ACCIDENT REPORT

Report on the investigation of the collision between

CMA CGM Florida

and

Chou Shan

140 miles east of Shanghai, East China Sea

on 19 March 2013

MAIB
MARINE ACCIDENT INVESTIGATION BRANCH

SERIOUS MARINE CASUALTY REPORT NO 11/2014 MAY 2014

Pursuant to Regulation 6 of Chapter XI-1 of the International Convention for the Safety of Life at Sea (SOLAS) and the Code of the International Standards and Practices for a Safety Investigation into a Marine Casualty (Casualty Investigation Code) (Resolution MSC.255(84)), the MAIB has investigated this accident with the co-operation and assistance of the Panama Maritime Authority, whose contribution to the investigation is acknowledged and gratefully appreciated.

Extract from

The United Kingdom Merchant Shipping

(Accident Reporting and Investigation)

Regulations 2012 – Regulation 5:

"The sole objective of the investigation of an accident under the Merchant Shipping (Accident Reporting and Investigation) Regulations 2012 shall be the prevention of future accidents through the ascertainment of its causes and circumstances. It shall not be the purpose of an investigation to determine liability nor, except so far as is necessary to achieve its objective, to apportion blame."

NOTE

This report is not written with litigation in mind and, pursuant to Regulation 14(14) of the Merchant Shipping (Accident Reporting and Investigation) Regulations 2012, shall be inadmissible in any judicial proceedings whose purpose, or one of whose purposes is to attribute or apportion liability or blame.

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GLOSSARY OF ABBREVIATIONS AND ACRONYMS

AB	-	Able seaman
AIS	-	Automatic Identification System
ARPA	-	Automatic Radar Plotting Aid
CEC	-	Certificate of Equivalent Competency
CMA CGM	-	CMA CGM International Shipping Company PTE Ltd
CoC	-	Certificate of Competency
COLREGS	-	International Regulations for Preventing Collisions at Sea 1972 (as amended)
CPA	-	Closest Point of Approach
EBL	-	Electronic Bearing Line
ECDIS	-	Electronic Chart Display and Information System
GPS	-	Global Positioning System
HSFO	-	High Sulphur Fuel Oil
ICS	-	International Chamber of Shipping
IMO	-	International Maritime Organization
JRC	-	Japan Radio Company Limited
LSFO	-	Low Sulphur Fuel Oil
m	-	metre
MAIIF	-	Marine Accident Investigators' International Forum
MCA	-	Maritime and Coastguard Agency
MGN	-	Marine Guidance Note
mile	-	Nautical mile (1852m) or approximately 1.15 statute miles
MRCC	-	Maritime Rescue Co-ordination Centre
OOW	-	Officer of the Watch
SMCP	-	Standard Marine Communication Phrase
SMS	-	Safety Management System
SSEMS	-	Safety, Security and Environmental Management System

STCW	-	International Convention on Standards of Training, Certification and Watchkeeping for Seafarers
t	-	tonne
T	-	True (course)
TCPA	-	Time to Closest Point of Approach
UK	-	United Kingdom
UTC	-	Universal Time Co-ordinated
VDR	-	Voyage Data Recorder
VHF	-	Very High Frequency
2/O	-	Second Officer

TIMES: All times in this report are local (UTC+8) unless otherwise stated.

SYNOPSIS

At 0033 on 19 March 2013, the container vessel *CMA CGM Florida* and the bulk carrier *Chou Shan* collided in the East China Sea resulting in both vessels sustaining serious damage, and approximately 610 tonnes of heavy fuel oil being spilled from *CMA CGM Florida*. There were no injuries. *CMA CGM Florida* had left Yang Shan, China, on 18 March and was heading towards Pusan, Korea. *Chou Shan* was heading from Qinhuangdao, China, towards the east coast of Australia.

CMA CGM Florida's Filipino second officer, who was the officer of the watch, altered course to starboard to pass between a group of fishing vessels on the port bow and a vessel on a reciprocal course to starboard. This resulted in a risk of collision with *Chou Shan*, which was crossing *CMA CGM Florida* from port to starboard. *Chou Shan*'s officer of the watch then used the Very High Frequency (VHF) radio to request that *CMA CGM Florida* pass around *Chou Shan*'s stern. The VHF radio conversation was conducted in Mandarin by *CMA CGM Florida*'s Chinese second officer, who had joined the vessel in Yang Shan and was on the bridge for familiarisation.

CMA CGM Florida's Filipino officer of the watch did not understand Mandarin and was unaware that the Chinese second officer had, tacitly, agreed to *Chou Shan*'s request. Both vessels altered course to port, which resulted in a continued risk of collision with each other. *CMA CGM Florida*'s Chinese second officer then called *Chou Shan* on the VHF radio to request that both vessels pass port-to-port. This was agreed to by *Chou Shan*'s officer of the watch. Both vessels then altered course to starboard, resulting in a collision.

CMA CGM Florida's second officers and *Chou Shan*'s officer of the watch considered that it was appropriate to use VHF radio for collision avoidance, contrary to industry advice. Furthermore, *Chou Shan*'s officer of the watch considered that it was appropriate to use VHF radio for negotiating a passing protocol that was contrary to Rule 15 of the International Regulations for Preventing Collisions at Sea.

CMA CGM Florida's Filipino officer of the watch lacked situational awareness. Contributing to this was the Chinese second officer's incomplete translation of the VHF radio communications with *Chou Shan* and the Filipino officer of the watch's disproportionate reliance on Automatic Identification System (AIS) target Closest Point of Approach and Time to Closest Point of Approach information.

CMA CGM International Shipping Company PTE Ltd (CMA CGM) and Sincere Navigation Corporation have each taken action aimed at preventing a recurrence. A recommendation has been made to CMA CGM for it to take appropriate measures to ensure its company shipboard policies and procedures are adhered to and that its masters recognise the importance of engaging with and motivating crew in the safe and efficient management of its vessels. Sincere Navigation Corporation has been recommended to review and amend its safety management system to ensure that VHF radio is not normally used for collision avoidance and that its masters are empowered to provide specific metrics in their standing orders as to when they should be called by the officer of the watch. The International Chamber of Shipping and the Maritime and Coastguard Agency have been recommended to update their respective guidance on the use of AIS data for collision avoidance.

SECTION 1 - FACTUAL INFORMATION

1.1 PARTICULARS OF *CMA CGM FLORIDA*, *CHOU SHAN* AND ACCIDENT

SHIP PARTICULARS		
Vessel's name	*CMA CGM Florida*	*Chou Shan*
Flag	United Kingdom	Panama
Classification society	Bureau Veritas	American Bureau of Shipping
IMO number/fishing numbers	9348704	9296963
Type	Container vessel	Bulk carrier
Registered owner	Provence Shipowner 2008-1 Limited	Rockwell Shipping Limited
Manager(s)	CMA CGM International Shipping Company PTE Ltd (CMA CGM)	Sincere Navigation Corporation
Construction	Steel	Steel
Keel laid	5 November 2007	1 December 2004
Length overall	294.1m	289.0m
Registered length	Not applicable	Not applicable
Gross tonnage	54,309	91,166
Minimum safe manning	15	14
Authorised cargo	Containers	Bulk cargoes
VOYAGE PARTICULARS		
Port of departure	Yang Shan	Qinhuangdao
Port of arrival	Pusan (intended)	Not specified
Type of voyage	International	International
Cargo information	Containers	Ballast
Manning	24	24

MARINE CASUALTY INFORMATION		
Date and time	19 March 2013 at 0033 (UTC+8)	
Type of marine casualty or incident	Serious Marine Casualty	
Location of incident	140 miles east of Shanghai, East China Sea	
Place on board	Not applicable	Not applicable
Injuries/fatalities	None	None
Damage/environmental impact	Serious damage to port side and accommodation block, Nos 4 and 5 cargo holds flooded, ~610t fuel oil lost	Serious damage to bow area
Ship operation	On passage	On passage
Voyage segment	Mid-water	Mid-water
External & internal environment	Southerly wind force 4, slight sea state, 4 miles visibility, dark	
Persons on board	24	24

CMA CGM Florida

Chou Shan

1.2 BACKGROUND

1.2.1 *CMA CGM Florida*

CMA CGM Florida was one of 11 vessels serving CMA CGM's Pacific Express (PEX 3) liner service. This service was a 76-day round trip from Hong Kong, which called at 13 ports.

Vessels loaded in Hong Kong, three further ports in China, and Pusan, Korea, before sailing across the Pacific Ocean, transiting the Panama Canal, to various ports on the east coast of the United States of America. They then returned to Hong Kong via Vostochny, Russia. Yang Shan was the fourth port in the rotation. At the time of the accident *CMA CGM Florida* was on passage from Yang Shan towards Pusan at a speed of about 23 knots.

1.2.2 *Chou Shan*

Chou Shan operated on the spot market. When fixed on a charter, the vessel proceeded directly to the loading port in accordance with the charterer's instructions. At the time of the accident, *Chou Shan* was in ballast, on passage from Qinhuangdao, China, towards the east coast of Australia at a speed of about 11.5 knots.

1.3 NARRATIVE

1.3.1 Events leading up to the collision

At about 2340 on 18 March 2013, one of *CMA CGM Florida*'s third officers handed over the officer of the watch (OOW) duty to the Filipino second officer (2/O). The able seaman (AB), acting as lookout, changed at the same time. The traffic situation was discussed during the handover between the officers. However, *Chou Shan,* whose radar target was not displayed, did not feature in this discussion **(Figure 1)**.

A Chinese 2/O, who was on board for a period of familiarisation, arrived on the bridge while the handover between the third officer and the Filipino 2/O was underway. Not able to understand the conversation between them as it was conducted in Tagalog, he began to familiarise himself with the bridge paperwork.

After the handover was completed, the Chinese 2/O engaged with the Filipino OOW and began asking questions in English about the bridge equipment and procedures. At times, this took the Filipino OOW away from his position at the port radar to demonstrate equipment operation or the location of documentation.

At 0000 on 19 March 2013, *Chou Shan*'s third officer handed over the watch to the 2/O. The AB engaged as lookout changed at the same time. During the handover, the officers discussed two vessels that were ahead, one to port (*Monte Pascoal*) and one to starboard (*Hong Yun No1*). *CMA CGM Florida*, whose radar target had just appeared on the edge of the radar display, was not discussed **(Figure 2)**.

At 0000 on *CMA CGM Florida,* the Global Positioning System (GPS) alarm sounded to indicate the time. This prompted the Filipino OOW to record and plot the vessel's position on the paper chart. Shortly afterwards he looked at the port radar display and observed a number of vessels in the vicinity.

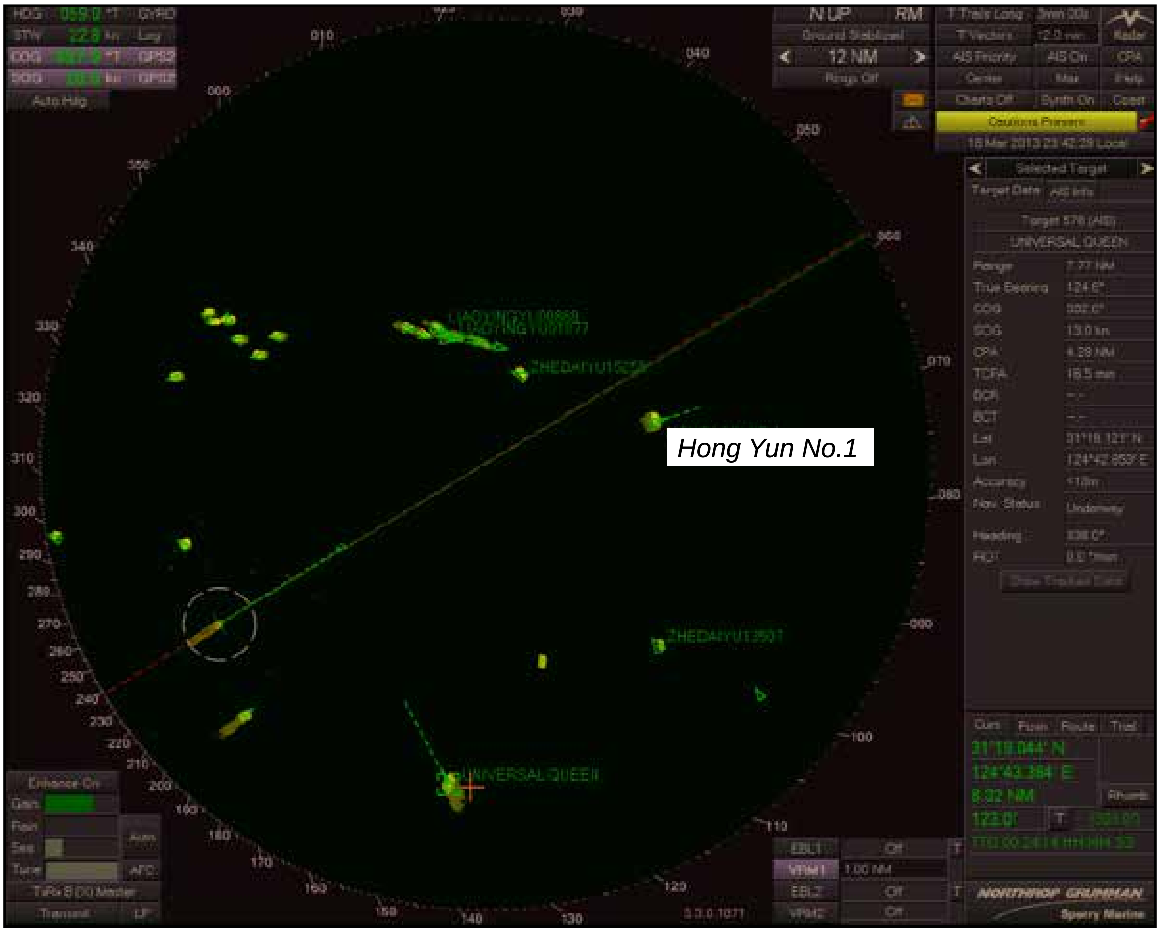

Figure 1: *CMA CGM Florida*'s port radar display at the time of the handover

Figure 2: *Chou Shan*'s port radar display at the time of the handover

About 1 minute later, the lookout reported, in Tagalog, to the Filipino OOW that he could see fishing vessels on the port bow. The Filipino OOW returned to the port radar and inspected the multiple AIS target list **(Figure 3)**.

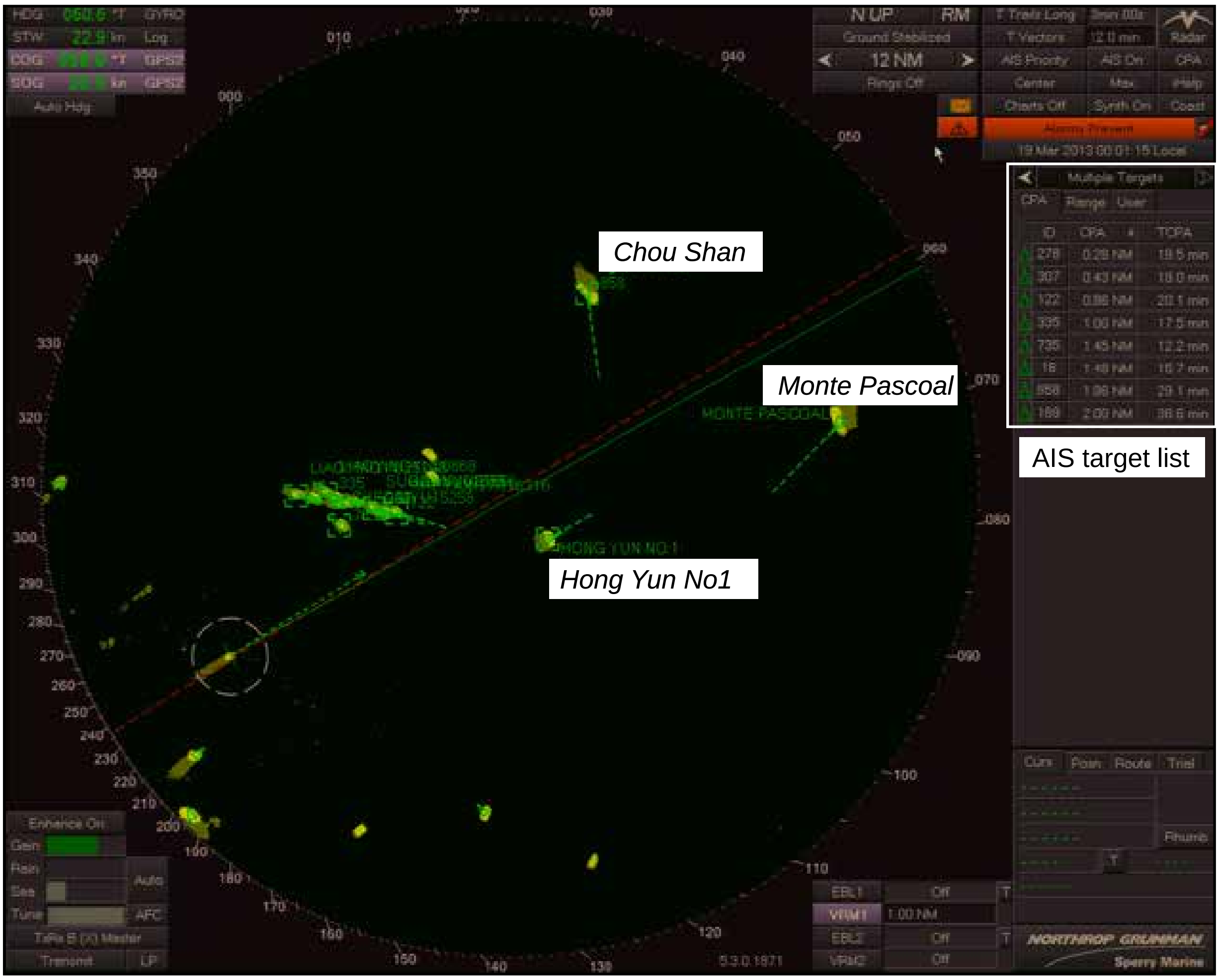

Figure 3: *CMA CGM Florida*'s port radar display at 0002

Monte Pascoal was ahead and to starboard of *CMA CGM Florida* at a range of 17½ miles. The vessel was on an approximately reciprocal course with a Closest Point of Approach (CPA) of more than 2½ miles to starboard.

Hong Yun No1 was also ahead and to starboard of *CMA CGM Florida* at a range of 9 miles. *Hong Yun No1* was steering a similar course to that of *CMA CGM Florida* with a CPA of more than 2 miles to starboard.

Chou Shan was ahead and to port of *CMA CGM Florida* at a range of 14 miles. *Chou Shan* was crossing *CMA CGM Florida*'s track from port to starboard, and had a CPA of more than 1½ miles ahead.

A group of fishing vessels was on the port side of *CMA CGM Florida* at a range of 6 miles. The closest fishing vessel to *CMA CGM Florida*'s bow, *Sheyangyu 16316*, had a CPA of 0.1 mile to starboard. There were two other fishing vessels in the group with a CPA of approximately 0.1 mile.

Chou Shan featured second from the bottom on the multiple AIS target list owing to its relatively large CPA in comparison to that of the fishing vessels. *Hong Yun No1* was at the bottom of the list and *Monte Pascoal* was not listed.

At 0002, the Filipino OOW altered *CMA CGM Florida*'s course by 6 degrees to starboard to 065º(T) using the autopilot. He also reduced the port radar range scale to 6 miles, and selected relative vectors.

At 0007, the Filipino OOW altered *CMA CGM Florida*'s course by a further 5 degrees to starboard, using the autopilot. He also began talking aloud about the fishing vessels, remarking that he did not understand why they did not keep clear and kept changing their course. This was acknowledged, conversationally, by the Chinese 2/O.

The Filipino OOW altered course by 5 degrees to starboard, twice more, to bring *CMA CGM Florida* onto a heading of 080º(T). Just before making the final 5-degree course alteration, *Monte Pascoal* had appeared at the edge of the port radar display.

Throughout the period of course alterations, the Filipino OOW had been alternating the radar range scale between 3, 6 and 12 miles, and had been changing between true and relative vectors/trails.

Becoming concerned about the presence of *Monte Pascoal,* the Filipino OOW asked the Chinese 2/O to call the fishing vessels, in Mandarin, to ask them to keep clear. Using the Very High Frequency (VHF) radio, the Chinese 2/O called *Sheyangyu 16316* but did not receive a response to the call.

Chou Shan's OOW, who was Chinese, manually acquired *CMA CGM Florida*'s radar target to obtain Automatic Radar Plotting Aid (ARPA) information, and then activated the vessel's AIS target to identify it. At this time *CMA CGM Florida*'s CPA was less than ½ mile ahead of *Chou Shan*.

CMA CGM Florida's Filipino OOW again remarked that he did not understand why the fishing vessels did not keep clear, and why "*they wanted to lose their lives*". The Chinese 2/O then made a second VHF radio call to *Sheyangyu 16316,* stating, in Mandarin, that they "*will lose their life*". This second call was not requested by the Filipino OOW.

At 0019, *Chou Shan*'s OOW called *CMA CGM Florida* using his VHF radio. The call was answered by the Chinese 2/O and the resulting conversation was conducted in Mandarin.

The following is a translation of the call and conversation:

Chou Shan:	*CMA CGM Florida, CMA CGM Florida. Chou Shan, Chou Shan calling. Over.*
CMA CGM Florida:	*Who is calling Florida? Speaking please.*
Chou Shan:	*This is Chou Shan ship. Could you pass astern of us please?*
CMA CGM Florida:	*I have to avoid that small fishing boat first, and I will turn back after I have avoided it.*
Chou Shan:	*Oh, alright. Thank you.*

The following conversations then occurred, in English, between the Filipino OOW and the Chinese 2/O on *CMA CGM Florida*:

Filipino OOW:	*What does he want?*
Chinese 2/O:	*No… this is another vessel… Chou Shan*
Filipino OOW:	*Chou Shan… ah*
Chinese 2/O:	*Ya… he want we are passing his stern*
Filipino OOW:	*Ah ok*
Chinese 2/O:	*I… I tell him… ah ok… we are passing the fishing boat and we change the course*
Filipino OOW:	*But if you put into the relative they are going to pass behind… only these fishing boats… because… they don't care*
Chinese 2/O:	*Ha*
Filipino OOW:	*Even if you call them ah*
Chinese 2/O:	*Ah you can little bit… er turn back your route… just a little bit*
Filipino OOW:	*So… very close these fishing boats… I don't know*
Chinese 2/O:	*Oh no they change… they change their course*
Filipino OOW:	*Ah they are going to change, they reply they are going to change their course ah*

By 0021, *CMA CGM Florida* was drawing ahead of the fishing vessels and the Filipino OOW altered *CMA CGM Florida*'s course 5 degrees to port, to 075º(T).

Chou Shan's OOW continued to monitor *CMA CGM Florida*'s radar target, and commented to the AB that he expected *CMA CGM Florida* to alter course to port once clear of the fishing vessels.

At 0026, *CMA CGM Florida*'s Filipino OOW made a 5-degree alteration of course to port, to 070º(T). He then remarked aloud that *Chou Shan*'s CPA was very small. This prompted the Chinese 2/O to question whether *CMA CGM Florida* would pass *Chou Shan*'s stern. The Filipino OOW stated his expectation that *Chou Shan* would pass *CMA CGM Florida*'s stern, and that both vessels would pass port-to-port.

At the same time, *Chou Shan*'s OOW altered course from 165º(T) to 160º(T), then to 155º(T).

At 0027, the Filipino OOW on *CMA CGM Florida* altered course by 5 degrees to port to 065º(T).

Shortly after making the course alteration, the Filipino OOW stated aloud that, owing to the presence of *Hong Yun No1* ahead, *CMA CGM Florida* and *Chou Shan* should pass port-to-port. The Chinese 2/O then called *Chou Shan*, in Mandarin, on the VHF radio.

Chou Shan was at a range of just under 2 miles, with a CPA of around 0.3 mile ahead **(Figure 4)**.

