The Nautical Institute
Mariners' Alerting and Reporting Scheme
MARS Report No 224 June 2011

Providing learning through confidential reports – an international cooperative scheme for improving safety

## MARS 201135

### Hazards of Hydrogen Sulphide ($H_2S$) gas

**(Edited from MAIB Safety Digest 1/2010, Case 1)**

A chemical tanker was instructed to load 2000 tonnes of crude sulphate turpentine (CST), a Category X cargo under MARPOL Annex II. The cargo was to be discharged to another tanker via a ship-to-ship (StS) transfer at a receiving terminal. Although there were several experienced crewmembers on board, none of them had any previous experience of this cargo, or knew about its associated hazards. The ship's Safety Management System (SMS), Procedures and Arrangements (P&A) Manual, cargo checklists and procedures were all followed, despite there being no information on this specific cargo.

Prior to arrival, a briefing was conducted by the chief officer. The material safety data sheets (MSDS), were not available at the time. Accordingly, the hazards of the cargo (toxicity of $H_2S$, organo-sulphides and mercaptans) were not properly discussed. On arrival, the shipper handed the vessel a cargo-specific MSDS. The ship's manager also supplied a generic MSDS which did not mention $H_2S$. Because of the delayed and incomplete information from a large number of sources, the crew remained largely ignorant of the dangers of the cargo. The receiving STS ship, the terminal staff and even the cargo surveyor, who also obtained a generic MSDS from the internet, were also largely unaware of the dangers. Although there was a week's delay in the transfer operation, information on hazards was not updated among the parties because everyone thought they had the correct data. As a result, the surveyor used a respirator filter that was ineffective against $H_2S$ vapours. The accompanying seaman, who opened the tank's Butterworth hatch (Figure 1), was not protected. He did not query why the surveyor was wearing a respirator and yet he was not.

▲ Figure 1: View of open Butterworth hatch

▲ Figure 2: Another view of deck area around Butterworth hatch showing the enclosed nature of the v space and possibility of heavy vapours settling at the bottom

During the transfer, which was completed without incident, there was a very strong odour of rotten eggs, yet no one investigated this properly and no reference was made to the MSDS to verify the cargo hazards. Following the STS transfer, a mandatory pre-wash of the tanks was carried out. As several fixed washing machines were defective, portable machines were lowered down the Butterworth hatches. As the washers agitated the tank's atmosphere the pungent, heavier-than-air cargo vapours were driven out through the opening and settled in the vicinity of the hatch.

When the pre-wash was completed, a seaman went down to the hatch to remove the portable washer. Although part of the upper deck, the area around the Butterworth hatch was in effect an enclosed space: there were limited openings, unfavourable natural ventilation and the area was not designed for continuous worker occupancy (Figure 2). As he descended the ladder, the seaman became unable to detect the pungent smell, began to shake uncontrollably, and collapsed across the open hatch.

Very soon afterwards, another crewmember saw the casualty and alerted the chief officer. The chief officer informed the Master, who went to the bridge to sound the general alarm. Instead of using the terminal's emergency procedures, he informed the agent of the problem. The agent, in turn, informed the Harbourmaster, who contacted the emergency services. Meanwhile, the chief officer attempted to rescue the seaman, but without testing the atmosphere and without wearing breathing apparatus. The inevitable happened. As he approached the seaman, he lost his motor functions, could not speak, and slipped in and out of consciousness. Another seaman attempted a further rescue from the walkway above the Butterworth hatch. He took large gulps of air before descending to the casualties. He was badly affected by the cargo vapours, but fortunately managed to struggle back to the walkway.

Soon afterwards, crew members wearing breathing apparatus rescued the chief officer and seaman. They were transferred to hospital, where, fortunately, they made a full recovery.

### Root cause/contributory factors

**1.** Use of deficient and different versions of MSDSs;

**2.** Complacency, leading to lapses in procedures – in this case there were inadequate safety briefings and an acceptance of strong smells;

**3.** Failure to use breathing apparatus despite the strong odour of $H_2S$;

**4.** Defective fixed washing systems;

**5.** Potentially dangerous spaces were not identified – the Butterworth hatch was effectively in an enclosed space;

**6.** Would-be rescuers acted on impulse and emotion rather than knowledge and training – the initial rescue was attempted without breathing apparatus and without testing the atmosphere;

**7.** Terminal emergency procedures were not followed – only the chief officer was briefed on terminal emergency procedures, so the Master was not aware of the correct procedure to expedite assistance.

