Marine Safety Investigation Unit

Transport Malta

SAFETY INVESTIGATION REPORT

201202/006 REPORT NO.: 23/2012 December 2012

MT Haldoz
Cargo spill
In the port of Tarragona
03 February 2012

SUMMARY

The Maltese registered motor tanker *Haldoz* (Figure 1) arrived at Tarragona, Spain pilot station on 03 February 2012 at 0400 (LT). She eventually was alongside Terquimsa Terminal Pier No. 4 at about 0455 (LT).

Once the berthing operations were completed, the Terminal loading master and the cargo surveyor boarded the vessel for the routine safety checks together with the ship's officers.

Loading operations commenced at 0950 (LT), after the safety checks were formally completed. There were eight cargo parcels, which had to be loaded; four parcels of Styrene monomer and four parcels of Polyol.

About one hour into the cargo operations, the port emergency centre received a report of cargo pollution within the Terminal. Cargo operations were eventually suspended at 1105 (LT).

Emergency level was raised by the Terminal's emergency centre and several resources to mitigate the pollution. The Spanish authorities estimated that cargo spill was in the order of 100 metric tonnes.

Although MSIU has not established with utmost certainty the circumstances into the cargo spill, one recommendation was made both to the vessel's managers and Terminals intended to improve the cargo operations procedures.

Figure 1 – MT *Haldoz*

FACTUAL INFORMATION

Vessel

Haldoz, a 2603 GT Type 2 chemical /oil tanker[1] was built in 2008 and is registered in Malta. She is owned by YD Shipping Ltd., managed by Ayder Tanker A.S., Turkey and classed with Bureau Veritas. The vessel has an overall length of 92.86 m and a beam of 14.10 m.

The vessel's cargo tank area is divided into ten cargo oil tanks, arranged in five pairs (numbered 2 to 6) by means of longitudinal and transverse corrugated bulkheads. The total volumetric capacity Is 4085.29m^3. Tank no. 1 centre is designated as a slop tank and has a capacity of 119.60 m^3 (at 98% filling). A nitrogen generator is also fitted on board for inerting and padding purposes.

The cargo manifold system's design allows for six different cargo parcels to be loaded / unloaded simultaneously. Moreover, the same cargo can be loaded / unloaded to / from all cargo tanks by means of two common lines located forward and aft of the cargo manifold. Each pair of cargo tanks has common loading and unloading pipes and manifolds. Each cargo oil tank and slop tank has a separate electrical driven deepwell pump.

Discharge of Noxious Liquid Substances (NLS) Effluents

For the purpose of the controlled discharging of NLS effluents in accordance with the provisions of MARPOL Annex II, regulation 5, *Haldoz* is fitted with overboard discharges below the waterline and on either side of the vessel. The port and starboard overboard underwater discharge is fitted 40075 mm aft of the fore peak line between frames 70 and 71. The overboard discharges are fitted in way of the turn of bilge, about 1600 mm from the baseline (Figures 2 and 3).

Chemical discharge lines are connected to the cargo manifold common line by means of spool pieces and one butterfly valve.

Crew

Haldoz Minimum Safe Manning Certificate required a crew of 12 but there were two special conditions, which if satisfied, would have allowed the minimum number to be lowered to 10. In fact, the vessel had a valid UMS notation, and therefore, one engineering OOW and one engine rating could be omitted in accordance with a special condition granted by the flag State Administration. Nonetheless, there were 14 crew members on board at the time of the spill. All the crew members were Turkish nationals and recruited by the Company's own crewing department.

The master, aged 33 years, held an STCW II/2 Certificate of Competency (CoC), issued in Turkey. He was also issued with the flag State Administration's endorsement attesting recognition. He had been serving as a master on tankers for four years. He had been on board for 15 days when the accident happened.

The chief mate was 34 years old. He also held an STCW II/2 CoC, issued in Turkey and duly recognised by the flag State Administration. He was responsible for the cargo operations. He had been serving as a chief mate on tankers for just over two years. The chief mate had joined the vessel 20 days before the accident happened.