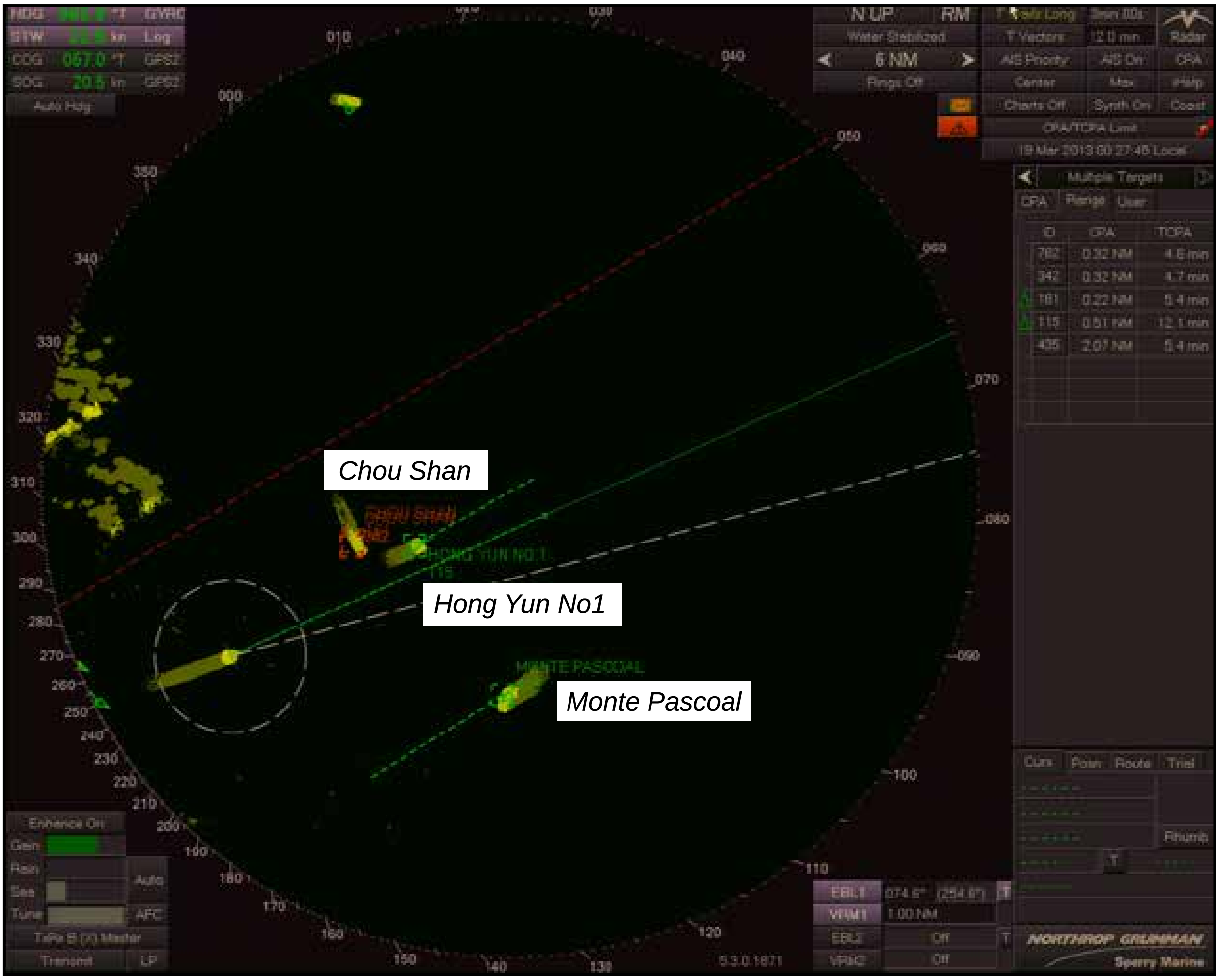

Figure 4: *CMA CGM Florida*'s port radar display at the time of the second VHF radio call to *Chou Shan*

The following is a translation of the call and conversation:

CMA CGM Florida:	*Chou Shan, Chou Shan, … (this is)*[1] *Florida.*
Chou Shan:	*Received. Speaking please.*
CMA CGM Florida:	*Ah, Chou Shan, we … shall we pass each other red to red*[2] *shortly please? On my side, in front of me there is (are) still, still fishing boat(s) so that we are unable to pass astern of you, alright?*

[1] Words in brackets have been added by the translator to indicate their interpretation of what was meant.

[2] Port side to port side.

Chou Shan:	*Oh? You can pass astern of us. I cannot (agree with what you have suggested) but I can adjust (my direction) a little bit more to the port side.*
CMA CGM Florida:	*Ah, no, that is not possible, not possible. … our captain wants, wants us to pass each other red to red. Let us pass each other red to red.*
Chou Shan:	*Oh, that means (that I have to make) a large-angle turn.*
CMA CGM Florida:	*Yes. Ah, please turn your ship and we turn ours. Let us pass each other red to red, alright? Many thanks.*
Chou Shan:	*Okay, alright.*
CMA CGM Florida:	*Good, thanks a lot.*

Shortly after the VHF radio conversation had finished, *Chou Shan*'s OOW told the AB to take the wheel in manual steering, and ordered 'starboard 20º'. On *CMA CGM Florida,* the Chinese 2/O told the Filipino OOW, in English, that *Chou Shan* had agreed to a port-to-port passing. He provided no further translation of the conversation with *Chou Shan*.

At 0030, concerned that *Chou Shan* did not appear to be altering course, the Filipino OOW instructed the AB to alter *CMA CGM Florida*'s course by 10 degrees to starboard, to 075º(T), using the autopilot.

As *Chou Shan* was turning to starboard, the OOW commented to the AB that he should not have agreed to a port-to-port passing. He then instructed the AB to head towards *CMA CGM Florida.* The AB placed the wheel amidships in preparation to steady the vessel on the required heading, and then suggested 'hard-a-starboard' to the OOW. The OOW agreed and the AB executed the turn at 0031.

CMA CGM Florida's Chinese 2/O continued to question whether *CMA CGM Florida* would pass *Chou Shan*'s stern. The Filipino OOW repeated his expectation that *Chou Shan* would pass *CMA CGM Florida*'s stern, port-to-port, and that he had just altered course to assist with this. He also began flashing the daylight signalling lamp (Aldis lamp), quickly and repeatedly, towards *Chou Shan*.

The Filipino OOW continued to express his doubt as to whether *Chou Shan* had started altering course, and questioned the Chinese 2/O as to whether *Chou Shan* expected a port-to-port passing. The Chinese 2/O said "*yes*", but suggested that it may be better for *CMA CGM Florida* to pass *Chou Shan*'s stern.

At 0031, the Filipino OOW instructed the AB to take the wheel and ordered 'hard-a-port'. Shortly afterwards, he ordered 'steady' and then 'hard-a-starboard'.

As both vessels continued to close each other, the Filipino OOW continued to flash the daylight signalling lamp before calling the master about 18 seconds before the collision. The Filipino OOW reported to the master that *CMA CGM Florida* was very close to another vessel **(Figures 5** and **6)**. *Chou Shan*'s master was not called prior to the collision.

Figure 5: *CMA CGM Florida*'s port radar display immediately prior to the collision

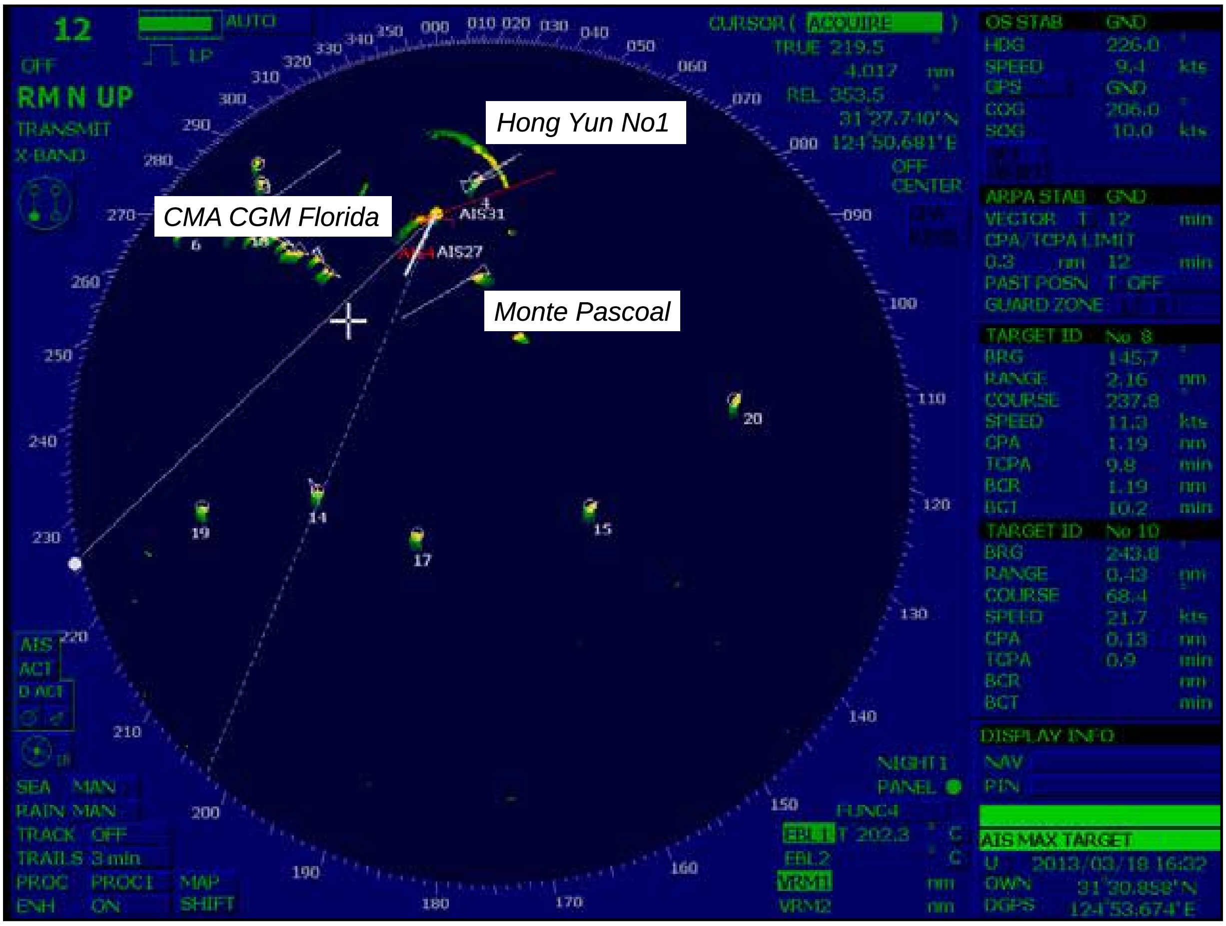

Figure 6: *Chou Shan*'s port radar display immediately prior to the collision

1.3.2 Collision

At 0033, *Chou Shan*'s bow hit *CMA CGM Florida'*s port side. *Chou Shan* had approached on a heading about 40 degrees from *CMA CGM Florida's* fore and aft line, and struck in the vicinity of No.5 cargo hold immediately forward of the accommodation block.

1.3.3 *CMA CGM Florida* - immediate post-collision actions

The general alarm was sounded on *CMA CGM Florida* as the master stepped through the bridge doorway. He asked the Filipino OOW what had happened, ordered the main engine to be stopped, observed *Chou Shan* astern, and asked for the collision checklist.

The chief engineer proceeded to his muster station in the engine control room, and then went into the engine room to inspect for damage. He reported to the bridge that the engine room was free of damage. However, he was concerned that the levels in the engine room port low sulphur fuel oil (LSFO) tank, and No.5 upper high sulphur fuel oil (HSFO) tank had dropped, and so went to the main deck to investigate.

Meanwhile, the master told the chief officer to use the vessel's heeling system to correct the list that had developed. All other crew members proceeded to their muster station. However, no report of who was present was made to the bridge. Later, one of the third officers was instructed to go to the bridge and help to maintain a contemporaneous log of events.

Recalling the vessel's departure condition, the master ordered that No.6 ballast tank be pumped out to reduce the stresses on the hull. At about the same time, the chief engineer was attempting to transfer oil from what he now believed to be breached fuel oil tanks. This was largely unsuccessful as the valve control station, situated in the port underdeck passage, was destroyed in the collision. The master then ordered no further ballast transfers until the vessel's stability had been verified.

The master then called CMA CGM's emergency telephone number to report the accident. He then contacted *Chou Shan* using the VHF radio. Previous calls from *Chou Shan* had not been answered.

At about 0100, all crew were accounted for, and a systematic inspection of the vessel began to establish the extent of damage. Individual crew members were ordered to carry out inspections of particular areas, according to the master's instructions. Contact had now been made with the Bureau Veritas damage stability assessment service, and it was making an assessment of the vessel's condition.

By 0310, a full inspection of the vessel had been completed, and all tanks had been sounded. Being concerned about the extent of the damage sustained, the master instructed all crew members, except the chief engineer, chief officer and one of the third officers, to muster in the crew mess room with lifejackets and immersion suits.

At 0644, a telephone call was made by CMA CGM to the Maritime Rescue Co-ordination Centre (MRCC) Falmouth to report the accident. This report was forwarded by MRCC Falmouth to MRCC Shanghai.

1.3.4 Post-collision events

Following the collision, *Chou Shan*'s crew were mustered and an inspection of the vessel's forward part carried out. Significant damage was reported, however it was found to be limited to the area forward of the collision bulkhead. *Chou Shan*'s master reported the accident to the vessel's manager and regular soundings of appropriate spaces continued overnight.

Chou Shan proceeded to dry dock during the afternoon of 19 March. Due to the resulting oil pollution caused by ruptured fuel oil tanks, *CMA CGM Florida* was required to await inspection before any repair arrangements could be made.

A salvage vessel was contracted and officials from China Maritime Safety Administration boarded *CMA CGM Florida* to carry out an inspection. On 21 March, the vessel was anchored 80 miles off Shanghai so that the damaged tanks could be cleaned prior to allowing the vessel to proceed into port.

CMA CGM Florida received clearance to proceed towards Yang Shan on 26 March, and berthed alongside on 27 March. After a naval architect was consulted, most of the containers were discharged from the vessel, and the vessel then proceeded to dry dock for repairs.

1.4 DAMAGE AND POLLUTION

1.4.1 *CMA CGM Florida*

CMA CGM Florida suffered extensive damage to the port side **(Figures 7** and **8)**. Damage was focused in the vicinity of No.5 cargo hold and the outboard No.5 upper HSFO tank, which were holed above and below the waterline. No.4 cargo hold and the engine room LSFO tank adjacent to No.5 cargo hold were also breached.

Above the main deck, the accommodation block was damaged over five decks, and the port lifeboat was seriously damaged, rendering it unusable. Five pontoon-type hatch covers were damaged and 263 containers were damaged or lost overboard.

No.s 4 and 5 cargo holds flooded as a result of the collision. Breach of the engine room LSFO tank and No.5 upper HSFO tank resulted in the loss of around 610t of fuel oil.

There were no injuries and the resulting oil pollution was contained and cleaned up with minimal environmental impact.

1.4.2 *Chou Shan*

Chou Shan sustained serious damage to its bow, limited to the area forward of the collision bulkhead **(Figures 9** and **10)**. The full force of the impact was concentrated on its port side due to the angle of approach with *CMA CGM Florida*.

The fore peak tank was opened to the sea. No other compartments were breached as a result of the collision. Considerable shell plate and frame damage occurred to the bow area. The port anchor and hawse pipe were destroyed.

There were no injuries and no oil pollution resulting from *Chou Shan*'s damage.

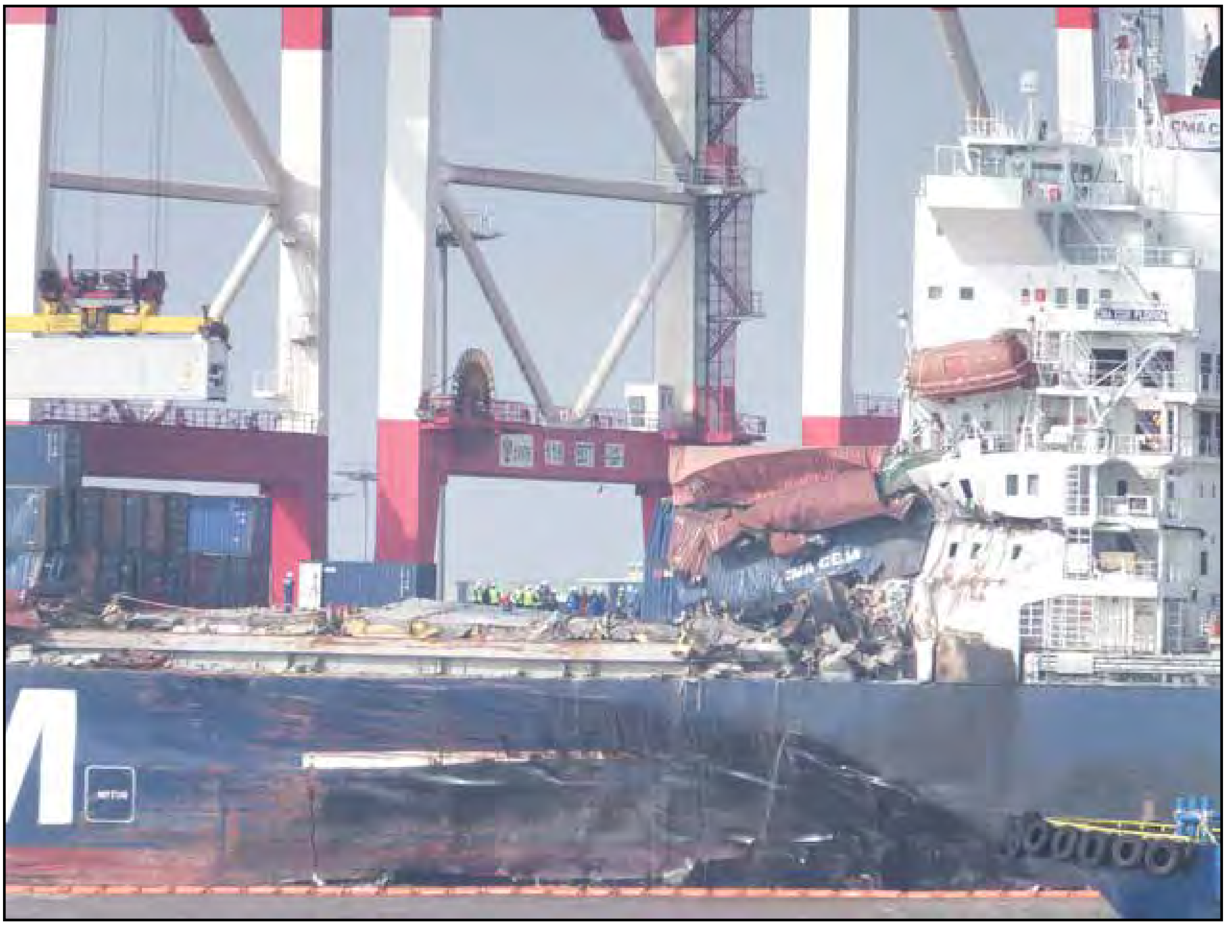

Figure 7: *CMA CGM Florida*'s port side

Figure 8: Close-up on *CMA CGM Florida*'s damaged port side

Figure 9: *Chou Shan*'s bow under repair

Figure 10: *Chou Shan*'s bow under repair

1.5 ENVIRONMENTAL CONDITIONS

At the time of the accident, the wind was southerly force 4, and the sea state was slight with a low swell. It was dark with haze. There were various reports regarding the range of visibility, the lowest being 4 miles.

1.6 MANNING AND WATCHKEEPING

1.6.1 *CMA CGM Florida*

Overview

CMA CGM Florida had a safe manning document[3] requiring a minimum of 15 crew members. At the time of the accident there were 24 crew members on board. This total included two trainees and two officers undergoing familiarisation.

The senior officers (i.e. master, chief officer, chief engineer and second engineer) were Romanian nationals. Junior officers and ratings were predominantly from the Philippines.

The working language on *CMA CGM Florida* was English.

Key personnel

- Master

  The master was 38 years old. He held a STCW[4] II/2 Master Unlimited Certificate of Competency (CoC), which had been issued in 2008 by the Government of Romania. He had also been issued an appropriate Certificate of Equivalent Competency (CEC) by the United Kingdom's (UK) Maritime and Coastguard Agency (MCA).

  He had worked at sea for 15 years, having joined CMA CGM in 1998. In 2008, he was promoted to master and served successive contracts on different vessels within the fleet.

  The master had joined *CMA CGM Florida* for the first time on 3 February 2013 on a normal 4-month contract. Since joining, he had not discussed with the deck officers any detailed requirements with regard to bridge watchkeeping.

- Filipino 2/O

  The Filipino 2/O was 50 years old. He held an STCW II/1 OOW Unlimited Certificate, which had been issued by the Government of the Republic of the Philippines in 2004. He had also been issued an appropriate CEC by the MCA.

  He graduated with a degree in marine transportation in 1982 and, after completing his deck apprenticeship in 1984, worked ashore. From 1991 he worked at sea on refrigerated cargo vessels and tankers as an AB.

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[3] Document issued by a vessel's Flag State detailing the minimum number of crew, and their qualifications, required to be on board to operate the vessel safely.

[4] International Convention on Standards of Training, Certification and Watchkeeping for Seafarers

In 1999, he sailed as third officer, for the first time, on refrigerated cargo vessels. He then completed a number of contracts on various vessels before joining CMA CGM as third officer in 2008, and was promoted to second officer in March 2011.

The Filipino 2/O had joined *CMA CGM Florida* in September 2012 for a normal 6-month contract following 6 months' leave. He was due to go home on leave when the vessel arrived in Pusan the next day.

- Chinese 2/O

The Chinese 2/O was 30 years old. He held an STCW II/1 OOW Unlimited Certificate, which had been issued by the Government of the People's Republic of China in 2009. As this was his first contract on a UK-flagged vessel, he had been issued with a certified receipt of application for a CEC. This allowed him to sail in the capacity of 2/O on *CMA CGM Florida* while his application was being processed.

He had worked at sea since 2006. Although this was his first contract with CMA CGM, he had completed three previous contracts as a 2/O on container vessels of a similar size to that of *CMA CGM Florida*.

The Chinese 2/O had joined *CMA CGM Florida* in Yang Shan on 18 March 2013 following 16 months' leave.

Bridge watchkeeping routine

CMA CGM Florida was operating a traditional watchkeeping pattern with three officers working 4 hours on duty followed by 8 hours rest.

As the vessel was carrying an additional third officer, the master and chief officer did not routinely keep navigational watches. The Filipino 2/O kept the 0000-0400 and 1200-1600 watches.

Pusan's time zone was 1 hour ahead of that of Yang Shan. On the night of the accident, the watches were reduced by 20 minutes to share the hour lost due to advancing clocks. Therefore, the Filipino 2/O was scheduled to start his watch at 2340.

Hours of rest

Records for hours of rest indicated that *CMA CGM Florida*'s master and two 2/Os had received the required minimum hours of rest[5] in the period leading up to the accident.

Familiarisation

The Chinese 2/O had joined *CMA CGM Florida* in Yang Shan so that he could receive a handover from the outgoing Filipino 2/O. The purpose of this handover period was to familiarise himself with the duties and responsibilities of the 2/O on board *CMA CGM Florida*, and with the vessel's layout and fittings, including its bridge navigation equipment.

[5] Minimum hours of rest are set out in The UK Merchant Shipping (Hours of Work) Regulations 2002.

On joining, he had been met by a third officer, who checked his certification. He then had a brief discussion with the chief officer before being paired with the Filipino 2/O.

The two 2/Os spent the 1200-1600 watch together supervising cargo operations and then securing the vessel for sea.

After taking dinner together, the two 2/Os parted company with the Filipino 2/O going to rest. The Chinese 2/O went to the bridge to see the navigation equipment in daylight. However, as the vessel was under pilotage at that time, outbound from Yang Shan, he changed his mind and, after introducing himself to the master, went to his cabin to rest.

1.6.2 *Chou Shan*

Overview

Chou Shan's safe manning document required a minimum of 14 crew. At the time of the accident there were 24 crew members on board, which included two cadets.

The master was Taiwanese. The majority of the other officers and crew were Chinese nationals.

The working language on *Chou Shan* was Mandarin.

Key personnel

- Master

  The master had worked for Sincere Navigation Corporation for 11 years, 6 years as master.

  This was his second contract on *Chou Shan* and he had been on board for 6 months.

- Second officer

  The 2/O was a 26-year-old Chinese national who held an STCW II/1 OOW unlimited Certificate issued by the Government of the People's Republic of China in 2012.

  He first went to sea in 2008 with Sincere Navigation Corporation and, apart from his time training, had completed 18 months as third officer and one previous contract as a 2/O prior to joining *Chou Shan*.

  This was his first trip on *Chou Shan*, which he had joined on 26 October 2012.

Watchkeeping routine

Chou Shan was operating the same watchkeeping pattern as *CMA CGM Florida*, with three officers, including the chief officer, working 4 hours on duty followed by 8 hours rest.

The 2/O kept the 0000-0400 and 1200-1600 watches.

1.7 BRIDGE EQUIPMENT

1.7.1 *CMA CGM Florida*

CMA CGM Florida was fitted with a Sperry VisionMaster FT series integrated navigation system. The system had four independent workstations, which could be configured as either a radar, chart radar, electronic chart display and information system or a display showing conning information **(Figures 11** and **12)**.

At the time of the accident, the Filipino OOW was working at the port workstation, which had been configured as a radar display. The display had been set up to show the picture from the X-band scanner.

The port workstation had previously been configured by the third officer so that information from the X-band radar was presented in the 12-mile range scale, with true vectors and ground stabilisation, and selected the display offset to give a greater range ahead than astern.

The display of target information could be provided from either activated AIS targets or acquired radar targets. When the third officer handed over the watch to the Filipino 2/O, the port radar was in 'AIS priority'[6], and it remained in this mode until the time of the collision.

Shortly after the watch handover, the Filipino OOW changed the presentation mode for target information to a multiple target list **(Figure 13)**. This list displayed a target number, CPA and Time to Closest Point of Approach (TCPA) for a maximum of eight targets. As the target information was based on activated AIS targets, a green triangle was displayed to the left of the target number.

When the 'CPA' or 'Range' tabs were selected, CPA and TCPA were sorted in descending order in terms of increasing CPA or range respectively.

All AIS targets were displayed initially as 'sleeping targets', which were then activated either manually or automatically. On *CMA CGM Florida,* targets were predominantly activated automatically on infringement of manually set CPA and TCPA limits.

1.7.2 *Chou Shan*

Chou Shan was fitted with stand-alone equipment, which was mostly supplied by Japan Radio Company Limited (JRC). Two radar displays were located to port of the steering stand. The port display, showing an X-band radar picture, was being used by the OOW **(Figures 14** and **15)**.

