



MINISTÈRE DU DÉVELOPPEMENT DURABLE
ET DES INFRASTRUCTURES
Département des transports

Administration des enquêtes techniques

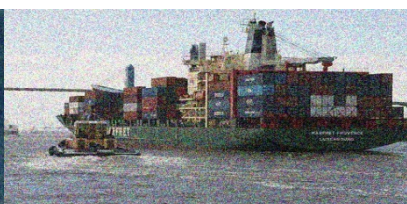
FINAL REPORT

FATAL ACCIDENT ON BOARD JUAN SEBASTIAN DE ELCANO ON 3 NOVEMBER 2014

DATE OF ISSUE: 22 December 2016

ADMINISTRATION OF TECHNICAL INVESTIGATIONS

CIVIL AVIATION – RAIL – MARITIME – RIVER



Ministry of Sustainable Development and Infrastructure
Department of Transports

Administration of Technical Investigations

Report N° AET/TM-2016/01

FINAL REPORT

**Fatal accident on board *Juan Sebastian de Elcano*
on 3 November 2014**

Administration des enquêtes techniques (AET)

B.P. 1388 L-1013 Luxembourg

Tél: +352 247-74408

Fax: +352 247-94404

Email: info@aet.etat.lu

Web: www.mt.public.lu/transports/AET

FOREWORD

In accordance with Directive 2009/18/EC of the European Parliament and of the Council of 23 April 2009 establishing the fundamental principles governing the investigation of accidents in the maritime transport sector and Luxembourg law dated 30 April 2008 on technical investigations in relation to accidents and serious incidents which occurred in the domains of civil aviation, maritime transport and railways, it is not the purpose of the maritime investigation to apportion blame or liability.

The sole objective of the safety investigation and the Final Report is the prevention of accidents and incidents.

Consequently, the use of this report for purposes other than accident prevention may lead to wrong interpretations.

Note 1: The present safety investigation is mainly based on factual information provided by the ship operator.

Note 2: All times indicated in this report are in Philippines Local Time (LT, UTC +8), unless stated otherwise.

GLOSSARY OF ABBREVIATIONS AND ACRONYMS

Add. -	Addendum
AET -	Administration des enquêtes techniques (Luxembourg safety investigation authority)
ALARP -	As Low As Reasonable Practicable
BV -	Bureau Veritas
DoT -	Department of Transport
DPA -	Designated Person Ashore
ECR -	Engine control room
EU -	European Union
GA -	General Arrangement
HM -	Hazard Management
IMO -	International Maritime Organization
ISM -	International Safety Management
JHA-	Job Hazard Analyses
LMRA -	Last Minute Risk Assessment
LOTO-	Lock-Out/Tag-Out procedure
LT -	Local Time
MCA -	Maritime and Coastguard Agency
MGN -	Marine guidance note
MSC -	Maritime Safety Committee
PA -	Public address
PCG -	Philippines Coast Guard
PS -	Port side
PSM -	Pre-Start Meeting
PTW -	Permit-to-Work system
PPE -	Personal Protective Equipment
RIA -	Risk and Impact Assessment
SB -	Starboard side
SMS -	Safety Management System
SOLAS -	International Convention for the Safety of Life at Sea
SWP -	Safe Work Practice
TIVM -	Technical Superintendent
UTC -	Universal Co-ordinated Time
VDR -	Voyage Data Recorder
VHF -	Very high frequency

CONTENTS

1. SUMMARY	6
2. FACTUAL INFORMATION	7
2.1. SHIP PARTICULARS	7
2.1.1. Main data	7
2.1.2. Hopper	8
2.1.2.1. General	8
2.1.2.2. Dumping Shore discharging	8
2.1.2.3. Overflow	8
2.2. VOYAGE PARTICULARS	9
2.3. MARINE CASUALTY OR INCIDENT INFORMATION	11
2.4. WEATHER AND SEA CONDITIONS	11
3. NARRATIVE	12
3.1. SEQUENCE OF EVENTS	12
3.1.1. 22 October 2014	12
3.1.2. 28 October 2014	12
3.1.3. 31 October 2014	12
3.1.4. 3 November 2014 / day of the occurrence	12
3.1.5. 4 November 2014	19
3.1.6. 5 November 2014	19
3.2. ADDITIONAL INFORMATION	19
3.2.1. Thickness measurement task	19
3.2.2. Hazard Management (HM)	19
3.2.3. Autopsy report	23
3.2.4. First aid provided to the rescued crew member	23
3.2.5. Pre-Start Meeting (3 November 2014, 06:00 AM)	23
3.2.6. Written statements	23
3.2.6.1. Master of JUAN SEBASTIAN DE ELCANO (3 November 2014)	23
3.2.6.2. Chief Officer Day (4 November 2014)	24
3.2.6.3. Electrician (3 November 2014)	24
3.2.6.4. Chief Officer Night and 2 nd Pipe Officer Night (date unknown)	24
3.2.6.5. Rescued 2 nd Pipe Operator (day shift) (4 November 2014)	24

4.	ANALYSIS	26
4.1.	RISK ASSESSMENT AND JOB HAZARD ANALYSIS	26
4.2.	JOB PLANNING/PRE-START MEETING	26
4.3.	TASK COMPLETION.....	27
4.4.	TASK SUPERVISION.....	27
4.5.	LOWERING OF THE WATER LEVEL	27
4.6.	SAFETY AND RISK AWARENESS.....	28
4.7.	OPERATIONAL IMPLEMENTATION OF THE HM SYSTEM.....	28
5.	SAFETY RECOMMENDATIONS	29
5.1.	OPERATOR'S EVALUATION OF THE HM SYSTEM.....	29
6.	APPENDIX 1 – SWP 'Thickness measurements in hopper' (Excerpt).....	30

1. SUMMARY

The scope of the project was dredging and dumping of 1,500,000 m³ silt to design depth -11.50 m at Harbor Centre, Manila, Philippines. After completing the previous project on 22 October 2014, the vessel dropped anchor at 05:05 PM LT in Manila Bay, at position 14.55° N, 120.94° E. The vessel was scheduled to mobilize to the next project in Taiwan around mid-November. While at anchor, the crew was performing regular maintenance tasks and some preparation for the next docking.

On the day of the occurrence, the deck crew took part in a daily Pre-Start Meeting (PSM) at around 06:00 AM, discussing the tasks for the day. The PSM was chaired by the Chief Officer as the Captain was not present on deck. One of the tasks was to perform thickness measurements of the hopper walls, side, fore and aft plates. The 2nd Pipe Operator (day shift) and the Apprentice Pipe Operator, both attending the PSM, were assigned to the task.

First, the hopper was filled with water after the aft overflow was blinded off and the fore overflow set at 11.82 m. A small boat was then lowered into the hopper and the crew assigned to the task entered the boat with their equipment. After the first set of measurements, the unsecured boat with both occupants was located at the aft starboard (SB) part of the hopper. After radio co-ordination with the Chief Officer on the bridge, the water level was lowered for the next level thickness checks.

While the water level was being lowered, the crew in the boat tried to paddle to the front port side (PS) of the hopper, but the strong current caused by the outflowing water made the boat bump against the overflow. At that point, according to the statement of the 2nd Pipe Operator (day shift), the Apprentice Pipe Operator stood up to grab for a hold. The boat became unstable and flipped over. Both occupants fell into the hopper and got pulled down through the overflow. The 2nd Pipe Operator (day shift) exited under the vessel's hull and managed to swim to the surface, where he was subsequently rescued. Unfortunately the Apprentice Pipe Operator was missing. His floating body was found the following day close to the ship near the trunnion gantry.