## MARS 201136

## Unsafe venting of sour crude vapour

One of our VLCCs recently reported a near miss. The Master, on his way to the wheelhouse to conduct an emergency drill, became aware of a strong smell of hydrogen sulphide ($H_2S$) gas. On arriving on the bridge, he was told that due to a sudden rise in the pressure in one cargo tank, the chief officer had ordered the mast riser to be opened briefly. In violation of SMS procedures, the mast riser had been opened without Master's permission or issuing any warnings to the crew.

At the time, the true wind was blowing from astern at a velocity of just under the ship's speed, so a very light relative wind was blowing from right ahead. The toxic gas left the riser and settled on the deck, entering the open intakes of the engine room fans and the accommodation heating, ventilation and air-conditioning (HVAC) system. Despite plenty of sea room, no seamanlike precaution was taken to alter course to ensure that the vented gas would be blown clear of living spaces while permitting A/C fresh air intakes to be adjusted to full recirculation mode. Fortunately, as the vessel was passing through a known piracy threat area at the time, only one accommodation door was open to the deck, thus limiting the intake of $H_2S$ to the living quarters.

### Root cause

Non-compliance with risk assessment procedure for venting cargo tanks during navigation.

### Lessons learnt

**1.** The human element can never be discounted. Despite being aware of the dangers, frequent onboard training sessions and the adoption of best industry practices by the company, a temporary lapse of concentration/omission of procedures by a senior officer seriously compromised the safety of all the crew;

**2.** Post-incident investigation also revealed poor appreciation of hazards associated with venting of $H_2S$-rich vapours by some of the ship's crew, despite a recent company circular relating to a previous similar incident on another company vessel, which resulted in the hospitalisation of two crew members during the venting of a cargo tank containing high sulphur crude.

### Corrective/preventative action

A further circular was transmitted to the fleet on the latest incident, highlighting the dangers and the importance of following correct operational procedures.

■ **Editor's note:** (Sourced from www.safetydirectory.com and safetyadvantage.net)

Hydrogen sulphide has a very low odour threshold, with its smell being easily perceptible at concentrations well below 1 part per million (ppm) in air. The odour increases as the gas becomes more concentrated, with a strong smell of rotten eggs recognisable up to 30 ppm. Above this level, the gas is reported to have a sickeningly sweet odour up to around 100 ppm. However, *at concentrations above 100 ppm, a person's ability to detect the gas is affected by rapid temporary paralysis of the olfactory nerves in the nose, leading to a loss of the sense of smell.* This means that the gas can be present at dangerously high concentrations with no perceptible odour. This unusual property of hydrogen sulphide makes it extremely dangerous to rely totally on the sense of smell to warn of the presence of the gas.

| $H_2S$ concentration (ppm)* | Potential effect |
|---|---|
| 10 to 20 | Eye irritation, especially in hyper-susceptible workers. |
| 20 to 100 | Inflammation, corneal blistering and the capacity of the eye, loss of the sense of smell, headache, cough, nausea. |
| 100 to 300 | Respiratory difficulty, pulmonary edema, respiratory depression and irritation (30 min-8 hrs). |
| 300 to 600 | Central and peripheral nervous system effects, eg tremors, weakness, numbness of extremities, unconsciousness and convulsions (several minutes – hrs). |
| 600 to 1000 | Rapid breaths, unconsciousness resulting in death if emergency aid is not promptly administered. |
| 1000 and greater | Cessation of breathing (instantaneous) and death. |

▲ Table of potential effects on health of $H_2S$ at various concentrations

## MARS 201137

## Movement at berth due to ineffective moorings

After completing loading operations our gas tanker's crew secured the ship's accommodation ladder. As a routine pre-sailing procedure, the terminal had rigged a temporary gangway from the shore for two representatives, who boarded to disconnect the loading arm. A large tanker passed our vessel, causing it to surge and sway away from the jetty by about two metres. The shore end of the gangway came away from the jetty and fell on top of taut mooring ropes (after backsprings). Immediately, our crew safely re-moored the vessel and the shore gangway was repositioned and secured. The gangway and loading arm were visually examined after the incident.

