Enclosed Space Entry Awareness

Mandatory drills **OR** reinforcement of the ISM Code and SMS?

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Seafarers are still being killed by entering into enclosed spaces where there may be an oxygen deficient, oxygen enriched, flammable and/or toxic atmosphere. There is no lack of information about the risks. In fact, there is a plethora of guides, posters, videos and advice from P&I Clubs, training establishments, marine accident investigation boards as well as the IMO Recommendations for entering enclosed spaces aboard ships. The reason for continuing casualties must be insufficient knowledge of, or disregard for, the need to take precautions rather than a lack of guidance. How can we change behaviour to make sure risk awareness is automatic when contemplating entering into enclosed spaces aboard ships?

The article by Dr Barrie Jones CBE and Adam Allan MBA of the Mines Rescue Service (*Seaways*, May 2011) highlighted the problem of rescues from enclosed spaces on board ships. Notably, it mentioned that 'entrants should be aware of the environment before they enter the confined space, monitor the air quality, communicate frequently and carry escape breathing apparatus'. But this awareness cannot be taken for granted, and the best method of ensuring it is causing considerable discussion across the industry, at the IMO level and beyond.

IMO debate – drills or SMS?

At the IMO Sub Committee on Dangerous Goods, Solid Cargoes and Containers (DSC) meeting last September, a document proposed amending the SOLAS Convention to include mandatory drills for enclosed space entry. Opinion was divided during the debate. Many delegations expressed the view that the the SOLAS Convention was not the appropriate instrument to address this important issue. Instead it should be addressed by stricter enforcement of the ISM code and the Safety Management System (SMS) as the fatalities are a result of failure of these systems. As consensus could not be reached, the DSC invited member governments and international organisations to submit comments and proposals to the next meeting. This will take place at the IMO this month, September 2011.

Canvassing views

In order to represent our members' views at the September meeting of the IMO we have been collating the opinions and preferences of our members through the sea going correspondence group (SGCG), seminars, workshops and other feedback. In addition, a discussion on the topic was started on the Nautical Institute LinkedIn forum. This has proved to be the most popular discussion on the forum, with input from NI members and non-members, both sea-going and those working in the industry ashore. From the feedback, the majority view indicates that the *practicing* seafarer considers the ship's safety management system, with the support of the management, is the appropriate way to address this issue. Based on this feedback, The Nautical Institute has submitted a document for discussion at this month's meeting of the DSC reflecting these views of the members in the matter of mandatory enclosed space entry drills.

▲ Enclosed spaces safety meeting

▲ Entering an enclosed space with breathing apparatus

The case against drills

'Establishing a requirement for mandatory entry drills would set a dangerous precedent for addressing these incidents without addressing the root cause,' said one member. Some members argued that monthly drills can be beneficial in that they become regular. However, others have said that making drills the 'norm' means that they become repetitive and boring, and denigrate the importance of the behaviour being drilled. The danger is that entry procedures can be reduced to a mindless check process without some form of reinforcement.

Just ticking the box?

In this day and age, safety behaviour should be more about quality than quantity – are we getting back from the drills what we want, or are they just a means of showing the regulators that what is required is being done? Some correspondents noted that by merely introducing frequency of drills into SOLAS, we will only be instigating the senior officers to make one more drill entry. Whether the drill is actually done or not remains debatable. This theme emerged repeatedly, with another respondent saying 'We can legislate for drills, but all that does is make many crews 'flog' entries to make it seem as if legislation was being complied with.'

Others have pointed out that it will be difficult to ask a vessel to carry out realistic drills without accepting complaints from mariners that their equipment is inadequate for the task. It will end up as another 'tick box' drill to satisfy legislation. In addition, each confined space carries its own specific hazard. Access procedures, and rescue, from a large open tank require little added equipment/procedures (above the minimum) compared to a very narrow space with tight accesses and small pockets.

Even where drills are carried out properly, the realism of those drills is a function of the time, effort and interest of those running the drill and the participants. ISM already requires owners/managers to determine the known risks and develop means of alleviating them i.e. training for enclosed space entry and rescue. How would drills under SOLAS change things?