The port radar display was configured to display the picture in relative motion, offset, ground-stabilised, and predominantly on the 12-miles range scale with true vectors.

All AIS targets were displayed. However, target information was that obtained from radar targets.

[6] When in AIS priority, target information, including CPA and TCPA, is that received by the AIS.

Figure 11: *CMA CGM Florida*'s bridge centre console viewed from the steering stand

Figure 12: *CMA CGM Florida*'s bridge centre console, port side workstation area

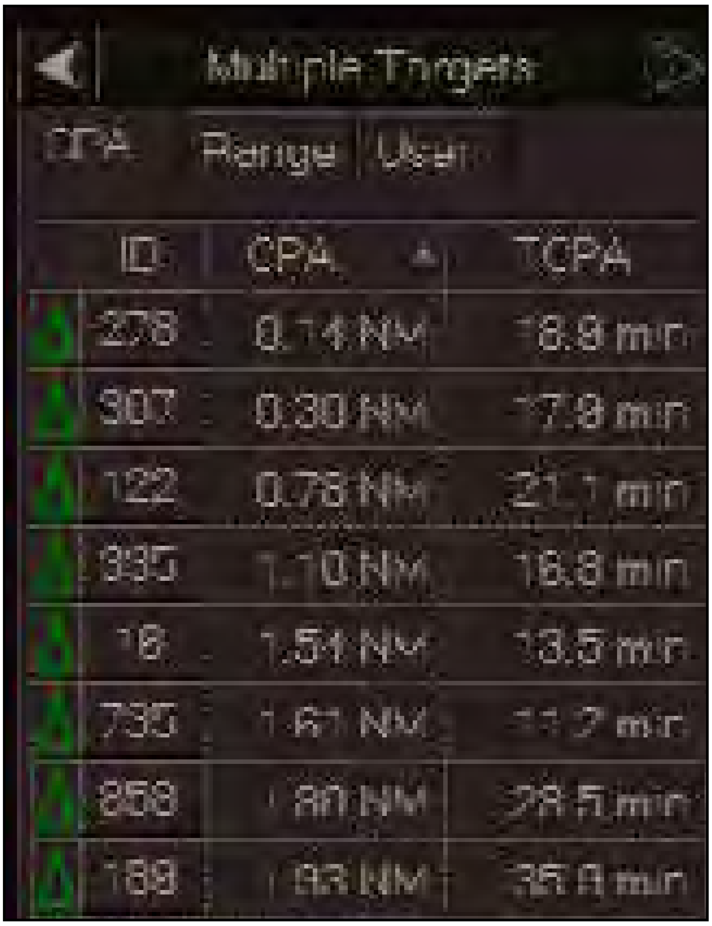

Figure 13: Sperry Visionmaster FT multiple target list

Figure 14: *Chou Shan*'s bridge viewed from the port side

Figure 15: *Chou Shan*'s port X-band radar

1.8 COMPANY INSTRUCTIONS AND MASTER'S STANDING ORDERS

1.8.1 *CMA CGM Florida*

Safety Management System (SMS)

CMA CGM's SMS specified the master's responsibilities. It stated that the master was:

> *"Responsible for motivating the crew in the observation and strict compliance of the 'Safety Management System'."*

The SMS included the following instructions in respect of master's standing and special orders, and provided general guidance as to what the standing orders should include:

> "*The Officers of the watch need to clearly know the behaviour that the master expects from them when he entrusts them with the responsibility of handling the ship.*" [sic]

> "*By his standing and special orders, the Master will therefore give clear and unambiguous written instructions and directives.*" [sic]

With regard to navigational watchkeeping, the SMS included the following instructions:

> "*A proper look-out shall be maintained at all times by both the AB and the officer on watch. It consists of (but is not limited to):*

> - *Maintaining a continuous vigilance by sighting and hearing. All other available means must be used as well, such as radar, radar EBL*[7]*, ARPA, AIS, Gyro compass repeater, etc…*

[7] Electronic Bearing Line

- *Full appraising of the situation and the risk of collision, stranding and other dangers to navigation…*" [sic]

"The Officer in charge of the navigational watch shall notify the Master immediately and record in the log book that he called the Master, at what time and when Master is on the bridge:

- *...If the traffic conditions or the movements of other ships are causing concern, when entering a traffic separation scheme…"* [sic]

The SMS contained a schedule for emergency drills, and stated:

"*To be effective, these exercises should be as close as possible to real conditions.*"

A checklist was included for use following a collision.

Other than in the master's standing orders, no reference was made in the SMS with regard to the use of VHF radio for collision avoidance. However, in its internal publication "Maritime SSE Events Feed-back nº01/2009", CMA CGM included feedback on a previous collision. In its analysis of the event, it stated the following deviation:

"*VHF was used to avoid collision. The use of VHF in this case is not recommended.*"

<u>Master's standing orders</u>

CMA CGM Florida's master had produced a set of standing orders, including the following:

"*The Officer of the Watch shall notify the Master immediately under the following circumstances:*

- *…if the traffic conditions, or the movements of other vessels, are causing concern…*"

"*VHF is not to be used for personal communication. The Officer of the Watch should be aware of the dangers of using VHF in collision avoidance. Only if positively identified on the AIS or visually, they may be called directly by name.*" [sic]

"*The Officer of the Watch shall take frequent and accurate compass bearings of approaching vessels, to ascertain if risk of collision exists. This should be in addition to ARPA plotting. Early and positive action should be taken to avoid collision or a close-quarters situation. Such action should be in compliance with the Collision Regulations, and should be monitored subsequently to ensure that it is having the desired effect.*"

Three additional documents containing bridge instructions were located on *CMA CGM Florida*'s bridge:

- The deck logbook contained a generic set of instructions to watchkeeping officers and a list of situations during which the master should be called. These were pre-printed in the front of the book.

- The bridge 'order book with standing orders' contained similar guidance to that contained in the deck logbook, which was also pre-printed in the front of the book.

- Posted on the bridge bulkhead was a set of 'bridge instructions' published by The Swedish Club. These also contained general guidance for watchkeeping and a list of circumstances when the master should be called.

1.8.2 *Chou Shan*

Safety Management System

Sincere Navigation Corporation's SMS designated responsibility for navigation and shipboard operations to the master, and required compliance with national and international regulations, including the COLREGS.

General guidance was provided for bridge watchkeeping, navigation and watch handovers. In particular, the SMS included the following instructions:

> "*The officer on watch should notify the Master immediately under the following circumstances:*
>
> - *…when traffic conditions or movements of other vessels cause concern…*"
>
> "*When navigating in high density traffic areas or confined area* (defined as "*an area where the presence of more than two ships makes it difficult to maintain the original course of the ship, and this condition occurs continuously, a channel of less than 2 miles in width, and insufficient Under Keel Clearance*")
>
> *....the officer on watch should:*
>
> - *VHF to be used to communicate with vessel in the vicinity to avoid misunderstanding…*" [sic]

Master's standing orders

Chou Shan's master's standing orders included the following:

> "*The OOW should call the Master immediately…*
>
> - *…if traffic conditions or the movements of other ships are causing concern…*"

1.9 REGULATIONS AND GUIDANCE

1.9.1 International Regulations for Preventing Collisions at Sea

The International Regulations for Preventing Collisions at Sea, as amended, (COLREGS) that are referred to in this report, are reproduced in **Annex A**.

1.9.2 International Chamber of Shipping's Bridge Procedures Guide

The following extracts from the Bridge Procedures Guide (Fourth Edition 2007) published by the International Chamber of Shipping (ICS) are referred to in this report:

> "*Safe navigation is the most fundamental attribute of good seamanship, and is clearly vital to the protection of safety of life at sea. However, an increasingly sophisticated range of navigational aids – most recently supplemented by the introduction of Automatic Identification Systems (AIS) – now complement the core skills of navigating officers which have developed over the previous centuries.*
>
> *This increased sophistication brings its own dangers and a need for additional precautionary measures against undue reliance on technology. Experience continues to demonstrate that properly formulated bridge procedures and, most importantly, the development of bridge teamwork are critical to maintaining a safe navigational watch.*"
>
> "*VHF radio should not be used for collision avoidance purposes. Valuable time can be wasted attempting to make contact since positive identification may be difficult and, once contact has been made, misunderstandings may arise.*"

1.9.3 Marine Guidance Note 324 (M+F)

The MCA's Marine Guidance Note (MGN) 324 (M+F) is entitled "Radio: Operational Guidance on the Use of VHF Radio and Automatic Identification Systems (AIS) at Sea". The MGN is reproduced in **Annex B**.

1.9.4 International Maritime Organization Resolution MSC.192(79)

International Maritime Organization (IMO) Resolution MSC.192(79) contains revised international performance standards for radar equipment. The following extracts are referred to in this report:

> "*The integration and display of AIS information should be provided to complement radar.*"
>
> "*The target information may be provided by the radar target tracking function and by the reported target information for the Automatic Identification System (AIS).*"
>
> "*If the target data from AIS and radar tracking are both available and if the association criteria (eg position, motion) are fulfilled such that the AIS and radar information are considered as one physical target, then as a default condition, the activated AIS target symbol and the alphanumeric AIS target data should be automatically selected and displayed.*"

1.10 VOYAGE DATA RECORDER RECOVERY AND DATA

1.10.1 *CMA CGM Florida*

Good quality video and audio records were successfully retrieved from *CMA CGM Florida*'s Sperry Voyage Data Recorder (VDR). All required sensor inputs were in place and had recorded correctly.

1.10.2 *Chou Shan*

Chou Shan's JRC VDR data was downloaded about 48 hours after the accident by a technician. Despite having all the required sensor inputs in place, exactly 1 minute of audio data was found absent from all voice sensors. The missing minute of audio data coincided with *Chou Shan*'s OOW's request for *CMA CGM Florida* to pass astern of *Chou Shan*. Fortunately, the VHF radio conversation at this time was recorded fully on *CMA CGM Florida*'s VDR. The reason why this data was lost has not been established.

1.11 SIMILAR ACCIDENTS

1.11.1 Recent MAIB investigations

Spring Bok/Gas Arctic (MAIB report No 24/2012)

On 24 March 2012, the Netherlands-registered cargo vessel *Spring Bok* collided with the Maltese-registered liquefied petroleum gas tanker *Gas Arctic*. The collision occurred in less than 2 miles visibility, 6 miles south of Dungeness while the vessels were proceeding in the same direction in the south-west lane of the Dover Strait Traffic Separation Scheme. There were no injuries or pollution, but both vessels suffered structural damage.

The MAIB investigation concluded that, despite each vessel detecting and identifying the other by radar and AIS, neither OOW made a full appraisal of the risk of collision, nor took the action required by the COLREGS to prevent the collision.

Scottish Viking/Homeland (MAIB Report No 4/2010)

On 5 August 2010, the Italian-registered Ro-Ro passenger ferry *Scottish Viking* collided with the fishing vessel *Homeland* about 4 miles off St Abbs Head, UK. As a result of the collision, the fishing vessel sank and one of her crew was lost.

The MAIB investigation concluded that *Scottish Viking*'s OOW did not: determine at an early stage if there was a risk of collision with *Homeland*; sufficiently monitor or plot *Homeland*'s track; and, once a risk of collision was deemed to exist, take sufficient action to avoid a collision.

1.11.2 Request to the Marine Accident Investigators' International Forum (MAIIF)

As part of its investigation, the MAIB requested MAIIF members for information on marine casualties or incidents featuring the following:

1. Lack of foresight and substantial early action to avoid a developing congested traffic situation.

2. Significant reliance on AIS information to determine risk of collision solely in terms of CPA.

3. Use of VHF radio communication to negotiate action to avoid collision.

4. Agreement to take avoiding action in conflict with action required by the COLREGS.

Table 1 below summarises the responses received from MAIIF members. The MAIB received a total of seven responses from MAIIF members, referring to eight marine casualties or incidents featuring one or more of the specified safety issues.

Safety issue	Number of marine casualties or incidents
Lack of foresight and substantial early action to avoid a developing congested traffic situation.	5
Significant reliance on AIS information to determine risk of collision solely in terms of CPA.	0
Use of VHF radio communication to negotiate action to avoid collision.	5
Agreement to take action in conflict with action required by the COLREGS.	0

Table 1: Summary of responses received from MAIIF members

SECTION 2 - ANALYSIS

2.1 AIM

The purpose of the analysis is to determine the contributory causes and circumstances of the accident as a basis for making recommendations to prevent similar accidents occurring in the future.

2.2 FATIGUE

There is no evidence that any of the crew involved in the accident were suffering from fatigue. Therefore, fatigue is not considered to be a contributing factor to this accident.

2.3 OVERVIEW

CMA CGM Florida's OOW, the Filipino 2/O, initially altered course to pass between the fishing vessels and *Monte Pascoal,* which resulted in a risk of collision with *Chou Shan*. *Chou Shan*'s OOW used the VHF radio to call *CMA CGM Florida* to request it to pass around the stern of *Chou Shan*. The Chinese 2/O on *CMA CGM Florida*, who was undergoing familiarisation, had tacitly agreed to this course of action.

Both *CMA CGM Florida* and *Chou Shan* altered course to port following the VHF radio agreement, which resulted in a continued risk of collision with each other.

CMA CGM Florida's Chinese 2/O then called *Chou Shan* on the VHF radio to request that both vessels pass port-to-port. This was agreed to by *Chou Shan*'s OOW. Both *Chou Shan* and *CMA CGM Florida* altered course to starboard, but these measures were insufficient and taken too late to prevent collision.

2.4 ACTION BY *CMA CGM FLORIDA*'S FILIPINO OOW

2.4.1 Situational assessment at 0002

At 0002, the Filipino OOW made the following assessments of the risk of collision with vessels in the vicinity of *CMA CGM Florida* and his obligations under the COLREGS. The assessments were primarily based on the radar-displayed AIS target CPA information and his general overview of the displayed radar targets. Three merchant vessels and one group of fishing vessels featured in these assessments.

The Filipino OOW correctly interpreted that, in accordance with Rule 13 of the COLREGS, *CMA CGM Florida* was overtaking *Hong Yun No1* and was required to keep out of her way.

The Filipino OOW also correctly interpreted that there was a risk of collision with the fishing vessels, and these became the focus of his attention. It is unclear what navigation lights the fishing vessels were exhibiting. Regardless of whether they were those of vessels engaged in fishing or power-driven vessels underway, the Filipino OOW correctly interpreted that *CMA CGM Florida* had an obligation to keep out of the way under Rule 13 of the COLREGS.

2.4.2 Action to avoid fishing vessels

The Filipino OOW's initial starboard course alteration of only 5 degrees, followed by three further 5-degree starboard course alterations, was inappropriate in that they would not have been readily apparent to other vessels, contrary to Rule 8(b). Furthermore, the initial 5-degree alteration of course did not constitute substantial action, contrary to Rule 16.

The Filipino OOW's decision to alter course in 5-degree steps resulted from a lack of situational awareness in that he had not determined the course and speed of the fishing vessels and so could not assess what course alteration would be necessary for *CMA CGM Florida* to pass safely ahead of them. Instead of using ARPA to ascertain radar target compass bearing, course and speed, and to conduct a radar target trial manoeuvre, he continued predominantly to use the multiple AIS target list from which he was able to ascertain AIS target CPA and TCPA only. Consequently, in an attempt to restrict the overall course alteration to a minimum and not wishing to impede the passage of *Monte Pascoal*, he conducted a series of small reactive course alterations rather than a single and substantial proactive one.

The Filipino OOW's initial course alteration to starboard coincided with his reducing the port radar display range scale to 6 miles, on which it predominantly remained. This meant that only the radar targets of the fishing vessels and *Hong Yun No1* were displayed. *Chou Shan* featured second from bottom on the multiple AIS target list as fishing vessels with smaller CPAs featuring at the top of the list. *Monte Pascoal*'s radar target appeared on the display following the third 5-degree course alteration. Therefore, in making the final 5-degree course alteration, the Filipino OOW would have been aware that *CMA CGM Florida* was now showing a port aspect to *Monte Pascoal*.

Precautionary thought (ie the ability to analyse the effect of an intended manoeuvre) is an important skill that every OOW should have and reflects the requirements of Rule 2(a). Instead of deciding to make an initial course alteration of 5 degrees to starboard, the Filipino OOW could have made a far greater starboard course alteration, taking *CMA CGM Florida* well clear of the bottleneck that was developing ahead.

Before taking action to avoid the vessels posing the most immediate risk of collision, it would have been appropriate for the Filipino OOW to assess the movements of vessels at greater range to ensure that by resolving one risk of collision he was not creating another.

2.4.3 VHF radio communications

After altering course for the fishing vessels, interpreting that a risk of collision with them still existed but not wanting to alter course further to starboard, the Filipino OOW asked the Chinese 2/O to call the fishing vessels on VHF radio and request that they keep clear of *CMA CGM Florida*.

He asked the Chinese 2/O to do this because he believed there would be a better chance of a positive outcome from the VHF radio call if it was made in Mandarin, which he assessed to be the likely first language of the fishing vessel crews.

Both 2/Os considered that it was appropriate to use the VHF radio in collision avoidance situations having identified the names of the vessels concerned using the AIS.

This request had three consequences. The first was that it made the Chinese 2/O an active member of the bridge team. Secondly, it effectively announced to other vessels in the vicinity that a Mandarin-speaking watchkeeper was on *CMA CGM Florida'*s bridge, and thirdly, it indicated that there was a willingness to negotiate passing protocols for collision avoidance. Specifically, it was hearing the VHF radio call transmitted in Mandarin that prompted *Chou Shan'*s OOW to call *CMA CGM Florida*.

As the VHF radio call took place in Mandarin, the Filipino OOW was not aware of its content and he relied on the Chinese 2/O's feedback to him in English. He was still focused on the fishing vessels and *Monte Pascoal*, initially thinking that the VHF radio call had, in fact, come from *Monte Pascoal*.

The fact that *Chou Shan* had requested *CMA CGM Florida* to pass astern was correctly conveyed. However, the fact that a tacit agreement had been made by the Chinese 2/O was not passed on to the Filipino OOW.

When the Filipino OOW checked the relative vector of *Chou Shan'*s radar target, it showed the vessel passing astern of *CMA CGM Florida*. His assessment of the situation was that if a risk of collision existed, *Chou Shan* would be the give-way vessel and would avoid passing ahead in accordance with Rule 15 of the COLREGS. He therefore dismissed *Chou Shan'*s request for *CMA CGM Florida* to pass astern of *Chou Shan* as being inappropriate.

However, being unaware that the Chinese 2/O had tacitly agreed to the course of action, he made no attempt to reply to *Chou Shan'*s request. This left the watchkeeping officers on both vessels with different expectations about what the other vessel would do.

When *CMA CGM Florida'*s Chinese 2/O later called *Chou Shan* in Mandarin and agreed a port-to-port passing, he omitted to inform the Filipino OOW in English that he had also agreed that *CMA CGM Florida* would alter course to starboard to assist the passing. He also omitted to say that this agreement had been made in response to *Chou Shan'*s OOW's concern over the large turn that his vessel would have to make. These omissions again left the Filipino OOW with an erroneous expectation as to what the other vessel would do.

2.4.4 Traffic situation and course alteration after passing the fishing vessels

By 0021:

- *CMA CGM Florida* was drawing ahead of the fishing vessels.
- *Monte Pascoal* was on the starboard bow of *CMA CGM Florida* at a range of 6 miles and with a CPA of 2.4 miles to starboard.
- *Hong Yun No1* was ahead and to port of *CMA CGM Florida* at a range of 4 miles with a CPA of 1.1 miles to port.

- *Chou Shan* was ahead and to port of *CMA CGM Florida* at a range of 4½ miles with a CPA of 0.2 mile astern.

As an overtaking vessel, *CMA CGM Florida* still had an obligation to keep out of the way of *Hong Yun No1*. A risk of collision now existed with respect to *Chou Shan* and, as a stand-on vessel in a crossing situation, *CMA CGM Florida* was required to maintain its course and speed in accordance with Rule 17(a)(i) of the COLREGS. There was no requirement for the Filipino OOW to take any action with respect to *Monte Pascoal*.

The Filipino OOW's primary concern was to open up sufficient sea room with *Monte Pascoal* so as not to impede its passage. Although aware of the presence of *Chou Shan*, he was comfortable in his assessment that *Chou Shan*'s OOW would take avoiding action in the event of risk of collision.

The Filipino OOW then made three 5-degree course alterations to port. This action had the desired effect of increasing *Monte Pascoal*'s CPA and reducing *CMA CGM Florida*'s deviation from the planned track. However, it was contrary to Rules 17(a)(i) and (c), did not remove the risk of collision with *Chou Shan*, and reinforced in the mind of *Chou Shan*'s OOW that *CMA CGM Florida* would alter course around his vessel's stern, as he had earlier requested.

2.4.5 Action to avoid *Chou Shan*

At 0026, with *CMA CGM Florida* on a heading of 070º(T), *Chou Shan* was ahead and to port at a range of 2.9 miles and with a CPA of 0.2 mile ahead. The Filipino OOW's attention was now focused on *Chou Shan* and he stated his concern over that vessel's small CPA to the Chinese 2/O. Despite the Chinese 2/O then conveying his expectation that *CMA CGM Florida* would pass around *Chou Shan*'s stern, the Filipino OOW remained resolved in his opinion that *Chou Shan* should pass around *CMA CGM Florida*'s stern. At 0027, the Filipino OOW altered *CMA CGM Florida*'s course to port by a further 5 degrees and stated aloud to the Chinese 2/O that the vessels should pass port-to-port.

Although initially required to maintain course and speed in accordance with Rule 17(a)(i) of the COLREGS, the Filipino OOW had an option of taking avoiding action himself, in accordance with Rule 17(a)(ii), as soon as he considered that *Chou Shan* was not taking appropriate avoiding action. As *Monte Pascoal* was now drawing clear, appropriate precautionary actions would have been for the Filipino OOW to have sounded at least five short and rapid blasts on the whistle supplemented by a light signal of at least five short and rapid flashes, in accordance with Rule 34(d), and to have then altered course to starboard. However, although concerned, the Filipino OOW was not yet in doubt that *Chou Shan* would take appropriate action.

Chou Shan was under 2 miles away on the port bow, steering a course at right angles to that of *CMA CGM Florida.* The Filipino OOW lacked situational awareness in that he underestimated the time it would take for *Chou Shan* to complete its turn so as to pass port-to-port with *CMA CGM Florida.* This was because he lacked an appreciation of *Chou Shan*'s likely rate of turn and/or how large a turn *Chou Shan* would have to make, given its relative bearing, range and heading at the start of the turn. A number of factors potentially contributed to his lack of appreciation:

- The Filipino OOW may not have appreciated the significance of the aspect presented by the navigation lights of *Chou Shan.*

- In the period leading up to this point, *Chou Shan*'s displayed radar target vector and trail were predominantly relative.

- Use of the multiple AIS target list meant that *Chou Shan*'s course and speed information was not displayed.

- Although *Chou Shan*'s OOW had indicated to *CMA CGM Florida*'s Chinese 2/O that he was concerned over the large turn he would have to make, this information had not been passed to the Filipino OOW.

At 0030, seeing no apparent change to *Chou Shan's* visual aspect or CPA, the Filipino OOW began to doubt that *Chou Shan* was taking appropriate avoiding action. He decided to alter *CMA CGM Florida's* course by 10 degrees to starboard and to repeatedly flash the daylight signalling lamp in the direction of *Chou Shan*. Although this action was in the spirit of Rules 17(a)(ii) and 34(d), the success of *Chou Shan*'s manoeuvre now required a significant alteration of course by *CMA CGM Florida* in accordance with Rule 17(b). This occurred about 1 minute later, when the Filipino OOW ordered 'hard-a-starboard' and then called the master. However, his avoiding action was too late to prevent the collision.

2.5 ACTION BY *CMA CGM FLORIDA*'S CHINESE 2/O

The Chinese 2/O was on the bridge to receive a handover from the Filipino OOW and to familiarise himself with the bridge equipment. Neither officer had received any guidance as to how the handover and familiarisation should be conducted during the watch. Therefore, when they arrived on the bridge, each had individual expectations and priorities.

The Chinese 2/O realised that this would be his main opportunity to learn about the bridge equipment before taking on the duty of OOW at sea, and he was, therefore, focused on his familiarisation. The Filipino OOW's focus was on safely discharging his duties as OOW.

The Chinese 2/O did not have a defined role within the bridge team. However, he was willing to temporarily join the bridge team to assist as required before reverting back to his familiarisation role.

When he was asked by the Filipino OOW to call the fishing vessels on the VHF radio, he readily accepted the task believing his ability to communicate externally, in the local language, to be helpful in the circumstances. Use of the VHF radio for collision avoidance was common practice in his experience.

By accepting this task, the Chinese 2/O had assumed an external communicator role within the bridge team. As the Filipino OOW did not understand Mandarin, the success of this role relied heavily on accurate transmission of the Filipino OOW's intentions, with correct and comprehensive translation of any received responses.

Not otherwise engaged with the conduct of the watch, the Chinese 2/O was not fully aware of the navigational situational or the potential risks to *CMA CGM Florida* posed by other vessels in the vicinity. Therefore, when the two officers began discussing the fishing vessel movements after the first VHF radio call, he was unable to provide any informed opinion on the navigational situation.

The second VHF radio call was not requested by the Filipino OOW. The Chinese 2/O autonomously transmitted the call, again in Mandarin, in his assumed role as external communicator, believing this to be helpful to the Filipino OOW. By not questioning the content of the VHF radio call or the Chinese 2/O's autonomous action, the Filipino OOW effectively gave tacit approval for the Chinese 2/O to continue to act in this way.

