drainage carefully*, in conformity with the procedures described in the instructions affixed in the engine-room and included in the plan safety management of the ship, in the form of the “ISM Code”.

Thus, it is evident that the material factor was a remote cause, but fundamental culminating in the accident investigated, due the inadequate location of the manifold of the drain valves which compromises the safety of the operator in a case of leakage of steam that in this specific case contributed for the fact of the victim having suffered the direct impact of live steam and the drainage accumulated in the mentioned tank, issuing from the rupture of the bottom of same, causing the burns which were fatal for him.

However, not just material factor, but also the operational factor was one essential component in the close evolution of the events that were precursors to the accident, having in view that the SOLAS Convention, in chapter II-1, Part C, Rule 33, paragraph 2 (see page 15 in this Report) alerts for the possibility of occurrence of dangerous “hydraulic hammers”, and that the steam systems should be provided with a means to drain adequately, each canalization of the steam system.

Add to all this the fact that the steam pipelines and each accessory connected to it, through which steam passes, should be projected, constructed and installed in a manner that they are resistant to the maximum value of the efforts of work to which they may be submitted (Rule 33, paragraph 1, of chapter II -1-C of the SOLAS), not being justifiable that, even for an operational fault, the drainage tank should have burst. The drain would have had to support maximum pressures that could occur in all the conditions of operation, allied with the fact ascertained that even if the
working pressure of the system was around 7kg/cm², the system could normally work with pressure up to 12 kg/cm².

Observe further, the following: “if a canalization of steam or one of its accessories be susceptible of receiving steam coming from any source, with a pressure higher than that for which they were designed, should possess an adequate reducing valve, a safety valve and a pressure gauge (Rule 33, paragraph 3, of chapter II-1-C of the SOLAS, presented in this report). The investigators do not observed the existence of this safety and monitoring equipment in this area of the installation.

Furthermore, the fact of the procedures for verification, tests and inspections of the steam artefacts being defined by each classification society, according to the criteria adopted by them and do not specifically appear in the reports existing onboard, there always remains a doubt if the Classification Society had effectively submitted the drainage tank to appropriate tests, including a pressure test and approved the continuation of operation of the ship in the manner of everything that had been presented with respect to the SOLAS convention, particularly the Rules 10 and 11, of Chapter I - Part B and Rule 26, of Chapter II-1 – Part C, as discriminated in this report.

6.0 - PRELIMINARY LESSONS LEARNT AND CONCLUSIONS

According to information collected by the investigators of the accident the steam pipeline operated with pressure smaller than 7kg/cm² which was corroborated by the registries of the Engine-room Log Book of 09/11/2009, in the watch of 0400 hrs to 0800 hrs, however it can reach pressures in the order of 12.5 kg/cm² during the use of the ballast pumps. The maximum working pressure permitted on the steam pipeline is 16 kg/cm². The tests of the steam networks are carried out normally on the occasion of the dry-dockings, for during the operation of the ship the network is permanently pressurized with steam, impeding the carrying out of hydrostatic tests.

The investigators were unable to obtain information about who carried out the last pressure test of the steam pipeline and how it was done, verifying only that the last docking occurred in July of 2008. During the docking were performed the intermediary inspections, the continuous inspection of engines, the inspection of boilers and the extraordinary inspection, besides the tests of the safety valves on the boilers and hydraulic test and of resistance of some pipelines onboard.

It was further verified that the majority of the steam leakages result from the gaskets of the flanges of the pipelines and not from the welding of joining of same and that all the pressures and
temperatures are checked by the engine-room crewmembers during the watches. After the damage the system was checked and nothing was found that could compromise the structure of the steam pipeline, the same being considered in a good state of conservation.

As for the operation of the steam pipeline, the investigators ascertained that the valve of the drain line of steam should be opened slowly, until the operator has made sure that the network is completely drained. However, according to testimonies, the Chief Engineer suspects that the officer on watch opened the drain valve very rapidly, causing a flux of live steam in the network, still with condensation, and in the drainage tank, with water accumulated, which had provoked the bursting of the plate of the bottom of the drainage tank.

