Confined space operations

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Abstract The intent of this paper is to further stimulate a global approach to managing the risk exposure for seafarers working in, on or around confined spaces. Whilst this requires a holistic approach, this paper focuses on the standards of training and competence, in an effort to enhance the human and confined space operations interface within maritime specific training, drills, equipment and regulatory aspects. The ultimate aim being to mitigate the rate of injury and fatal incidences.

It is widely accepted in the maritime industry working in, on or around confined spaces has its risks. Whilst these risks are controllable, incidents resulting in serious injury and fatalities are nothing new, the continued loss of seafarer lives must be addressed.

In an effort to improve safety, the International Maritime Organisation (IMO) released its revised recommendations for entering enclosed spaces aboard ships in 2011. However incidents listed by maritime investigation bodies since the adoption of the IMO’s revised recommendations, suggest more needs to be done. The introduction of mandatory entry & rescue drills are certainly a move in the right direction; question is, are they enough to positively influence safety and reduce incidents? Or do they simply provide a mechanism to tick the compliance box.

Why is it, in this day and age, seafarers are still succumbing to the hazards and risks of these spaces? Investigative reports often cite the cause of fatalities, as atmospheric, this being the most common hazard. What is contributing to these lethal situations? Is it a combination of error inducing factors at individual, job or organisational levels?

More needs to be done in developing and embracing standards, including operational, equipment and training to enhance human reliability and reduce error inducing factors and those fatal consequences that follow. Could part of the answer be the introduction of confined space training under the mandatory Standards of Training, Certification and Watchkeeping (STCW) structure?

Keywords: Competence, standards of training certification and watchkeeping, confined space operations, fatalities, error inducing factors, relevant.

1. Introduction

‘Seafaring has always been one of the world’s most dangerous occupations’ [25]. The maritime industries guidelines and regulations have been developed and enhanced in response to many incidents over the years. In 1912 when the RMS Titanic collided with an iceberg tearing a hole in her, many lives were lost. This event prompted the creation of the International Convention for the Safety of Life at Sea (SOLAS) with the first convention enacted in 1914 [26]. Standards for training, certification and watchkeeping were introduced in 1978, through the implementation of the International Convention on Standards STCW.

Prior to this, standards were set by the governments of each country, subsequently the standards across the global maritime industry proved inconsistent. [27].

Across the globe, countries/flag states have various regulatory frameworks and guidance documents, along with recommendations from the IMO and yet, fatalities continue to occur.
Standards for training associated with enclosed/confined space currently remains under the control of governing countries with a wide range of standards. The vast differences in approaches to confined space is supported by a global survey conducted in 2011 by Enhesa, an environmental, health and safety consultancy firm, specialising in supporting business to meet regulatory requirements. Enhesa found, of the sixty countries surveyed, “no two countries used the same regulatory approach”. [16] As the maritime industry has a diverse multicultural workforce, would it not make sense to standardise this training under the STCW.

2. Background

Incidents resulting in fatalities in, on or around confined spaces aboard ships are nothing new; sadly this ‘unnecessary and avoidable loss of seafarer’s lives’ [3] is a theme that has been continuing for many years. For the ill-informed or ignorant seafarer, confined spaces may be likened to an iceberg. Whilst the top of the space can be clearly seen, they may not appreciate or be aware of what may lay beneath the surface. In this day of age it is reasonable to expect seafarers to have a heightened level of knowledge and awareness of the risks which may be associated with confined spaces.

Whilst the loss of lives attributed to confined space work on vessels should not occur, it does! According to Patraiko D[1] this remains ‘a deadly serious issue, and one which the marine industry has to come to grips with,’ this is further echoed by Lloyd and Allan’s view that the maritime industry ‘have reached a critical situation with more people injured and dying in enclosed spaces than through any other related on-board work activity.’ [2] Surely the time has come for change of mindset, with more needing to done to address the continued loss of seafarer’s lives. The international maritime community must become more proactive and move to develop, embrace and enforce standards, which address the harsh realities of confined space operations within the industry. It is time to get serious about this deadly issue.