Therefore, when *Chou Shan*'s OOW called on the VHF radio, the Chinese 2/O autonomously responded. Having answered the call, he was now drawn into a VHF radio conversation with *Chou Shan*'s OOW, in Mandarin, during which he, in effect, agreed that *CMA CGM Florida* would alter course to pass *Chou Shan*'s stern, without first consulting the Filipino OOW or fully translating the conversation into English for him.

At this time, the Chinese 2/O had noticed that *CMA CGM Florida* was south of her intended track, and assumed that the Filipino OOW would alter *CMA CGM Florida*'s course to port to regain the planned track after passing clear of the fishing vessels.

When the Chinese 2/O translated the VHF radio conversation to the Filipino OOW, he did not convey that he had tacitly agreed that *CMA CGM Florida* would pass astern of *Chou Shan*. Instead, he urged the Filipino OOW to alter *CMA CGM Florida*'s course to port. He also tried to convince him that the fishing vessels would change their course, the validity of which was challenged by the Filipino OOW.

This challenge caused the Chinese 2/O to make a further unanswered VHF radio call to *Sheyangyu 16316*, asking the fishing vessel's skipper to alter course. The Chinese 2/O then reverted to familiarising himself with the navigation equipment and he neither questioned the Filipino OOW's understanding of what he had agreed nor monitored the situation with *Chou Shan*. He did not consider these tasks to be necessary as they were not his responsibility.

However, the Chinese 2/O demonstrated a continued willingness to offer his opinion when the Filipino OOW voiced his concern regarding *Chou Shan*'s small CPA. This re-opened their earlier, unresolved conversation, and he again suggested that *CMA CGM Florida* should pass *Chou Shan*'s stern.

The Chinese 2/O's expectation was in direct conflict with the Filipino OOW's interpretation and intention with regard to *Chou Shan*. This was a confusing situation, which almost certainly contributed to the Filipino OOW's delay in asserting his requirement that *CMA CGM Florida* and *Chou Shan* should pass port-to-port. Again, this challenge caused the Chinese 2/O to revert to his external communicator role, and he then called *Chou Shan* on the VHF radio to request a port-to-port passing.

During the VHF radio conversation, *Chou Shan*'s OOW expressed concern over his vessel's ability to make a large enough turn to enable a port-to-port passing. Tasked with getting agreement, and possibly fearing loss of face, *CMA CGM Florida*'s

Chinese 2/O leveraged his national cultural power-distance hierarchy[8] by stating that his "captain" wanted the two vessels to pass in this way. This influenced *Chou Shan*'s OOW to re-negotiate, and then to agree to the port-to-port passing following the Chinese 2/O's stated intention for *CMA CGM Florida* to also alter course.

After the VHF radio conversation, the Chinese 2/O informed the Filipino OOW that *Chou Shan* had agreed to pass port-to-port, but not that he had stated that *CMA CGM Florida* also would alter course.

Having obtained the agreement, the Chinese 2/O again adopted a passive role within the bridge team. However, he considered that *CMA CGM Florida* could still pass astern of *Chou Shan*, and offered this opinion to the Filipino OOW in the short time leading up to the collision. This would have added further confusion to the situation and was inappropriate given that the Chinese 2/O was fully aware that *Chou Shan* would be turning to starboard. Any turn to port at this time had the potential to take *CMA CGM Florida* across the path of *Chou Shan*, contrary to Rule 17(c) of the COLREGS, and would have been highly dangerous.

<u>Summary</u>

By inviting the Chinese 2/O to communicate in Mandarin on VHF radio on his behalf, the Filipino OOW unnecessarily put himself in the position of having to deal with the consequences of the Chinese 2/O's VHF radio conversations, which he did not understand and was unable to control. He was now reliant on the Chinese 2/O accurately transmitting his intentions, and translating his received responses correctly and comprehensively into English.

The Chinese 2/O did not convey fully to the Filipino OOW the content and outcome of his VHF radio communications with *Chou Shan*'s OOW. Whether or not the two individuals had direct interpersonal conflicts is unclear. However, they were both hampered in their attempts to communicate by having to converse in a second language. Current research suggests that culturally, the Chinese 2/O, although of equivalent rank to that of the Filipino OOW, is likely to have been respectful of the Filipino OOW's age, experience and authority as the OOW[8]. Research has also identified industry concerns about the compatibility of Chinese and Filipino nationals on board some vessels[9].

2.6 ACTIONS BY *CHOU SHAN*'S OOW

2.6.1 Initial action to avoid collision with *CMA CGM Florida*

By 0019, *CMA CGM Florida* had altered course to 080º(T), resulting in a risk of collision with *Chou Shan*. Having previously heard the VHF radio call from *CMA CGM Florida* to *Sheyangyu 16316,* and then having identified *CMA CGM Florida*'s radar target by AIS and having obtained full radar target information for her, the OOW called *CMA CGM Florida* on VHF radio and requested that the vessel pass astern of *Chou Shan*.

[8] Referred to in "Effects of national culture on human failures in container shipping: The moderating role of Confucian dynamism" (reproduced in Annex C), Sections 2.1, 2.2, 2.5, 4.1, 4.2 and 5.1

[9] "The Impact of Multicultural and Multilingual Crews on Maritime Communication" - The MARCOM Project (1999). Pages 69-70 of this report provide details of a questionnaire provided to a number of shipping companies in 1996. Responses from a number of these companies to a question 'if the respondents felt that, in their experience, there were mixes of nationalities that were not compatible on ships', placed at number one on the list, Chinese and Filipino incompatibility.

Chou Shan was a give-way vessel in a crossing situation and was required to avoid crossing ahead of *CMA CGM Florida* in accordance with Rule 15 of the COLREGS. However, on hearing the VHF radio call transmitted in Mandarin from *CMA CGM Florida*, *Chou Shan*'s OOW was alerted to the fact that a Mandarin-speaking watchkeeper was on her bridge and that there was an opportunity to negotiate a passing protocol for the crossing vessels.

In the absence of evidence from which to conclude an alternative explanation, a VHF radio call to *CMA CGM Florida* to request the vessel to pass astern of *Chou Shan*, albeit contrary to Rule 15 of the COLREGS, presented the OOW with a convenient solution to the risk of collision that dispensed with the need for *Chou Shan* to take avoiding action.

The OOW interpreted *CMA CGM Florida*'s subsequent course alterations to port on clearing ahead of the fishing vessels as action in accordance with the agreed manoeuvre. Despite the resulting minimal CPA, no agreement had been made as to when and by how much *CMA CGM Florida* would alter course and so the OOW had no reason to doubt that things were going to plan. However, by 0026, he had become concerned that *CMA CGM Florida* was not taking sufficient action to safely pass astern and altered *Chou Shan*'s course by 10 degrees to port. This had the effect of increasing *CMA CGM Florida*'s TCPA. At that point, it would also have been appropriate for the OOW to have indicated his concern to *CMA CGM Florida* by sounding at least five short and rapid blasts on the whistle supplemented by a light signal of at least five short and rapid flashes.

2.6.2 *CMA CGM Florida*'s request to pass port-to-port

When he received the request for a port-to-port passing from *CMA CGM Florida*, the OOW initially challenged it, demonstrating that he was aware how difficult it would be for *Chou Shan* to make a turn to starboard at that stage to leave *CMA CGM Florida* clear on *Chou Shan*'s port side.

The statement received on VHF radio that *CMA CGM Florida*'s master required a port-to-port passing clearly had an effect on the OOW's decision-making. This was probably due, at least in part, to the high power-distance heirarchy of his national culture and the consequent level of respect he would ordinarily give to a master. His concerns about the proposed manoevre were further allayed by the stated intention that *CMA CGM Florida* would also alter course. The result was that, despite his reservations, he agreed to a port-to-port passing.

Having allowed *Chou Shan* to approach within 2 miles of *CMA CGM Florida*, becoming concerned about that vessel's inaction following the initial course alterations to port, and now faced with this request for a port-to-port passing about which he was clearly in doubt, the OOW should by now have called the master. His reason for not doing so at any time prior to the collision has not been established from the available evidence.

Sincere Navigation Corporation's SMS and *Chou Shan*'s master's standing orders required an OOW to notify the master when traffic conditions or movements of other vessels caused concern. This presumed that the OOWs and the master had a mutual understanding of the circumstances in which the OOWs would become sufficiently concerned to warrant their calling the master.

2.7 ACTIONS BY *CMA CGM FLORIDA*'S MASTER

2.7.1 Management style

CMA CGM Florida's master did not meet new officers on joining his vessel, and, as permitted by the SMS, he delegated the company's requirement to verify officers' certification to one of the third officers. He believed that international and national regulations, company requirements and master's standing orders on the bridge negated any need for him to discuss any detailed requirements for watchkeeping. His rationale was that officers had open access to the necessary information required to safely carry out their navigational watch, and could refer to it if necessary.

When new officers joined the vessel, they relied on the outgoing officer to explain their understanding of the master's expectations. In the absence of unambiguous guidance in the master's standing orders, this understanding was, effectively, what the outgoing officer had interpreted to be behaviour that was acceptable to the master. As individual competence, personal standards and cultural background can vary widely, there would have inevitably been different interpretations of what was acceptable.

CMA CGM required the master to produce clear and unambiguous standing and special orders to watchkeeping officers, and provided general guidance as to what the standing orders should include. This empowered masters to give instructions relating to their own specific requirements for watchkeeping.

The master had produced a set of standing orders. However, they lacked specific metrics, particularly on when the master expected to be called. For example, with regard to traffic conditions and movements, they relied on the OOW becoming concerned before the master was required to be called. Similar to the situation on board *Chou Shan*, this presumed that the OOW and the master had a shared understanding of the circumstances in which the OOW would become sufficiently concerned to warrant their calling the master.

The standing orders also failed to provide unambiguous instructions on the use of VHF radio, stating:

"*VHF is not to be used for personal communication. The officer of the watch should be aware of the dangers of using VHF in collision avoidance. Only if positively identified on the AIS or visually, they may be called directly by name.*" [sic].

The above order could be interpreted to mean that if another vessel has been identified, the VHF radio may be used for collision avoidance.

No instructions were provided to officers regarding the master's expectations with respect to radar operating mode and AIS integration. CMA CGM's SMS required radar and AIS to be used to maintain a proper lookout, but provided only a description of the different functions available to the operator.

The potential for further confusion existed through the presence of three other documents containing bridge instructions and an SMS procedure, all of which listed requirements for calling the master. None of these instructions contained specific metrics, and each had variations as to what was required.

Ultimately, the master's approach to inducting, coaching and monitoring his officers was insufficient. His relaxed management style would potentially have been confusing to his officers, particularly those of Chinese and Filipino nationalities[10], who would have expected, and required, specific instructions and guidance from the master. The unquestioning acceptance of a hierarchical structure by these two nationalities meant that the individuals concerned would likely have been positively influenced by strong leadership and direction, and negatively influenced by their absence.

In the absence of detailed instructions and a role model to follow, the two second officers could draw only on individual principles. In this case, this meant that use of VHF radio and AIS for collision avoidance was acceptable, and the point at which the master was to be called relied solely on the OOW's perception of risk.

2.7.2 Post-collision actions

CMA CGM Florida's master arrived on the bridge very quickly after the collision and immediately took charge of the situation. The general alarm having already been sounded, he ordered the main engine to be stopped. These actions were in accordance with the SMS collision checklist, which he initially referred to but then dismissed. In not following the collision checklist, a number of important actions were either delayed or not taken. This resulted in a period of about 27 minutes before the crew were accounted for, the movement of ballast and other fluids before a damage assessment had been completed, and a distress or urgency message not being transmitted.

The SMS schedule of emergency drills required a collision drill to be conducted once per year. The SMS required emergency drills to be as realistic as possible. However, most drills conducted on board consisted of instruction or video-based training, and did not provide for a practical simulation of actions required by the muster list and the relevant emergency checklist.

The master had no confidence in the value of following the collision checklist and, instead, responded instinctively based on his experience and training. Had realistic drills been conducted on board, it is likely that he would have practised using the checklist and would have gained a better understanding of its value.

The master had had little opportunity to assess his crew's ability to respond to emergency situations in general. Therefore, in this unfamiliar situation he opted to engage primarily with the chief officer and chief engineer, and the few other crew members on board whose abilities he trusted and with whom he could readily interact. Instead of the crew following a preplanned response to the emergency, the master devised and orchestrated a plan of action that required his greater participation and undertaking of multiple tasks, which, in the stressful situation, caused him to become quickly overloaded.

Although in this case the above shortcomings did not adversely affect the consequences of the collision, a similar delay or absence of actions could have very serious consequences in different circumstances.

[10] Referred to in "Effects of national culture on human failures in container shipping: The moderating role of Confucian dynamism" (reproduced in Annex C), Sections 2.1, 2.2, 2.5, 4.1, 4.2 and 5.1

2.8 USE OF VHF RADIO FOR COLLISION AVOIDANCE

Following each of the two VHF radio communications between *CMA CGM Florida* and *Chou Shan*, the Filipino OOW and *Chou Shan*'s OOW were left with different expectations. A significant contributing factor to this misunderstanding was that the communication was conducted in a language which the Filipino OOW was unable to understand.

CMA CGM Florida's two 2/Os and *Chou Shan*'s OOW considered that it was appropriate to use VHF radio for collision avoidance. The latter also considered that it was appropriate to use it for negotiating a manoeuvre that was contrary to Rule 15 of the COLREGS.

The ICS's Bridge Procedures Guide recommends against using VHF radio for collision avoidance and warns that, even where vessels have identified each other, misunderstandings may still arise. This warning is reflected in the MCA's MGN 324 (M+F), which further advises that even when VHF radio is resorted to, the COLREGS should be complied with.

In an internal feedback publication, CMA CGM had previously indicated that use of VHF radio to avoid collision was not recommended. However, its SMS provided no specific instructions regarding the use of VHF radio for collision avoidance and made no mention of this in its general guidance as to what the master's standing orders should include. This left the management company's expectations on the use of VHF radio for collision avoidance open to interpretation by its masters. *CMA CGM Florida*'s master's standing orders were ambiguous and did not fully reflect the above recommended practice.

The instructions provided in Sincere Navigation Corporation's SMS were in direct conflict with the guidance contained in the ICS's Bridge Procedure Guide.

The use of VHF radio for collision avoidance was unnecessary, was contrary to internationally recognised best practice, and was a significant contributing factor to the collision.

2.9 USE OF AIS AND RADAR FOR COLLISION AVOIDANCE

2.9.1 *CMA CGM Florida*

CMA CGM Florida's Filipino OOW lacked situational awareness. Consequently, he altered his vessel's course in 5-degree steps to avoid the fishing vessels being overtaken, and gave no consideration to making a larger, more strategic alteration of course to starboard at an early stage to avoid vessels further ahead. A contributing factor to his lack of situational awareness was his use of AIS and radar for collision avoidance. His risk of collision assessments were primarily based on the radar-displayed AIS target CPA information and his general overview of the displayed radar targets.

The Filipino OOW used AIS priority and the multiple AIS target list, which displayed CPA and TCPA in ascending order either of CPA or range. This encouraged him to focus on those vessels with the smallest CPA or range at the expense of maintaining a more strategic overview of the traffic situation.

Use of the multiple AIS target list was in the spirit of Rule 7(b) of the COLREGS for determining risk of collision. However, it did not provide additional information that would otherwise be available through radar plotting, such as radar target compass bearing, and the course and speed of other vessels. It also detracted from using long-range scanning to obtain early warning of risk of collision.

CMA CGM's SMS required AIS and radar to be used for the purpose of fully appraising the navigational situation and the risk of collision. Additionally, *CMA CGM Florida*'s master's standing orders required the OOW to ascertain risk of collision by compass bearings in addition to ARPA plotting.

The SMS did not refer to, or reflect the guidance contained in MGN 324 (M+F) with respect to the use of AIS for collision avoidance. Although the master's standing orders to some extent reflected best practice for ascertaining risk of collision, no instructions were provided as to the manner and extent to which AIS should be used.

2.9.2 Guidance

The ICS's Bridge Procedures Guide warns that increasingly sophisticated navigational aids, now including AIS, bring their own dangers, and that there is a need for properly formulated bridge procedures to counter undue reliance on technology.

The MCA's MGN 324 (M+F) states that there is no provision in the COLREGS for the use of AIS information and therefore recommends that decisions should be taken primarily on visual and/or radar information.

MGN 324 (M+F) includes extracts from IMO Resolution A.917(22), as amended by Resolution A.956(23), with regard to AIS operation on board ship. The extract pertaining to the use of AIS in collision avoidance states that the potential of AIS as an anti-collision device is recognised and it may be recommended as such a device in due time. Meanwhile, it warns that AIS is an additional source of navigational information and does not replace, but supports, navigational systems such as radar target tracking.

MGN 324 (M+F) also includes an extract from the MCA's guidance on implementing the International Convention on the Safety of Life at Sea's safety of navigation requirements. The guidance states that *until the optimum display modes have been fully evaluated and decided upon internationally, AIS will comprise stand-alone units without integration to other displays.*

AIS was fully integrated into the radars fitted on board *CMA CGM Florida*. MGN 324 (M+F) therefore no longer reflects the current situation and provides no guidance on the use of AIS-integrated radar displays.

IMO Resolution MSC.192(79) contains revised international performance standards for radar equipment, which states that the integration and display of AIS information should be provided to complement radar. It further states that target information may be provided by the radar target tracking function and by the reported target information from the AIS, and that, as a default condition, AIS target data should be automatically selected and displayed.

The Filipino OOW’s use of AIS and radar was not in accordance with current UK national guidance. However, since the introduction of AIS-integrated radar displays and revised performance standards for radar, such guidance is now in need of revision.

SECTION 3 - CONCLUSIONS

3.1 SAFETY ISSUES DIRECTLY CONTRIBUTING TO THE ACCIDENT THAT HAVE BEEN ADDRESSED OR RESULTED IN RECOMMENDATIONS

1. *CMA CGM Florida*'s Filipino OOW lacked situational awareness and precautionary thought. [2.4.2, 2.4.3, 2.4.4, 2.4.5, 2.5, 2.9.1]

2. *CMA CGM Florida*'s two 2/Os and *Chou Shan*'s OOW considered that it was appropriate to use VHF radio for collision avoidance, contrary to the advice provided in ICS's Bridge Procedures Guide and the MCA's MGN 324 (M+F). [2.4.3, 2.5, 2.6.1, 2.8]

3. *CMA CGM Florida*'s Chinese 2/O acted autonomously in his role of external communicator, and did not fully translate his VHF radio conversations into English for the Filipino OOW. [2.5]

4. *Chou Shan*'s OOW considered that it was appropriate to use VHF radio for negotiating a passing protocol that was contrary to Rule 15 of the COLREGS. [2.6.1, 2.8]

5. *CMA CGM Florida*'s and *Chou Shan*'s master's standing orders presumed that the OOW and the master had a shared understanding of the circumstances in which the OOW would become sufficiently concerned to warrant their calling the master. [2.6.2, 2.7.1]

6. *CMA CGM Florida*'s master's standing orders lacked specific metrics, provided ambiguous instructions on the use of VHF radio for collision avoidance, and contained no instructions with respect to radar operating mode and AIS integration. [2.7.1, 2.8, 2.9.1]

7. CMA CGM's SMS provided no specific instructions regarding the use of VHF radio for collision avoidance and made no mention of this in its general guidance as to what the master's standing orders should include. [2.8]

8. Sincere Navigation Corporation's SMS conflicted with the advice provided in ICS's Bridge Procedures Guide relating to the use of VHF radio for collision avoidance. [2.8]

3.2 OTHER SAFETY ISSUES DIRECTLY CONTRIBUTING TO THE ACCIDENT

1. Whether or not the two individuals had direct interpersonal conflicts is unclear, however, they were both hampered in their attempts to communicate by having to converse in a second language. Current research suggests that culturally the Chinese 2/O is likely to have been respectful of the Filipino 2/O's age, experience and authority as OOW. Other research has also identified concerns over the compatibility of the two nationalities. [2.5]

2. *Chou Shan*'s OOW was probably influenced by the high power-distance hierarchy of his national culture in agreeing to a manoeuvre about which he had concerns. [2.6.2]

3.3 SAFETY ISSUES NOT DIRECTLY CONTRIBUTING TO THE ACCIDENT THAT HAVE BEEN ADDRESSED OR RESULTED IN RECOMMENDATIONS

1. On *CMA CGM Florida*, three documents containing bridge instructions and an SMS procedure all contained variations on requirements for calling the master, leading to potential confusion. [2.7.1]

2. The potential existed for *CMA CGM Florida*'s officers, particularly those of Chinese and Filipino nationalities, to have been negatively influenced by the master's relaxed management style. [2.7.1]

3. *CMA CGM Florida*'s master's confidence in the value of following the collision checklist would have been enhanced had he been more familiar with it. [2.7.2]

4. Most emergency drills conducted on *CMA CGM Florida* did not provide for a practical simulation of actions required by the muster list and the relevant emergency checklist, contrary to CMA CGM's SMS requirement for emergency drills to be as realistic as possible. [2.7.2]

5. In using AIS priority and the multiple AIS target list on the port radar, *CMA CGM Florida*'s Filipino OOW was encouraged to focus on those vessels with the smallest CPA or range at the expense of maintaining a more strategic overview of the traffic situation. [2.9.1]

6. The MCA's MGN 324 (M+F) no longer reflects the equipment currently fitted to vessels and is in need of revision to include guidance on the use of AIS-integrated radar displays. [2.9.2]

SECTION 4 - ACTION TAKEN

CMA CGM International Shipping Company PTE Ltd has:

1. Informed the company's fleet of the accident, highlighting contravention of the COLREGS and VHF radio use for collision avoidance.

2. Completed a review of the company's SMS documentation and has made numerous changes and enhancements to its documents and procedures. The updated system will be re-launched as the company 'Safety, Security and Environmental Management System' (SSEMS) on 1 May 2014[11].

3. Formulated the following amendments to its company navigation, watchkeeping and recruitment procedures:

    - Introduced a two stage deck officer skills training programme. Stage 1 includes COLREGS testing, passage planning and simulator training which is completed by all new officers on joining the company. All existing officers are required to complete this training prior to boarding their next vessel. Stage 2 requires the master to observe and validate the officers' skills at key stages following an officer joining the vessel, and is further intended to assist masters with monitoring and improving officer performance.

    - Introduced sea trainers to carry out OOW training (including training in company procedures and COLREGS) on board ship and to carry out appraisals of its officers while at sea.

    - Introduced a new procedure that states its requirements for minimum safe passing distances, manoeuvring limits and provides for a default 'calling the master limit' that is required to be included by its masters in their standing orders.

    - Provided warning to its masters and officers regarding the danger of VHF radio use for collision avoidance, and highlighted that misunderstanding may arise. Furthermore it has required that any VHF radio communication utilises English Standard Marine Communication Phrases (SMCP).

    - Highlighted the limitations of AIS, provided guidance to masters and deck officers regarding radar settings, and required that AIS information is not used for collision avoidance.

    - Revised its guidance regarding watch handovers, detailing specific items which must be discussed, including traffic situations.

[11] Although the new SSEMS will be launched on 1 May 2014, the MAIB acknowledges that all amendments as listed at 3 are now in force, and have been fully implemented.

Sincere Navigation Corporation has:

1. Highlighted its watchkeeping standard requirements to its recruitment agencies.

2. Carried out an internal safety investigation into the circumstances of the accident and provided a circular to its fleet, outlining the following requirements (summarised and extracted):

    - It is paramount important all collision avoiding actions must be in conformance with COLREG. VHF communication is only a kind of consensus between two ships and should not violate any regulations of COLREG. [sic]

    - Before taking avoiding action, watchkeepers shall use all available means such as VHF radio, ARPA, radar, AIS and visual observation to determine appropriate action... If circumstances permit, the give-way vessel must take the avoiding action before 6 miles, and the stand-on vessel must take the avoiding action before 3 miles.

    - The watchkeeper is to call the master if in any doubt and to sound five or more short blasts on the whistle/flashes by signal lamp.

    - Watchkeepers are to be familiar with the vessel's characteristics and the operation of all navigational equipment on board… including use of guard zones and trial manoeuvres as necessary.

    - Specific guidance on action to be taken in restricted visibility, highlighting the absence of stand-on/give-way vessels in such conditions.

    - Rules 5 – 10, 34 and 15 – 17 of the COLREGS for vessels in sight of each other and approaching so as to involve a risk of collision.

    - A minimum CPA of 1 mile is required when radar is being used to ascertain risk of collision.

    - Masters are to take every opportunity to carry out practical training on collision avoidance with watchkeepers.

SECTION 5 - RECOMMENDATIONS

CMA CGM International Shipping Company PTE Ltd is recommended to:

2014/114 Take appropriate measures to ensure:

1. Its company shipboard policies and procedures are adhered to.
2. Its masters recognise the importance of engaging with and motivating crew in the safe and efficient management of its vessels.

Sincere Navigation Corporation is recommended to:

2014/115 Review and amend its SMS requirements and verification procedures as necessary to ensure that:

1. OOWs recognise the dangers of using VHF radio for collision avoidance and that it should not normally be used for that purpose, in accordance with the advice provided in the ICS's Bridge Procedures Guide.
2. Its masters are empowered to provide in their standing orders their own specific metrics as to when they should be called by the OOW.