2. FACTUAL INFORMATION

2.1. SHIP PARTICULARS

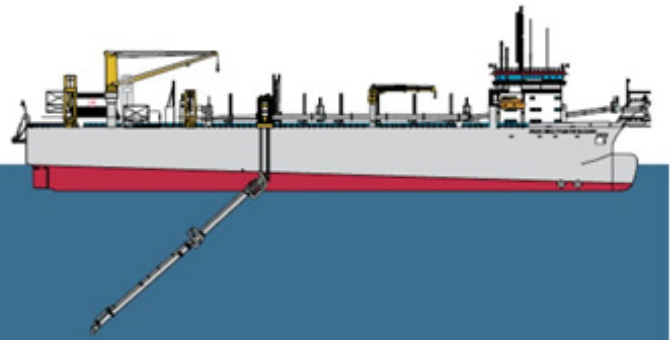


2.1.1. Main data

Flag:	Luxembourg
Name:	JUAN SEBASTIAN DE ELCANO
Type:	Trailing Suction Hopper Dredger
Year of building:	2002
Delivery date:	10 October 2002
Call sign:	LXDD
IMO N°:	9238909
Freeboard reduction:	Dredging within 15 miles out from shore or within 20 miles from port and dredging over 15 miles from shore with $H_s \leq 3.0$ m
	647 mm to DR67
Tonnage:	Gross 17370
	s Net 5211
Suez reg. tonnage:	Gross 16515.5
	s Net 14355.26

JUAN SEBASTIÁN DE ELCANO

Hopper capacity	16,500 m ³
Deadweight	26,650 ton
Length o.a.	157.5 m
Breadth	27.8 m
Draught loaded	11.10 m
Maximum dredging depth	40.5 / 54.5 m
Suction pipe diameter	1,100 mm
Pump power (trailing)	2 x 2,250 kW
Pump power (discharging)	9,500 kW
Propulsion power	2 x 8,400 kW
Total installed diesel power	17,880 kW
Speed	15.7 kn
Accommodation	42
Built in	2002



2.1.2. Hopper

2.1.2.1. General

Capacity (to top coaming):	17831 m ³
Capacity (to top overflow):	16713 m ³

Max. length:	63.0 m
Max. width:	21.8 m

2.1.2.2. Dumping Shore discharging

Dumping:

Type: 7 double bottom doors at the centerline of the ship

Free passage (l x b): 6.00 m x 6.00 m

Pre-unloading by means of 2 pre-unloading doors, free passage 4.26 m x 1.80 m

Shore discharging:

2 self-emptying channels, with 7 doors on each side.

Doors operated by hydraulic cylinder with chain to deck.

2.1.2.3. Overflow

Number:	2 (fore and aft)
Type:	cylindrical
Diameter:	2.40 m
Stroke:	7.30 m
Lowest position:	6800 m ³ at 8.2 m.a.b.
Highest position:	16700 m ³ at 15 m.a.b.

2.2. VOYAGE PARTICULARS

JUAN SEBASTIAN DE ELCANO completed dredging works for a project at Manila Bay on 22 October 2014 and dropped anchor at 05:05 PM LT at position 14.55° N, 120.95° E. The vessel was scheduled to depart for the next project in Taiwan around mid-November.

While at anchor, the crew was performing regular maintenance tasks and some preparations for the next docking.



Figure 2.1 – Harbor Centre, Manila
(Source: Operator)

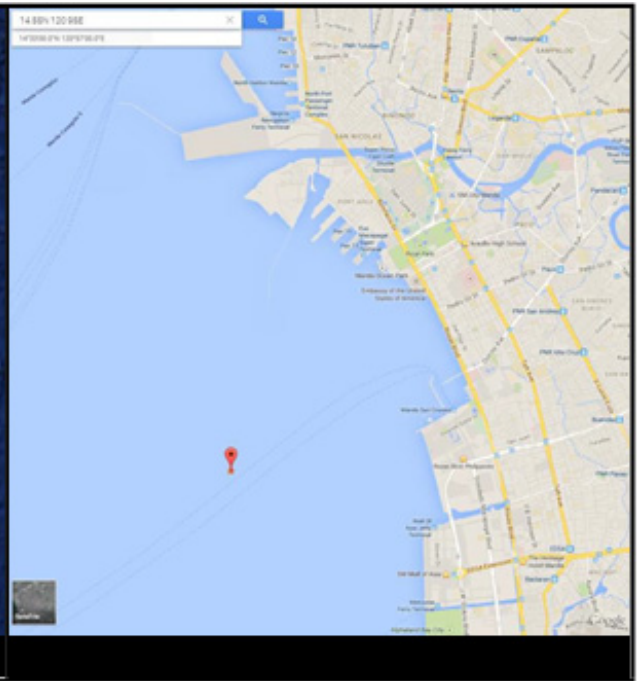


Figure 2.2 – Vessel Position at time of occurrence
(Source: Operator)



Figure 2.3 – Dredge and Dump Area (Source: Operator)