It is the opinion of the author’s that forward progress to reduce the rate of incidences can only be achieved through a holistic approach addressing aspects such as; ship design, safety culture, procedures, appropriate equipment & most importantly seafarer competence.

3. Confined space fatalities

In 2007 the Maritime Accident Investigators International Forum (MAIIF), identified the rate of incidence, resulting in fatalities and serious injuries across the maritime industry on global scale was increasing [4]. In 2008 the Marine Accident Investigation Branch (MAIB) of the United Kingdom, released a global safety bulletin, highlighting the issue of fatalities as a result of spate of confined spaces incidents. Contained within, the MAIB released details that the MAIIF had received responses from eighteen flag states at this time identifying “120 fatalities and 123 serious injuries had occurred since 1991”. [4]

The industry as a whole should be horrified by these figures derived from such a small percentage of flag states, particularly when one considers what the magnitude of the true figures could be, if all flag states data had been included. It is fair to say that we may never know or appreciate the true magnitude of seafarers who have sustained fatal injuries, serious injuries, minor injuries and/or near misses. This is a significant challenge for the maritime industry, but it is one that must be undertaken. The time for change has come.

Confined space fatalities and serious injuries are not restricted to international shipping alone. It affects all of the maritime industry regardless of; the ship’s country of origin, seafarer’s nationality, or the position one holds in the crew compliment. People are dying in these spaces unnecessarily, from cadets starting their career to the chief officer and all that come between. No singular vessel type is exempt; it occurs on them all, tankers, bulk cargo, containerships, passenger liners, roll on roll off, trawlers, barges, cruise vessels, research vessels and the list goes on.
4. Continuing incidents

The incidence of seafarers sustaining injury when interacting with confined spaces are continuing, the following incidents represent a brief overview: March 2014 a first mate, died from asphyxiation after entering a hold containing zinc concentrate. During the rescue the space was found to have an oxygen concentration of 2.8%. [5] May 2014 two crewmen and a chief officer lost their lives during preparation to unload a vessel with a cargo of sawn timber and the rescue party narrowly escaped death during the rescue. [6] August 2013 during an attempted recovery of a broken oil sampler, a master lost his life and a cadet sustained injuries. Prior to their entry atmospheric testing established the following readings: 20.6% oxygen, with HC at 26% of LEL. [7] June 2011 a chief officer and a crew member, peered through a hatch and saw the bosun lying motionless. They raised the alarm, prior to the emergency team arriving, the chief officer entered the space to assist he collapsed, the other seaman entered to help he collapsed. All three were recovered from the space, the chief and seaman recovered in hospital however the bosun died. [8] November 2009, a chief mate on a chemical tanker lost his life after entering a cargo tank containing hydrocarbon vapours and deficient in oxygen. [9] May 2009 a chief officer and an able seaman went to the aid of other crew member who was overcome by toxic cocktail of hydrogen sulhide, volatile organic compound (VOCs) and mercaptans vapours. The chief officer was overcome as they had no respiratory protection; luckily they made a full recovery [10]

The following incidents highlight that one does not need to be in the space, to be impacted by it: November 2001, eight seafarers lost their lives as a result of a ballast tank explosion that occurred during the painting, of the eight only one crew member was in the space. [11] July 1996, three seafarers lost their lives and six sustained irreversible medical conditions, when an engineer opened a refrigerated seawater tank’s side door. The engineer was quickly overcome, two seafarers who came to his aid were overcome and six others in the vicinity were injured. [12] These examples are a small sample of death and injury associated with confined spaces and without serious intervention incidences will continue to grow and seafarers will continue to die.

5. Contributing factors

After a serious incident investigations are conducted to ascertain the root cause and determine how similar incidents can be prevented. The contributing factors can often be referred to as ‘human factors which fall into three basic categories, individual, job & organisational’ [22]. Investigative reports will identify a range of factors that may have contributed to a fatality or serious injury. Common themes re-emerge time after time. They are: lack of competence, acting on impulse or emotional decisions (rescuer), inability to identify confined spaces, complacency and failure to follow confined space entry procedures including: poor preparation and planning, inability to identify hazards, risks and suitable control measures. The list continues with ineffective safety management system procedures, lack of equipment which is fit for purpose, or inappropriate use of equipment and training in the use of equipment. If these ‘factors are not managed they are known as error inducing factors’. [22]

‘Often the concept of human error leads to the conclusion that the intervention should be directed towards the human operator e.g. more training, better education’ etc. [21] and while this conclusion is not always the cause, there can be no better argument for better skills and knowledge development for those likely to be affected by confined spaces.