The second and third mates were also duly qualified to serve on board. The second mate had embarked on the vessel about two months before the accident, whilst the third mate had been on board for 11 days when the spill happened.

[1] A type 2 ship is a chemical tanker intended to transport chapter 17 products with appreciably severe environmental and safety hazards, which require significant preventive measures to preclude an escape of such cargo.

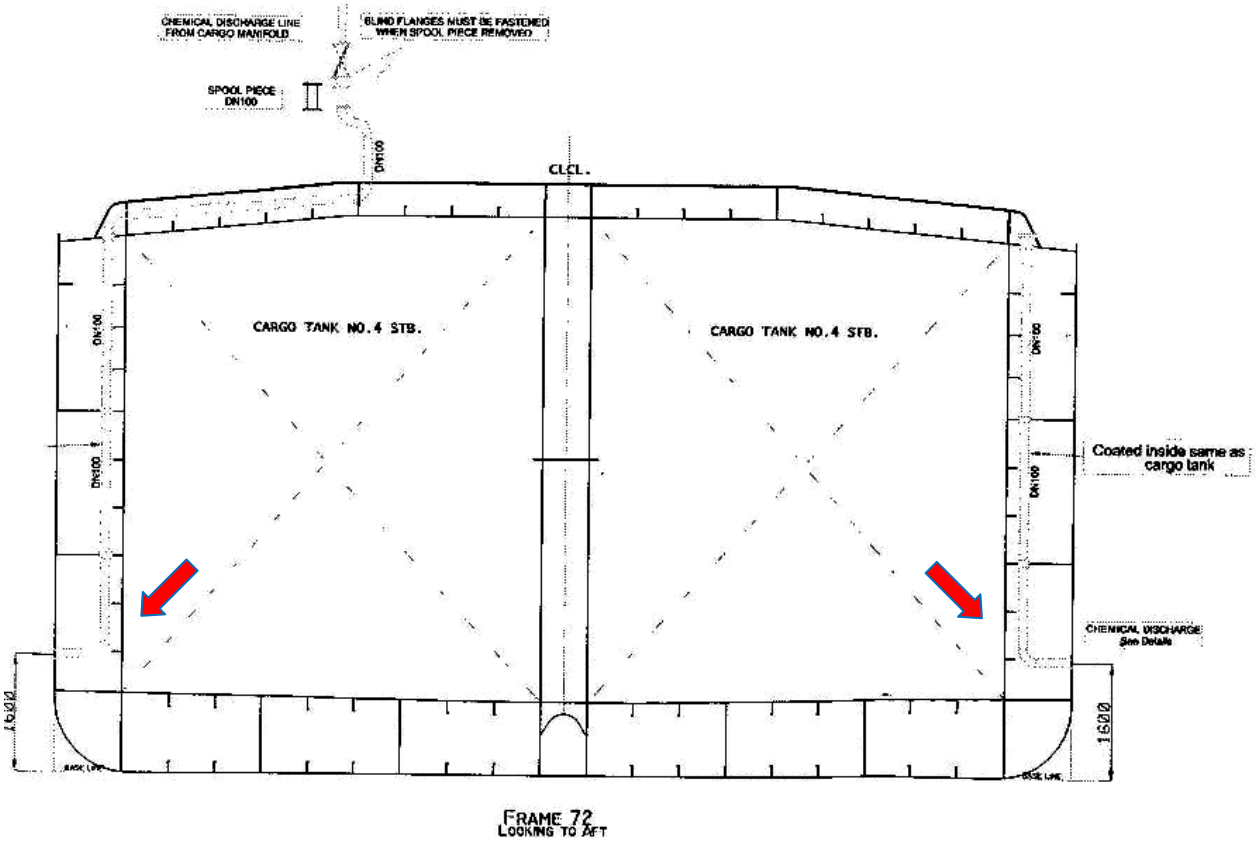

Figure 2: Drawing of the Annex II discharge

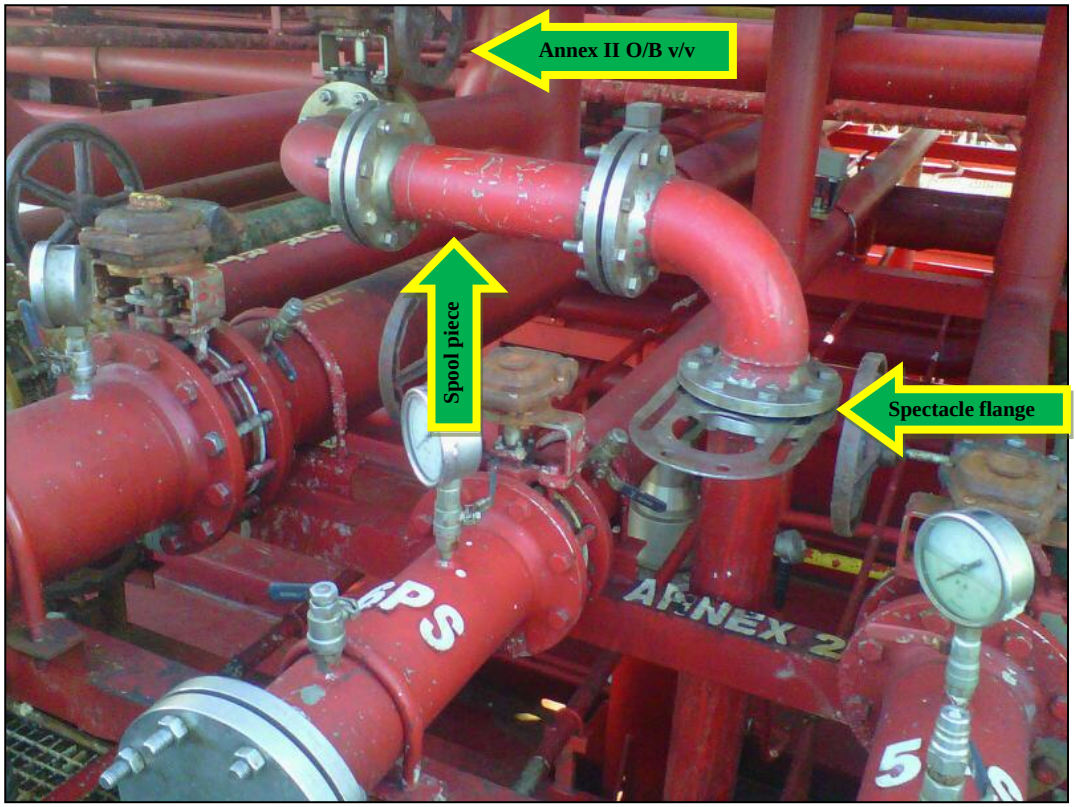

Figure 3: Annex II discharge on the main deck

All crew members had completed their familiarisation on board, which was related to safety and pollution prevention.

Environment

The wind was west-north-west, force 4 to 5 and gusting up to 27 knots. The sea state was slight. Visibility was good.

Narrative[2]

Haldoz arrived at Terquimsa Terminal in the port of Tarragona on 03 February 2012, at about 0400. She safely berthed port side alongside Pier No. 4 at 0455 in order to load eight parcels of cargo; four parcels of Polyol (P4311, P3621 and F4811) and four parcels of Styrene monomer[3]. After the vessel berthed safely alongside, the loading master and the cargo surveyor went on board at about 0515. A meeting was held with the ship's officers and both sides compiled the ship-shore safety checklist at 0520. The safety checklist was completed by 0605.

At 0830, a hose was connected for the loading of Styrene monomer, whilst a cargo hose for the loading of the first parcel of Polyol F4811 was connected at 0945 (Figure 4). With both hoses in place, a pre-loading checklist was completed at 0947, in accordance with the company's requirements as laid down in its safety management system manual.