### Damage caused:

**1.** The wire operating the counterweight of the loading arm was stretched during the incident and will need renewal;

**2.** The triple swivel of the loading arm was found to be stuck after the incident and will need to be surveyed and repaired.

## Potential losses

**1.** There was a risk of death/or serious injury to the terminal personnel if they happened to be on the gangway at the time of the incident;

**2.** The loading arm will be out of service for some time, resulting in financial consequences for the terminal;

**3.** The shore gangway could have been lost overboard;

**4.** The vessel's mooring ropes were suddenly overstretched, and this could have resulted in damage to ropes and equipment;

**5.** Other commercial losses for the terminal, charterer, cargo owner and vessel owners/managers due to this incident.

## Root cause/contributory factors

**1.** Slack in mooring ropes – the large tidal range caused slack in the vessel's moorings allowing the vessel to move dangerously at the berth;

**2.** Passage of large tanker in channel – AIS data and visual observation confirmed that the tanker's speed was not excessive and it was not abnormally close. It is speculated that its size, draught, and the channel blockage factor may have generated the large disturbing forces;

**3.** Mooring configuration – the vessel was moored port side alongside with two headlines, two forward backsprings, two after backsprings and two sternlines. The position of our vessel and configuration of the shore bollards did not allow the deployment of breastlines. The four backsprings were all belayed on one bollard. This configuration was not effective in countering athwartship forces;

**4.** The crew underestimated the possible consequences of this ineffective mooring configuration;

**5.** The responsible officer of the watch and the deck watch did not properly check and adjust the tension of the moorings during the loading operation;

**6.** The vessel was kept alongside by the wind and tide and the crew became complacent and did not observe that the vessel was not moored safely.

## Lessons learnt

**1.** In consultation with the berthing pilot and the terminal, the Master should determine an optimum mooring plan;

**2.** If unavoidable, a mooring configuration with lines predominantly extending parallel to the berth must be closely and continuously monitored and tended; lines must always be maintained under optimum tension and never left slack;

**3.** Environmental conditions (wind, tides, currents etc) and their effects should be correctly predicted/anticipated and closely monitored.

■ Further advice on moorings can be found in The Nautical Institute's reference publication Mooring and Anchoring Ships Volumes 1 & 2. See link http://www.nautinst.org/pdf/publicationsList.pdf for details.

# MARS 201138

# Loose grating causes fall and injury

During coastal passage, the chief engineer inspected the lower side of the forward seal of the stern tube as part of his rounds. He then turned around and proceeded forward towards the ladder leading up to the bottom plates. He stepped on a flat-bar and rod grating section forming part of the walkway along and underneath the tail-end shaft. The grating section was too small for the bilge well that it covered, and fell down into the well. Thrown off-balance due to the fall, the engineer's right leg hit the exposed sharp edge of the bilge well with great force, inflicting a serious gash wound extending almost the full length of his shin bone. After being rescued and given first aid, he was medevacced by helicopter to receive medical treatment on shore.

## Root cause

**1.** Mismatch in dimensions of grating section and bilge well opening resulting in grating being insufficiently supported by the edges of the bilge well;

**2.** No lock bolts fitted on the grating;

**3.** Due to the location's low lighting levels and difficult access, the potential hazard could not be readily seen;

**4.** The location was not included in the unmanned operation route risk assessment check list as crewmembers rarely go there.

## Corrective/preventative actions

**1.** Fleet advised to thoroughly inspect all gratings, floor plates, their supports and locking devices for proper and secure fit.

**2.** Safely carry out necessary modifications to any similar deficiencies and/or deformed floor plate(s). For example, proper lock bolts or an angle bar support should be welded in place to prevent the fall of a grating or floor plate section. Alternatively, hinges should be welded on those sections that are frequently removed for inspection.

**3.** Post appropriate warnings and fence off the opening when any grating or floor plate is removed temporarily for access.

◀ Figure 3: View of loose and under-size grating

Grating just touching edge of bilge well opening instead of resting fully on lip

# MARS 201139

# Facial injury from dislodged deckhead panel

The fourth engineer and the fitter dismantled the deckhead panelling in an unoccupied spare cabin to carry out maintenance work. After completing the work, they both stood on a bench to fix the panel back in place. The engineer held the panel in place while the fitter inserted the holding screws of the panel, which was located just inside the entrance to the cabin with the door opening inward. Hearing noises inside an empty cabin, a curious crewmember suddenly opened the door, knocking the fourth engineer to the deck. The panel fell on top of him, its sharp edge inflicting a deep laceration below the right eye that could have resulted in permanent damage.