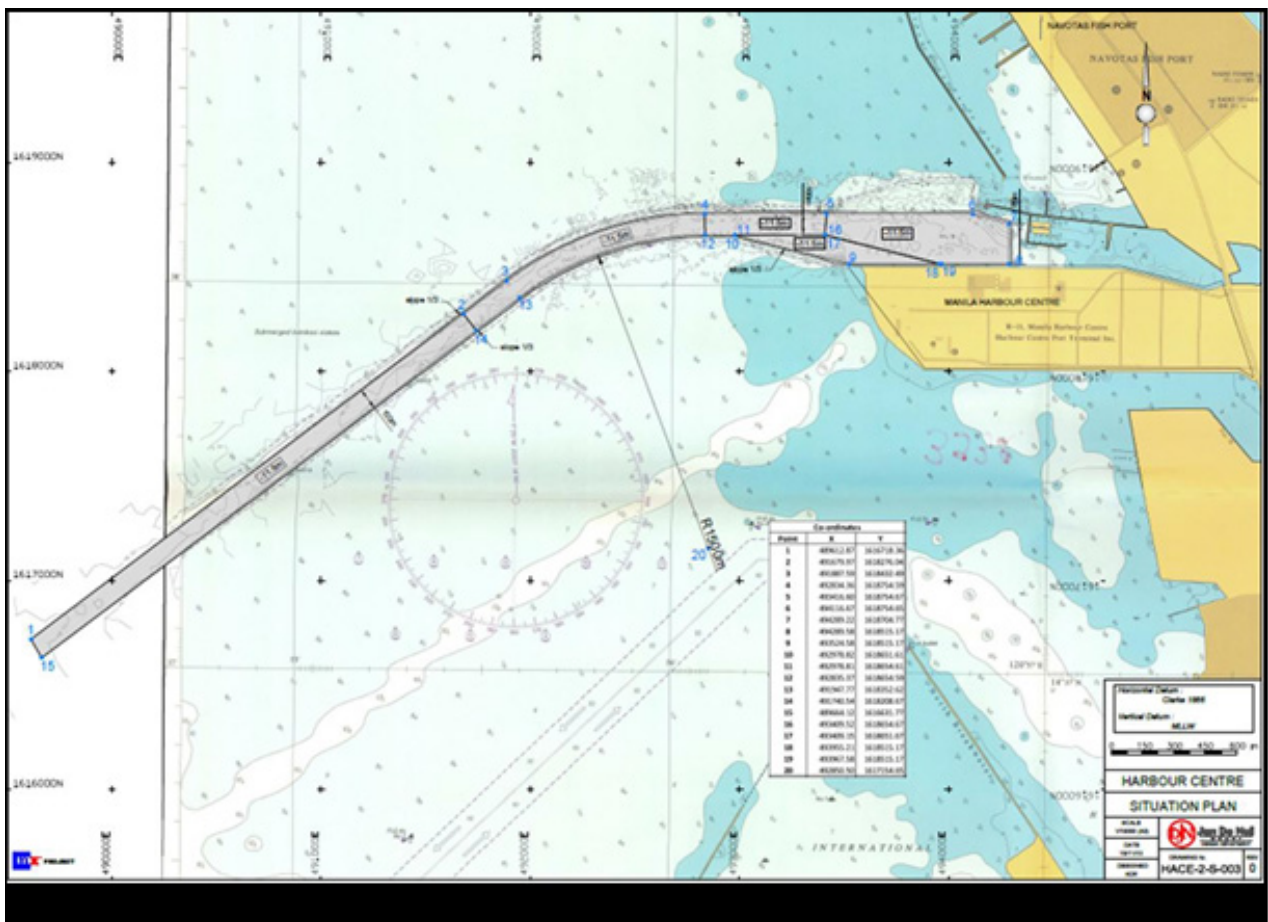


Figure 2.4 – Dredge Area (Source: Operator)

2.3. MARINE CASUALTY OR INCIDENT INFORMATION

Accident details

Time and date:	3 Nov. 2014 at 11:10 AM LT
Location of accident:	Inside hopper of JUAN SEBASTIAN DE ELCANO, Manila Bay (14.55° N, 120.95° E), Manila, Philippines
Persons on board:	35
Deceased:	Apprentice Pipe Operator, Belgium National Cause of death – asphyxia by drowning
Injured:	2 nd Pipe Operator, Dutch National Injury to right elbow and right knee
Experience of involved crew:	Apprentice Pipe Operator worked on similar vessels since 12 Sept. 2012 and first time onboard the occurrence vessel on the 10 Dec. 2012 2 nd Pipe Operator worked on similar vessels since 6 Dec. 2007 and onboard the occurrence vessel since 4 Aug. 2014

2.4 WEATHER AND SEA CONDITIONS

At the time of the occurrence, the sky was clear and the outside temperature was 27° C. The sea was calm, but there was a strong current underneath the ship.

3. NARRATIVE

3.1. SEQUENCE OF EVENTS

3.1.1. 22 October 2014

JUAN SEBASTIAN DE ELCANO completed dredging works for the project at Manila Bay on 22 October 2014 and dropped anchor at 05:05 PM LT at position 14.55° N, 120.95° E. The vessel was scheduled to depart for the next project in Taiwan around mid-November.

While at anchor, the crew was performing regular maintenance tasks and some preparations for the next docking.

3.1.2. 28 October 2014

The Apprentice Pipe Operator signed on.

3.1.3. 31 October 2014

The 2nd Pipe Operator (day shift) signed on.

3.1.4. 3 November 2014 / day of the occurrence

On the day of the occurrence, the deck crew (including the 2nd Pipe Operator (day shift) and the Apprentice Pipe Operator) took part in a daily Pre-Start Meeting at around 06:00 AM, discussing the tasks for the day. The PSM was chaired by the Chief Officer. The Captain was not present during the PSM.

As the engine room (ER) crew had to test the port side (PS) engine, it was considered to be a good occasion to reposition the vessel (for better V-Sat Signal coverage) and to fill up the hopper for the requested thickness measurements of fore and aft vertical hopper walls in preparation of the upcoming docking. During the morning, the vessel was repositioned and aft anchor was dropped at new position.

At around 10:00 AM, during coffee break, the crew started filling the hopper. The fore overflow was positioned at 11.82 m, while the aft overflow was blinded off.

Five minutes later, after the coffee break, the thickness measurement task was started by the assigned crew. The Chief Officer of the day shift was the Officer of the Watch. He positioned himself at the Bridge.

At around 10:30 AM, the Bosun was asked by the Apprentice Pipe Operator to lower a small boat into the hopper. The small boat was provided with a ~5 m rope on fore and aft. The 2nd Pipe Operator (day shift) descended the fixed ladder in the hopper on SB aft to disconnect the boat.



Figure 3.1 - Fore Overflow
(Source: Operator)

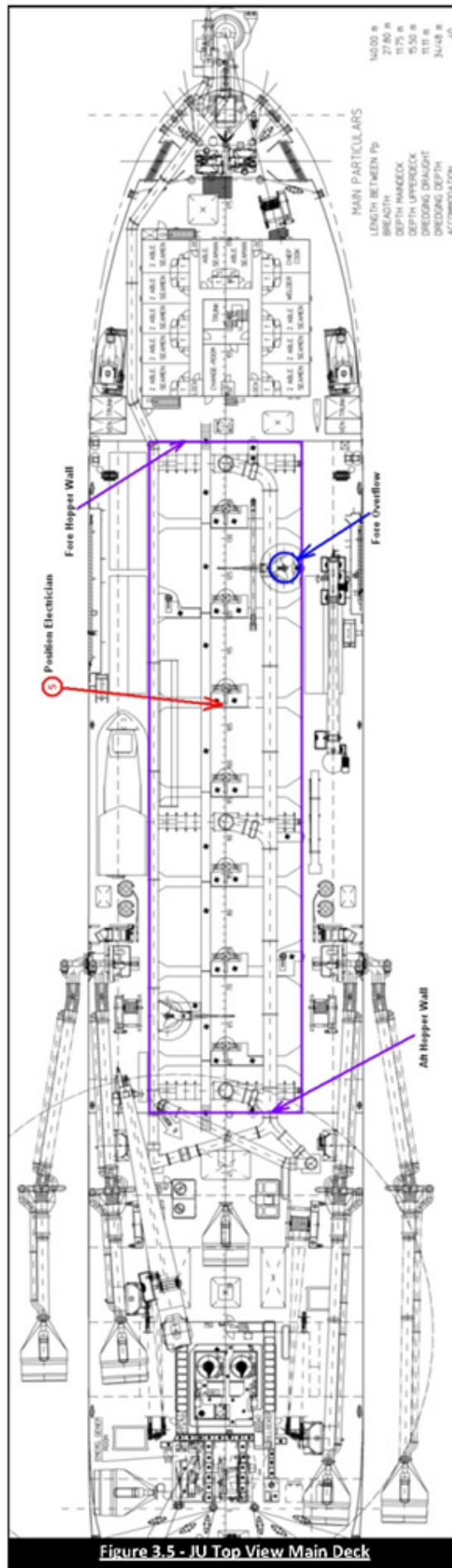
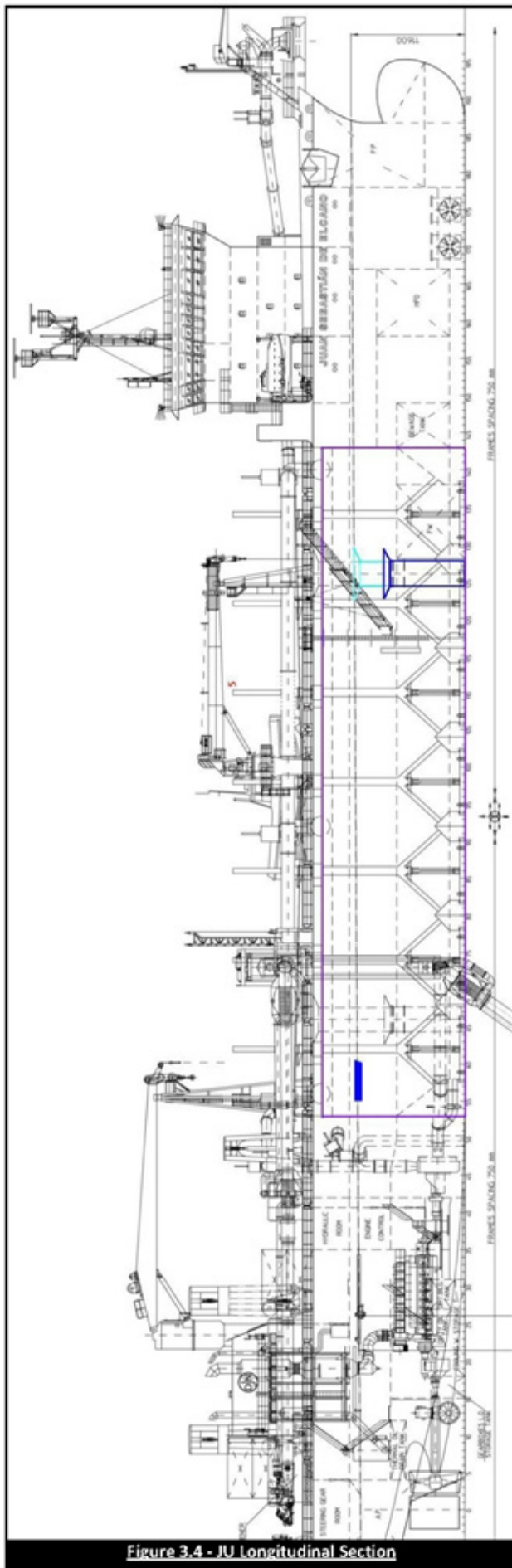