The **International Chamber of Shipping** is recommended to:

2014/116 Update its Bridge Procedures Guide to highlight the danger of limiting overall situational awareness through over-reliance on radar functions that focus on and prioritise AIS target CPA and TCPA.

The **Maritime and Coastguard Agency** is recommended to:

2014/117 Update Appendix IV of MGN 324 (M+F) to:

1. Acknowledge the growing trend of integrating AIS data with radar systems.
2. Acknowledge the increased availability and use of radar functions that focus on and prioritise targets for collision avoidance on the basis of AIS target CPA and TCPA rather than radar target tracking information.
3. Warn of the danger of limiting situational awareness through over-reliance on radar functions that focus on and prioritise AIS target CPA and TCPA.

Safety recommendations shall in no case create a presumption of blame or liability

Annex A

Extracts from the International Regulations for Preventing Collisions at Sea

Rule 2

Responsibility

(a) Nothing in these Rules shall exonerate any vessel, or the owner, master or crew thereof, from the consequences of any neglect to comply with these Rules or of the neglect of any precaution which may be required by the ordinary practice of seamen, or by the special circumstances of the case.

(b) In construing and complying with these Rules due regard shall be had to all dangers of navigation and collision and to any special circumstances, including the limitations of the vessels involved, which may make a departure from these Rules necessary to avoid immediate danger.

Rule 8

Action to avoid collision

(a} Any action taken to avoid collision shall be taken in accordance with the Rules of this Part and shall, if the circumstances of the case admit, be positive, made in ample time and with due regard to the observance of good seamanship.

(b) Any alteration of course and/or speed to avoid collision shall, if the circumstances of the case admit, be large enough to be readily apparent to another vessel observing visually or by radar; a succession of small alterations of course and/or speed should be avoided.

(c) If there is sufficient sea-room, alteration of course alone may be the most effective action to avoid a dose-quarters situation provided that it is made in good time, is substantial and does not result in another dose-quarters situation.

(d) Action taken to avoid collision with another vessel shall be such as to result in passing at a safe distance. The effectiveness of the action shall be carefully checked until the other vessel is finally past and clear.

(e) If necessary to avoid collision or allow more time to assess the situation, a vessel shall slacken her speed or take all way off by stopping or reversing her means of propulsion.

(f) (i) A vessel which, by any of these Rules, is required not to impede the passage or safe passage of another vessel shall, when required by the circumstances of the case, take early action to allow sufficient sea-room for the safe passage of the other vessel.

(ii) A vessel required not to impede the passage or safe passage of another vessel is not relieved of this obligation if approaching the other vessel so as to involve risk of collision and shall, when taking action, have full regard to the action which may be required by the Rules of this Part.

(iii) A vessel the passage of which is not to be impeded remains fully obliged to comply with the Rules of this Part when the two vessels are approaching one another so as to involve risk of collision.

Rule 13

Overtaking

(a) Notwithstanding anything contained in the Rules of Part B, Sections I and II, any vessel overtaking any other shall keep out of the way of the vessel being overtaken.

(b) A vessel shall be deemed to be overtaking when coming up with another vessel from a direction more than 22.5 degrees abaft her beam, that is, in such a position with reference to the vessel she is overtaking, that at night she would be able to see only the stern light of that vessel but neither of her sidelights.

(c) When a vessel is in any doubt as to whether she is overtaking another, she shall assume that this is the case and act accordingly.

(d) Any subsequent alteration of the bearing between the two vessels shall not make the overtaking vessel a crossing vessel within the meaning of these Rules or relieve her of the duty of keeping clear of the overtaken vessel until she is finally past and clear.

Rule 15

Crossing situation

When two power-driven vessels are crossing so as to involve risk of collision, the vessel which has the other on her own starboard side shall keep out of the way and shall, if the circumstances of the case admit, avoid crossing ahead of the other vessel.

Rule 16

Action by give-way vessel

Every vessel which is directed to keep out of the way of another vessel shall, so far as possible, take early and substantial action to keep well clear.

Rule 17

Action by stand-on vessel

(a) (i) Where one of two vessels is to keep out of the way the other shall keep her course and speed.

(ii) The latter vessel may however take action to avoid collision by her manoeuvre alone, as soon as it becomes apparent to her that the vessel required to keep out of the way is not taking appropriate action in compliance with these Rules.

(b) When, from any cause, the vessel required to keep her course and speed finds herself so close that collision cannot be avoided by the action of the give-way vessel alone, she shall take such action as will best aid to avoid collision.

(c) A power-driven vessel which takes action in a crossing situation in accordance with sub-paragraph (a)(ii) of this Rule to avoid collision with another power-driven vessel shall, if the circumstances of the case admit, not alter course to port for a vessel on her own port side.

(d) This Rule does not relieve the give-way vessel of her obligation to keep out of the way.

Rule 34

Manoeuvring and warning signals

(a) When vessels are in sight of one another, a power-driven vessel underway, when manoeuvring as authorized or required by these Rules, shall indicate that manoeuvre by the following signals on her whistle:

- one short blast to mean "I am altering my course to starboard";

-two short blasts to mean "I am altering my course to port";

- three short blasts *to* mean "I am operating astern propulsion".

(b) Any vessel may supplement the whistle signals prescribed in paragraph (a) of this Rule by light signals, repeated as appropriate, whilst the manoeuvre is being carried out:

(i) these light signals shall have the following significance-one flash to mean "I am altering my course to starboard";

- two flashes to mean "I am altering my course to port";

- three flashes to mean "I am operating astern propulsion";

(ii) the duration of each flash shall be about one second, the interval between flashes shall be about one second, and the interval between successive signals shall be not less than ten seconds;

(iii) the light used for this signal shall, if fitted, be an all-round white light, visible at a minimum range of 5 miles, and shall comply with the provisions of Annex I to these Regulations.

(c) When in sight of one another in a narrow channel or fairway:

(i) a vessel intending to overtake another shall in compliance with Rule 9(e)(i) indicate her intention by the following signals on her whistle:

- two prolonged blasts followed by one short blast to mean "I intend to overtake you on your starboard side";

- two prolonged blasts followed by two short blasts to mean "I intend to overtake you on your port side".

(ii) the vessel about to be overtaken when acting in accordance with Rule 9(e)(i) shall indicate her agreement by the following signal on her whistle:

- one prolonged, one short, one prolonged and one short blast, in that order.

(d) When vessels in sight of one another are approaching each other and from any cause either vessel fails to understand the intentions or actions of the other, or is in doubt whether sufficient action is being taken by the other to avoid collision, the vessel in doubt shall immediately indicate such doubt by giving at least five short and rapid blasts on the whistle. Such signal may be supplemented by a light signal of at least five short and rapid flashes.

(e) A vessel nearing a bend or an area of a channel or fairway where other vessels may be obscured by an intervening obstruction shall sound one prolonged blast. Such signal shall be answered with a prolonged blast by any approaching vessel that may be within hearing around the bend or behind the intervening obstruction.

(f) If whistles are fitted on a vessel at a distance apart of more than 100 metres, one whistle only shall be used for giving manoeuvring and warning signals.

Annex B

MGN 324(M+F) - Radio: Operational Guidance on the Use of VHF Radio and Automatic Identification Systems (AIS) at Sea

MARINE GUIDANCE NOTE

MGN 324 (M+F)

Radio: Operational Guidance on the Use Of VHF Radio and Automatic Identification Systems (AIS) at Sea

Notice to all Owners, Masters, Officers and Pilots of Merchant Ships, Owners and Skippers of Fishing Vessels and Owners of Yachts and Pleasure Craft.

This notice replaces Marine Guidance Notes MGN 22, 167 & 277

Summary

Given the continuing number of casualties where the misuse of VHF radio has been established as a contributory factor it has been decided to re-issue the MCA Operational Guidance Notes on the use of VHF Radio. It has also been decided to include operational guidance notes for AIS equipment on board ship formerly contained in Marine Guidance Notice 277.

Key Points

- The use of marine VHF equipment must be in accordance with the International Telecommunications Union (ITU) Radio Regulations.
- Although the use of VHF radio may be justified on occasion as a collision avoidance aid, the provisions of the Collision Regulations should remain uppermost
- There is no provision in the Collision Regulations for the use of AIS information therefore decisions should be taken based primarily on visual and/or radar information.
- IMO Guidelines on VHF Communication Techniques are given in Appendix I
- Typical VHF ranges and a Table of Transmitting frequencies in the Band 156 - 174 MHz for Stations in the Maritime Mobile Service is shown at Appendix II
- IMO Guidelines for the Onboard Operational Use of Shipborne Automatic Identification Systems (AIS) is shown in Appendix III
- MCA Guidance on the use of AIS in Navigation together with a list of MCA AIS base stations is shown in Appendix IV.

1. The International Maritime Organisation (IMO) has noted with concern the widespread misuse of VHF channels at sea especially the distress, safety and calling Channels 16 (156.8 MHz) and 70 (156.525 MHz), and channels used for port operations, ship movement services and reporting systems. Although VHF at sea makes an important contribution to navigation safety, its misuse causes serious interference and, in itself, becomes a danger to safety at sea. IMO has asked Member Governments to ensure that VHF channels are used correctly.

2. All users of marine VHF on United Kingdom vessels, and all other vessels in United Kingdom territorial waters and harbours, are therefore reminded, in conformance with international and national legislation, marine VHF apparatus may only be used in accordance with the International Telecommunications Union's (ITU) Radio Regulations. These Regulations specifically prescribe that:

(a) Channel 16 may only be used for distress, urgency and very brief safety communications and for calling to establish other communications which should then be concluded on a suitable working channel;

(b) Channel 70 may only be used for Digital Selective Calling not oral communication;

(c) On VHF channels allocated to port operations or ship movement services such as VTS, the only messages permitted are restricted to those relating to operational handling, the movement and the safety of ships and to the safety of persons;

(d) All signals must be preceded by an identification, for example the vessel's name or callsign;

(e) The service of every VHF radio telephone station must be controlled by an operator holding a certificate issued or recognised by the station's controlling administration. This is usually the country of registration, if the vessel is registered. Providing the Station is so controlled, other persons besides the holder of the certificate may use the equipment.

3. Appendix I to this notice contains the IMO Guidance on the use of VHF at sea. Masters, Skippers and Owners must ensure that VHF channels are used in accordance with this guidance.

4. Appendix II to this notice illustrates typical VHF ranges and a table of transmitting Frequencies in the Band 156 – 174 MHz for Stations in the Maritime Mobile Service, incorporating changes agreed by the 1997 World Radio Conference.

5. Channels 6, 8, 72 and 77 have been made available, in UK waters, for routine ship-to-ship communications, Masters, Skippers and Owners are urged to ensure that all ship-to-ship communications working in these waters is confined to these channels, selecting the channel most appropriate in the local conditions at the time.

6. Channel 13 is designated for use on a worldwide basis as a navigation safety communication channel, primarily for intership navigation safety communications. It may also be used for the ship movement and port services.

Use of VHF as Collision Avoidance Aid

7. There have been a significant number of collisions where subsequent investigation has found that at some stage before impact, one or both parties were using VHF radio in an attempt to avoid collision. The use of VHF radio in these circumstances is not always helpful and may even prove to be dangerous.

8. At night, in restricted visibility or when there are more than two vessels in the vicinity, the need for positive identification is essential but this can rarely be guaranteed. Uncertainties can arise over the identification of vessels and the interpretation of messages received. Even where positive identification has been achieved there is still the possibility of a misunderstanding due to language difficulties however fluent the parties concerned might be in the language being used. An imprecise or ambiguously expressed message could have serious consequences.

9. Valuable time can be wasted whilst mariners on vessels approaching each other try to make contact on VHF radio instead of complying with the Collision Regulations. There is the further danger that even if contact and identification is achieved and no difficulties over the language of communication or message content arise, a course of action might still be chosen that does not comply with the Collision Regulations. This may lead to the collision it was intended to prevent.

10. In 1995, the judge in a collision case said "It is very probable that the use of VHF radio for conversation between these ships was a contributory cause of this collision, if only because it distracted the officers on watch from paying careful attention to their radar. I must repeat, in the hope that it will achieve some publicity, what I have said on previous occasions that any attempt to use VHF to agree the manner of passing is fraught with the danger of misunderstanding. Marine Superintendents would be well advised to prohibit such use of VHF radio and to instruct their officers to comply with the Collision Regulations."

11. In a case published in 2002 one of two vessels, approaching each other in fog, used the VHF radio to call for a red to red (port to port) passing. The call was acknowledged by the other vessel but unfortunately, due to the command of English on the calling vessel, what the caller intended was a green to green (starboard to starboard) passing. The actions were not effectively monitored by either of the vessels and collision followed.

12. Again in a case published in 2006 one of two vessels, approaching one another to involve a close quarter's situation, agreed to a starboard to starboard passing arrangement with a person on board another, unidentified ship, but not the approaching vessel. Furthermore, the passing agreement required one of the vessels to make an alteration of course, contrary to the requirements of the applicable Rule in the COLREGS. Had the vessel agreed to a passing arrangement requiring her to manoeuvre in compliance with the COLREGS, the ships would have passed clear, despite the misidentification of ships on the VHF radio. Unfortunately by the time both vessels realised that the ships had turned towards each other the distance between them had further reduced to the extent that the last minute avoiding action taken by both ships was unable to prevent a collision.

13. Although the practice of using VHF radio as a collision avoidance aid may be resorted to on occasion, for example in pilotage waters, the risks described in this note should be clearly understood and the Collision Regulations complied with.

Use of VHF Automatic Identification Systems (AIS)

14. AIS operates primarily on two dedicated VHF channels (AIS1 – 161.975 MHz and AIS2 – 162.025 MHz). Where these channels are not available regionally, the AIS is capable of automatically switching to alternate designated channels. AIS has now been installed on the majority of commercial vessels, and has the potential to make a significant contribution to safety. However the mariner should treat the AIS information with caution, noting the following important points:

15. Mariners on craft fitted with AIS should be aware that the AIS will be transmitting own-ship data to other vessels and shore stations.

To this end they are advised to:

15.1 initiate action to correct improper installation;

15.2 ensure the correct information on the vessel's identity, position, and movements (including voyage-specific, see Annex IV) is transmitted; and

15.3 ensure that the AIS is turned on, at least within 100 nautical miles of the coastline of the United Kingdom.

16. The simplest means of checking whether own-ship is transmitting correct information on identity, position and movements is by contacting other vessels or shore stations. Increasingly, UK Coastguard and port authorities are being equipped as AIS shore base stations. As more shore base stations are established, AIS may be used to provide a monitoring system in conjunction with Vessel Traffic Services and Ship Reporting (SOLAS Chapter V, Regulations 11 and 12 refer).

17. Many ship owners have opted for the least-cost AIS installation to meet the mandatory carriage requirement. By doing so, many of the benefits offered by graphic display (especially AIS on radar) are not realised with the 3-line 'Minimum Keyboard Display' (MKD).

18. The Pilot Connector Socket and suitable power outlet should be located somewhere of practical use to a marine pilot who may carry compatible AIS equipment. This should be somewhere close to the wheelhouse main conning position. Less accessible locations in chart rooms, at the after end of the wheelhouse are not recommended.

19. The routine updating of data into the AIS, at the start of the voyage and whenever changes occur, should be included in the navigating officer's checklist and include:

-ship's draught;
-hazardous cargo;
-destination and ETA;
-route plan (way points);
-correct navigational status;
-short safety-related messages.

20. The quality and reliability of position data obtained from targets will vary depending on the accuracy of the transmitting vessel's GNSS equipment. It should be noted that older GNSS equipment may not produce Course Over Ground and Speed Over Ground (COG/SOG) data to the same accuracy as newer equipment.

21. Operational guidance for Automatic Identification Systems (AIS) on board ships can be found in the MCA Guidance on the Safety of Navigation - Implementing SOLAS Chapter V (accessible from the MCA website at www.mcga.gov.uk) and reproduced in Appendix IV of this notice.

More Information

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APPENDIX I

GUIDANCE ON THE USE OF VHF AT SEA

(Extract from: IMO Resolution A.954 (23). Proper use of VHF Channels at Sea (Adopted on 5th December 2003))

1. VHF COMMUNICATION TECHNIQUE

1.1 Preparation
Before transmitting, think about the subjects which have to be communicated and, if necessary, prepare written notes to avoid unnecessary interruptions and ensure that no valuable time is wasted on a busy channel.

1.2 Listening
Listen before commencing to transmit to make certain that the channel is not already in use. This will avoid unnecessary and irritating interference.

1.3 Discipline

(a) VHF equipment should be used correctly and in accordance with the Radio Regulations. The following in particular should be avoided:
(b) calling on channel 16 for purposes other than distress, and very brief safety communications, when another calling channel is available;
(c) non - essential transmissions, e.g. needless and superfluous signals and correspondence;
(d) communications not related to safety and navigation on port operation channels; communication on channel 70 other than for Digital Selective Calling;
(e) occupation of one particular channel under poor conditions;
(f) transmitting without correct identification;
(g) use of offensive language.

1.4 Repetition
Repetition of words and phrases should be avoided unless specifically requested by the receiving station.

1.5 Power reduction
When possible, the lowest transmitter power necessary for satisfactory communication should be used.

1.6 Automatic identification system (AIS)
AIS is used for the exchange of data in ship-to-ship communications and also in communication with shore facilities. The purpose of AIS is to help identify vessels, assist in target tracking, simplify information exchange and provide additional information to assist situational awareness. AIS may be used together with VHF voice communications.

AIS should be operated in accordance with Resolution A.917 (22) as amended by Resolution A.956 (23) on Guidelines for the onboard operation use of shipborne automatic identification systems.

1.7 Communications with coast stations
On VHF channels allocated to port operations service, the only messages permitted are restricted to those relating to the operational handling, the movement and safety of ships and, in emergency, to the safety of persons, as the use of these channels for ship-to-ship communications may cause serious interference to communications related to the movement and safety of shipping in port areas.

Instructions given on communication matters by shore stations should be obeyed.

Communications should be carried out on the channel indicated by the shore station. When a change of channel is requested, this should be acknowledged by the ship.

On receiving instructions from a shore station to stop transmitting, no further communications should be made until otherwise notified (the shore station may be receiving distress or safety messages and any other transmissions could cause interference).

1.8 Communications with other ships
VHF Channel 13 is designated by the Radio Regulations for bridge to bridge communications. The ship called may indicate another working channel on which further transmissions should take place. The calling ship should acknowledge acceptance before changing channels.

The listening procedure outlined above should be followed before communications are commenced on the chosen channel.

1.9 Distress communications
Distress calls/messages have absolute priority over all other communications. When heard, all other transmissions should cease and a listening watch should be kept.

Any distress call/message should be recorded in the ship's log and passed to the master.

On receipt of a distress message, if in the vicinity, immediately acknowledge receipt. If not in the vicinity, allow a short interval of time to elapse before acknowledging receipt of the message in order to permit ships nearer to the distress to do so.

1.10 Calling
In accordance with the radio regulations Channel 16 may only be used for distress, urgency and very brief safety communications and for calling to establish other communications which should then be conducted on a suitable working channel.

Whenever possible, a working frequency should be used for calling. If a working frequency is not available, Channel 16 may be used, provided it is not occupied by a distress call/message.

In case of difficulty to establish contact with a ship or shore station, allow adequate time before repeating the call. Do not occupy the channel unnecessarily and try another channel.

1.11 Changing channels
If communications on a channel are unsatisfactory, indicate change of channel and await confirmation.

1.12 Spelling
If spelling becomes necessary use the spelling table contained in the International Code of Signals and the radio regulations and the IMO Standard Marine Communication Phrases (SMCP)

1.13 Addressing
The words "I" and "You" should be used prudently. Indicate to whom they refer.
Example of good practice:
"Seaship, this is Port Radar, Port Radar, do you have a pilot?"
"Port Radar, this is Seaship, I do have a pilot."

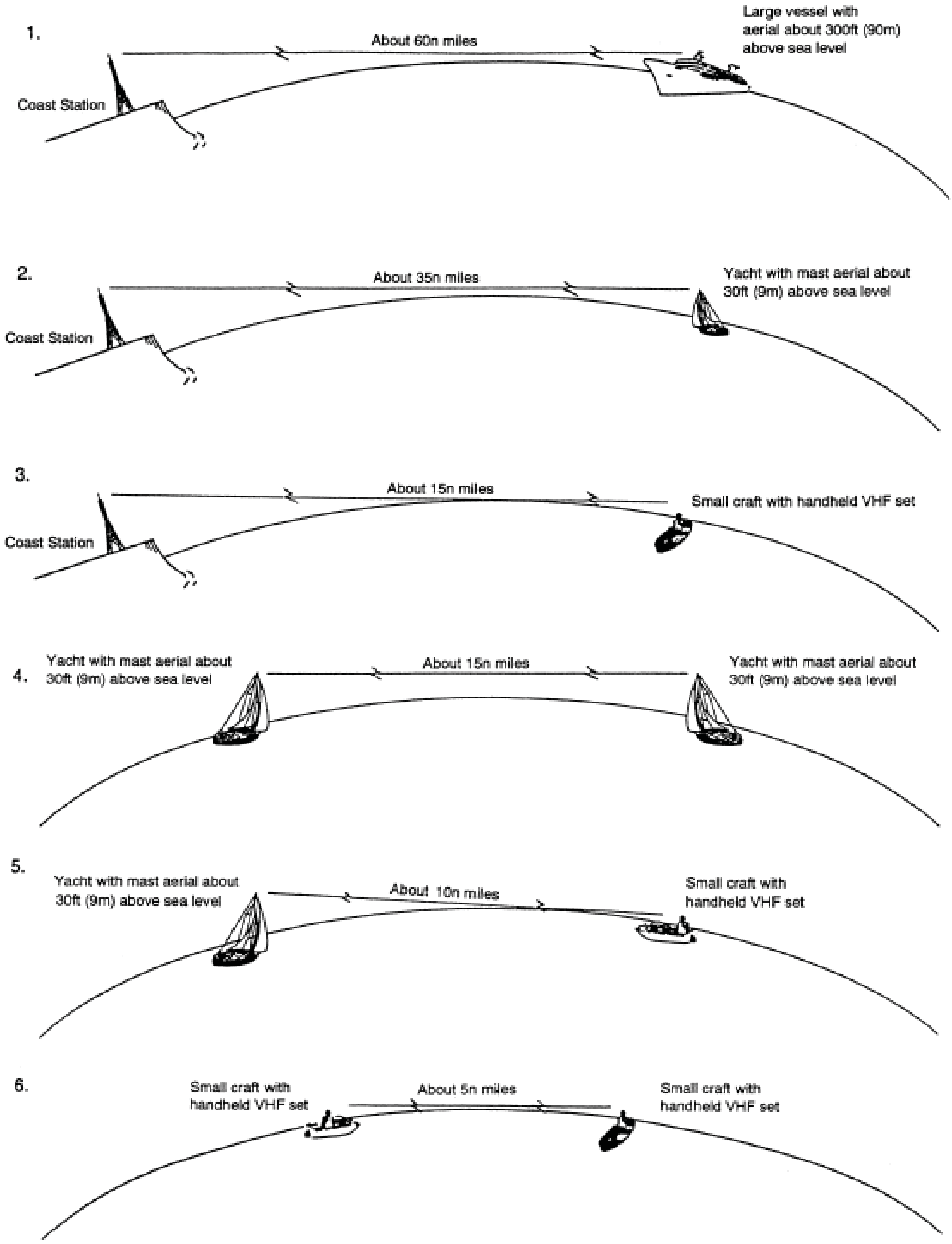
1.14 Watchkeeping
Every ship, while at sea, is required to maintain watches. Continuous watch keeping is required on VHF DSC Channel 70 and also when practicable, a continuous listening watch on VHF Channel 16.

In certain cases Governments may require ships to keep a watch on other channels.

APPENDIX II

TYPICAL VHF RANGES

(Extract from Admiralty List of Radio Signals Volume 5 published by the United Kingdom Hydrographic Office)



It should be noted that the fact that a transmitter and receiver are within radio sight does not automatically guarantee that an acceptable signal will be received at that point. This will depend, amongst other things on the power of transmission, the sensitivity of the receiver and the quality and position of the transmitting and receiving aerials. The range may also be affected to some degree by the pressure, temperature and humidity of the air between the transmitter and receiver.