Immediate medical treatment was administered by ship staff, including suturing the open wound. The engineer was sent ashore to the doctor for further medical attention at the next port. The accident resulted in a total of five days lost work time.

### Root cause/contributory factors

**1.** No risk assessment carried out prior to undertaking the task;

**2.** Cabin door was not locked during the execution of the work;

**3.** No warning notice was posted on the outside of the cabin door;

**4.** Insufficient personal protective equipment – wearing helmet and goggles could have avoided or mitigated the injury.

### Corrective/preventative actions

**1.** The accident was discussed in detail at a safety meeting called soon after the occurrence;

**2.** Master instructed all ship staff to carry out risk assessment prior to commencing any task;

**3.** The department head and the assigned work team must inspect the site of work and identify the hazards involved;

**4.** Master instructed all department heads to explain assigned tasks in greater detail to their subordinates. As far as possible, this briefing should be done at the job site;

**5.** Seniors, with their greater practical experience, should guide the juniors;

**6.** Management reviewed the accident and circulated its findings and recommendations within the fleet.

## MARS 201140

## Explosion with fatalities during cargo tank cleaning

**(Edited from report from IMO FSI Sub-Committee 12th Session.)**

On a product tanker on a short voyage between two busy ports, the crew started tank cleaning operations. They fitted a water-driven fan to ventilate the tank with plastic ducting extending to the lower portion of the tank. After completing the ventilation, two crew members entered the tank to remove oil cargo residues. There was an explosion which tore away bulkheads to adjoining tanks and ignited the aviation fuel and kerosene slops that were stored in them. The explosion breached the hull in these tanks and the engine room and the ship flooded rapidly, developed a starboard list and sank. The crew escaped by jumping into the sea. Out of a total of 16 crew, seven were rescued by passing ships. Three bodies were recovered from the sea, while a further six crew members are missing, presumed dead.

### Probable cause/contributory factors

**1.** The source of ignition could not be identified. It was probably either a discharge of static electricity from the crew's winter clothing or from the plastic ventilation ducting, or a friction spark created when an ordinary metal can that was used to carry tools impacted with the tank's internal surfaces;

**2.** The crew was under pressure to complete the tank cleaning operation due to the short duration of the transit.

### Lessons learnt

**1.** It is vital to ensure sufficient time for tank cleaning operations to minimise the possibility of missing steps or not paying adequate attention to the operation;

**2.** Crews are required to take training in tanker operations. That training must be continually reinforced onboard, and it is important to ensure that it is properly applied.

# MARS: You can make a difference.

**You can save a life, prevent injury and contribute to a more effective shipping community.**

Everyone makes mistakes or has – or sees – near misses. By contributing reports to MARS, you can help others learn from your experiences. Reports concerning navigation, cargo, engineering, ISM management, mooring, leadership, design, training or any other aspect of operations are welcome, as are alerts and reports even when there has been no incident. The freely accessible database (http://www.nautinst.org/mars/) is fully searchable and can be used by the entire shipping community as a very effective risk assessment and work planning tool and as a training aid.

Reports will be carefully edited to preserve confidentiality or will remain unpublished if this is not possible.

**Editor: Captain Shridhar Nivas FNI**

Email: mars@nautinst.org or MARS, c/o The Nautical Institute, 202 Lambeth Road, London SE1 7LQ, UK

The Nautical Institute gratefully acknowledges sponsorship provided by:

**American Bureau of Shipping, AR Brink & Associates, Britannia P&I Club, Cargill, Class NK, Consult ISM, DNV, Gard, IHS Fairplay *Safety at Sea International*, International Institute of Marine Surveying, Lairdside Maritime Centre, London Offshore Consultants, MOL Tankship Management (Europe) Ltd, Noble Denton, North of England P&I Club, Port of Tyne, Sail Training International, Shipowners Club, The Marine Society and Sea Cadets, The Swedish Club, UK Hydrographic Office, UK P&I Club**