Figure 3.2 - Blinded Aft Overflow
(Source: Operator)



Figure 3.3 - Aft 'Out-of-use' Ladder into hopper
(Source: Operator)

Both Pipe Operators assigned to the task boarded the boat taking along two paddles, a small grinder (on batteries), the thickness measurement device (Pocket Mike), some cleaning product, a radio and two small bottles of water. They did not wear a life jacket. They started their measurements at the fore (upper) hopper wall, then paddled back to the aft for further measurements.



(Source: Operator)

At around 11:05 AM, when the thickness measurements at the upper aft were completed, the 2nd Pipe Operator (day shift) called the Chief Officer Day over the radio with a request to lower the overflow to the next position. At that time the Chief Officer Day had visual contact with the boat and the crew. He followed the request and started to lower the overflow.



Figure 3.6 - View from Dredge Desk over the Hopper (Source: Operator) **Figure 3.7** - Overflow Level (4 Nov. 2014) (Source: Operator)

The initial position of the overflow was 11.82 m. When the overflow started to move down, both Pipe Operators were still at SB aft inside the unsecured boat in the hopper. They started to paddle to the front PS of the hopper. The boat moved forward and towards the overflow due to the current induced by the outflow of the water through the overflow.

At around 11:07 AM, the lowest position of the overflow reached 8.62 m (-3.20 m in 1'39") and within another minute, the final position of the overflow settled at 9.62 m (-2.21 m since initial position in 2'30"; +1.00 m in 51").

[Note: The accident was not witnessed by any crewmember other than the 2nd Pipe Operator (day shift), who was in the boat together with the Apprentice Pipe Operator during the occurrence and who was the sole survivor. The description of the event is solely based on his witness statements.]

According to the 2nd Pipe Operator (day shift), the boat bumped into the overflow due to the strong current induced by the outflowing water. At that point, the Apprentice Pipe Operator stood up and tried to get a hold at a part of the overflow structure. It can be assumed that due to the weight shift, the boat became unstable and capsized. The two occupants subsequently fell overboard into the hopper and got sucked through the overflow.

At approximately 11:10 AM, the apprentice electrician, who was disconnecting the measurement sensor of bottom door no. 5 above the hopper, heard unusual noises coming from the hopper. He stepped up from behind his work position to look into the hopper and saw the small boat upside down on the overflow. He couldn't see any of the operators inside the boat and started running towards the bridge, shouting for help.

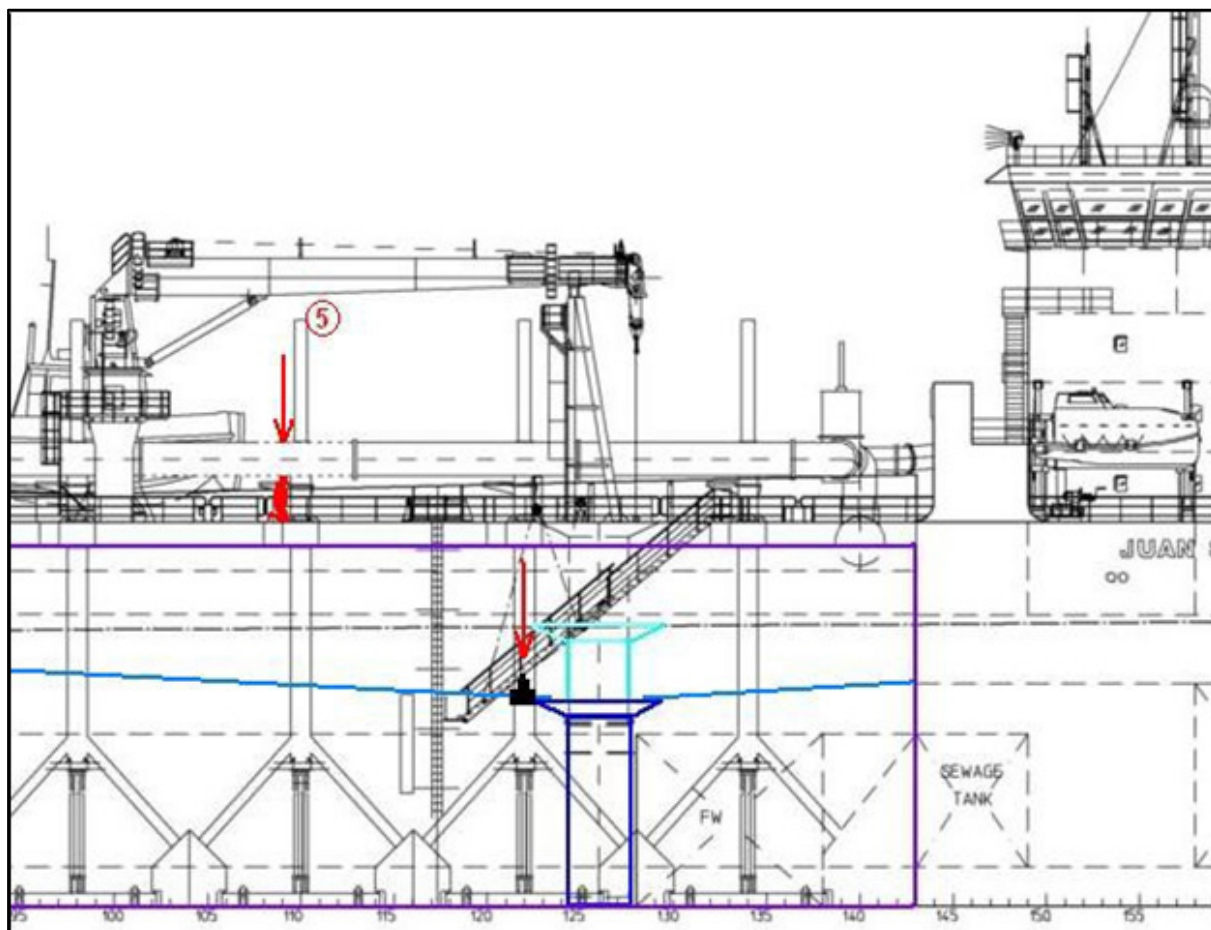


Figure 3.8 - Position Apprentice Electrician (Longitudinal Section)
(Source: Operator)

