April 2021 www.nautinst.org

Seaways

The International Journal of The Nautical Institute

Finding the missing piece

Seeing the whole picture in marine investigation p6

The Nautical Institute

Entry into enclosed spaces; an ongoing issue

Why do accidents still occur?

Francisco Juarrero

In recent years, there have been several reported fatalities on commercial ships attributed to entering into enclosed spaces.

Why do so many accidents still happen, given that entry into these spaces is regulated (see box, below), there is mandatory training and regular drills on board, and it is an identified risk?

Operating in an oxygen-deficient atmosphere

COSWP draws attention to the risk of possible pockets of oxygen deficient atmosphere, which are to be removed through ventilation, either mechanical or natural (section 15.5.1).

However, as pointed out in section 10.7.2 of the International Safety Guide for Oil Tankers and Terminals (ISGOTT), ventilation is not an infallible solution. ISGOTT highlights the problem of possible pockets of gas where the air flow is less effective and prescribes as a solution measuring the atmosphere at the top, middle and bottom of the tank.

Monitoring the atmosphere inside the tank (Credit: F Juarrero)

Recommendations and best industry practices

IMO Resolution A 1050(27) item 2 defines an enclosed space as having:

2.1.1 – Limited openings for entry and exit.

2.2.2 – Inadequate ventilation.

2.2.3 – Not designed for continuous worker occupancy.

That comprises amongst others: cargo spaces, fuel and ballast tanks, cargo pump room, cofferdams, etc.

This regulation lists some procedures or precautions for entering, amongst others:

- Assessment of risk (whether there is a present hazard, and if it is related to oxygen depletion, gas, etc.).
- Authorisation of entry (issuance of permits).
- Precautions before entering (compartment is illuminated, ventilation is applied, system of communication agreed upon, use of PPE, harness, falls arrestors and lifelines, rescue team and set with hoisting means in place).
- Testing the atmosphere for oxygen levels, presence of gas or Lower Explosive Limit (LEL).
- Precautions during entry (ventilation to continue, personnel using gas monitors).

With respect to ventilation and gas testing the regulations specify:

6.3.2 – The space has been thoroughly ventilated by natural or mechanical means to remove any toxic or flammable gases and to ensure an adequate level of oxygen throughout the space.

6.3.3 – The atmosphere of the space has been tested as appropriate with properly calibrated instruments to ascertain acceptable levels of oxygen and acceptable levels of flammable or toxic vapours.

When such levels are not acceptable, but it is still imperative to enter, the resolution goes on to state that this should be done with self-contained breathing apparatus (SCBA):

9.2 – Suitable breathing apparatus, eg, of the air-line or self-contained type, should always be worn, and only personnel trained in its use should be allowed to enter the space.

The Code of Safe Working Practices for Merchant Marine (COSWP) in Chapter 11, Reg 11.10 also defines an enclosed space and the precautions to be taken in entering.

Both IMO Resolution A 1050(27) and the COSWP regulations place considerable emphasis on risk assessment. Why risk assessment? Well, no single set of regulations can fit to every ship, compartment and situation, all being different. As the preamble of IMO Resolution A 1050(27) indicates; *'It may be impracticable to apply some recommendations to particular situations. In such cases, every endeavour should be made to observe the intent of the recommendations, and attention should be paid to the risks that may be involved.'*

The COSWP in particular draws attention for the need to have a rescue plan in place; again in line with a thorough risk assessment: COSWP Reg 15.8.3 reads: *A rescue plan should be in place (see section 15.14). In all cases, rescue and resuscitation equipment should be positioned ready for use at the entrance to the space. A risk assessment should identify what rescue equipment may be required for the particular circumstances but, as a minimum, this should include appropriate breathing apparatus, lifelines and rescue harnesses; torches or a lamp and a means of hoisting an incapacitated person from the confined space, if appropriate.*

The use of SCBA to enter compartments with lower levels of oxygen, probable presence of toxic vapours or for rescue poses its own challenges. SOLAS Reg II-1/3-6 attempts to address some of these challenges by specifying a minimum dimension for manholes in order to facilitate access:

5.1 – For access through horizontal openings, hatches or manholes, the dimensions shall be sufficient to allow a person wearing a self-contained air-breathing apparatus and protective equipment to ascend or descend any ladder without obstruction and also provide clear opening to facilitate the hoisting of an injured person from the bottom of the space. The minimum clear opening shall not be less than 600 mm x 600 mm.

The COSWP warns of the challenges of entering and transiting inside with such equipment:

15.8.4 – Breathing equipment may be bulky and limit movement in the space. Before entry is permitted, it should be established that entry with breathing apparatus is possible. Any difficulty of movement within any part of the space, or any problems if any incapacitated person had to be removed from the space (as a result of breathing apparatus or lifelines or rescue harnesses being used), should be considered. Risks should be minimised, or entry prohibited.

Operator having difficulties in entering the tank with SCBA

And yet, despite all these regulations, accidents continue to happen.

Accident reports

On 14 August 2018, the *MV La Donna I* was discharging coal in India. The chief mate asked the cadet to enter a cargo hold loaded with coal to take photographs for a superintendent. The cadet entered the enclosed Australian ladder trunk, and immediately collapsed. The chief mate entered the space to rescue him and collapsed as well. Both were rescued; the chief mate regained consciousness, but the cadet did not.

