Enclosed space operations – do we understand the real risks?

Is our current approach to risk assessment and control measures in enclosed space operations missing the point?

Dr Nippin Anand
PhD MSc MNI

On 16 May 2014, three crew members onboard the cargo ship *Suntis* lost their lives while entering into an enclosed space during cargo operations in port. The third crew member to lose his life was attempting to rescue the two crew members who had first entered the space. The preliminary investigation noted that while the oxygen content at the entrance point of the hatch was 20.9%, the reading reduced to just below 10% at the main deck level inside the hatch opening, and between 5% and 6% at the bottom of the ladder into the compartment. Similar cases of fatalities and injuries have noted the dynamic nature and distinctive challenges of enclosed space operations. According to Marine Accident Investigators' International Forum (MAIIF) statistics alone, there were 93 fatalities and 96 injuries as a result of enclosed space operations between 1998 and 2009.

Why enter enclosed spaces at all?

The Merchant Shipping Regulations define an enclosed space as one where it is 'foreseeable that the atmosphere may at some stage contain toxic or flammable gases or vapours, or be deficient in oxygen, to the extent that it may endanger the life or health of any person entering that space'. Note the use of the terms 'foreseeable' and 'at some stage' which acknowledge the unstable nature of the risk.

Ships are made of steel and structural corrosion is unavoidable when ships spend their entire lifetime in salt water. The condition of steel particularly in tanks, cargo holds and void spaces must be inspected on a regular basis to ensure that structural integrity is maintained throughout the lifecycle of the asset. This means sending personnel to carry out physical inspections. And the frequency of inspections will only increase as the vessel begins to show signs of wear and ageing. The need to ensure structural integrity, and ultimately the protection of lives and environment, is one of the basic reasons for entering into enclosed spaces in our industry. Apart from inspections, enclosed spaces may also require cleaning, painting, sanitisation and repair work (steel replacement, access to remote underwater machinery and equipment etc.).

Are pre-entry checks effective?

Despite our best efforts, incidents involving serious personal injury and fatalities continue to occur. According to the US's Occupational Safety and Health Administration (OSHA), 89% of fatalities in enclosed spaces have occurred during jobs authorised by supervisors. This shows the potential weakness in the existing approach to risk management that remains embedded in administrative controls. More importantly, it shows a failure to acknowledge the dynamic nature of risks in a space where the atmosphere can rapidly change from ambient to oxygen-deprived, toxic or flammable – all within the time span of a 'valid' permit to work (between 12-24 hours).

We need to acknowledge that the tasks we perform at the front line are anything but stable and predictable. The most critical resource to sustain life in an enclosed space is a continuous supply of (breathable) air. But the existing approach to risk assessments rarely considers this critical resource as a variable. An authorisation for access is granted based on an atmospheric check at the entrance to the space (in most cases by lowering gas monitoring sensors vertically down into the space). After that, the atmosphere in the enclosed space is measured either at the start of operations or at fixed intervals during the operation, in fixed areas within the space. But assuming the continuity and evenness of breathable air through measurements obtained at fixed points in time and space can be seriously misleading.

This means it is hardly surprising when we review OSHA reports and find out that in many fatalities the hazards were not present at the time of initial entry. It shows the transient nature of certain risks which exist only at a particular point in time and space. By measuring dynamic variables in fixed time and space we are drawn into the illusion that the risks that we face are stable and predictable.

There are of course portable gas meters that can provide continuous assessment of the atmosphere within the space, but their function and limitations are not always clearly understood. Here, the purpose of a portable gas meter is to act not as a detector (as it is commonly referred to) but as a monitor. A detector is meant to warn of a risk in advance, whereas a monitor is simply for monitoring an ongoing process or development. The situation is similar to using an echosounder on a fast moving vessel navigating in shallow water. If the technology does not provide sufficient time to respond to the situation before the hazard gets out of control, the technology should only be considered as a monitor (and not a detector).