Also the Officer of the previous watch presented a similar version for the occurrence and informed that there exist explanatory instructions on the functioning of the steam pipeline fastened on the bulkhead beside the boiler, informing that the system possesses mechanisms of relief of excess of pressure, which are tested and homologated by the Classification Society. Furthermore, he had not observed any mechanical fault in the pipeline, having operated same twice in the week of the accident, concluding it being most probable that there was an operational fault on the part of the officer of the watch, once that the work pressures of the pipeline were around 7kg/cm² and the steam system could work normally with a pressure up to 12 kg/cm².

He further mentioned that on the occasion of repair carried out on the damaged steam accessories, they were in a good state of conservation, nothing indicating that they were with their structural resistance compromised.

Meanwhile, both witnesses could not explain how the Officer of the watch, onboard for more than ten months as responsible for the operation and maintenance of the steam pipeline, having already carried out this task various times and qualified as engineering officer 2 years ago, could commit an operational fault or disregard some basic safety rule, that led to a serious accident, principally considering that the company responsible for the operation of the ship supplies before the embarkation of the crewmember, the specifications of the equipment and systems onboard and, upon embarking, the Chief Engineer shows the functioning of all the systems and equipment of the engines. The crewmember that will be substituted by that newly embarked pass to him all the details of the occurrences of the equipment that he will operate, besides the entries in the Engine-room Logbook.
In this manner, everything leads one to believe that the continuity of the task of draining by the officer of the watch, accelerated the descent of the hydraulic hammer, reaching an excessive pressure, particularly when in contact with the condensation accumulated in the drainage tank, which culminated with a sudden and violent vaporization, making the tank collapse with the bursting of its bottom. Thus, one cannot affirm that there was an operational fault on the part of the victim, in view of his professional formation and experience as engineering officer, being responsible for the operation and maintenance of referred installation for more than ten months.

In the conversion of the ship in July 2008, it was verified that the pumps for transference of the cargo of fuel oil were modified to be utilized as ballast pumps, one being able to conjecture in respect of these alterations carried out on the ship – did they not compromise the safety of the steam pipeline? – permitting the involuntary formation of a “hydraulic hammer” and the consequent bursting of the drainage tank. It was also observed that the place where is installed the manifold of drainage valves is not the most indicated, for it stays right below the drainage tank, compromising the safety of the operator in case of spillage of steam, not attending that foreseen in SOLAS 74 and its protocol of 1978, chap. II-1 – Part C – Rule 26 (applicable to the ship, in accordance with Rule 1 of the referred chapter).

Therefore, the investigation concluded that the accident fits as a fortuitous case, related to the deficiency of the project of the means available to effectuate a safe and efficient drainage of the steam pipeline, or to some modification or adaptation carried out on the occasion of the alteration effectuated, during its conversion (big modifications), in the period of 18th February to 27th July 2008.

The very serious accident which victimised an engine-room officer of the ship, occurred independent of the will of its crewmembers, nothing proving in respect of a possible fault of training or even inadequate training, once that all the crewmembers were duly qualified and certified, possessing the adequate maritime formation that capacitiated them for the exercise of their functions, there being reports and registers of adequate teaching and training in the diverse systems onboard, particularly the victim who had the longest time onboard the ship, amongst the officers, besides his formation and function exercised, already mentioned before.

With then intention of better clarifying the precursory causes of the referred very serious maritime accident, contact was made with the Maritime Agency that represented the ship to obtain
some information from the Classification Society KOREAN REGISTER OF SHIPPING (KRS) that would complement the data obtained from the ship, being presented a List of Questions which was answered by the regional representative established in Buenos Aires-Argentina and by the General Manager of the Survey Team, by means of electronic correspondence.

The Classification Society informed that it only assumed the classification of the ship as from 13th December 2007, not possessing registries of the inspections previous to that date, when the ship was under the supervision of the Classification Society “DET BORSKE VERITAS” (DNV). Thus, as since its building up to December 2007, the ship was under the classification of the DNV, all the registers of the inspections, during and after the building up to that moment, would be in the possession of same, KRS having agreed with all the previous conditions and approvals that were made by the DNV.