Loading of both parcels commenced at the agreed initial rate of 100 m^3 hr^{-1} per cargo tank at 0950. The loading rate had to be gradually increased to 200 m^3 hr^{-1}. Eventually, loading of cargo had to terminate at a rate of 100 m^3 hr^{-1}.

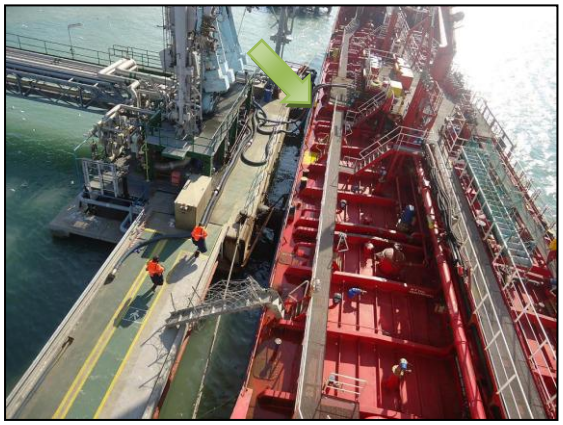

Figure 4: *Haldoz* alongside during the pre-loading operations (arrow shows loading manifold)

The cargo loading operation was uneventful until about 1045. During a routine patrol by two harbour policemen, a strong smell of chemicals was noticed. Moreover, a reddish substance was seen on the water. It seemed that a spill was coming from the starboard side of *Haldoz*.

The matter was reported to the Terminal operators, who until then were unaware of any cargo spill. It was reported that an immediate inspection of the Terminal did not reveal any immediate abnormalities.

At about 1104, the chief Terminal policeman and the two policemen, who noticed the red substance on the water, boarded the vessel and notified the master of an alleged pollution within the confinements of the harbour[4]. Upon receipt of this notification, the pump man, who was in the messroom, was called on VHF to proceed urgently to the starboard main deck. Cargo operations were suspended at about this time.

The harbour official also noticed a reddish substance being discharged from below the sea water level. However, the police officer also reported that after notifying the ship of the reports received at the Terminal, one of the crew members was noticed closing a

[2] Unless otherwise stated, all times are local.

[3] *Haldoz* already had 675.148 m^3 of Methylene Chloride (Dichloromethane) on board in cargo tanks nos. 2 port and starboard.

[4] *Haldoz* was the only ship in the Terminal loading these particular parcels of cargo at the time of the occurrence.

valve. The overboard flow was observed to stop at around this time.

A series of safety and pollution checks on board were initiated at 1135. Crew members reported that everything was found in order and all plugs secured in place. All the lines and valves, which were not in use at the time, were reported to be closed and blinded.

The vessel was eventually served with an official detention letter by the Harbour Master Office on the same day of the alleged pollution at 1540 which, however, was refused by the master. Eventually, cargo hoses were disconnected at 1815.

Extent of Pollution

During their visit on board, the harbour authorities observed a substance around the vessel, which was red in colour (Figure 5). By 1139, the first seagulls were reported dead, whilst a number of dead fish were also sighted floating on the sea surface. At 1240, the Terminal emergency control centre reported that the total amount of spilled cargo into the harbour waters was about 100 m^3.

Figure 5: Spilled Styrene monomer in the harbour waters

Oil booms were deployed in the area and the Terminal authorities also ensured that six mobile shore reception facilities were made available for the collection of the spilled cargo and contaminated water.

Port State Control

On 06 February, *Haldoz* was subjected to a port State Control expanded inspection. Five deficiencies were identified, none of which were related to the cargo equipment and cargo operations. Only one deficiency was indirectly related to pollution prevention; oil filtering equipment was found not in compliance with the guidelines in IMO Resolution MEPC.107(49)[5], which had to be rectified before departure.