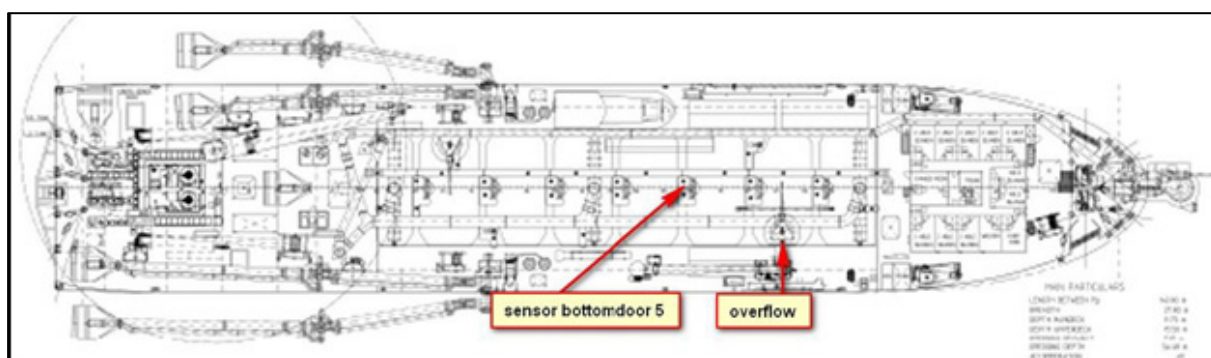


Figure 3.9 - Position Apprentice Electrician (Top View)
(Source: Operator)

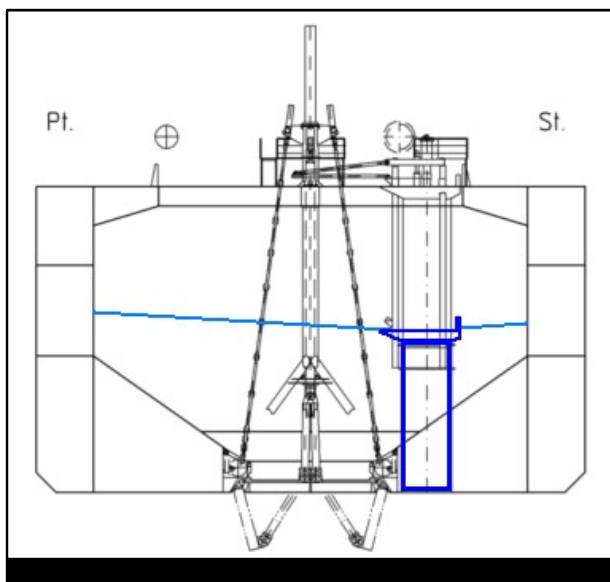


Figure 3.10 - Vessel Cross Section
(Source: Operator)



Figure 3.11 - Position Apprentice Electrician
(Source: Operator)



Figure 3.12 - Overturned boat on fore overflow
(Source: Operator)

The Chief Officer Day, who heard the shouting of the apprentice electrician through the open door of the bridge, came outside, saw part of the overturned boat on the overflow and immediately tried to reach the Captain. The Captain, who had given his internal mobile vessel phone to the bridge (internal mobile bridge phone was out of service), could not be reached as he was on his morning round and checking a SB sliding piece. So the Chief Officer Day went down to the main deck.

While exiting the overflow pipe underneath the vessel's hull, the 2nd Pipe Operator (day shift) lost his shoes and started swimming with no visual reference. He was able to surface on SB side of the ship and started shouting for help. A Lifebuoy was thrown in the sea by the Chief Officer whilst pilot ladder and gangway were lowered to the sea level.

At around 11:14 AM, the Captain and other crew arrived near the gangway while the 2nd Pipe Operator (day shift) was rescued from the sea and brought to the main deck. The remaining crew started searching for the missing Apprentice Pipe Operator from deck level.

The Captain informed shore staff (surveyor) about the accident at 11:20 AM and requested to inform the company's local agent to arrange a launch boat to bring the rescued crewmember to shore. In the meantime, the 2nd Pipe Operator (day shift) was brought to the ship's hospital and received First Aid.

Ten minutes later, the Captain informed the Designated Person Ashore (DPA) and another ten minutes after that, he informed the Coastguard about a missing person. At 11:45 AM, the Captain notified the Vessel Traffic Management System about the occurrence.

At around 12:10 PM, the requested launch boat came alongside the vessel and left to shore at 12:20 PM with the 2nd Pipe Operator (day shift) onboard, accompanied by another crew member. The 2nd Pipe Operator (day shift) arrived on shore at 12:56 PM and was brought to the Hospital, where he arrived at 01:10 PM. He was discharged from the Hospital later that day and returned onboard.

At the same time, the search for the Apprentice Pipe Operator continued.

The Philippines Coast Guard (PCG) boat came alongside at 01:15 PM and three people (two of them divers) boarded the vessel. A meeting with the PCG followed in order to detail the occurrence.

At 02:00 PM, PCG divers disembarked to collect their diving gear and then came back onboard fully equipped about an hour later. At 03:00 PM, the diving team completed their job hazard analysis and Dive Checklist for their upcoming task and informed the authorities of their intentions at around 03:25 PM, before resuming the dive operations. At 03:42 PM, two divers started their search for the missing crewmember (overflow, beneath the hull, etc.). Dive operations were finally stopped at 04:48 PM due to the strong current underneath the vessel, bad visibility and falling darkness.

The company's Relief Technical Superintendent (TIVM) and Incident Investigator arrived on the same day in Manila, between 10:00 PM and 11:00 PM.

3.1.5. 4 November 2014

The PCG resumed the search and rescue operation.

At 07:54 PM, the body of the Apprentice Pipe Operator was spotted in the sea on SB side close to the ship near the trunnion gantry and retrieved from the sea. The Health, Safety, Security and Environment adviser and the DPA were informed. At 10:05 PM, the body was handed over to PCG and transferred to a PCG Boat.

3.1.6. 5 November 2014

The body of the Apprentice Pipe Operator was autopsied in the Crime Laboratory Office Headquarters in Manila to determine the cause of death.

3.2. ADDITIONAL INFORMATION

3.2.1. Thickness measurement task

The vertical hopper walls are exposed to wear and abrasion by hard particles (e.g. soil, sediment) contained in the water whenever the hopper is filled and emptied. To ensure normal operation of the vessel, the hopper walls have to maintain a defined minimum thickness. The thickness measurement task is intended to measure the thickness of the vertical hopper walls on a regular basis and usually before the start of a new project.