Table of Transmitting Frequencies in the VHF maritime mobile band

(Extract from Admiralty List of Radio Signals Volume 5 published by the United Kingdom Hydrographic Office)

Channel designators	Notes	Transmitting frequencies (MHz)		Inter Ship	Port operations and ship movement		Public correspon-dence
		Ship stations	Coast stations		Single frequency	Two frequency	
60		156 025	160 625			X	x
01		156 050	160 650			X	x
61	*m), o)*	156 075	160 675		x	X	x
02	*m), o)*	156 100	160 700		x	X	x
62	*m), o)*	156 125	160 725		x	X	x
03	*m), o)*	156 150	160 750		x	X	x
63	*m), o)*	156 175	160 775		x	X	x
04	*m), o)*	156 200	160 800		x	X	x
64	*m), o)*	156 225	160 825		x	X	x
05	*m), o)*	156 250	160 850		x	X	x
65	*m), o)*	156 275	160 875		x	X	x
06	*f)*	156 300		x			
66		156 325	160 925			X	x
07		156 350	160 950			X	x
67	*h)*	156 375	156 375	x	x		
08		156 400		x			
68		156 425	156 425		x		
09	*i)*	156 450	156 450	x	x		
69		156 475	156 475	x	x		
10	*h)*	156 500	156 500	x	x		
70	*j)*	156 525	156 525	**Digital selective calling for Distress, Safety and Calling**			
11		156 550	156 550		x		
71		156 575	156 575		x		
12		156 600	156 600		x		
72	*i)*	156 625		x			
13	*k)*	156 650	156 650	x	x		
73	*h), i)*	156 675	156 675	x	x		
14		156 700	156 700		x		
74		156 725	156 725		x		
15	*g)*	156 750	156 750	x	x		
75	*n)*	156 775			x		
16		156 800	156 800	**Distress, Safety and Calling**			
76	*n)*	156 825			x		
17	*g)*	156 850	156 850	x	x		
77		156 875		x			
18	*m)*	156 900	161 500		x	X	x
78		156 925	161 525			X	x

Continued on next page

Channel designators		Notes	Transmitting frequencies (MHz)		Inter Ship	Port operations and ship movement		Public correspon-dence
			Ship stations	Coast stations		Single frequency	Two frequency	
19			156 950	161 550			x	x
	79		156 975	161 575			x	x
20			157 000	161 600			x	x
	80		157 025	161 625			x	x
21			157 050	161 650			x	x
	81		157 075	161 675			x	x
22		*m)*	157 100	161 700		x	x	x
	82	*m), o)*	157 125	161 725		x	x	x
23		*m), o)*	157 150	161 750		x	x	x
	83	*m), o)*	157 175	161 775		x	x	x
24		*m), o)*	157 200	161 800		x	x	x
	84	*m), o)*	157 225	161 825		x	x	x
25		*m), o)*	157 250	161 850		x	x	x
	85	*m), o)*	157 275	161 875		x	x	x
26		*m), o)*	157 300	161 900		x	x	x
	86	*m), o)*	157 325	161 925		x	x	x
27			157 350	161 950			x	x
	87		157 375	161 975		x		
28			157 400	162 000			x	x
	88	*h)*	157 425			x		
AIS 1		*l)*	161 975	161 975				
AIS 2		*l)*	162 025	162 025				

Note—For assistance in understanding the Table, see notes *a)* to *o)*

General notes

a) Administrations may designate frequencies for the following purposes, intership, port operations and ship movement services for use by light aircraft and helicopters to communicate with ships or participating coast stations in predominantly maritime support operations. However, the use of the channels which are shared with public correspondence shall be subject to prior agreement between interested and affected administrations.

b) The channels in this table, with the exception of Channels 06, 13, 15, 16, 17, 70, 75 and 76, **may** also be used for high-speed data and facsimile transmissions, subject to special arrangement between interested and affected administrations.

c) The channels in this table, but **preferably** Channel 28 and with the exception of Channels 06, 13, 15, 16, 17, 70, 75 and 76, may be used for direct-printing telegraphy and data transmission, subject to special arrangement between interested and affected administrations.

d) The frequencies in this table may also be used for radiocommunications on inland waterways.

e) Administrations having an urgent need to reduce local congestion may apply 12·5 kHz Channel interleaving on a non-interference basis to 25 kHz channels, provided:

— Recommendation ITU-R M.1084-2 shall be taken into account when changing to 12·5 kHz Channels;
— it shall not affect the 25 kHz Channels of the Appendix 18 maritime mobile distress and safety frequencies, especially the Channels 06, 13, 15, 16, 17, and 70, nor the technical characteristics mentioned in Recommendation ITU-R M.489-2 for those channels;
— implementation of 12·5 kHz channel interleaving and consequential national requirements shall be subject to prior agreement between the implementing administrations and administrations whose ship stations or services may be affected.

Specific notes

f) The frequency 156·300 MHz (Channel 06) **may** also be used for communication between ship stations and aircraft stations engaged in co-ordinated search and rescue operations. Ship stations shall avoid harmful interference to such communications on Channel 06 as well as to communications between aircraft stations, ice-breakers and assisted ships during ice seasons.

g) Channels 15 and 17 may also be used for on-board communications provided the effective radiated power does not exceed 1 W, and subject to the national regulations of the administration concerned when these channels are used in its territorial waters.

h) Within the European Maritime Area and in Canada, these frequencies (Channels 10, 67 & 73) may also be used, if so required, by the individual administrations concerned, for communication between ship stations, aircraft stations and participating land stations engaged in co-ordinated search and rescue and anti-pollution operations in local areas.

i) The preferred first three frequencies for the purpose indicated in note a) are 156·450 MHz (Channel 09), 156·625 MHz (Channel 72) and 156·675 MHz (channel 73).

j) Channel 70 is to be used exclusively for digital selective calling for distress, safety and calling.

k) Channel 13 is designated for use on a worldwide basis as a navigation safety communication channel, primarily for intership navigation safety communications. It may also be used for the ship movement and port operations service subject to the national regulations of the administrations concerned.

l) These Channels (AIS 1 and AIS 2) will be used for an automatic ship identification and surveillance system capable of providing worldwide operation on high seas, unless other frequencies are designated on a regional basis for this purpose.

m) These Channels (18 and 82 to 86) may be operated as single frequency channels, subject to special arrangement between interested or affected administrations.

n) The use of these Channels (75 and 76) should be restricted to navigation-related communications only and all precautions should be taken to avoid harmful interference to Channel 16, e.g. by limiting the output power to 1 W or by means of geographical separation.

o) These channels may be used to provide bands for initial testing and the possible future introduction of new technologies, subject to special arrangement between interested or affected administrations. Stations using these channels or bands for the testing and the possible future introduction of new technologies shall not cause harmful interference to, and shall not claim protection from, other stations operating in accordance with ITU Radio Regulations / Volume 1 / Chapter SII - Frequencies / Article S5 / Frequency allocations.

OPERATION OF AIS ON BOARD

(Extract from IMO Resolution A.917. (22). Guidelines for the onboard operational use of shipborne Automatic Identification Systems (AIS) (Adopted on 29th November 2001). As amended by Resolution A.956. (23). (Adopted 5th December 2003).

INHERENT LIMITATIONS OF AIS

31. The officer of the watch (OOW) should always be aware that other ships, in particular leisure craft, fishing boats and warships, and some coastal shore stations including Vessel Traffic Service (VTS) centres, might not be fitted with AIS.
32. The OOW should always be aware that other ships fitted with AIS as a mandatory carriage requirement might switch off AIS under certain circumstances by professional judgement of the master.
33. In other words, the information given by the AIS may not be a complete picture of the situation around the ship.
34. The users must be aware that transmission of erroneous information implies a risk to other ships as well as their own. The users remain responsible for all information entered into the system and the information added by the sensors.
35. The accuracy of the information received is only as good as the accuracy of the AIS information transmitted.
36. The OOW should be aware that poorly configured or calibrated ship sensors (position, speed and heading sensors) might lead to incorrect information being transmitted. Incorrect information about one ship displayed on the bridge of another could be dangerously confusing.
37. If no sensor is installed or if the sensor (e.g. the gyro) fails to provide data, the AIS automatically transmits the 'not available' data value. However the built in integrity check cannot validate the contents of the data processed by the AIS.
38. It would not be prudent for the OOW to assume that the information received from the other ship is of a comparable quality and accuracy to that which might be available on own ship.

USE OF AIS IN COLLISION AVOIDANCE SITUATIONS

39. The potential of AIS as an anti collision device is recognised and AIS may be recommended as such a device in due time.
40. Nevertheless, AIS information may be used to assist collision avoidance decision making. When using the AIS in the ship to ship mode for anti collision purposes, the following precautionary points should be borne in mind:
    a. AIS is an additional source of navigational information. It does not replace, but supports, navigational systems such as radar target tracking and VTS; and
    b. The use of AIS does not negate the responsibility of the OOW to comply at all times with the Collision Regulations
41. The user should not rely on AIS as the sole information system, but should make use of all safety relevant information available
42. The use of AIS on board ship is not intended to have any special impact on the composition of the navigational watch, which should be determined in accordance with the STCW Convention.
43. Once a ship has been detected, AIS can assist tracking it as a target. By monitoring the information broadcast by that target, its actions can also be monitored. Changes in heading and course are, for example, immediately apparent, and many of the problems common to tracking targets by radar, namely clutter, target swap as ships pass close by and target loss following a fast manoeuvre, do not affect AIS. AIS can also assist in the identification of targets, by name or call sign and by ship type and navigational status.

USE OF AIS IN NAVIGATION

(Extract from MCA Guidance on the Safety of Navigation – Implementing SOLAS Chapter V)

1. AIS is designed to be able to provide additional information to existing Radar or ECDIS displays. Until the optimum display modes have been fully evaluated and decided upon internationally, AIS will comprise “stand alone” units without integration to other displays.

2. AIS will provide identification of targets together with the static and dynamic information listed in the IMO Guidelines paragraph.12. Mariners should, however, use this information with caution noting the following important points:

a.) Collision avoidance must be carried out in strict compliance with the COLREGs. There is no provision in the COLREGs for use of AIS information therefore decisions should be taken based primarily on visual and / or radar information.

b.) The use of VHF to discuss actions to take between approaching ships is fraught with danger and still discouraged. (See above). The MCA’s view is that identification of a target by AIS does not remove the danger. Decisions on collision avoidance should be made strictly according to the COLREGs.

c.) Not all ships will be fitted with AIS, particularly small craft and fishing boats. Other floating objects which may give a radar echo will not be detected by AIS.

d.) AIS positions are derived from the target’s GNSS position. (GNSS = Global Navigation Satellite System, usually GPS). This may not coincide exactly with the target.

e.) Faulty data input to AIS could lead to incorrect or misleading information being displayed on other vessels. Mariners should remember that information derived from radar plots relies solely upon data measured by the own-ship’s radar and provides an accurate measurement of the target’s relative course and speed, which is the most important factor in deciding upon action to avoid collision. Existing ships of less than 500 gt. which are not required to fit a gyro compass are unlikely to transmit heading information.

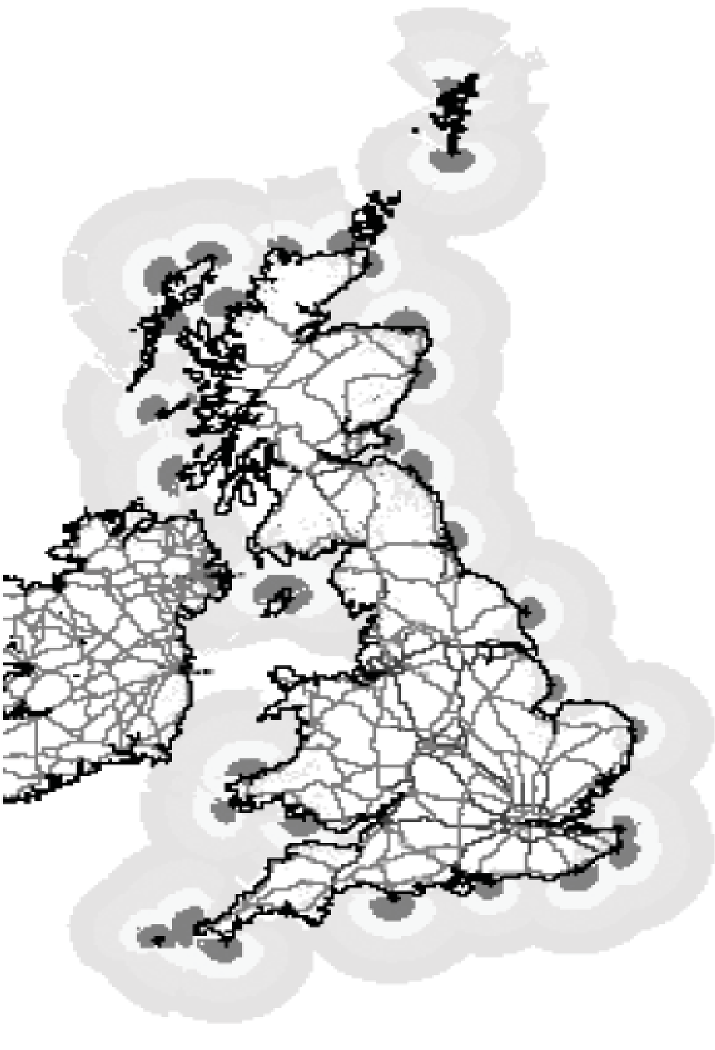
f.) A future development of AIS is the ability to provide synthetic AIS targets and virtual navigation marks enabling coastal authorities to provide an AIS symbol on the display in any position. Mariners should bear in mind that this ability could lead to the appearance of “virtual” AIS targets and therefore take particular care when an AIS target is not complemented by a radar target. AIS will sometimes be able to detect targets which are in a radar shadow area.

The MCA has established an Automatic Identification System (AIS) network in accordance with SOLAS Chapter V Regulation 19 and the European Traffic Monitoring Directive 2002/59/EC for base station transponders. The AIS network consists of base stations located as shown in the table on page 15.

The AIS Network is defined to operate within IMO guidelines and will be capable of receiving all message types and in particular AIS message type 5: Ship Static and Voyage related data, provided as 6 minute intervals in accordance with ITU R M. 1371-1. This automated procedure will enable identification and tracking of suitably equipped vessels without further intervention from either the vessel's crew or Coastguard personnel.

Areas Covered

The diagram below provides an indication of the areas covered by the AIS Network (Although the prediction indicates no coverage in the Southern Irish Sea, the trial to date has shown the area is covered).



MCA District	Base Station	Latitude			Longitude			AIS
		Degrees	Minutes	N / S	Degrees	Minutes	W / E	MMSI
Aberdeen	Dunnett Head	58	40.313	N	3	22.491	W	002320722
	Durness	58	34.000	N	4	44.500	W	002320720
	Gregness	57	7.643	N	2	3.136	W	002320721
	Noss Head	58	28.750	N	3	2.972	W	002320723
	Rosemarkie	57	37.900	N	4	4.800	W	002320719
	Windy Head	57	38.924	N	2	14.590	W	002320718
Belfast	Limavady	55	6.712	N	6	53.390	W	002320709
	Orlock Head	54	40.416	N	5	34.966	W	002320708
Brixham	East Prawle	50	13.200	N	3	42.500	W	002320710
Clyde	Glengorm	56	37.917	N	6	7.885	W	002320714
	Kilchairan	55	45.900	N	6	27.200	W	002320711
	Law Hill	55	41.800	N	4	50.500	W	002320712
	Pulpitt Hill	56	24.300	N	5	29.000	W	002320713
	South Knapdale	55	55.100	N	5	27.600	W	002320717
	Tiree	56	30.238	N	6	57.776	W	002320716
Dover	Fairlight	50	52.300	N	0	38.100	E	002320715
	MRCC Dover	51	7.800	N	1	20.200	E	002320705
	North Foreland	51	22.300	N	1	26.900	E	002320706
Falmouth	Lands End	50	8.068	N	5	38.096	W	002320704
	Lizard Point	49	57.821	N	5	12.396	W	002320733
	Scillies	49	55.710	N	6	18.180	W	002320734
Forth	Inverbervie	56	51.200	N	2	15.700	W	002320735
	MRSC Forth	56	16.731	N	2	35.380	W	002320732
	St. Abbs Crosslaw	55	54.455	N	2	12.295	W	002320741
Holyhead	South Stack	53	18.600	N	4	41.000	W	002320776
Humber	Cullercoats	55	4.374	N	1	27.799	W	002320775
	Flamborough Head	54	7.848	N	0	5.205	W	002320766
	Whitby	54	29.000	N	0	36.000	W	002320778
Liverpool	MRSC Liverpool	53	29.800	N	3	3.200	W	002320777
	Snaefell	54	15.829	N	4	27.596	W	002320770
Milford	Dinas	52	0.300	N	4	53.700	W	002320774
	St. Anns Head	51	40.950	N	5	10.500	W	002320781
Portland	The Grove	50	32.885	N	2	25.098	W	002320763
Shetland	Collafirth Hill	60	32.040	N	1	23.352	W	002320771
	Compass Head	59	52.066	N	1	16.318	W	002320772
	Saxa Vord	60	49.600	N	0	50.600	W	002320764
	Wideford Hill	58	59.300	N	3	1.400	W	002320765
Solent	Needles	50	39.700	N	1	34.600	W	002320779
	Newhaven	50	46.800	N	0	3.000	E	002320773
	Selsey	50	43.788	N	0	48.141	W	002320780
Stornoway	Butt of Lewis	58	27.683	N	6	13.851	W	002320769
	Forsnaval	58	12.801	N	7	0.499	W	002320768
	Melvaig	57	50.542	N	5	46.883	W	002320767
	Rodel	57	44.900	N	6	57.500	W	002320764
Swansea	Hartland Point	51	1.795	N	4	31.300	W	002320765
	Mumbles Hill	51	34.200	N	3	59.100	W	002320779
	Severn Bridge (2)	51	36.400	N	2	37.800	W	002320773
Thames	MRSC Thames	51	51.271	N	1	16.908	E	002320780
Yarmouth	Langham	52	56.600	N	0	57.200	E	002320769
	MRCC Yarmouth	52	36.300	N	0	42.500	E	002320768
	Skegness	53	8.916	N	0	20.784	E	002320767

Annex C

“Effects of national culture on human failures in container shipping: The moderating role of Confucian dynamism”

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Effects of national culture on human failures in container shipping: The moderating role of Confucian dynamism

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ABSTRACT

Recent reports on work safety in container shipping operations highlight high frequencies of human failures. In this study, we empirically examine the effects of seafarers' perceptions of national culture on the occurrence of human failures affecting work safety in shipping operations. We develop a model adopting Hofstede's national culture construct, which comprises five dimensions, namely power distance, collectivism/individualism, uncertainty avoidance, masculinity/femininity, and Confucian dynamism. We then formulate research hypotheses from theory and test the hypotheses using survey data collected from 608 seafarers who work on global container carriers. Using a point scale for evaluating seafarers' perception of the five national culture dimensions, we find that Filipino seafarers score highest on collectivism, whereas Chinese and Taiwanese seafarers score highest on Confucian dynamism, followed by collectivism, masculinity, power distance, and uncertainty avoidance. The results also indicate that Taiwanese seafarers have a propensity for uncertainty avoidance and masculinity, whereas Filipino seafarers lean more towards power distance, masculinity, and collectivism, which are consistent with the findings of Hofstede and Bond (1988). The results suggest that there will be fewer human failures in container shipping operations when power distance is low, and collectivism and uncertainty avoidance are high. Specifically, this study finds that Confucian dynamism plays an important moderating role as it affects the strength of associations between some national culture dimensions and human failures. Finally, we discuss our findings' contribution to the development of national culture theory and their managerial implications for reducing the occurrence of human failures in shipping operations.

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1. Introduction

Over the past three decades, there has been a significant change in the supply of seafarers for international shipping operations. A new system, called the "flag of convenience" (FOC), emerged and spread widely in the shipping industry. The FOC allows ship owners to change their ships' registers from a national flag (e.g., the US, the UK, Germany, or Japan) to an "open" flag (e.g., Liberia, Panama, or the Bahamas) to get round the constraints of national regulations in recruiting low-cost and competent labor worldwide (Winchester and Alderton, 2003; Wu and Morris, 2006). This system has led to a rapid decline in the supply of seafarers from traditional maritime places, e.g., North America, Western Europe, and Japan, and given rise to new seafarer supply countries in Asia and Eastern Europe, e.g., the Philippines, India, China, Myanmar, and Ukrainian (Lane, 2000; BIMCO/ISF, 2005). International ship owners have become accustomed to tapping the global labor market to recruit and retain qualified seafarers. For example, Håvold (2005) finds that Norwegian shipping companies employ seafarers from many countries and almost half of the total crews on board Norwegian registered vessels are foreigners. The popular nationalities of crew members on board vessels registered in Norwegian ship registers by the end of 1999 were Filipino (24.2%), Indian (5.2%), Polish (5.0%), and Russian (3.5%). The emergence of multinational crews drawn from different countries working on the same ship has important managerial implications for safety in international container ship operations (Wu and Morris, 2006).

Container shipping services are cargo transportation services provided by liner shipping companies whose cargo-carrying ships operate between scheduled, advertised ports of call on a regular basis (Lu et al., 2005; Lu, 2007; Brodie, 1994; Lun et al., 2009). Lu and Tsai (2010) observe that container shipping is one of the world's most dangerous occupations. The sea is a potentially hazardous and dangerous working environment (IMO, 2006). Hanson (1996)

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reports that fatal injuries and drowning among Danish seafarers were 11.5 times higher than the average rate among Danish male workforce ashore over 1986–1993. Roberts and Marlow (2005) conduct a study of 530 fatal accidents that occurred in the workplace in the UK between 1976 and 2002. They find that mortality accident in sea was 27.8 times higher than in the general workplace, suggesting that seafaring remains a hazardous occupation. According to UK Protection & Indemnity (P&I) Club (2005), the numbers of vessel accidents, hazardous incidents, and accidents to people on UK merchant vessels were reported as 319, 134, and 528, respectively, in 2004. A survey conducted by the International Maritime Organization (2005) reveals that 589 ships and 101 lives were lost in serious vessel accidents in 2004. Statistics from UK's P&I Club (2005) show that loss prevention claims made in recent years as a result of marine and port accidents attributable to human failures amount to approximately 53% of the total claims. Among the human failures, 21%, 16%, 11%, 4%, and 2% originate from deck officers, crew members, shore persons, pilots, and engineering officers, respectively. Human factors are major causes of accidents in sea transportation. For instance, previous studies have reported that between 60% and 90% of the accidents in sea or in air are attributable to "human factors" (Mars, 1996; MOTC, 2010; UK P&I Club, 2005).

Multiculturalism on board could be a factor influencing work safety on ships as cultural difference is very often considered a weakness in ship operations (Theotokas and Progoulake, 2007). Kahveci and Sampson (2001) observe problems related to mixed nationality crews on board among culturally diverse crews. A study examining the problems of Filipino seafarers finds that 34% of the Filipino seafarer respondents encounter communication problems, which are induced by differences in language, attitude, and culture manifested among crew members (Philippine National Maritime Polytechnic, 2002). In addition, Progoulake (2003) examines the impacts of multicultural crews on effective crew management and ship operations in Greek shipping companies.

A number of studies have suggested that safety culture or safety climate factors are associated with safety-related outcomes such as accidents or injuries (Glendon and Litherland, 2001; Håvold, 2005; Lu and Tsai, 2010; Mearns and Yule, 2008; Zohar, 1980). In the shipping context, Håvold (2005) confirms the importance of employee and management's attitude to safety and quality. Other studies have also found that employees' and management's attitude are the most important factor influencing work safety (e.g., Zohar, 1980; Flin et al., 2000). Furthermore, Lu and Tsai (2010) point out the importance of safety climate and its effect on safety behaviors.

As shipping is a global business, Håvold (2007) and Lu and Tsai (2010) argue that national culture influences how people behave with respect to safety matters. There is a relatively few research examining whether human failures are related to seafarers' perceptions of national culture dimensions in the container shipping context. Is national culture important for the occurrence of human failures? What are the key national culture dimensions in container shipping operations? How are they related to human failures? We attempt to answer these questions by examining the impact of national culture on work safety in container ship operations from the perspective of seafarers. Specifically, we seek to study the impact of national culture on work safety in container shipping operations by comparing the beliefs of seafarers from different national cultures. The findings will contribute to research on national culture theory and managerial practices of shipping operations.

Many researchers have proposed definitions and taxonomies of national culture (see, e.g., Hofstede, 1980, 1991; Child, 1981; Brislin, 1983; Triandis, 1994; Schein, 1985; Chow et al., 1999a). Among these, Hofstede's national cultural dimensions (1980, 1991) are one of the most widely used constructs in studies examining cultural effects. In recent years there has been recognition of a relationship between safety and national culture (Mearns and Yule, 2008; Helmreich and Merritt, 1998). Helmreich (1999) reveals that organizations need to recognize the influence of national cultural on the effectiveness of safety measures. Mearns and Yule (2008) examine the relationships between Hofstede's national cultural value dimensions, safety climate, and risk-taking behavior in the workforce of a multi-national engineering organization operating in six countries. While the antecedents to national culture have been widely discussed in the operations management literature, relatively little research except Theotokas and Progoulake (2007) and Håvold (2007) has been conducted on the relationship between work safety in shipping operations and national culture. Filling this research gap, we investigate in this study the influence of the major national culture dimensions on work safety in container shipping operations from the perspective of seafarers.

Based on Hofstede's (1991) national culture dimensions, which include power distance, uncertainty avoidance, individualism/collectivism, masculinity/femininity, and Confucian dynamism/long-term orientation, we construct a theoretical model and develop a set of hypotheses to guide this research. This paper is organized as follows: we introduce the study and discuss the background in the first section. We develop the research model and formulate the hypotheses in the second section. In the third section we discuss development of the research instrument, including the measurement constructs used in the survey, the sampling technique, and the research procedures. In sections four and five we present the statistical results from the exploratory factor analysis, confirmatory factor analysis, and hierarchical regression analysis performed to address the research issues. In the final section we draw conclusions from the research findings and discuss their academic and managerial implications.

2. Theory and research hypotheses

Previous cross-cultural studies on cultural effects have proposed definitions and taxonomies of national culture (Hofstede, 1980, 1991; Child, 1981; Brislin, 1983; Schein, 1985; Håvold, 2007; Burke et al., 2007; Theotokas and Progoulake, 2007). Consistent with the literature (Chinese Cultural Connection, 1987; Bochner, 1994; Chow et al., 1999b; Burke et al., 2007), the Hofstede's theoretical constructs of national culture have been extensively validated and widely used in research on ship operations (see, e.g., Håvold, 2007; Burke et al., 2007; Theotokas and Progoulake, 2007). We use Hofstede's construct to develop a research model to examine the effects of national culture on work safety in container shipping operations based on the perceptions of seafarers from China, the Philippines, and Taiwan.