Spilled Cargo Characteristics

Styrene monomer is a clear viscous liquid with an aromatic sweet smell[6]. It has a boiling point of 145.2°C and a specific gravity of 0.9051 at 15°C. It is slightly soluble in cold water. The vapour density is 3.58. Chapter 17 of the International Code for the Construction and Equipment of Ships carrying Dangerous Chemicals in Bulk (IBC Code) provides detailed carriage requirements for Styrene monomer.

Styrene monomer is a Category Y cargo[7]. It is included in the IBC Code because of its safety and pollution hazards. Styrene monomer can only be carried in integral and gravity tanks as defined in chapter 4 of the IBC Code. Although its carriage does not necessitate special requirements under the Code, controlled tank ventings are a requirement[8]. Restricted gauging, as per the

[5] The Revised Guidelines and Specifications for Pollution Prevention Equipment for Machinery Space Bilges of Ships (Resolution MEPC.107(49)), were adopted on 18 July 2003.

[6] Styrene monomer may be coloured, depending on the additives.

[7] Category Y cargo is defined in MARPOL Annex II, chapter 2, regulation 6 is a noxious liquid which, if discharged into the sea from tank cleaning or deballasting operations, is deemed to present a hazard to either marine resources or human health or cause harm to amenities or other legitimate uses of the sea and therefore justify a limitation on the quality and quantity of the discharge into the marine environment.

[8] This was to be achieved on board by means of the cargo tanks' PV valves.

requirements of chapter 13 of the IBC Code is necessary.

The cargo gives off flammable vapours and is normally protected by additives against several chemical changes. There is the possibility of a dangerous reaction of the cargo, resulting in overheating in either the tank or associated pipelines.

Therefore, Styrene monomer has to be loaded and carried adequately segregated from other products, whose temperature is sufficiently high to initiate a reaction of this cargo. In fact, in order to ensure that the cargo is not exposed to excessive heating, heating coils in cargo tanks carrying Styrene monomer have to be blanked off or secured by equivalent means.

The Material Safety Data Sheet did not provide any details on ecotoxicity; it cautioned that although possible hazardous short term degradation products are not likely to occur, long term degradation products may arise.

Pre Arrival and Commencement of Cargo Operations Checklist

It was a safety management system requirement for the chief mate to complete the Pre Arrival and Commencement of Cargo Operations checklist prior to the vessel's arrival in port and the commencement of cargo operations.

The checklist extensively addressed the preparations of the vessel for the loading of the cargo from the pollution prevention and safety points of view. The checklist confirmed that "portable spool pieces had been fitted and unused connection flanges blanked" and that all the "sea suction and overboard discharge valves were closed, lashed and locked."

ANALYSIS

Aim

The purpose of a marine safety investigation is to determine the circumstances and safety factors as a basis for making recommendations, to prevent further marine casualties or incidents from occurring in the future.

Cooperation

MSIU deployed a safety investigator on board, who collaborated very closely with the Spanish Comisión Permanente de Investigación de Accidentes e Incidentes Marítimos (CIAIM) investigator. CIAIM has also provided numerous documents to MSIU, which were reviewed, albeit in Spanish.

Ship / Shore Safety Checklists[9]

It is understandable that when a tanker arrives alongside at a Terminal, there is considerable preparatory work to be done before she is ready to commence the cargo operations. Most of the cargo operations' preparations were affected through the completion of a series of checklists. Two relevant checklists were the ship / shore safety checklist and the pre-arrival and commencement of cargo operations checklists (referred to above). Both checklists were part of the Company's safety management system.

Whilst several items in the ship / shore safety checklist had to be compiled together with the Terminal representative, all questions had to be answered in the affirmative for the cargo operations to be commenced. Of particular interest was item 14 on this checklist.

[9] It has to be clarified that there were two checklists entitled 'Ship/Shore Safety Checklist'. One checklist is compiled by the Terminal whereas the other one is compiled by the ship. There was a requirement for both checklists to be signed by the Terminal and ship representatives. The items in the two checklists were very similar but were neither identical nor listed in the same order. This sub-section refers to the Ship/Shore Checklist, which was required to be filled in by the crew members.