3.2.2. Hazard Management (HM)

➤ General

The vessel operator has implemented a system which is intended to identify and manage all standard and known risks and impacts of the company group.

The HM aims to limit the risks of exposure to work related hazards, either by eliminating the hazards as the preferred method (Elimination; Substitution/Alternative) or, if not feasible, by putting control measures into place to mitigate the risks (Engineering Control/Isolation; Collective Protection Means; Administrative Control; Personal Protective Equipment (PPE)). The adopted mitigation approach is to reduce the risk to 'As Low As Reasonable Practicable (ALARP)'.

The risks and their impacts are assessed in relation to both the consequences and the likelihood of an occurrence and subsequently categorized into three different levels on the basis of a matrix. The three levels are:

- Low Significant Risk - Trivial/Acceptable Impact Level
- Medium Significant Risk – Moderate Impact Level
- High Significant Risk – Substantial/Not Acceptable Impact Level

The 'Means of control' associated to the Risk/Impact Levels (low to high) are defined as follows:

- Not necessarily required
- Required
- Required to reduce the significance of the risk/impact to an acceptable level

➤ HM Process

The HM Process is based on a Risk and Impact Assessment register elaborated by the operator at different levels - Organisational and Task level. The HM provides various documents and tools to manage and communicate the means of control defined in the Risk and Impact Assessment register.

The timeline below shows the four different HM phases and the associated assessment and documentation tools.

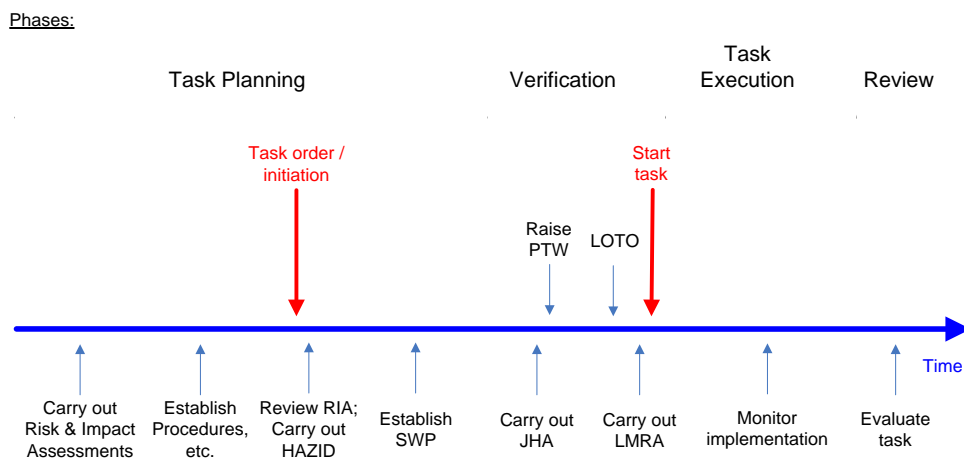


Figure 3.2.2.1.: Hazard Management Timeline (Source: Operator)

The task specific approach of the HM Process is shown in the figure hereafter:

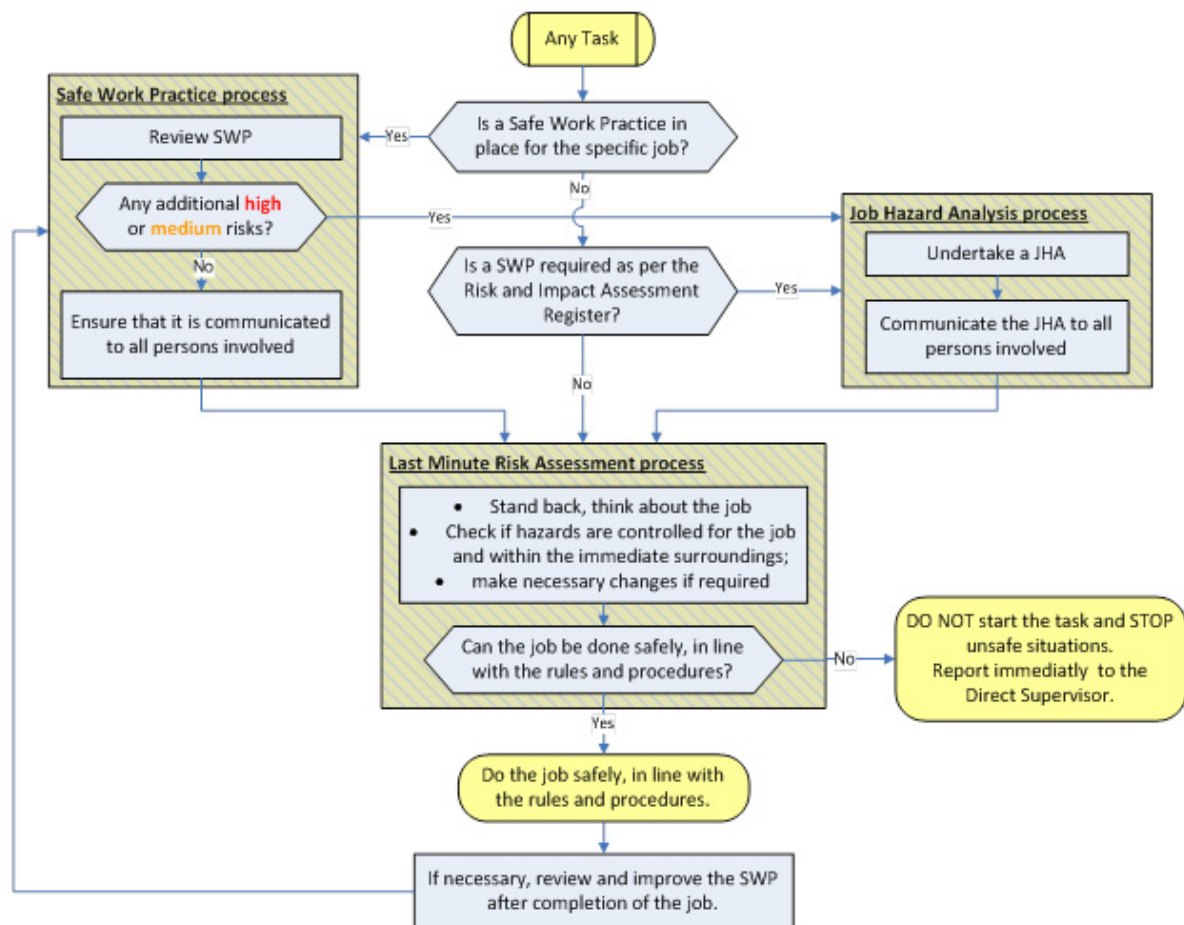


Figure 3.2.2.2.: Task specific approach (Source: Operator)

The HM tools and procedures relevant for the investigated occurrence are the following:

- Pre-Start Meeting (PSM)

Pre-start meetings for scheduled tasks are part of the HM Process and shall be used to communicate identified hazards covered by a Safe Work Practice (SWP) and to discuss those hazards and the related SWP with the personnel assigned to the task. Personnel shall acknowledge their presence and their understanding of and compliance with the SWP.

Tasks for which no SWP has been implemented shall also be addressed during the meeting in application of the Last Minute Risk Assessment (LMRA) process.