In short, the investigators verified that there did not exist registers of recent hydrostatic tests of the steam pipelines or other tests not destructive to the welding, junctions of the pipelines and points of presumable fragility, for in accordance with the procedures of the KRS for tests of the pipelines and vessels of steam, hydrostatic tests are made on the system of steam pipelines and vessels during the period of building (after completion of fabrication and after installation onboard). During the periodical inspections are carried out a general examination of the engines, boilers, all the steam pipelines, hydraulics, pneumatics and other associated systems and their accessories, to verify their adequate maintenance and if there is presented any non-conformity with the International Safety Management Code (ISM Code).

Unless the steam pipeline has been substituted or modified, the KRS does not demand any hydrostatic test. The registers are only made for deficiencies and repairs noted in the referred inspections. If is found a hole or damage in the network the substitution of same is required, but the ordinary inspections on all the networks are made visually, as much to verify the state of conservation of same, as of their insulation, indicating preventive and corrective actions necessary.

The simple change of the steam pipeline for a new one is responsibility of the ship, without necessity of approval of the Classification Society, as well the ordinary accompanying of the steam line and its accessories. Attention should be given to the junctions of the networks, curves and welding, where may be demanded by the Classification Society the carrying out of non-destructive tests, to assure the conditions of the repair carried out and approve it, such procedure may be omitted at the criterion of the Classification Society, who should inspect such service carried out on
board. The Classification Society can carry out a more detailed inspection, but cannot control the ordinary and sudden problems.

The Classification Society DNV was also consulted and manifested itself by electronic means, through its representative in Brazil. The representative of the DNV presented replies similar to those of the representative of the KRS, being however more specific, incisive and detailed in its answers, presenting various extracts of the Rules of the DNV, which present rules and procedures more rigid and complete that demand the accompanying of the tests carried out on boilers onboard, by the surveyor of the Classification Society and the approval of any repair carried out, even at sea, in the case of an emergency, the presence of the surveyor should be requested at the first safe or scheduled port of call to accompany the definitive repair and approve it.

As to the periodical surveys of the item of engines (pipelines, valves and filters of steam) every five years the DNV also foresees a visual inspection, without dismantling, and test of functioning, opening and, if necessary, verification of the last revision. Only for the heat exchangers, evaporators, condensers and steam turbines, the procedure is more rigorous, foreseeing the visual inspection with complete or partial opening of the equipment, according to the surveyor’s requirements. The working tests and/or pressure tests should be carried out when considered necessary and relevant.

With regard to the tests of approval and periodic inspections that evaluate the existing drains in the steam system and indicate if they are sufficient and fully attend the requirements of safety foreseen in the international conventions, the DNV informed that the arrangements and the dispositions are evaluated in the approval of the design and arrangement of the steam system, therefore in the phase of building or big modification of the ship.

As for the accompanying of the conditions of conservation and maintenance of the steam pipelines and accessories of the ship, the DNV informed that the classifier only verifies the situation of the steam systems, in the manner described above, at the time of the inspections. For in the day to day such verification is responsibility of the ship.

From everything ascertained during the carrying out of this marine safety investigation a significant contribution was made by some conditions of the installation, which are:
a) deficiency of the project of the means available to carry out a safe and efficient drainage of the steam system, by not paying attention to that foreseen in SOLAS 74, Chap.II-1 – Part C – Rules 26 and 33, permitting the collapse of a steam artefact that was working within the normal conditions of functioning, foreseen for the referred equipment, so far as structural resistance, and also for its inadequate location and also the prevention of the occurrence of dangerous “hydraulic hammers”;

b) the conversion carried out on the ship, in the period of February to July of 2008, where it is observed that the pumps used for transference of the cargo of fuel oil were modified to be utilized as ballast pumps whose alteration had compromised the safety of the steam system permitting also the involuntary formation of “hydraulic hammer”;