Item 14, which was only required to be checked by the ship, indicated that the scuppers and save-alls on board were effectively plugged and the drip trays in position and empty.

Moreover, item 14 was coded 'R', *i.e.* it had to be rechecked at appropriate, regular intervals as agreed by both parties in the declaration. The checklist indicated that on the day of the cargo spill, these additional checks were done at 0855, 1255, and 1655.

It may be deduced that there were two checks for item 14 before the accident – an initial one when the ship / shore safety checklist was being compiled, and another one at 0855. The second re-check at 1255 was carried out after the accident had happened.

The Harbour Master reported that during an inspection on board, which was carried out in the presence of the vessel's management representatives after the accident, residues of Styrene monomer were found in one of the save-alls. This finding was not reflected in the Ship / Shore Safety Checklist.

The safety investigation was unable to determine whether this meant a missed entry in the checklist[10]. Therefore, either the spill went undetected (and therefore not recorded in the checklist), or else it was cleaned before the next entry in the checklist.

Inconsistencies in the available evidence

From the onset of this safety investigation, the inconsistencies in the respective claims made by the ship managers' representatives and the Terminal were strongly evident. During the meetings held immediately after the spill, the vessel's managers and the master denied that the spill came from the vessel.

In their submissions, the ship managers based their counterargument on the quantity of 'missing' Styrene monomer, which stood at about 100 mt (according to shore figures). They claimed that the ullage report indicated that the vessel had received 153.52 mt of cargo, whereas the shore figures indicated that 261 mt (*i.e.* 288 m^3 at ρ = 0.9051 at 15°C) were transferred from the Terminal storage tanks. That leaves a discrepancy of about 110 mt, without taking into considerations any adjustments due to temperature and specific gravity.

The loading operation commenced at 0950 and was suspended one hour and 15 minutes later. During the first 45 minutes, the agreed pumping rate was 100 m^3 hr^{-1}, and increased to 200 m^3 hr^{-1}, until the operation was suspended. If these figures were accurate, and the agreed pumping rates adhered to, then the ship would have only received about 175 m^3 (approximately 158 mt) of Styrene monomer when the cargo operations were suspended[11]. As such, that would almost equate to the amount claimed by the managers to have been received on board.

Thus, the problem with this scenario was the pumping rate. As indicated above, if the Terminal delivered the cargo at the agreed rate, and subject that the ship figures were correct, then there was no way that 288 m^3 of cargo were pumped in 75 minutes. Moreover, even if the pumping rate throughout was 200 m^3 hr^{-1}, the Terminal would still have only managed 250 m^3 (about 226 mt) of cargo.

Styrene monomer had been observed on the Terminal waters and therefore there is no denial that the pollution did occur. Thus, on the basis of the above calculations,

[10] The vessel did not have Styrene monomer on board before arriving at Tarragona. Therefore, the Styrene monomer traces found in the save-all must have come from the cargo, which was being loaded prior to the spill.

[11] The figure is calculated by using the specific gravity at 15°C. The figure may therefore have a margin of error.

1. either the ship figures were not correct;
2. the Terminal figures were wrongly recorded; or
3. both figures were accurate but the Terminal delivered at a rate of about 230 m^3 hr^{-1}.

On 07 February 2012, the Harbour Master called for a meeting on board the vessel to discuss further the spill. It was reported that during the meeting, the cargo surveyor denied the statement released by the master. He also claimed that following the spill report, he personally saw one of the crew members sealing the Annex II discharge line with the spectacle flange. This claim collaborated with what has been stated by the chief police when he saw one of the crew members closing a valve on the main deck[12].

Cargo tank washing from the previous cargo

It was reported that on 28 January 2012, the vessel had carried out cargo tank cleaning operations of cargo tanks nos. 2 port and starboard, using the Annex II discharge. The cargo in question was molasses[13].