Another correspondent commented 'Just making these drills mandatory on board ships won't help because I think even the senior officers won't be very well aware of the procedures to perform an effective drill. If they had been aware of proper procedures, accidents wouldn't occur in the first place. And thus on board drills will end up being 'tick box' drill to satisfy legislation and the seriousness will be lost.'

A drill is done to ensure that the training in a particular discipline is adequate for that situation and ship and to blend the training into a team environment. It is therefore necessary to ensure that enclosed space training is completed before drills can be done.

One member highlighted as a golden rule that: 'no one should be allowed to enter any enclosed space that they cannot be adequately rescued from with the existing equipment on the ship.'

If drills and checklists are to be really effective, an attitude change is required. They are too often dismissed as mere paper-shuffling by seafarers, officers and shore-based staff for the purposes of mere compliance, not safety. An airline pilot completes his or her checklist with the thought 'If I do not do this correctly I, my crew and my passengers may die'. The same attitude must prevail when it comes to confined space checklists: 'If I do not do this correctly, I, and my friends who try to rescue me, may die'. There are cases where crew members were unaware that they were in a potentially dangerous space. More emphasis on the subject at induction stage and through shore based and onboard training for new entrants and staff at all levels is needed.

While enclosed (or confined) space entry needs to be a routine safety process, some people suggested that it is confined space rescue, rather than entry, that needs to be drilled. While this may seem counter-intuitive – because people are being killed in confined spaces – actually entering and working in them needs to be routine, and therefore the subject of entry-level competency training is crucial. We are, ironically, in danger of creating an entirely inappropriate mindset which will mystify that which ought to be routine and almost mundane.

Developing a safety culture

The discussion ventured into the safety culture issue, with many reiterating the point that 'What we need in the industry is real commitment to safety from management and senior officers with the right mindset who care about their crews. If the management of the ship, company and those responsible onboard do not follow procedures and build a sustainable safety culture the risk for accidents is very high. The training has to be given at the top of the industry as well as at the bottom.'

There has to be a culture of safety aboard the ship and a lack of commercial pressure to do everything quickly. This must start from the top. The company must be run by professionals that are committed to safety, and the ships run by management teams that are committed to safety. A fresh initiative on this is the SafeSpace project (*Seaways* Nautelex July 2011) aiming to bring together those in the industry who have an active and passionate commitment to safety and to make a safety culture an integral part of shipboard practice and within shore management.

In the article 'Building blocks of a safety culture' (*Seaways* Oct 2010), Paul Drouin noted that safety culture is first and foremost the way in which a company does business and is initiated and nurtured by senior management. However, studies have shown that companies can comply with the letter of a safety

management system without actually adopting the spirit of that system.

Senior officers on board should act as the catalyst to inspire and motivate as well as serve as the 'safety coach' for the employees under their charge and if the basic principles are understood and undertaken in good faith, a safety culture will surely take root, grow, strengthen and bear fruit.

Awareness of enclosed space entry dangers should be disseminated throughout the vessel and company through the onboard Safety Management System. All companies should have thorough procedures and training procedures in place to ensure the SMS regulations are passed down to the vessels and crews onboard.

The safety coach should make use of all available material including that from P&I Clubs, accident reports, IMO guidance, the NI MARS database and the recently launched series of training films 'Entry In Enclosed Spaces' made by Videotel. These six films, made with assistance from the Mines Rescue Service, show very graphically seafarers collapsing, gasping for air, becoming unconscious and dying in various enclosed spaces on board and deal with the on board enclosed space management to produce the overall cultural change so urgently needed.

Education and awareness

Enclosed space entry procedures should be clearly outlined in safety manuals on board and a safety culture instilled into the ship and the management ashore. This can only be achieved by constant education and training. If the management of the company and those responsible on board do not follow procedures and build a sustainable safety culture, the risk for accidents is very high. All mariners should be made aware of enclosed space entry risks and procedures as part of their familiarisation when joining a ship.

Some correspondents suggested a compulsory basic introductory awareness course in entry into confined spaces. This course could be conducted at the fire school in addition to the Marine Emergency Duties courses a mariner needs to follow in order to join a vessel. This way, all officers and ratings who work on board ocean going vessels would be quite well trained to do such dangerous tasks on board ships. Another idea put forward was to include it in STCW basic training. Before an entrant sets foot on a ship he/she should have full training in shipboard emergency procedures which includes awareness of entry into enclosed/hazardous spaces. Another correspondent asked "Shouldn't confined space training be a compulsory component of the basic SOLAS or firefighting courses?"