Where a portable gas meter is not capable of detecting a gradual change in atmosphere and warning the worker (or even better, those outside the space) of what may develop ahead, the device should be treated with caution. However, some modern designs are capable of detecting and forewarning of gradual variations in atmosphere and alerting the crew.

Rescue and recovery operations

In May 2013 the Maritime Safety Committee (MSC) of the IMO added a new requirement for mandatory enclosed space entry and rescue drills. It is now mandatory to conduct enclosed space drills at intervals not exceeding two months. The problem with regulatory enforcement is that good intentions often become paper-pushing exercises. It has become common practice to conduct emergency drills in the form of table top exercises, with limited practical handling of emergencies. Even where emergency exercises are simulated, this is not always in the spirit of realistic situations. In some cases, lightweight dummies are used to demonstrate rescue and recovery from enclosed spaces, but this may not accurately simulate the actual challenges of handling a casualty through a complex web of wet and slippery steel plates. Of course this is not to suggest utilising heavyweight dummies or crew members themselves during drills, but there is a real need to be aware of crew capabilities in handling such emergencies.

Access challenges and PPE

Adding to this, physical access has always been a concern in enclosed space rescue. The extremely narrow access points, often termed 'manholes', barely allow an average size person to squash through the space. Donning breathing apparatus will only add to the challenges of a rescue operation. Even where the entrance to the space allows the rescuer to enter wearing breathing apparatus, the inside structure may become increasingly narrow and restrictive. It should also be noted that the breathing apparatus commonly found on most vessels is not designed for rescue operations in enclosed spaces; it is provided for the purpose of fighting fire in fairly accessible work spaces. In one case a seafarer commented, 'If I put on all the PPE [personal protective equipment] I will be the first casualty inside the tank'. This may be a slight exaggeration, but the danger of 'death by excessive PPE' is becoming a common perception among workers in high risk operations. Our growing preoccupation with PPE, apparently lowest in the hierarchy of risk control measures, brings to light our disproportionate focus on the behaviour of workers at the sharp end. These workers are often reminded that any compensation arising due to personal injury may be lost if adequate PPE was not chosen for the operation.

Time constraints

Rescue and recovery from enclosed spaces is also subject to time constraints. According to the UK's National Health Service (NHS) a lack of oxygen of between three and nine minutes can result in irreversible damage to the human brain. For a vessel alongside in port or at anchorage it is important to ascertain the response time needed for emergency services to turn up and familiarise themselves with the nature of emergency.

Nor is time the only issue. In one shore-based emergency, the fire department turned up and found that the team could not enter into the space wearing breathing apparatus due to the narrow access. A hole was cut alongside the manhole, which resulted in an explosion due to a lethal combination of hydrocarbons and excessive oxygen in the space. This shows the unique nature of each enclosed space operation and the need to consider the complex combination of hazards in risk awareness and assessment. An attempt to mitigate one risk may well lead to more. Furthermore, not all ports and coastguards will have the same level of commitment and resources for handling medical emergencies and evacuation, especially those in less developed countries. All these factors play an important role when every moment counts.

The role of would-be rescuers

Perhaps the most disturbing aspect of enclosed space incidents is fatalities among would-be rescuers. According to US National Institute for Occupational Safety and Health (NIOSH) publication no. 86-110, nearly 60% of enclosed space fatalities occur among would-be rescuers. The problem is not limited to enclosed space rescue alone; various studies in mountaineering, drowning, electric shock, fire and animal rescue have shown rescuers risking their own lives to save the victims. According to the UK's Royal Society for the Prevention of Accidents (ROSPA), there are at least seven animal rescue-related deaths in the UK every year. It is the fundamental nature of human beings to offer assistance to those in distress even if that means putting their own lives in danger – something that has often been misinterpreted at best as instinctive and at worse 'foolhardily stupid'. Our endeavours have focused excessively on tightening administrative barriers when the answer to the problem lies not so much in prevention and control, but in understanding why human beings act this way, and empowering them instead to act critically and be resilient in the face of such emergencies.