- Safe Work Practice (SWP)

A Safe Work Practice describes the different steps required to perform a task and the equipment to be used. It also highlights the related hazards and details the means of control to be used to mitigate the risks.

In general, an SWP shall be established for:

- All activities where the need for an SWP has been identified in the Risk and Impact Assessment register;
- Routine tasks where the risks have been assessed as High or Medium Significant.

- Job Hazard Analysis (JHA)

A Job Hazard Analysis is a task specific means of control within the operator's HM. It is normally used to control tasks involving Medium to High Significant risks, for which a SWP has not yet been established or where additional risks for a known task have been identified.

According to Figure 3.2.2.2, the JHA is an integral part of any new SWP and begins with the breakdown of a task into basic job steps. Subsequently, the task related potential hazards are identified and appropriate means of control are determined to lower the risk to an acceptable level. The JHA also aims to identify the personnel required to safely perform the task.

- Last Minute Risk Assessment (LMRA)

The Last Minute Risk Assessment is intended to be carried at personal level by everyone involved in a job or task. It serves as an ultimate identification of hazards and related risks before the start and during the completion of each task. The LMRA is also used to validate existing procedures and eventually identify unknown or new hazards related to the performed task.

- Lock-Out/Tag-Out Procedure (LOTO)

The Lock-Out/Tag-Out Procedure is an industry practice designed to protect personnel performing a job or task by isolating any sort of machinery or plant which, when operated, could induce a direct hazard to the working personnel.

As an example, in the investigated case, LOTO could be used to prevent the operation of the overflow while personnel are working in the water filled hopper.

3.2.3. Autopsy report

The autopsy report, issued by the Manila Police District Crime Laboratory on 5 November 2014, concludes that the cause of death of the Apprentice Pipe Operator was asphyxia by drowning and that the body did not sustain external injuries.

3.2.4. First aid provided to the rescued crew member

The 2nd Pipe Operator (day shift) received First Aid at ship's hospital. The 2nd Officer Day who provided the First Aid noted a bleeding wound on the right elbow and shallow scratch wounds on the right leg. This was later confirmed at the Manila Doctors Hospital.

3.2.5. Pre-Start Meeting (3 November 2014, 06:00 AM)

The Pre-Start Meeting form from the date of the accident contains, under the point “Tasks for Today: What, where, whom, when,...”, amongst a total of ten items one item with the following subject: “Fill up hopper -> measure fore and aft hopper wall”. The field named “Safety Topic/Reminder” did not contain any information.

3.2.6. Written statements

3.2.6.1. Master of JUAN SEBASTIAN DE ELCANO (3 November 2014)

“On the 3th of November, the said vessel's hopper was filled up with water to make thickness measurements from the bulkheads fore and aft. A small boat was lowered inside the hopper and two crewmembers went inside.

They had direct radio contact with the officer on the bridge. When they finished the measured level at the aft ship, they called the bridge to lower the overflow a few meters. This was followed up by the officer.

After several minutes an electrician working above the hopper heard a strange noise and saw the boat upside down in the overflow. He reported directly the officer on the bridge who alarmed the captain and crew.

A call for help was heard next to the ship on starboard.

A lifebuoy was thrown and one off the crewmembers was rescued. The other crewmember was missing.”

3.2.6.2. Chief Officer Day (4 November 2014)

“The 2nd Pipe Operator (day shift) called me by radio, he said to me that they were finished with taking thickness measurements at the aft of the hopper and asked me to lower the overflow a few meters. I saw them visually at the aft and lowered the overflow 2,5/3 meter (in the past if we took measurements in the hopper we did it always on this way. I did nothing special or unusual).

....

When I stopped the overflow, everything looked ok.

I was planning to go to the bridge computer, and at that time I heard a noise outside (luckily the bridge door was open). The noise was the Electrician who was working at the bottom door. He was shouting.”

3.2.6.3. Electrician (3 November 2014)

“I was busy disconnecting cim measurement of bottom door N°5. I heard strange noise coming out of the hopper. I stepped from behind the cylinder so I can look into the hopper. I saw the small boat upside down laying on the overflow.”

3.2.6.4. Chief Officer Night and 2nd Pipe Officer Night (date unknown)

“In December 2013 I did thickness measurements of complete hopper.... In my 7 years' experience with company all thickness measurements in hopper always has been done with small boat. That time we decided to do the same, we wish to start from top till bottom of the hopper.....Once we did everything we row back to the aft part of hopper and we attached our boat with magnets to the side plates or we just connect to one of the many hoisting eyes over there. Then we call over radio to bridge to lower overflow approximately 1 meter and we wait till water level goes down. I must say that if we stay with boat on the aft part of hopper after lowering, the overflow flow of water in hopper was not that strong and we manage without any problem to stay over there.”

3.2.6.5. Rescued 2nd Pipe Operator (day shift) (4 November 2014)

“When Chief Officer Day started lowering the overflow, we were with the boat on starboard aft and started going forward. I said to Apprentice Pipe Operator that we need to go portside of the hopper to stay away from the overflow. Apprentice Pipe Operator didn't take me serious and we kept on going forward.... After three times telling Apprentice Pipe Operator, he started to understand the danger of the situation, but he didn't react to get away from the overflow....we turned sideways and ended up against the overflow.

Nobody called the bridge over the radio....The watch-keeper on the bridge wasn't informed and up to date on the ongoing situation.

In an action of panic, Apprentice Pipe Operator stood up in the boat to get an extra grip above his head. This caused an extra momentum (together with the floating water) to flip the boat over. The force of the floating water pushed us down through the overflow.

I realized what happened. When I reached the bottom of the ship I lost my shoes and started swimming. Due to my advanced diving skills I was able to apply certain skills that helped me survive this situation. My vision in the water was blocked due to high grade of pollution in the water. I was able to reach the starboard side of the hull. I started shouting for help and for Apprentice Pipe Operator.....

This accident happened during a routine maintenance job. The little boat was used several times before on similar jobs in the hopper.”

4. ANALYSIS

4.1. RISK ASSESSMENT AND JOB HAZARD ANALYSIS

Based on the crew statements and after investigation, it was found that the thickness measurements task in the hopper was not performed according to a standard procedure. In fact, on a previous occasion, the boat inside the hopper was secured before the water level was changed. This was not the case on the day of the occurrence.

The investigation showed that, although it was a recurrent task on this type of vessel, the related risks had not yet been assessed by the operator as High or Medium Significant. The thickness measurement task was subsequently not included in the company's Risk and Impact Assessment register which would have mandated a SWP.

In accordance with the HM system, for tasks contained in the Risk and Impact Assessment register, a number of assessments shall be carried out before the start of the task (Fig. 3.2.2.1.: Hazard Management Timeline). Since the task was not part of the Risk and Impact Assessment register, neither the Job Hazard Analysis defined in the HM system, nor the associated Hazard Management (Risk Assessment Procedure) was available at the time of the occurrence and there was no operational Safe Work Practice for the performed task at the time.

As a corrective action by the operator, a Safe Work Practice for thickness measurements of the vertical hopper walls was implemented on the vessel on 15 January 2015 and on the entire company fleet during the year 2015.

4.2. JOB PLANNING/PRE-START MEETING

A Pre-Start Meeting is part of the HM and was held on board of the vessel on the day of the occurrence. It was limited to a one-page listing of tasks scheduled for the dayshift. There was no reference, neither to the exposure to risk associated with the tasks, nor to other procedures and mitigation strategies to be applied.