Several members observed that mandatory carriage and use of an oxygen meter or other device on board all vessels would help to instil into the crew a need to be aware of the consequences. However, it was pointed out that on one vessel only the Chief Officer or the cadet knew how to operate the Multi Gas detectors.

To reiterate; confined space entry fatalities and near misses continue to be of major concern to us all and are continuing to occur in spite of existing legislation, industry initiatives, education and training already in place. Most crew are aware of the hazards of enclosed space entry and their consequences, so do accidents and fatalities occur because of complacency? Do people become complacent because, on cargo and bulk carriers, they only associate enclosed space accidents with the carriage of 'hazardous cargoes' whereas those on tankers, gas carriers, chemical carriers and in the oil and gas industry are more aware of the consequences as they are daily involved in hazardous operations?

Certainly the initiatives proposed in the LinkedIn discussion are welcomed, as is anything that improves awareness on this issue and reduces this type of accident.

■ The Nautical Institute LinkedIn discussion forum can be accessed at www.linkedin.com/groups?gid=1107227. You will need to join the group to access the discussions

Enclosed space design

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Whilst tackling the cultural issues and improving training and equipment are all essential in dealing with the problem of accidents in enclosed space, the more neglected aspect, and one which deserves more attention, is enclosed space design. The overall intention of this paper is to draw the industry's attention to the problems caused by enclosed space design on board a ship, and to discuss how these problems may be overcome or alleviated either at the design stage or by assessing and, where practicable, modifying, the spaces on an existing ship.

It is a matter of record that ships have more incidents, accidents and fatalities involving enclosed spaces than any other component of the marine sector. This unacceptable situation is no longer tolerable and concerted efforts to address the safety aspects of entry and rescue from these spaces are currently under way.

There are four main contributory causes of enclosed space accidents and fatalities may be shown as a four sided dilemma: culture, training, equipment and enclosed space design.

Changing the culture of people within the marine industry toward the problems of enclosed space entry is a formidable undertaking. However, the change process is already underway with the industry generally now acknowledging that there is a serious problem – although there is some

discussion about how the culture is to be changed (see article, pp 11). Whilst tackling the cultural issues, together with training and equipment, are all essential in dealing with the problem, the more neglected aspect of the four, and one which deserves more attention, is Enclosed Space Design.

Accidents

It is regrettable that in any review of enclosed space incidents onboard ship, the impact and effect that enclosed space design has on entry, work and rescue has not been considered.

In industry ashore, entry, work and rescue are major considerations in the design of any structures which contain enclosed spaces. Onboard ship, the only regulation for tank design is that regarding the manhole size on bulk carriers and tankers, with requires sizes of 800mm x 800mm for vertical and 800mm x 600mm for horizontal entries. These dimensions are specified with the sole intention of allowing a person wearing a breathing apparatus [BA]set to enter them. It is strange that only bulkers and tankers ships are singled out for even this very basic requirement as accidents and fatalities are shown to occur on all types of ship.

Case study: *Viking Islay*

In the tragic case of the *Viking Islay*, where three crew members died, investigators missed the contributory factor of tank design in their conclusions. The entry point especially was crucial. According to the report:

'During the consequent rescue efforts, the first rescuer found he was unable to enter the chain locker wearing a BA, and therefore donned an Emergency Escape Breathing Device (EEBD). He subsequently entered the space, but at some point the hood of the EEBD was removed, (or became dislodged) and this rating also collapsed.'

Of course the rescuer should not have entered the tank with an EEBD, but it was the inability to get in with a BA set that caused him to wear it. If he had been able to enter the chain locker wearing a BA then it could well be that he would be alive today and possibly have been able to rescue at least one of the casualties.