Managers confirmed that the ship and shore checklist indicated that both the Terminal and the vessel had confirmed that the overboard valves had been closed prior to the loading of the cargo. The checklist was made available to the MSIU as documentary evidence and the managers' position was confirmed to be correct.

System defences

Academic studies have shown that omission errors are the largest single category of (maintenance)[14] errors. In view of this, the safety investigation did not exclude the possibility of such error, when the cargo tank washing was completed on 28 January 2012, even if there was no hard evidence to support this hypothesis.

Maintenance errors are widely acknowledged, necessitating the erection of safety barriers to protect the system against this disturbance. 'Soft' barriers (which is a blend of people and paper-based measures), were applied on board to ensure that Annex II discharge was blanked off and isolated.

Considering that the Terminal had witnesses who saw the crew members closing a valve on the vessel after the loading operations had commenced, the safety investigation did not exclude the possibility that the checklist did not actually reflect the actual status of the cargo system.

The safety investigation was cautious on the matter, although witnesses on board claimed that the outflow stopped as soon as the crew members closed a valve on the main deck. However, information made available to MSIU indicated that the cargo operation was also stopped from the Terminal.

Therefore, at that particular time, there were two variables, which happened in close proximity to each other. These are the stopping of the cargo operation and the

[12] The submissions of the cargo surveyor and the chief police suggested that unless the status of the system was altered (for no particular reason) after the joint inspection by the Terminal and the ship, item 14 of the ship / shore safety checklist did not reflect the actual system status.

[13] Molasses has a pollution category 'OS' and therefore falls outside Annex II Categories (*i.e.* X, Y, Z). Molasses is biodegradable, has been included in Chapter 18 of the IBC Code, and is not deemed to present safety and pollution hazards to such an extent as to warrant the application of the Code.

[14] For the scope of this safety investigation report, maintenance is given a broad meaning and not necessarily limited to repair and / or maintenance from the strict engineering point of view. Omission errors are therefore a well-known phenomenon across all safety critical domains and in no way do they reflect any sort of negligence and recklessness on the crew members' side.

closing of the valve on the main deck. The safety investigation could not determine which one of the two variables (or combination) actually stopped the cargo spill.
The following two sections attempt to address the issue of maintenance error.

Memory and situation awareness
Memory failures may frustrate soft barriers. A failure to carry out a necessary check can be caused by some local distraction. Distractions may lead to 'premature exits' *i.e.* a job is terminated before all the actions are complete – especially if it is the end of a routine task. It is expected that tasks on board may be subject to frequent interruptions. Irrespective of their nature, all interruptions may raise stress levels and increase the likelihood of memory lapse – omission being the most likely one.

The ability to maintain information in the working memory is particularly important, especially when engaged in safety critical tasks[15]. For instance, working memory is utilised when going through a series of steps within a process.

If someone is distracted or interrupted while focussing attention to hold this information, they will probably forget steps s/he may have completed. Literature suggests that any information contained in the distraction phase, erases the material that the working memory store would have been holding.

Attention is a cognitive system that has a limited capacity and depends on, *inter alia*, memory. Thus, attention and working memory are closely tied together. It is for this particular reason that workload is considered to be very important to attention and working memory.

Whilst sequencing tasks (even by the use of checklists), is an effective way to address workload, interruptions may be problematic – especially when these lead to the loss of memory contents. This may create a situation where the individual will not resume his work from the point which he had left it before the interruption. The reason behind this is because situation awareness depends on perception, which in return is influenced by attention and working memory.

Teamwork
The concept of teamwork, albeit in an extremely limited manner, was found to be relevant to this accident, given that both the ship and Terminal personnel were checking items together. As already explained, managers have indicated that all unused cargo and bunker connections were properly secured with blank flanges and fully bolted.