Although the cargo hold and bubby hatch were opened, it is probable that there was little ventilation in the split trunks, and that gas less dense than air remained in the upper or higher sections.

The incident bears some similarities with that on board the *Viking Islay*, more than 11 years before. The vessel was in the North Sea on 29 September 2007 conducting operations related to a rig, when the anchor chain started rattling. Crewmembers attended to secure it in the chain locker. A first crew member collapsed as he descended in the chain locker and a second crew member attempting to rescue him collapsed too.

A third rescuer tried to reach them using SCBA, but was unable to enter the compartment, so he switched to an Emergency Escape Breathing Device (EEBD). As he was descending the ladder, the hood of the EEBD became dislodged, and he also collapsed. All three lost their lives.

This incident, like the one on *La Donna I*, shows that passing out can occur extremely fast; and that it is vital to be aware of what is considered an enclosed space; to thoroughly test the atmosphere before entering; to be aware of the risk of pockets of gas, to use SCBA where appropriate, and to have a rescue plan in place.

Even where all the procedures are followed, and gas testing is carried out, this is no guarantee of safety. In December 2020, The Swedish Club reported an incident on an undisclosed tanker, where a defective valve leaked oil into the pump room. Cargo operations were stopped, and the superintendent advised that the room should be ventilated. The Lower Explosive Limit (LEL) was monitored. Once it was below 1% the room was washed, and the water pumped out. Fans were brought in to ventilate the room. When one of the fans was connected to a corner that had not yet been not dried, a spark ignited a pocket of gas and an explosion ensued. The AB who connected the fan later passed from the injuries and burns.

It is probable that the ventilation did not reach that corner sufficiently to remove the gas.

This seemingly unrelated event has something in common with the incident on *La Donna*: the existence of pockets of gas, which may not have been removed by ventilation. This brings us back to IMO resolution items 6.3.2 and 6.3.3. Even if the space is ventilated and oxygen levels are carefully measured and acceptable, there is still a risk that a pocket of gas or sections depleted of oxygen remain.

The same accident could have happened in a double bottom, in a cofferdam or any intricate section or compartment where ventilating thoroughly can be difficult.

Risk assessment is not risk removal

If we are to prevent further accidents of this kind occurring, what else can be done? The regulations already state the need for:

- Ventilating;
- Measuring oxygen at different levels;
- Carrying a portable gas monitor inside the tank;
- Having rescue equipment ready including resuscitator;
- Using safety harness and fall arrestors, etc.

No procedure can cover every risk – and risk remains, even when procedures are followed to the letter. As always, the devil is in the detail.

Tanks showing acceptable levels of oxygen or lack of toxic gases at one level or area might have a different reading in another level or even in a small section. These so-called pockets of gas or low-level oxygen, might not be reached by the ventilation or by monitoring even if done at different levels.

Vessels should ensure multi-level forced ventilation of vertical compartments or, better yet, that people do not enter sections of the space that have not been directly ventilated unless absolutely necessary and using SCBA.

Spaces which appear relatively open should not be ruled out as being at risk of oxygen depletion. That includes cargo holds ladder trunks, bow thruster and forward emergency fire pump rooms, chain lockers, etc.

While use of a personal gas monitor might detect low oxygen levels, it doesn't remove risk. The onset of hypoxia can be sudden and unexpected – as seen in both the *La Donna* and the *Viking Islay*. Even if we do not collapse immediately, breathing and moving in a tank can be difficult enough in normal conditions, let alone with the onset of dizziness, headache and lack of coordination.

Entering the tank with SCBA can be challenging, moving inside the tank with it and with a foggy mask even more so. EEBDs, although smaller, may not be easier to wear and their capacity is much more limited. They should definitely not be considered as a substitute for SCBA in rescue operations.

But not all the possible situations or relevant details of the

procedures are spelled out in the regulations. My personal experience with many entries every year while performing condition surveys, vetting surveys, structural inspections and entry into enclosed spaces drills shows the following:

Problem: Communications are agreed sometimes every five minutes or ten minutes. Hypoxia can lead to brain damage after just five minutes. If the alarm is not raised well before this, the time needed for the rescue team to reach the person might mean loss of life.

Suggested solution: Rather than relying on communication at given intervals, continuous communication should be in place. Any interruption to this communication should warrant an immediate alert to the rescue party. This is open to interpretation in the regulation and perhaps the regulatory bodies can revise it.

Problem: The size of the person using the SCBA can be of relevance, as can the weather: in sub-zero environments, winter clothes can add volume and make going through a manhole even more difficult. Regardless of SOLAS regulated dimension of manholes, some older ships do exhibit openings measuring less than 600 mm, which makes the entry rather difficult even without the SCBA.

Suggested solution: When doing the entry into enclosed spaces drill, crewmembers who are fit and agile should be chosen and trained for carrying SCBA in enclosed spaces. These are the same personnel to be in situ as rescue team every time while they are on board, (as per IMO Resolution A 1050(27) 9.2 above: *only personnel trained in its use should be allowed to enter the space).*

Whenever possible, the party in the tank should chose a direct and short path of transit in the space, avoiding crossing many floors or transversal members, and staying close to the exit trunk for easy evacuation. This would be the case for routing inspections, for example.

There are other risks related to entry into enclosed spaces that are not listed above, such as collapsing decks or platforms, missing railings, etc., hence, caution should be exercised when transiting inside.

Manhole measuring less than 21 inches across (less than 530 mm)