Case 2 – *Saga Rose*

Similar problems occurred in the fatality on board the *Saga Rose* in Southampton in September 2008. According to the investigation: *'The rescue team entered the cofferdam wearing Self Contained Breathing Apparatus (SCBA) at 15.25 hrs and assessed the second bosun to be deceased shortly before 16.00 hrs. The limited room available, the possibility of contaminated air and low oxygen levels, and the high temperatures experienced, all hampered the removal of the second Bosun from the tank which was not completed until 19.10hrs.'*

This prolonged and unacceptable rescue time was clearly not the fault of the crew, as the report goes on to say that: *'The ship's internal procedures worked very efficiently. The response team assembled in the purifier room within about three minutes, and the safety officer, staff & chief engineer were quick to enter the space with ample breathing apparatus.'*

Case 3 – *Ville de Mars*

Apart from accidents due to lack of oxygen or the presence of dangerous gases there are numerous accidents in enclosed spaces due to falls.

The MAIB's accident database records numerous instances of falls from relatively low heights which have resulted in minor injuries. Since 2005 there have been 16 serious injuries occurring on board UK registered ships of 500 gross tonnage and over as a result of falls from fixed ladders, including those fitted in tanks, when the casualty was not wearing a safety harness or fall arrestor. It must be remembered that these accidents are only those investigated on UK registered ships. It can only be surmised that the total worldwide must be many times higher.

On 28 January 2009 the chief officer of the UK registered *Ville de Mars* entered a water ballast tank for inspection purposes. During his inspection he fell. Extract taken from the report; *'Without an eye witness, it is not known exactly how or why the chief officer fell. Given the oxygen levels measured during his entry, and that none of the crew who rescued him from the tank wore BA, it is extremely unlikely that he lost consciousness through asphyxiation. It is also extremely unlikely that he fell through the access hole in the first stringer; otherwise he would have landed on the middle stringer where the ladder terminated. Also, had the chief officer fallen backwards from the ladder, he would probably have landed near the centreline, not on the port side of the tank. Therefore, as the chief officer stepped onto the stringer moments before he fell, it is almost certain that he fell off its un-guarded edge, possibly as a result of slipping on its sludgy coating while holding his torch in one hand and the gas analyser in the other.'*

'On this occasion, the absence of lighting was significant. The chief officer was totally reliant on his torch, which was probably of limited use as he descended the ladder.'

'The stringer from which the chief officer fell was wide enough to stand on comfortably but, unlike the stringer below which was a permanent means of access between the two vertical ladders, it was not required to have guardrails fitted. The requirements of MSC 133(76) apply only to structures in the tanks of oil tankers and bulk carriers which are also designated as permanent means of access for the purpose of inspection.'

There are many more such cases, each different in their own way, but all of them involving some aspect of failure of 'human' design in these spaces. Essentially, we need to recognise that, when designing any enclosed space on board a ship, consideration should always be given to the fact that people may need to enter these spaces and, in some instances, be rescued from them.

While a ship is in itself an enclosed space and the size and structural strength in certain cases will limit what can be achieved, it would seem that there is currently no culture of consideration for the human factor in the design of enclosed spaces, either in legislation or at the design stages of a ship's construction.

Design factors

Human activity within the space should always be the prime consideration and it must be seen as the starting point in the design cycle. Safety procedures, training and specialist equipment can be put in place when the ship is completed, but the design of the spaces will determine the effectiveness of those measures.

▲ An example of a difficult access. It is not possible to wear any type of BA set to enter this compartment

The factors which may affect human survivability need to be considered and where possible, solutions established. Amongst these factors are:

- Adequacy and quality of respirable air;
- Suitable and sufficient lighting (illumination);
- Ease of access into and out of the space;
- Ease of movement within the space;
- Ability to undertake rescue operations.

If these factors were assessed at the earliest stages of design, and where possible, the space designed to an established standard, then undoubtedly there are many improvements which can be made to exisiting layouts.

Respirable air

The first and foremost requirement for any person entering an enclosed space is to be able to breathe freely and without hindrance. It therefore follows that the adequacy and quality of respirable air within the space is of utmost importance.

Prior to opening up a possible hazardous space, consideration should be given to the previous contents which may have produced substances or gases which are or may be injurious to health. An obvious benefit would be to check the air quality prior to opening the space thus lessening the risk by minimising exposure. This may be achieved by allowing samples of air to be drawn off through sampling pipes which are fixed in place through bulkheads via an external valve arrangement, thereby allowing the air quality to be determined. Internally, the open end of the sample pipe can be positioned to give the most effective representation of the air inside the space. This would be particularly advantageous in horizontal spaces.