> " The problem with regulatory enforcement is that good intentions often become paper-pushing exercises "

Understanding altruism

Neurosciences and social sciences have both been successful at throwing light on the impulsive nature of human beings by expanding on the concept of altruism.

In everyday parlance, altruism is defined as a conscious intention of helping others. Dr Donald Pfaff demonstrates through scientific evidence that human beings are hardwired for kindness. According to Pfaff, we derive pleasure from offering assistance. There is a sense of personal gain and achievement in offering assistance. Dacher Keltner, director of the Berkeley Social Interaction Laboratory, published a study in the *Journal of Psychological Bulletin* arguing that prototypical suffering triggers massively powerful reactions of compassion in the human brain. Keltner suggests that sympathy is one of the strongest human instincts — sometimes even stronger than self-interest. A strong relationship between empathy and compassion leads human beings to imagine themselves in the position of the victim thus resulting in a feeling of mutual suffering.

The concept of instinctual altruism supports the view that human actions are not always the result of conscious choices made as a result of analysis and reflection. This is certainly the case when we examine decision making in front line operations, which involve instantaneous and reflexive thinking.

These studies in neurosciences are also supported by research in social sciences. Pearn and Franklin applied the concept of ethical altruism in drowning rescue and found that there are four main reasons for this impulsive behaviour:

- A self-imposed ethical responsibility or a duty of care to respond to those in distress.
- A shared sense of identity with the victim – something which is supported in a number of studies. The duty of care towards the victim becomes even stronger when the rescuers are related to the victims either as relatives or co-workers. In one case a bosun was asked if, given all the risks involved, he would still attempt a rescue.

The bosun responded 'I don't know, but we have to save the guy. These are our people; we have to look after our people'. Such a strong sense of professional community is not uncommon among vessel crew.

- The rescuer's own subjective perception is based on the assumption that the risk to one's own self in saving the victim is less than 100%. This subjective feeling prompts instant stimulus in the mind of the rescuer and calls for immediate action when faced with a situation.
- The moral courage that provides the rescuer 'the willpower to handle the instinctive reaction to fear'. In moments of crisis, moral courage enables an individual to overcome inner fear and instigate an action.

It is important to understand these core aspects of human behaviour in vivid detail before we claim that we can address these issues through detailed procedures and management controls. Unfortunately, the quasi-mathematical models of risk assessment that are often used to assess risk in the maritime industry are unsuited to understand this impulsive and subjective aspect of human behaviour.

Research in altruism leaves us with more questions than answers. More research is needed to understand the attributes of would-be rescuers in a global labour market, for example personal gain, faith, moral obligation, courage or a sense of community. If the answer lies in addressing impulsive behaviour, it may be a while before we can address this core aspect of human nature. It requires a training programme focused on behavioural changes and not so much on re-enforcing management controls. Until such time as this problem can be solved, we need to look instead at practical solutions and portable devices aiming to facilitate rescue from enclosed spaces.

More questions than answers

Port state controls will soon be starting a concentrated campaign focusing on examining the risks associated with enclosed spaces on ships. We keep hearing the hollow maxim: 'Do your risk assessment, sign here, wear your PPE, make sure you have completed the permit to work!' Let us hope that this policy initiative does not turn into a similar exercise in supervisory controls. Instead, policy makers should engage with the crew and make a genuine attempt to understand the dynamics and complexities of enclosed space operations from planning and pre-entry up to rescue and recovery.

Far too many lives have been lost at sea either during enclosed space operations or in attempting to rescue the victims. Let us not assume that the risks that we face in such complex situations are 'tolerable' or 'acceptable', as we often try to prove through probabilistic and deterministic risk assessment exercises.

Future designs and concepts of shipbuilding and operations should aim for better integration between human needs and engineering solutions. The point is simple – no one should be allowed in those dark catacombs if rescue and recovery cannot be guaranteed in time, and without putting the rescuers themselves at risk.

The views expressed in this article may not necessarily represent the views of the company which the author represents.