c) the inexistence of a detailed and specific record of the appropriate tests including pressure tests of the pipelines and other artefacts of steam and new plans of arrangement of the modifications carried out, in the moulds of SOLAS 74 Chap. II-1 – Part C – Rule 26, paragraph 5, presented on the present Report; and

d) the fact of the procedures for verification, tests and inspections of the steam artefacts being defined for each classification society, according to the criteria adopted by them and not appear specifically in the reports existing onboard, remaining a doubt if the Classification Society has effectively submitted the drainage tank to appropriate tests including pressure test and approved the continuity of the ship on the moulds of everything which was presented, as regards the SOLAS convention, particularly that contained in Rules 10 and 11, of Chap. I – Part B and Rule 26, of Chap. II-1- Part C , as discriminated on the present Report.

7.0 – RECOMMENDATIONS

Aiming to prevent the occurrence of a similar maritime accident in the future, some suggestions will be presented, coming from conclusions of the present investigation and from the identification of questions related to maritime safety.

According to what was ascertained during the present investigation, the conclusion was arrived at that the system of drainage of steam of the installation of the ship presented operational and structural deficiencies that indicate a lack of care with the safety of human life at sea, during the conception of the initial project or, even of the project of conversion, having in view that was
identified an inadequate localization of the steam drainage valves (right below the drainage tank) and a fragility of the referred tank, which did not resist the pressure of normal work of the system, and collapsed. Was not also observed the existence of adequate means to prevent the formation of “hydraulic hammers” in the steam networks and artefacts, all this in detriment of that foreseen in SOLAS 74 and its protocol of 1978, ChapII-1 – Part C- Rules 26 and 33.

Also, the fact of the procedures for verification, tests, inspections and registers of the respective activities, as regards the steam artefacts, defined by each classification society, according to the criteria they have adopted and not recorded specifically in the reports existing onboard, does not permit presentation of proof in the external audits and inspection of “Port State Control” that the Classification Society effectively submitted the referred artefact to appropriate tests, including the pressure test and if the approval of continuity of the operation of the ship really follows the moulds of everything presented, as regards to the SOLAS convention, particularly the Rules 10 and 11, of Chap. I – Part B and Rule 26, of Chap II-1 – Part C, as previously described.

Nevertheless the deficiencies pointed out in the present investigation as regards the installation of engines of the ship can only be proven by the carrying out of tests on the drainage system, in various situations of functioning and load of the steam network and drainage and a technical analysis by a mechanical engineer specialized in this type of steam installation, with the support of the Classification Society.

The SOLAS Convention itself, in chapter II-1, Part C, Rule 33, paragraph 2, alerts for the possibility of the occurrence of the action of dangerous “hydraulic hammers”, and the steam systems should by provided with means to drain each canalization of the steam network, which indicates the necessity of the carrying out of a judicious technical inspection by the Classification Society of the ship, with the accompaniment of the Administration of the Flag Country.

Thus, some procedure for verification, tests and inspections of the artefacts of steam should be standardized by the IMO and not just defined by each classification society in conformity with their own criteria, in order for it to be possible to verify their fulfilment in a clear form and expressed in the documents delivered to the ship, with a label or stamp of quality affixed or marked on the steam networks and artefacts themselves.

This would create thus, a specific register of the tests and checking, based on the hours of operation and not just in a generic form, on the occasion of the dockings, periodic and annual
inspections, carried out by the Classification Society of the ship, it being possible to insert a specific annex for such registers, addendum of the respective certificates of Safety of the Building and Equipments of cargo ships and Safety in General of passenger ships.

Such procedures and recommendations would also apply after the carrying out of a conversion or big alterations effectuated on the ships, in order to avoid that are created new risks for the safety of the original systems modified, rendering it as one all new and integrated, adapting itself and substituting all the plans diagrams and manuals of the various systems and equipment altered and also of those that may suffer interferences, due to the new operational situation of the ship, in order that become minimum any possibility of damage to the persons onboard the merchant ships of all the international maritime community.