Hofstede (1980, p. 25) defines national culture as "... the collective programming of the mind which distinguishes the members of one group or society from another ..." Hofstede uses the data collected by questionnaire surveys from 117,000 employees in a multinational corporation (IBM) and its subsidiaries in 71 countries to examine national cultural differences. In his original study, Hofstede (1980) identifies four national cultural dimensions, namely power distance, individualism/collectivism, uncertainty avoidance, and masculinity/femininity. In an attempt to link national culture with economic growth, Hofstede and Bond (1988) add the fifth dimension, Confucian dynamism/long-term orientation. In line with this stream of research, we adopt these five dimensions as the key national culture elements that may affect human failures in shipping operations in our research model (see Fig. 1). Some recent studies on the enhancement of work safety (Håvold, 2007; Burke et al., 2007; Theotokas and Progoulake, 2007) also adopt these theoretical dimensions of national culture. We elaborate on the five national culture dimensions in the following.

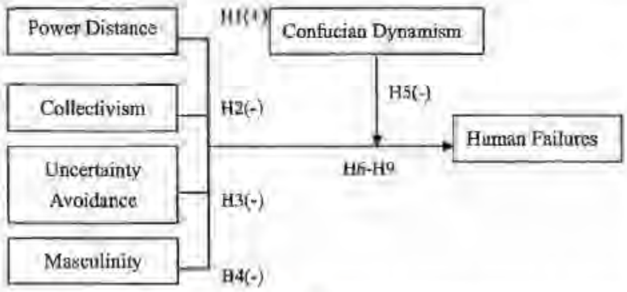

Fig. 1. The effects of national culture dimensions on human failures in container shipping operations.

2.1. Dimension 1: power distance

Power distance refers to the degree to which people accept interpersonal inequality in power and organizational institutionalization of such inequality (Hofstede, 1991). Hofstede suggests that people who possess high power distance tend to prefer, or at least are more willing to accept, greater centralization of decision-making authority and participate less in decision-making processes (Merchant et al., 1995). On the other hand, subordinates possessing low power distance consider themselves to have the same rights as their superiors, and they expect to be consulted and to participate in making decisions that affect them (Child, 1981; Hofstede, 1980; Chow et al., 1999b). The organizational hierarchy is perceived as a structure of inequality of roles and established for convenience among organizational members with interdependence between superiors and subordinates (Hofstede, 1983; Flynn and Saladin, 2006). The safety research conducted by Helmreich and Merritt (1998) and Merritt (1998) suggests that there is a link between national culture and work safety. Their studies also find that power distance is one of the most important national culture dimensions affecting work safety. Håvold (2007) examines the effect of national culture on work safety in a Norwegian shipping company. Similarly, he finds a negative relationship between power distance and seafarers' safety attitude and behavior. A vessel operates in an unstable operating environment, which is liable to vessel accidents or failures. To mitigate risk, it is crucial for crew members to report any potential risks to the master for responsive decisions. A low power distance culture is favorable for crews to report potential risk factors. Accordingly, we propose that:

H1. Lower power distance as experienced by seafarers helps reduce human failures in container shipping operations.

2.2. Dimension 2: collectivism/individualism

This national culture dimension refers to the degree to which people are oriented towards acting as individuals on one hand and part of a group on the other hand (Hofstede, 1980). In nations with a collectivist national culture, an organization is viewed like a family. People in collective societies achieve satisfaction in well-recognized jobs, striving to preserve face and avoid shame, so as not to bring disrespect to their peer group (Hofstede, 1980; Flynn and Saladin, 2006). In contrast, individualism refers to the degree to which individuals are integrated into social groups. Hofstede (1980) finds that societies with a high degree of individualism have loose ties among social members – everyone looks after their own interests and those of their immediate family. Typical individualistic countries are Canada, the UK, and the US, whereas societies experiencing less individualism include Iran, Japan, and Taiwan, where people hold group values and beliefs and pursue collective interests.

In the context of shipping, Håvold (2007) examines culture in a Norwegian shipping company and finds that the individualism/collectivism dimension from Hofstede's model of national culture is a factor influencing employees' attitudes towards work safety. According to Triandis (1994), cultural differences such as cultural complexity and tightness (i.e., the tolerance of little deviation from group norms) are key socio-cultural environmental factors influencing the individual system, which consists of the following variables: (1) perceptual selectivity, (2) cognitive patterns that emphasize comparison with a standard of excellence, (3) habits such as checking that a job has been done precisely as required by a blueprint, and (4) behavioral intentions such as asking for subordinates' advice. Individuals from individualistic countries determine personal standards on their own while individuals from collectivistic cultures are more likely to define their personal standards with reference to the group norm. Collectivism is a value that people in a society desire a close relationship with their in-groups and members of those in-groups. A collectivist culture includes a prominent emphasis on hierarchy, harmony, and saving face (Triandis et al., 1990). The shipping industry has some unique characteristics. For instance, the ship can be seen as a "closed" social milieu, where all the required competence is aboard. The official positions on a vessel can be divided into three different functional areas, i.e., deck, engine, and catering, with different competence requirements and assigned tasks (Håvold, 2007). Seafarers from the collective culture tend to follow the wishes, needs, and directions of others, rather than asserting their own impulses and predilections (Tafarodi et al., 1999). Chow et al. (2001) find that team members from the collectivist culture are significantly more satisfied with imposed, stretched safety performance standards as they show more concern for collective interests. Therefore, we argue that:

H2. Collectivism as experienced by seafarers helps reduce human failures in container shipping operations.

2.3. Dimension 3: uncertainty avoidance

Uncertainty avoidance focuses on how a society deals with unknown aspects of the future (Nakata and Sivakumar, 1996). Uncertainty avoidance is the degree to which the members of a society feel uncomfortable with uncertainty and ambiguity, which leads them to support beliefs promising certainty and to maintain institutional norms for protecting conformity (Hofstede, 1985, p. 347). People from the uncertainty-avoiding culture try to minimize the possibility of uncertainties by strict rules and regulations, by safety and security measures, and, on the philosophical and religious level, by a belief in absolute truth. Shackleton and Ali (1990) find that people from the uncertainty avoidance culture are strongly and positively associated with formalization and motivation to acquire information such that the uncertainty during interpersonal communication can be reduced. In the social context characterized by high uncertainty avoidance, people tend to avoid ambiguous situations and are more conscious of rules and procedures. They prefer clearly designated lines of authority and appear to be more emotional, active, fidgety, and aggressive. Alternatively, the uncertainty avoidance culture at a low level would lead people to explore ambiguous situations, where they are more open to change and rely on their own views to determine what they should do (Bird, 2000). People from the uncertainty-accepting culture are more tolerant of opinions different from what they are used to and they try to have as few rules as possible; on the philosophical and religious level, they are relativists and allow many ideas to flow side by side (Hofstede and McCrae, 2004).

The uniformity of container shipping provides a favorable setting to conduct research on national culture. Broadly speaking, all the vessels are operated on similar technologies and encounter the same set of hazards. Moreover, technical standards for all the vessels are regulated through the requirements of the International Maritime Organization (IMO) and vessels are required to be inspected by classification societies. Furthermore, the required competence of the crew is regulated by an international certificate system (e.g., Standards of Training Certification and Watchkeeping for seafarers) and the management systems of shipping companies have to satisfy identical requirements (e.g., the International Safety Management Code) (Håvold, 2007). Burke et al. (2007) report that uncertainty avoidance is an important factor influencing safety. Furthermore, Håvold (2007) finds that low power distance and high uncertainty avoidance are positively related to safety orientation in Norwegian shipping companies based on a correlation analysis. His findings show that seafarers from high uncertainty avoidance countries are more likely to follow orders and adhere to standard operating procedures. However, the links between national culture dimensions and work safety have not been validated. Thus, we hypothesize that:

H3. Uncertainty avoidance as experienced by seafarers helps reduce human failures in container shipping operations.

2.4. Dimension 4: masculinity/femininity

Masculinity is defined as "the degree to which a society is characterized by assertiveness (masculinity) versus nurturance (femininity)" (Hofstede, 1980; Nakata and Sivakumar, 1996). Masculinity refers to a preference for achievement, heroism, assertiveness, and material success, whereas femininity stands for a preference for relationships, modesty, caring for the weak groups, and quality of life (Hofstede, 1985). High masculine societies place a low value on caring for others, inclusion, cooperation, and solidarity. Cooperation is considered a sign of weakness. Career advancement, material success, and competition are paramount. Ringov and Zollo (2007) and Steensma et al. (2000) suggest that people from more masculine countries have a lower appreciation of cooperative strategies. Interestingly, there is evidence that low masculinity, as manifested in managerial attention to people and their interrelations, is conducive to work safety. Theotokas and Progoulake (2007) find that people-related aspects, such as good communication, team spirit, trust, and low conflict between seafarers, are associated with superior safety performance. Tice and Baumeister (2004) also find that high masculinity is negatively related to work safety (Håvold, 2007). Following this logic, it is reasonable to posit that a higher level of masculinity will have a positive impact on human failures in container shipping operations. Accordingly, we suggest that:

H4. Masculinity as experienced by seafarers helps increase human failures in container shipping operations.

2.5. Dimension 5: Confucian dynamism

Hofstede and Bond (1988) develop a fifth dimension of national culture, i.e., Confucian dynamism, based on a study of students in 22 countries around the world, using a questionnaire designed by Chinese scholars. Confucian dynamism at a low level implies a long-term orientation, which refers to the degree to which a culture focuses on the future (Bearden et al., 2006). People with a low level of Confucian dynamism are thrifty, hardworking, and persevering, while those with a high level of Confucian dynamism are respectful of tradition, fulfilling social obligations, and protecting one's face (Hofstede and McCrae, 2004). According to Nakata and Sivakumar (1996), the positive values of Confucian dynamism attributes include persistence, hard work, thrifty, shame, and regard for relationships. In the context of shipping, Håvold (2007) finds that there is a negative relationship between Confucian dynamism and safety orientation of seafarers on Norwegian-owned vessels based on Hofstede's original index. Several attributes of the Confucian dynamism such as face saving, shame, and respect for social status, are negatively related to work safety. Face is a ubiquitous concept and applicable in all cultures (Gudykunst et al., 1988). Face refers to the projection of self in a relational situation and, more specifically, it is the tension between a sense of threat from or consideration given to others and the claim of self-respect (Gudykunst and Nishida, 1993; Nakata and Sivakumar, 1996). Saving face involves preserving a person's dignity and social status. It is argued that an emphasis on the effects of certain actions or events on a person's own or another's reputation or status may have a negative impact on work safety (Nakata and Sivakumar, 1996). A potential risk may not be explored in advance when seafarers feel shame or respect the master's social status. Therefore, we postulate that:

H5. Confucian dynamism as experienced by seafarers helps reduce human failures in container shipping operations.

The study of Hofstede and Bond (1988) reveals five dimensions of national culture, four of which are correlated with Hofstede's (1984) indices of culture while the fifth is not. Bond (1987) interprets the fifth dimension of national culture (i.e., Confucian dynamism) as representing a range of Confucian-like values to explain the differences between Western and Eastern values. Accordingly, we seek to test the moderating effects of Confucian dynamism on the relationships between four of the national culture dimensions, namely power distance, individualism/collectivism, uncertainty avoidance, and masculinity/femininity, and human failures. In the context of shipping operations, seafarers would expect instructions from their supervisors and participate less in decision-making processes when they show social respect and status obligations. We suggest that seafarers who are from a high Confucian dynamism national culture, the strength of the relationship between power distance and human failures in container shipping operations is enhanced. Therefore, we propose the following moderation hypothesis:

H6. Confucian dynamism strengthens the relationship between power distance and human failures in container shipping operations; specifically, high power distance will foster human failures as experienced by seafarers in container shipping operations when Confucian dynamism is high rather than low.

In addition, this study proposes that Confucian dynamism positively influences human failures in container shipping. The Confucian dynamism culture attaches more importance to stability by saving "face", respecting tradition, and reciprocating greetings (Hofstede and Bond, 1988). Face is threatened when a person feels disregarded due to criticisms or questions of ability from others. These attributes are particularly relevant to the collectivism culture and will have a greater long-term ethos towards relationships with colleagues and avoid chaos for organizational benefit. We suggest that when seafarers are from a high Confucian dynamism national culture, the relationship between collectivism and human failures in container shipping operations is enhanced. Therefore, we hypothesize that:

H7. Confucian dynamism weakens the relationship between collectivism and human failures in container shipping operations; specifically, high collectivism will lead to fewer human failures as experienced by seafarers in container shipping operations when Confucian dynamism is low rather than high.

An uncertainty avoidance culture suggests that individuals express a preference for long-term predictability of rules, work arrangements, relationships, and avoidance of risk taking, and that they expend more effort on planning to reduce uncertainty (Hofstede, 1984; Pressey and Selassie, 2006). Newman and Nollen (1996) point out that uncertainty is manifested in terms of clarity of plans, policies, procedures, rules, and systems. The attributes of the Confucian dynamism culture such as social respect, status obligation, and perseverance could help employees to follow rules and procedures and clearly designated lines of authority. Following this line of reasoning, for seafarers from a high Confucian dynamism national culture, the relationship between uncertainty avoidance and human failures in container shipping operations is strengthened. Therefore, we conjecture that:

H8. Confucian dynamism strengthens the relationship between uncertainty avoidance and human failures as experienced by seafarers in container shipping operations; specifically, high uncertainty avoidance will lead to fewer human failures in container shipping operations when Confucian dynamism is high rather than low.

The ship is a closed society. Crew members can be divided into different functional areas and organized in hierarchical command from the master downwards. Hence, formalization of tasks and team work are fundamental to shipping operations. Hofstede (1985) suggests that masculinity is a preference for achievement, heroism, assertiveness, and material success. People from a high masculine culture have a low attitude or behavior towards cooperating with others (Ringov and Zollo, 2007). This study argues that such attributes of Confucian dynamism as respect for tradition, fulfilling social obligations, and protecting one's face strengthen the relationship between masculinity and human failures in container shipping operations. Therefore, we suggest that:

H9. Confucian dynamism strengthens the relationship between masculinity and human failures in container shipping operations; specifically, high masculinity will lead to more human failures as experienced by seafarers in container shipping operations when Confucian dynamism is high rather than low.

3. Research methodology

3.1. Research sample

We obtained the data for this study by administering a questionnaire survey to seafarers working on 81 vessels from 13 top global container carriers. These container carriers are APM Maersk, APL/NOL, CMACGM, Hapag Lloyd, MSC, Yang Ming, Evergreen group, Wan Hai Line, K-line, NYK, MOL, Hanjin, and Hyundai Marine. These vessels are randomly selected at the Port of Kaohsiung in Taiwan. The Port of Kaohsiung, located in major trade routes – Eastern Asian coastal, Far East/Europe, and Transpacific service lines – has been ranked the top 12th largest container port in the world since 1980 (UNCTAD, 2008). The number of crews ranged from 15 to 20 people per vessel. There were in general 18 crew members in a container ship. Eighteen questionnaires were sent to each vessel ($N = 1458$), where the shipmaster was requested to distribute them to the entire crew. The first page of the questionnaire emphasizes that respondents are kept anonymous in our data reporting and analyses, and that their participation is voluntary. Once the questionnaire was completed, it was collected by the shipmaster and returned by DHL express. The data collection began at the start of March till the end of May 2008. We received completed questionnaires from 773 respondents from 13 countries took part in this study, but only in three countries we found more than 100 respondents, which included the Philippines (267), Taiwan (208), and China (133). We excluded small samples of respondents belonging to certain countries from our data analyses because they were far from being effectively representative of the study population. These respondents came from such countries as Myanmar (29), Korea (24), India (21), Russia (15), Ukraine (12), Japan (3), and others (59).

Table 1
Overview of sample size, response-rates based on the size of vessel.

Size of vessel (in TEUs)	Number of vessel	N	n	Response rate
Less than 1000	8	144	56	38.9
1001–2000	15	270	118	43.7
2001–3000	7	126	49	38.9
3001–5000	15	270	114	42.2
5001–6500	22	396	159	40.2
Greater than 6500	14	252	112	44.4
Total	81	1458	608	41.7

Note: $\chi^2 = 1.039$, degrees of freedom = 5, $p = 0.959$.

In statistics, stratified sampling is a useful method of sampling from a population when the researcher wants to study the characteristics of certain population subgroups (Cooper and Schindler, 2003). We stratified the study samples based on the size of vessel. Table 1 illustrates the categorization of size of vessel that answered the questionnaire. The response rate ranges from 38.9% to 44.4%, with an average response rate of 41.7%. Upon excluding small samples from certain countries and the 43 vessels that did not respond, we obtained 608 usable questionnaire returns from the survey for data analyses. The response rate is 27.7%. Håvold (2007) achieves around a 70% response rate; however, the participants in this research are different from those in his study. The sample in Håvold's (2007) study was stratified according to vessel type, which included dry cargo, tank, and passenger vessels, whereas this study specifically focuses on seafarers who work on container ships. In addition, small samples with fewer than 100 respondents were excluded for data analyses in this study. This might explain why the response rate of this study is lower than that of Håvold's (2007) study.

We performed a chi-square test to assess whether a sample of 608 respondents taken from a population is similar to that population in terms of its breakdown among six vessel size categories. As shown in Table 1, the variance is not significant ($\chi^2 = 1.039$, $df = 5$, $p > 0.05$). The results show that the distribution of frequencies based on the size of vessel in these samples is representative of the population distribution (Cooper and Schindler, 2003).

The respondents held different positions on the ships. Those working on the deck included masters, deck officers, and deck ratings, whereas those working in the engineering department included chief engineers, engineers, and engine ratings. They are members of teams responsible for performing ship operations. Thus, they are all working interdependently in a team responsible for work safety on the vessel. Nearly 44% of the respondents had been working on the ship for ten years. Most of the respondents (51%) were between 30 and 50 years' old. A majority of the respondents believed in Christianity (47.4%), followed by Buddhism (17.1%), and Taoism (5.1%). However, nearly 31% of the respondents did not indicate their religion.

3.2. Measures

We adapt the measurement items for evaluating national culture mainly from prior research (see Appendix A). We conducted preliminary exploratory field research via in-depth, descriptive case studies of national culture projects to gather contextual knowledge for developing the measurement scales. We developed or refined all of the measurement scales according to the input from experienced seafarers comprising captains, chief engineers, and ratings. In addition, we validated the resulting scales with field pilot tests to ascertain their content validity, as well as construct reliability and validity. Appendix A presents the final measurement items employed for evaluating national culture and human failures.

3.3. Independent variables

We assess power distance using three items adapted from Hofstede (1980, 2001) and Nakata and Sivakumar (1996) (see Table 2). A high agreement with these items indicates that low power distance is perceived because society accepts that power in institutions and organizations is distributed equally. Seafarers could feel free to express their opinions and are comfortable with the shipmaster. The Cronbach-alpha is 0.646. It should be noted that a Cronbach-alpha value below 0.5 will provide a basis for questioning the measurement items' internal consistence. For a larger number of items, a Cronbach-alpha value between 0.5 and 0.6 will be too low; however, for a smaller number of items in the range between two and four, the obtained value is acceptable for ensuring reliability (Menor and Roth, 2007; Nunnally, 1978).

We assess collectivism using four items adapted from Hofstede (2001) and Nakata and Sivakumar (1996) (see Table 2). A high agreement with these items indicates that seafarers' opinions tend to be consistent with those of others in their ship or group. Seafarers accord a high priority to the maintenance of harmonious group cooperating relationships. The item "I think cooperation with my colleagues is important" has two factor loadings greater than 0.5 and they are loaded on two factors. We removed this item due to a lack of interpretability of this solution. The Cronbach-alpha is 0.633.

We measure uncertainty avoidance using three items adapted from Hofstede (1980, 1994, 2001) and Nakata and Sivakumar (1996) (see Table 2). High scores on these items suggest that seafarers like to collect more information for planning and decision-making before taking actions. The Cronbach-alpha is 0.801.

We assess masculinity using four items, which are again developed from Hofstede (1980, 1994, 2001) and Nakata and Sivakumar (1996) (see Table 2). High scores on the masculinity items indicate that self-recognition and career development are important issues in this national culture dimension. The Cronbach-alpha is 0.590.

3.4. Moderating variable

We measure Confucian dynamism using five items adapted from Hofstede and Bond (1988), Nakata and Sivakumar (1996), and Bond (1987). High scores on these items suggest that seafarers perceive that social respect, social status, and perseverance are important issues. The Cronbach-alpha is 0.786.

3.5. Dependent variable

We use the annual number of individual human failures occurring on board to operationalize the dependent variable of human failures. It should be noted that the measures of human failures can be calculated at different levels (e.g., individual, unit (ship), and company). The numbers of human failures per ship and per company could be obtained from a designated person in the shipping company or the Port State Control Data from the port authority. However, this study aims to examine the effects of seafarers' perceptions of national culture on individual human failures. Crews within a ship may come from different countries. We conduct the analysis at the individual level.

The actual reported data on individual human failures are very sensitive and confidential to shipping companies or seafarers. Self-reporting of human failures and perceptions of safety can offer alternative measures for determining workplace safety performance (DeJoy, 1994; Janssens et al., 1995). Workers' perception of safety is considered to be a useful indicator of safety performance (Borman and Motowidlo, 1993). Accordingly, we asked respondents to indicate the number of human failures they experienced on board the year before the survey. We define human failures as any error occurring on board at the individual level concerning ship operations such as handling, ballasting, or machine operations; concerning navigation such as collision, contact, grounding, or stranding; and concerning inappropriate equipment usage in general.

The majority of past safety studies suggest that human error is the main cause of accidents. Nevertheless, this view has never been empirically validated with regard to its capacity to offer sound explanations for human error (Elslande and Fouquet, 2007). Hence, human failures in this study are not considered as causes of vessel accidents, but as a result of malfunctions in the driving system, which may occur in the system's components (seafarer/port/ship) and their defective interactions (misfit between components). Such a view seeks to extend "accident causation" analysis beyond causes of accidents to include the processes involved in accidents.

3.6. Control variables

We control for possible confounding effects by including various relevant control variables. We included the respondent's age, education level, and working experience in the regression models as control variables. Age is a commonly employed control to account for personal effects that may affect the hypothesized relationships. Education level reflects the degree to which respondents understand the different national cultures, whereas a long working experience suggests that the respondent has abundant experience to avoid human failures.

3.7. Validity of measurement

Since all the self-report measures of national cultural dimensions and human failures in this study are collected using the same survey instrument answered by a single respondent, there exists possibility of common method variance that could bias the findings when both independent and dependent measures are obtained from the same source. This study examines such a possibility by conducting Harman's single-factor test (Podsakoff and Organ, 1986). For the survey, several factors, as opposed to one single factor, emerge and the first factor does not account for the majority of the variance. Moreover, nearly 65% of the respondents have been working on board for five or more years. Most of the respondents are probably the most qualified people on board to provide information on human failures. Accordingly, a substantial amount of common method variance does not seem to be present in this study (Podsakoff and Organ, 1986).

3.8. Procedures

Håvold (2007) investigated the impact of national culture and safety orientation by using a questionnaire survey based on a study of seafarers working for Norwegian shipping companies. The shipping companies in his sample used either English or Norwegian as the working language. He therefore conducted his research in Norwegian and English. Accordingly, we develop the questionnaire for this study in both Chinese and English. The original version was in English, which was translated into an equivalent Chinese version. The questionnaire was then back translated into English. Similar to Håvold's (2007) study, we distributed the questionnaires to a contact person at each participating shipping company, which sent a package containing 18 questionnaires in English and Chinese to a container vessel. The package contained a letter addressed to the shipmaster on the vessel who would be responsible for handing out and collecting the questionnaires. We attached a DHL freight collected envelope in the package for use by the shipmaster to send

Table 2
Results of explanatory factor analysis with Varimax rotation (N = 608).

Item	Factor 1 PDI[a]	Factor 2 UNA	Factor 3 MAS	Factor 4 COL	Factor 5 CON
I always feel free to express my opinions.	0.783	0.084	−0.003	0.150	0.014
I think people are equal in my society.	0.709	−0.002	0.224	−0.140	0.243
I feel easy and comfortable with the supervisor.	0.681	0.065	0.101	0.323	0.107
I think clear and detailed organization rules are important.	0.050	0.806	0.048	−0.109	−0.061
I like to seek more information for making decisions.	0.039	0.842	0.024	0.003	−0.130
I like to have elaborate planning before taking actions.	0.036	0.822	0.019	0.010	−0.226
I like self-recognition.	0.135	−0.154	0.696	0.079	0.115
I think altruistic action is not important.	0.089	−0.046	0.616	0.381	0.077
I stress quality of life less than developing a career.	0.088	0.216	0.681	−0.076	0.046
Advancing career is more important than developing good relationships with co-workers.	−0.008	0.101	0.536	0.089	0.318
I like to be instructed by the supervisor	0.427	−0.045	0.081	0.601	0.030
I think respect for rules and regulations are important.	0.057	0.001	0.147	0.723	0.288
I think cooperating with colleagues is important.	0.072	−0.070	0.132	0.500	0.529
I think loyalty to organization is important.	0.056	−0.068	0.013	0.615	0.389
I prefer a long-term outlook than seeking immediate benefits.	0.117	−0.051	0.076	0.127	0.696
I respect social and status obligations within limits.	0.068	−0.087	0.139	0.212	0.741
I think perseverance is important in my life.	0.166	−0.092	0.057	0.191	0.746
I keep large savings and find opportunities to invest.	0.078	−0.152	0.042	0.153	0.597
I think having a sense of shame is important.	−0.046	−0.139	0.239	−0.005	0.670

Notes: PDI: power distance; UNA: uncertainty avoidance; MAS: masculinity; COL: collectivism; CON: Confucian dynamism.
[a] Measures for power distance are based on questions using a reverse scale.

the completed questionnaires directly back to us while the ship was calling at a port.