If this could become a shipbuilding standard, it would ensure that all spaces classified as permanent risk spaces could be continually monitored by those on the ship and, in particular, prior to entry.

Whether or not this function exists, sufficient time should be given to establish a ventilation system when opening up an enclosed space, in order to ensure that air containing a sufficiency of oxygen to sustain life is introduced into the space.

This air may be introduced in one of two ways:

- Natural Ventilation: Where a compartment has two or more access points, these need to be opened simultaneously, preferably one at either end of the compartment, in order to create a natural flow through of air. Special care should be taken if the presence of contaminants is suspected and the direction of flow has not been established. Where the direction of the natural flow is known, the air from the space should be ducted to an external point thus preventing potential contamination of the area surrounding the space. Unfortunately, natural air ventilation seems to be the default in too many spaces where mechanical ventilation would be a preferred option.
- Mechanical Ventilation: Mechanical apparatus such as fans either forces air into or exhaust air out of a space. Whatever the system, entrances are opened simultaneously and the mechanical system introduced to the space. Again, care should be taken to duct away air from the space if the presence of contaminants is suspected. Portable ventilation systems are available but it is our observation that many more spaces would benefit from fixed forced ventilating systems.

Lighting

The vast number of spaces entered will have no natural light. On the majority of ships, crew members carry an artificial light source into the space in order to see where they are going and to illuminate the immediate work space. This often encumbers the users, or is not adequate to light up dangers within the space.

Whilst there are certain spaces in a ship, where for safety reasons, fixed lighting cannot be fitted; there are many spaces where fixed lighting could be installed. This would considerably improve the safety standards of those entering and working in the enclosed space. There are two systems of internal lighting:

- Fixed Internal Lighting: Obviously, fixed permanent lighting is the best and most suitable option, utilising fittings which are robust, waterproof and where required intrinsically safe. This system is hard wired inside the space with the supply cabling coming outside the space to an isolation breaker. Switching arrangements can be either inside or outside the space. This is an expensive option, but it meets all the requirements of the entrant in relation to luminosity.
- Temporary Internal Lighting: A second and more commonly used method of fixed lighting is 'string lights', frequently used when in port or dry dock. These low voltage lights may be installed throughout the space on a temporary basis and removed on completion of the work. This option gives high levels of luminosity but cabling can get tangled and there is the risk of damage to cables, junctions and fittings if they are not properly supported.

Access

Access into and out of enclosed spaces is a particular concern. In the majority of cases, they are not designed with safety and rescue as the prime consideration. Points to consider include:

- Manholes: It can be a time consuming and labour intensive task to remove the nuts and open up the space. These covers, normally being of heavy plate construction, have a notable lack of bespoke lifting handles, risking nipped or fractured fingers or toes. During a temporary stoppage of work these covers are rarely replaced due to time constraints. At best the cover is placed across the manhole leaving gaps at each end. In heavy weather, these covers can slip away if not secured. This problem could be addressed by employing quick release mechanisms and built in lifting points, thereby saving time and increasing safety factors.

The physical size of the opening is of paramount importance. It is essential that anyone going into an enclosed space can be rescued from that space. It therefore follows that the openings must be of a sufficient size to allow rescuers to enter these spaces wearing a BA set and also allow a stretcher to be taken in and hoisted out.

- Handrails and hand holds: These should always be present at the point of entry and immediately inside in order to provide the entrant with additional support and confidence. All platforms inside a space should have guard rails.
- Ladders and footholds: Most vertical access points into tanks or compartments have permanently fixed ladders or foot holds to enable safe and easy entry. Ladders need to be immediately below or inset from the openings so as not to restrict the person entering. On many ships these ladders are bent, broken or corroded. As with all ladder systems these should be continually maintained to ensure that they remain in good order. It is extremely difficult for the ship to maintain these vertical ladders whilst they remain fixed in position. If they are not maintained regularly at each docking, the best way to maintain these ladders is to disconnect them and take them out of the space. If the ladders were designed in short removable sections, the necessary maintenance could be carried out on board the ship.
- Anchorage points: Permanent anchorage points are essential, and should be fitted above each vertical entry point

where a temporary tripod or quad pod lifting system cannot be employed. They should be checked and load certified at the required intervals in conjunction with the winch system.