The Pre-Start Meeting logs were analyzed for all the days since the Apprentice Pipe Operator had come on board. The investigation showed that the Pre-Start Meetings did not include detailed information of the scheduled tasks and the related risks for the crew. In fact, all tasks, whether or not covered by a SWP, should be thoroughly discussed during the Pre-Start Meeting. The Meeting form provides the possibility to highlight the task related hazards and associated risks in the "*Safety Topic/Reminder*" field. Based on the available form from the day of the occurrence, it seems that a discussion of the tasks and the related means of control was not part of the meeting.

Pre-Start Meetings offer a good opportunity to raise the crew's awareness for the procedures and safety related topics associated to specific task. In the investigated case, the Pre-Start Meeting should ideally have pointed to a Safe Work Practice describing how to perform the task, identifying who should perform the task and highlighting the related risks and applicable control measures/procedures (e.g. LOTO). Unfortunately, with no SWP in place and no LMRA to account for the absence

of a SWP, the hazards did not seem to be apparent to the involved personnel. This led to an increased risk without the application of mitigation through control means.

4.3. TASK COMPLETION

The task was assigned to two crewmembers which only had limited task related experience. In addition, one crewmember had limited overall experience on the job. This subsequently led to an increased risk situation, in which the least experienced crewmember assigned to the task supposedly underestimated the hazards they were exposed to and made an inappropriate action which finally led to the capsizing of the small boat and the ensuing loss of life.

4.4. TASK SUPERVISION

The Chief Officer Day stated that he had visual contact with the boat and the crew before he started lowering the overflow. During the lowering phase, when the accident actually happened, it can be assumed that he did not have the boat or its crew in sight, hence his absence of response. Furthermore, there was no other crewmember that actually saw the accident. The alarm was ultimately raised by the apprentice electrician due to unusual noises coming from the overflow. He subsequently left his workplace to look into the hopper, realized that the crew in the boat was missing and called for help.

The occurrence highlights the importance to have dedicated supervising personnel during the task completion, readily available and trained to respond in case of an emergency.

4.5. LOWERING OF THE WATER LEVEL

At about 11:05 AM, the 2nd Pipe Operator (day shift) asked the Chief Officer Day to lower the water level in the hopper for the next set of measurements. At 11:05:57 AM, the overflow position was 11.81 m when Chief Officer Day started to lower it. At 11:07:33 AM its position was 8.62 m. The overflow was lowered by 3.2 m in 96 seconds, which gives an average lowering speed of 3.3 cm/s. The overflow reached its final position of 9.62 m at 11:08:24 AM, which is 2.2 m below the initial position. The current induced by the draining water was strong enough to pull the boat with the two occupants against the overflow.

The event shows that the strength of the current induced by lowering the overflow too rapidly can be hazardous for a small unsecured boat or a person in the hopper. In general, lowering the water level in the hopper is likely to create a highly dynamic and uncontrollable environment and thus raise the risk for personnel working in that environment above ALARP. It should therefore be stressed that in order to control the increased risk, no person should be in the hopper and the boat should be secured during every water level change.

Furthermore, the LOTO procedure should be applied for every vertical movement of the overflow.

4.6. SAFETY AND RISK AWARENESS

Although training was provided by the operator on a regular basis (during Safety Management Training Masters Meeting, familiarizations, internal audits, etc.), the occurrence shows that the assigned crew was not fully aware of the risks and safety hazards related to their task.

AET has identified the following safety items to be addressed when performing the thickness measurement task:

- All participating personnel should be aware of the risks and mitigation strategies associated with the task and familiar with the execution of the task;
- The crew performing the task and the supervising personnel should wear life vests at all times;
- The ship used for the task and its occupants should be secured whenever the water level in the hopper or the position of the overflow is changed and should remain secured until a new water level has been reached;
- The task should be supervised by appropriate personnel to be able to assist the measuring crew without delay in case of an emergency.

In the course of 2015, the operator introduced a Safe Work Practice entitled '*Thickness measurements in hopper*' (Appendix 1), which covers all pre-mentioned task related safety issues raised by the safety investigation. Subsequently, AET considers these items addressed and does not issue a safety recommendation on these subjects.

4.7. OPERATIONAL IMPLEMENTATION OF THE HM SYSTEM

The investigation showed that the operator has developed a HM system which provides adequate procedures and tools to mitigate task related risks by controlling or eliminating underlying hazards. However, it also showed that the effectiveness of a HM on a vessel largely depends on its operational implementation and subsequently on the safety consciousness of the crew, at all levels. The challenge in the operation of a vessel is to find an acceptable balance between safety and efficiency, well knowing that one usually impedes on the other.

It is equally important for the operator to provide a HM system which is adapted to the operational environment where it supposed to produce its effects, the foremost effect consisting of improving safety. The challenge at this level is to implement a system which fits into the operational workflow without disrupting it too much. The operating personnel have to be trained adequately to comprehend the usefulness of the HM system in order to fully incorporate it. Furthermore, the operational implementation has to be supported from top down to give it an appropriate level of importance.

5. SAFETY RECOMMENDATIONS

5.1. OPERATOR'S EVALUATION OF THE HM SYSTEM

The investigation has identified safety items pointing to the fact that the implementation of the HM system into the work environment may be improved, either by adapting the system or by further educating the personnel working with it.

AET recommends that based on the information acquired through the HM system, the operator evaluates its current level of implementation together with all involved parties and, in respect of the results of the evaluation, takes corrective actions, where deemed necessary, to improve the effectiveness of the company's HM system.

6. APPENDIX 1 – SWP ‘Thickness measurements in hopper’ (Excerpt)

3.6.2 THICKNESS MEASUREMENTS OF HOPPER WALLS WITH FILLED HOPPER

Job Sequence:

1. Review SWP and ensure that all persons involved have read, understood and signed it.
2. Ensure that the hopper is filled up to a pre-defined level in order to facilitate that the thickness measurements can be carried out at the correct height and at the correct locations.
3. If a small boat is used, check its condition and its mooring ropes.
4. Raise PTW form and relevant verification checklists (e.g. working at heights; hot work; man basket; etc.). Responsible: OOW. Ensure that the PTW is signed off by the Captain.
5. Adapt LOTO as required:
 - lock the dredge pump
 - lock the jet system
 - ensure that bottom doors cannot be opened. Wedges should be inserted
 - lock the overflow system
 - lock valves: -suction hopper valves, water supply to self-emptying channel, main suction inlet
 - water admission valves

Basic Rule: No person is allowed in the hopper (with or without water) when the LOTO is not in place.

6. Lower the small boat safely into the hopper. Ensure that the small boat is tied up properly (fore and aft). Mooring lines should be tied up on deck (responsibility of the watchman).
7. From now onwards, a watchman with radio shall be present on deck overseeing the work activities. He shall be in constant contact with the OOW and the crew carrying out the work in the hopper. The watchman shall not carry out any other work.
8. 2 persons assigned to carry out the job shall enter the boat via the pilot ladder or via the man basket.
9. The thickness measurements shall be carried out as planned.
10. The 2 persons shall tie up the boat and egress from the boat to the deck before LOTO shall be removed and the level of the water shall be raised or lowered.

The job sequence as described above involves the use of a small boat. If the thickness measurements are done from the suspended man basket, then some job steps might be different and the working at height verification checklist shall be used. Furthermore, a plan for rescuing suspended crew must be in place.