4. Analyses and results

4.1. National level analysis

Although the data on human failures on ships were collected from individuals, we performed the analysis at the national level in this study. An analysis at the national level requires aggregation of the individual responses (the independent variables) to the national level. Therefore, for each national group, we calculated the mean scores of power distance, collectivism, uncertainty avoidance, masculinity, and Confucian dynamism. Table 3 presents the descriptive statistics and correlations of the study variables. The means of the five national culture dimensions were obtained from the respondents based on their reported nationality. Comparisons of the mean scores show that Chinese and Taiwanese seafarers have their highest mean scores on Confucian dynamism, followed by collectivism, masculinity, power distance, and uncertainty avoidance. Filipino seafarers display the highest mean scores on collectivism. Uncertainty avoidance receives the lowest mean scores for all the three national groups. High bivariate correlation coefficients between the dimensions of national culture indicate high potential of multicollinearity among them, which is hardly surprising given that previous research has reported strong relationships among the dimensions of national culture (Hofstede, 2001; Flynn and Saladin, 2006).

4.2. Confirmatory factor analyses

We performed a confirmatory factor analysis (CFA) of the collected data to assess the convergent and discriminant validity of the measurement items. Table 3 presents the intercorrelations of the national culture dimensions. Examination of the patterns of item correlations and item-total correlations indicates that there are no deviations from the internal consistency and external consistency criteria suggested in the literature (Anderson and Gerbing, 1988). The CFA resulted in a $\chi^2 = 276.04$ ($p = 0.00$, $df = 109$). The CFA overall fit indices (GFI = 0.95, AGFI = 0.93, CFI = 0.94, and NFI = 0.90) all exceed the critical levels suggested in the literature (Bentler, 1980; Bentler and Bonett, 1980) and the standardized loadings are all significant. The CFA and reliability assessment suggest that the scales for the multi-item construct possess convergent validity. We examine discriminant validity by calculating the confidence intervals around the estimates of the inter-dimension correlations (i.e., Φ) (Anderson and Gerbing, 1988). If the confidence intervals do not contain the value of 1, discriminant validity is supported. Since none of the confidence intervals for the multi-items constructs contains the value of 1, we conclude that the national culture dimensions possess discriminant validity.

Despite that Cronbach-alphas below 0.70 are obtained on measures of low power distance and masculinity dimensions, there is considerable debate about the validity and reliability of Hofstede's cultural dimensions (Mearns and Yule, 2008). Nevertheless, for the data set of this study, our confirmatory factor analytical results find the Hofstede's five-factor solution an acceptable factor structure. Furthermore, the measure is sensitive enough to differentiate between different national groups on all cultural dimensions. For example, as shown in Table 3, the level of low power distance in the Filipino seafarer samples (mean = 3.77) is slightly higher than seafarers from China (mean = 3.36) and Taiwan (mean = 3.35). There is more variability in the collectivism scores: Taiwanese seafarers (mean = 3.88) are significantly less masculine than seafarers from China (mean = 3.92) and Philippine (mean = 4.02).

Table 3 also shows the scores of lower power distance, uncertainty avoidance, masculinity, collectivism, and Confucian dynamism for the different national groups of seafarers, which are consistent with Hofstede and Bond's (1988) scores (HB's). The results show that Taiwanese seafarers have a propensity for uncertainty avoidance and masculinity, whereas Filipino seafarers lean more towards power distance, masculinity, and collectivism.

To evaluate the perceived differences of national cultures between Chinese, Taiwanese, and Filipino seafarers, we performed one-way analysis of variance (ANOVA). The results reveal no statistically significant differences for masculinity dimension at the 5% significance level. When comparing differences in national cultural dimensions, we find that power distance, uncertain avoidance, collectivism, and Confucian dynamism dimensions differ significantly among Chinese, Taiwanese, and Filipino seafarers at the $p < 0.05$ significance level (see Table 4).

Table 3
Comparison of Hofstede and Bond's scores and this study and correlations at the national level of analysis.

	Chinese	Taiwanese	Filipino	1	2	3	4	5	6	7
1. Age[a]	1.67	2.86	2.05							
2. Edu[b]	1.81	1.82	2.02	−0.128***						
3. Exp[c]	1.80	3.10	2.39	0.820***	−0.094**					
4. Low power distance[d]	3.36	3.35	3.77	−0.038*	0.033*	−0.039*				
HB's score[h]	–	2.1	4.70							
5. Uncertainty avoidance	2.07	2.17	2.56	−0.005*	0.020*	0.010*	0.073*			
HB's score	–	1.55	2.80							
6. Masculinity	3.59	3.63	3.53	−0.010*	0.036*	−0.008*	0.300***	0.045*		
HB's score	–	2.75	3.2							
7. Collectivism	3.92	3.88	4.02	0.028*	0.043*	0.013*	0.385***	−0.119***	0.315***	
HB's score	–	4.15	3.40							
8. Confucian dynamism	4.20	4.07	3.98	0.049*	0.035*	0.039*	0.263***	−0.274***	0.366***	0.484***
HB's score	–	4.35	4.05							

[a] Measures for age are based on questions using an ordinal scale: 1 represents respondents less than 30 years old, 2 represents 31–40 years, 3 represents 41–50 years, 4 represents 51–60 year, whereas 5 represents more than 60 years old.
[b] Measures for the level of respondents' education are based on questions using an ordinal scale: 1 represents high school, 2 represents university/college, 3 represents masters' degree or above.
[c] Measures for the period of respondents' working experience are based on questions using an ordinal scale: 1 represents less than 5 years, 2 represents 6–10 years, 3 represents 11–15 years, 4 represents 16–20 years, whereas 5 represents more than 20 years.
[d] Measures for power distance are based on questions using a reverse scale.
[h] HB's score = Hofstede and Bond's (1988) score (Index/20).
* Significant at $p \leq 0.10$.
** Significant at $p \leq 0.05$.
*** Significant at $p \leq 0.01$.

4.3. Hierarchical regression analysis

We employ the hierarchical moderated regression analysis to test the hypotheses. We follow the variance partitioning procedures suggested in Cohen and Cohen (1983) and Jaccard et al. (1990). As shown in Table 4, we conducted the analysis in several steps. First, we entered the control variables such as respondent's age, education level, and years of working experience into the regression (Model 01A). Second, we entered the national culture variables into the regression as a block (Model 01B). Third, we entered the main effects of the Confucian dynamism moderator variables as a block (Model 01C). If the interactions between Confucian dynamism and the other four national culture variables are significant, then there is evidence to support that there is a significant moderating influence of Confucian dynamism on the given national culture variables. Prior to the creation of the interaction terms in Models 01C to 04C, we mean-center the independent variables to reduce the potential multicollinearity problem in regression analyses. Multicollinearity is a statistical phenomenon in which two or more independent variables in a multiple regression model are highly correlated. In other words, when two variables are highly correlated, they both convey essentially the same information (Aiken and West, 1991). Moreover, to examine multicollinearity, we calculate the variance inflation factors (VIF) for each of the regression equations. The maximum VIF within the models is 3.13, which is well below the rule-of-thumb cut-off value of 10 (Neter et al., 1990).

This study proposes that lower power distance as experienced by seafarers helps reduce human failures in container shipping operations in the first hypothesis. As can be seen in Table 5, Model 01B ($\beta = -0.17$, $p < 0.1$) and Model 04B ($\beta = -0.126$, $p < 0.01$) show that the coefficients for human failures are negative and significant for the Chinese and Total groups, respectively. However, Model 02B and Model 03B show that the coefficients for human failures are negative but not significant. Thus, hypothesis H1 is partially supported in these two groups.

Regarding the effects of high collectivism on human failures as we posit in H2, the results of Model 01B ($\beta = -0.283$, $p < 0.05$), Model 02B ($\beta = -0.254$, $p < 0.1$), and Model 04B ($\beta = -0.19$, $p < 0.01$) for the Chinese, Taiwanese, and Total groups, respectively, show that higher collectivism is associated with fewer human failures. The coefficients are negative and significant. However, the coefficient for the Filipino group in Model 03B is not significant. Similar to H1, hypothesis H2 is partially supported, too.

This study predicts the national culture dimension of uncertainty avoidance will have a negative influence on human failures. With the exception of Model 04B ($\beta = -0.084$, $p < 0.05$), the coefficients of Model 01B, Model 02B, and Model 03B for the Chinese, Taiwanese, and Filipino seafaring groups are negative but not significant, so H3 is not supported. As shown in Models 01B, 02B, 03B,

Table 4
Comparison of differences in respondents' perceptions of national culture based on nationality.

National cultural dimensions	Nationality						*F* ratio	Scheffe test
	China (1)		Taiwan (2)		Philippine (3)			
	Mean	S.D.	Mean	S.D.	Mean	S.D.		
Low power distance	3.36	0.80	3.35	0.80	3.77	0.61	25.53**	(1,3),(2,3)
Uncertainty avoidance	2.07	0.75	2.17	0.72	2.56	0.88	22.02**	(1,3),(2,3)
Masculinity	3.59	0.58	3.63	0.62	3.53	0.57	2.01	
Collectivism	3.92	0.59	3.88	0.60	4.02	0.46	3.89*	(2,3)
Confucian dynamism	4.20	0.45	4.07	0.59	3.98	0.41	9.16**	(1,3)

Note: Mean scores based on a 5-point scale (1 = strongly disagree, 5 = strongly agree); S.D. = standard deviation.
* Significance level $p < 0.05$.
** Significance level $p < 0.01$.

Table 5
Hierarchical regression analysis result (standardized β coefficients).

	Model 01 Chinese			Model 02 Taiwanese			Model 03 Filipino			Model 04 Total		
	Model 01A	Model 01B	Model 01C	Model 02A	Model 02B	Model 02C	Model 03A	Model 03B	Model 03C	Model 04A	Model 04B	Model 04C
Control variables												
Age	−0.165	−0.123	−0.129	−0.071	−0.052	−0.143	−0.012	0.014	0.010	0.044	0.040	−0.011
Education	0.006	0.029	0.046	0.121[c]	0.111	0.097	-0.001	0.005	0.007	0.056	0.064	0.060
Experience	0.090	0.026	0.042	−0.094	−0.089	−0.16	−0.083	−0.093	−0.077	−0.071	−0.069	−0.029
Main effects												
PDI[d]		−0.170[c]	−0.021		−0.103	−0.943[b]		−0.009	0.426		−0.129[a]	−0.376
COL		−0.283[b]	0.363		−0.254[c]	0.850[c]		−0.018	0.503		−0.190[a]	0.908[a]
UNA		−0.006	−0.484		−0.105	−0.003		−0.074	0.675[b]		−0.084[b]	0.036
MAS		0.084	0.076		−0.061	−0.375		−0.002	−0.145		0.022	−0.360
CON		0.194[c]	0.540		0.109	0.242		0.099	0.975[b]		0.084[c]	0.576[a]
Moderators												
PDI × CON			−0.159			1.152[c]			−0.564			0.311
COL × CON			−0.912			−1.784[b]			−0.917			−1.714[a]
UNA × CON			0.470			−0.089			−0.753[a]			−0.105
MAS × CON			−0.001			0.544			0.161			0.561
F for the regression	0.725	1.900[c]	1.388	2.894[b]	3.528[a]	3.154[a]	0.778	0.796	1.635[c]	0.995	5.329[a]	5.598[a]
R^2	0.017	0.112	0.126	0.043	0.130	0.170	0.009	0.025	0.073	0.005	0.068	0.104

[a] Significant at $p \leq 0.01$.
[b] Significant at $p \leq 0.05$.
[c] Significant at $p \leq 0.10$.
[d] Measures for power distance are based on questions using a reverse scale.

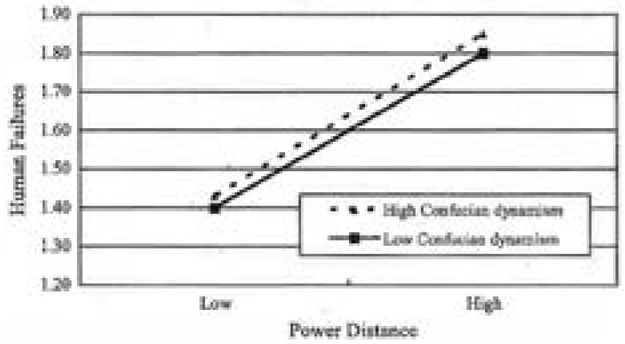

Fig. 2. The effect of power distance on human failures by the level of Confucian dynamism for Taiwanese seafarers.

and 04B, the coefficients for masculinity are not significant. Accordingly, hypothesis H4 that proposes a positive relationship between masculinity and human failures is not supported.

This study postulates the effects of Confucian dynamism on human failures. Results show that the coefficients of Model 01B ($\beta = 0.194$, $p < 0.1$) for the Chinese group and Model 04B ($\beta = 0.084$, $p < 0.01$) for the Total seafaring groups are positive and significant, contradicting the prediction of H5. Overall, these findings suggest that national culture partially influences human failures in the container shipping context.

Regarding the moderating effect of Confucian dynamism, in Model 02C for Taiwanese seafarers, the interaction between power distance and Confucian dynamism is positive and significant ($\beta = 1.152$, $p < 0.1$). To plot this interaction effect, we let Confucian dynamism take the values one standard deviation below (i.e., low level) and above (i.e., high level) the mean. Fig. 2 shows the plot of the interaction. Consistent with hypothesis H6, Fig. 2 shows a more positive relationship between power distance and human failures when Confucian dynamism is high. This reveals that seafarers possessing a high level of power distance are associated with more human failures when Confucian dynamism is high rather than low. However, as shown in Model 01 C, Model 03 C, and Model 04 C, the results indicate that the interaction between Confucian dynamism and power distance is not associated with reduced human failures. The coefficients of these models are not significant. Thus, hypothesis H6 is partially supported. In addition, as shown in Model 02C ($\beta = -1.784$, $p < 0.05$) and Model 04C ($\beta = -1.714$, $p < 0.01$) for the Taiwanese and Total seafaring groups, the coefficients for the interaction between collectivism and human failures are negative and significant as proposed by hypothesis H7. Consistent with the prediction of H7, the plots of this interaction in Figs. 3 and 4 show a less negative relationship between collectivism and human failures when Confucian dynamism is high. The figures also suggest that collectivism is associated with reduced human failures when

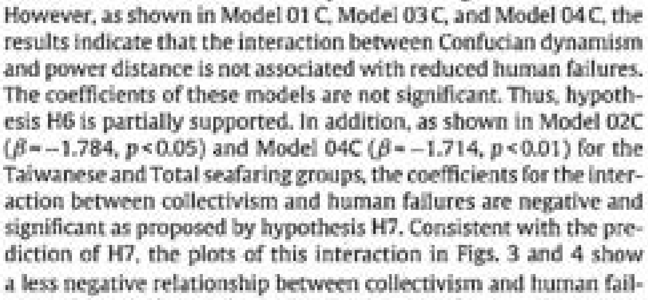

Fig. 3. The effect of collectivism on human failures by the level of Confucian dynamism for Taiwanese seafarers.

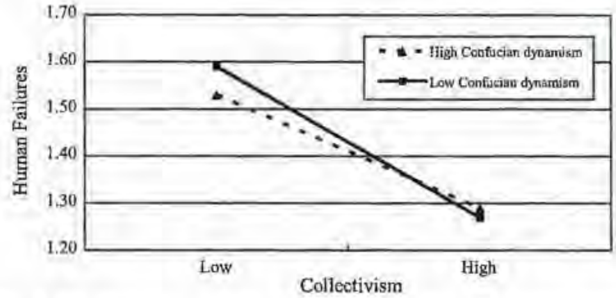

Fig. 4. The effect of collectivism on human failures by the level of Confucian dynamism for total seafarers.

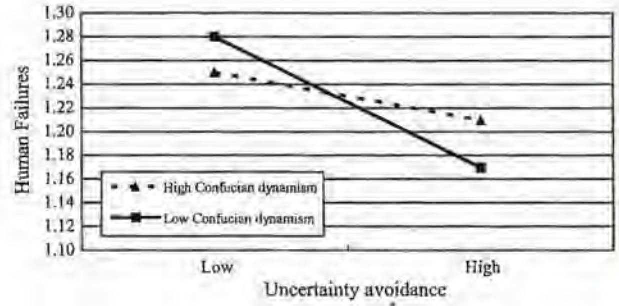

Fig. 5. The effect of uncertainty avoidance on human failures by the level of Confucian dynamism for Filipino seafarers.

Confucian dynamism is high rather than low. As shown in Model 03C ($\beta = -0.753$, $p < 0.01$) for the Filipino seafaring group, the interaction between uncertainty avoidance and Confucian dynamism is negative and significant. Thus, as plotted in Fig. 5, uncertainty avoidance is associated with fewer human failures when Confucian dynamism is high rather than low. Thus, hypothesis H8 is supported. However, Table 5 indicates that the coefficients for the interaction between masculinity and Confucian dynamism for all the seafaring groups are not significant, so hypothesis H9 is not supported.

5. Discussion and conclusion

Shipping is one of the most risky service industries. Although shipping companies attempt to assure work safety, they are not completely successful in eliminating human failures. We develop a theoretical model to explain the occurrence of human failures in the container shipping context and empirically validate the model. Theoretically, this study highlights the importance of national culture in explaining the occurrence of human failures on ships. We answer several important questions with regard to national culture in container shipping operations. First, what are seafarers' perceptions of national culture in the shipping context, and what are the perceived differences in the national culture dimensions between seafarers from China, the Philippines, and Taiwan? Second, our research illustrates how these dimensions influence the occurrence of human failures in the operations of vessels. In particular, this study examines and ascertains the moderating effect of Confucian dynamism on the relationships between national culture dimensions and human failures. To the best of our knowledge, this is the first study that provides empirical evidence on the importance of national culture in explaining human failures in work safety. More specifically, our study fills the gap in the literature that there is a void of studies explaining human failures from the perspective of national culture in container shipping operations.

5.1. Implications

Several implications can be made from the key findings of this study. First, national culture is of one of the important factors influencing human failures in ship operations affecting work safety that must be taken into consideration by shipping managers. Each dimension of national culture seems to be related to a different degree of human failures in ship operations. By understanding the differences in national culture, shipping managers and officers can develop effective action plans to reduce human failures in vessel management. This study finds that Filipino seafarers display the highest mean score on collectivism. This finding is consistent with those of Hofstede (1994) and Theotokas and Progoulake (2007). This implies that Filipinos are more group-oriented, which facilitates the development a more co-operative environment when working with seafarers from different cultures. Chinese and Taiwanese seafarers have the highest mean scores on Confucian dynamism, followed by collectivism, masculinity, power distance, and uncertainty avoidance. This finding is hardly surprising because the Chinese-based culture, prevalent in such countries/places as China, Hong Kong, Singapore, and Taiwan, is regarded as characterized by the Confucian culture (Chow et al., 1999a,b). The research findings of this study provide support for the beliefs that a high power distance society places a greater emphasis on hierarchy, and that there is an intense and pervasive emphasis on organizational hierarchy and face-saving in the Chinese-based culture.

The findings of this study also indicate that power distance and collectivism are negatively associated with human failures. These results suggest that low power distance might be good for work safety. The environment of shipping operations is dynamic. Thus, seafarers should report any factors influencing ship operations to the master to prevent accidents. Seafarers from a low power distance culture are inclined to participate in safety decision-making and report potential risk, so the risk could be avoided. Håvold (2007) finds that high power distance might be desirable for safety. He conducts a correlation analysis between Hofstede's (1980) original index, indexes derived from Hofstede's (1994) VSM model, and four "safety" factors including negative safety conditions at work and fatalism, positive safety conditions at work, attitude to safety improvements, and knowledge/competence. Håvold's (2007) study only confirms a significant statistical relationship between power distance and knowledge/competence; however, the effects of power distance on negative safety conditions at work and fatalism, safety conditions at work, and attitude to safety improvements are not found in his study. In addition, the "safety" factors used in Håvold's (2007) study seems belonging to a safety behavior/attitude related dimension. This study uses the number of individual human failures as a dependent variable. This might explain the differences between Håvold (2007) and this study.

More importantly, this study indicates that Confucian dynamism interacts with power distance, collectivism, uncertainty avoidance, and masculinity in their effects on human failures. An important finding of this study concerning Taiwanese seafarers is that low numbers of human failures occur when the power distance and Confucian dynamism are congruent with each other (see Fig. 2). Human failures also decrease for Taiwanese seafarers when Confucian dynamism is low and collectivism is high (see Fig. 3). This implies that in container shipping operations where seafarers possess lower power distance or Confucian dynamism, fewer human failures can be expected. Considering all the seafarers, the result also indicates that fewer human failures are associated with low Confucian dynamism and high collectivism (see Fig. 4). Another interesting result is that there are fewer human failures in container shipping where Filipino seafarers show high uncertainty avoidance, together with low Confucian dynamism (see Fig. 5). This result suggests that Filipino seafarers are not willing to take risk when they lack safety information. Thus, complete or clear information from the master or ship owner is very important. This may increase seafarers' motivation and efforts to prevent human failures. However, we find no effect of masculinity on human failures regardless of the level of Confucian dynamism.

5.2. Limitations and future research

We discuss various limitations of this study, which provide meaningful directions for future research on this topic. First, the collection of data on human failures and perceptions of national culture in container shipping may be subject to bias in terms of seafarers' willingness to report and respond. Seafarers may be reluctant to report human failures because of potential personal repercussions and an interest in avoiding lawsuits against the company. Second, this study is limited to five national culture dimensions based on the studies of Hofstede (1994, 2001), Hofstede and Bond (1988), as well as Nakata and Sivakumar (1996). While a majority of previous studies have suggested that safety culture or safety climate factors can predict safety issues (Zohar, 1980; Cox and Cheyne, 2000; Glendon and Litherland, 2001; Mearns and Yule, 2008; Lu and Tsai, 2010), future research could examine the linkages between safety culture or safety climate, national culture, and safety performance. Third, future research should seek to explain how the national culture dimensions influence individual behaviors or attitudes, particularly behaviors or attitude that may lead to human failures, and try to define the characteristics of such safety behaviors. In addition, it would be valuable to study the differences in national culture at the individual level (e.g., similar occupation status, race, and religion) versus using culture as a sociological, group-based construct (Bearden et al., 2006). Fourth, this research focuses specifically on seafarers from China, the Philippines, and Taiwan. It would be valuable to collect data from seafarers from other non-Asian countries to obtain a balanced view of the relationship between national culture and human failures in container shipping operations. Finally, this study specifically uses Hofstede's national culture dimensions as a theoretical framework for explaining seafarers' human failures. It should be noted that Hofstede's (1980) framework has been criticized on both empirical and theoretical grounds (Weber et al., 1996). Researchers may argue that national culture, in all its complexity, cannot be captured quantitatively and reduced to five variables. Others may criticize Hofstede's use of a single multinational corporation as a basis for his conclusions about national culture. Other criticisms include the compatibility of national culture and, its heterogeneity within any given country (Sivakumar and Nakata, 2001). Future studies may also be conducted by using the longitudinal approach to investigate the short- and long-term effects of national culture on container ship operations.

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Appendix A. Questionnaire

I. Personal Information

1. How old are you?

□ Less than 30 □ 31–40 □ 41–50 □ 51–60 □ More than 60 years' old

2. What is your nationality?

□ Chinese □ Greek □ Indian □ Iranian □ Italian □ Japanese

□ Korean □ Myanmarese □ Filipino □ Russian □ Taiwanese □ Turkish

□ UK □ Ukrainian □ Vietnamese □ Others (please specify):____________

3 What is your education?

□ High school □ University/College □ Master's degree or above □ Others:____________

4 Which is your religious extent?

□ Buddhism □ Christianity □ Islam □ Taoism □ Others:____________

5 How long have you worked on board ?

□ Less than 5 years □ 6–10 years □ 11–15 years □ 16–20 years

□ More than 20 years

II. Measures and items for evaluating national culture and human failures

National culture measures[a, b]:

Power distance
- I always feel free to express my opinions. (R)[c]
- I think people are equal in society. (R)
- I feel easy and comfortable with the supervisor. (R)

Uncertainty avoidance
- I think clear and detailed organization rules are important.
- I like to seek more information for making decisions.
- I like to have elaborate planning before taking actions.

Masculinity
- I like self-recognition.
- I think altruistic action is not important.
- I stress quality of life less than developing a career.
- Advancing career is more important than developing good relationships with co-workers.

Collectivism
- I like to be instructed by the supervisor
- I think respect for rules and regulations are important.
- I think cooperating with colleagues is important.
- I think loyalty to organization is important.

Confucian dynamism
- I prefer a long-term outlook than seeking immediate benefits.
- I respect social and status obligations within limits.
- I think perseverance is important in my life.
- I keep large savings and find opportunities to invest.
- I think having a sense of shame is important.

Human failures measures:
- How many operational failures did you experience (e.g., ship handling, ballasting, operating machines, equipment usage etc) on board last year? ______

Note:

a. All items are measured on a five-point scale, anchored by 1= strongly disagree and 5 = strongly agree.

b. Item deleted after exploratory factor analysis.

c. R indicates that a question uses a reverse scale.

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