This matter was raised with the Terminal through the intervention of the CIAIM. The Terminal was unable to provide a list of the system connections, which had been checked prior to and during the loading operations. It was also stated that all connections on the shore side were checked and found properly sealed with blank flanges.

The Terminal also confirmed that all was in order on the vessel's side. The Terminal reply, however, stopped short from confirming that its representatives verified the status of all connections on board the ship. Therefore, it remained unclear as to how one could confirm that all was in order with the ship, when this was not physically verified.

The safety investigation doubted that the ship's connections were actually checked and their status verified in the presence of the ship's crew members[16]. As such, it is the safety investigations view that what should have been a collective approach, had in reality

[15] Double checking the status of the cargo system is more an issue of environmental protection rather than safety. Nonetheless, the memory remains crucial.

[16] Even so, it has already been stated that there were possibilities that the checking step was also omitted by the crew members.

developed into a situation, where it was most probably assumed by the Terminal that certain checks should have been carried out by the ship.

The problem with such diffusion of responsibility is that it may very well be that the Terminal personnel would have expected that any problems on the ship would have been found and rectified by the crew members before the cargo transferring operation commenced.

The situation may well be interpreted as an overreliance on the ship from the Terminal side. The Terminal would have been unaware that this would have meant an overruling assumption that procedures and decisions on board had been carried out – without actually verifying this.

CONCLUSIONS

1. The checklists filled in jointly by the crew members and the Terminal representatives indicated that the scuppers and save-alls on board were effectively plugged.
2. The Harbour Master reported that during an inspection onboard, traces of cargo were found in one of the save-alls.
3. Available evidence indicates that one of the crew members was seen closing one of the Annex II discharge line after the spill alarm was raised on board.
4. It is possible that the crew members were distracted during the preloading condition and missed steps of the checklist.
5. It is probable that the Terminal representatives did not cross check that all the steps of the preloading checklist had been carried out, thereby compromising teamwork.
6. Given that pollution was factual, it is possible that the ship's or the Terminal's figures were not accurate, or both figures were correct but the pumping rate was much higher than what had been agreed.

RECOMMENDATIONS[17]

Ayder Tankers A/S and Terquimsa Terminal are recommended to:

23/2012_R1 promote adherence by their respective personnel to pre-loading instructions, (and if necessary modify existing procedures) in order to ensure that checklists, which require the joint inspection of critical areas and fittings of the cargo systems, are thoroughly compiled on the basis of actual inspections rather than on the basis of information provided by the other party.

Moreover, Ayder Tankers A/S is recommended to:

23/2012_R2 establish effective watch during loading and unloading of cargo in order to prevent cargo spillages on deck and at sea.

[17] **Recommendations should not create a presumption of blame and/or liability.**

SHIP PARTICULARS

Vessel Name:	*Haldoz*
Flag:	Malta
Classification Society:	Bureau Veritas
IMO Number:	9383613
Type:	Oil / chemical tanker (Type 2)
Registered Owner:	YD Shipping Ltd
Managers:	Ayder Tankers A/S, Turkey
Construction:	Steel
Length Overall:	92.86 m
Registered Length:	86.90 m
Gross Tonnage:	2603
Minimum Safe Manning:	10
Authorised Cargo:	Liquid cargo in bulk

VOYAGE PARTICULARS

Port of Departure:	Lavera
Port of Arrival:	Tarragona
Type of Voyage:	International
Cargo Information:	Styrene monomer
Manning:	14

MARINE OCCURRENCE INFORMATION

Date and Time:	03 February 2012 at 1045
Classification of Occurrence:	Serious Marine Casualty
Location of occurrence:	Tarragona
Place on board	Overboard
Injuries / fatalities:	None
Damage/environmental impact:	100 m^3 of cargo were spilled in the Terminal waters. Several birds and fish were noted dead on the sea surface.
Ship Operation:	Loading
Voyage Segment:	Alongside/moored
External & Internal Environment:	West-north-west force 4 to 5 winds gusting to 27 knots. Seas were slight.