- Limited height and width: Ideally, these issues should have been picked up at the design stage and the problem engineered out. Unfortunately that is not always the case.

Ease of movement

Ship's crew may need to enter an enclosed space for many reasons, not least to carry out inspection, repairs or maintenance. Once inside the space the entrant can find it difficult to traverse due to the physical size of the space, awkward bulkheads, strengthening girders, pipes and lightening holes. Consideration should also be given to the numbers of persons having to enter the space, their physical and mental state and any additional equipment or tools which may be required to do the work.

However, access through the space can be made easier by tackling the most obvious obstacles; those of manhole entrances and lightening hole dimensions.

Increasing the size and shape of the opening will allow for easier movement and lessen the stress on the entrant by physical exertion. Although there may be structural reasons why these lightening holes are of the size they are, increasing their dimensions or altering their shape where possible, will considerably benefit the safety of persons operating in these spaces and assist in their rescue if necessary.

Other design factors to consider would be to install handholds, safety rails and internal walking or working platforms to prevent people having to negotiate beams within the space. This would inevitably help to make the space safer for the entrant and reduce the possibility of accidents from slips, trips and falls.

Rescue operations

The problem of rescuing someone from an enclosed space is a most difficult operation and requires specialist equipment and trained personnel (see full report, *Seaways*, May 2011).

At some time or another most seafarers have had reason to enter a difficult enclosed space. It is essential that those entering the space know that they can be rescued if required, and that those in charge of the operation have confidence that they can perform such a rescue.

In all enclosed space design, it must be anticipated that for the purpose of rescue a BA set will be worn by the rescuers. It therefore follows that all access and entry points and indeed the areas within the space need to be able to accommodate the additional width of a person and breathing apparatus.

▲ A very small access within a tank, restricting movement inside

▲ This access is adequate but regrettably, the builders have put a cable run across the access

It is just as important that the area in front of and adjacent to the entry point is kept as clear as possible to enable an effective rescue to be carried out.

If we can address these problems at the design stage we can go a long way to eliminating the issues associated with rescue operations.

Further action

Having reviewed the effects of tank design on personnel access and the benefits which would undoubtedly be gained from giving consideration to the points highlighted in this paper, it becomes apparent that the safety of those working in these enclosed spaces could be enhanced by design considerations for human entry and work.

One of the most important issues, certainly from our perspective, is that of the ability to carry out a swift and efficient rescue, should that be required. The current arrangements make it difficult to enter many spaces wearing BA sets, surely a fundamental issue which requires immediate attention. If the entrance is too small to get in wearing a BA set, then we must question why personnel are required to enter these spaces.

The ship's own assessment of their existing difficulties is of considerable benefit. It is surprising just how much can be done to improve the onboard situation with the welding of hand holds, extra steps and eyebolts. Even the use of luminous strips to mark low beams or steps in dark spaces can assist towards overall safety.

Of prime importance is the ship's staff knowledge of which spaces can be entered with the existing rescue BA sets and which cannot, and whether rescue winches can be deployed over vertical entrances. This advance information can be lifesaving in any enclosed space emergency.

The present unacceptable casualty rate in these spaces cannot be tackled by resolving only one part of the overall problem. As efforts are continuing to deal with the culture, training and equipment issues, these should be matched by the realisation that enclosed space design must be recognised as an equal part of the problem and efforts made to deal with this situation. For existing ships, we need a combination of assessment by those on board who must report their findings of existing ship's space problem areas, coupled with shore management realising that the design is part of the problem. For newbuildings, it is the naval architects, the shipyard and those standing by who must also accept that every space on the ship will at some time or other require humans to enter it. It is in all our interests to ensure that we make that space as safe as we can.

In a personal capacity…

Seaways' authors are often employed in senior positions within the shipping industry, whether seagoing or ashore. They may represent international organisations, maritime authorities or ship-operating companies. Many are active in The Nautical Institute, at branch or Council level.

However when they write for our journal, they do so in a personal capacity unless otherwise stated. Their views are their own and do not necessarily represent their own organisations or the Institute.