6. Who needs to address this?

The International Maritime Organisation (IMO) principal function is to facilitate the development, implementation and maintenance of international regulatory frameworks that support international shipping. One of these areas is safety, which is addressed through the Safety of Life at Sea (SOLAS) convention. [13] The SOLAS convention is considered to be one of most important conventions, the first convention coming about after the sinking of the Titanic. Since then there have been modifications, updates, amendments and subsequent release of consolidated versions.
There is no disputing that the IMO has achieved much in the area of safety, for example the regulatory framework surrounding the prevention of fire through the Fire Safety Systems (FFS) code and the levels of training to prevent and respond to fire addressed by the Standards of Training & Certification for Watchkeepers (STCW) is sound. However! Compared to the likes of fire little has been done to stem the wake of fatalities and injuries, which continues aboard ships when working in, on or around confined spaces.

In 1997 the IMO provided guidance for the entering of enclosed / confined spaces through the introduction of the Resolution A.864 (20) Recommendations for entering enclosed spaces aboardships. [28] Sadly since the adoption of the resolution and up until 2009 there have been at least 101 incidents, resulting in 93 deaths and 96 injuries. [14] November 2011 saw the adoption of revised recommendations through Resolution A.1050(27). These recommendations provide sound guidance, however they are not mandatory. They ‘are intended to compliment national laws or regulations’. [15] Whilst it seems feasible to use such recommendations to compliment national laws and regulations, national laws and regulations are typically orientated to the land and not necessarily designed for confined space work in remote and isolated situations such as shipping. It has previously been stated that, the regulatory approaches found across the countries of the world are very different. This in turn impacts on how a confined space is defined and as a result how confined space work is approached.

In January 2015 a new resolution came into force, bringing change to SOLAS chapter three regulation nineteen (Emergency Training & Drills). This requires seafarers with roles and responsibilities relating to confined space entry & rescue, to participate in drills at least once every two months [17]. This resolution refers to ‘revised recommendations for entering enclosed spaces aboard ships’, [18] These mandated entry & rescue drills are certainly a move in the right direction: the question is, are they enough to positively influence safety and reduce incidents? Or do they simply provide a mechanism to tick the compliance box? Anecdotal evidence suggests that there is room for improvement at all human factor levels, with particular emphasis on individual factors.

In general terms the maritime industry tends not to use the term ‘confined space’, instead continuing to use the term ‘enclosed space’, which the IMO “defines as a space which has limited openings for entry and exit; inadequate ventilation; and is not designed for continuous worker occupancy”. [18] This definition fails to bring to the attention of seafarers working in or around confined spaces the potential, and foreseeable risks; furthermore many hazardous areas are only partially enclosed. Could the IMO’s definition contribute to seafarers’ not recognising areas that are potentially life threatening.

Whilst the requirement to conduct drills for confined space entry and rescue is acknowledged, a question remains, what standards underpin the training, procedures and equipment requirements of those drills? Could substandard knowledge, skills and acceptance of inappropriate equipment be inadvertently perpetuated?

7. Time to change the mindset

All too often when discussions occur, procedures are written or legislation is drafted the term confined space “entry” is used. Entry being: “the act or instance of entering, a point or place for entering” [19] Use of the term entry might also lead people into a false sense of security, i.e. if we are not actually entering the space, there is minimal or no risk! Rather than thinking about the entire operation at hand or indeed acknowledging the high casualty count of people affected by confined spaces without entering them. E.g. Eight seafarers died when a ballast tank exploded, only one had entered the space. [11] Three seafarers died and six sustained irreversible respiratory damage, no one had entered the space. [12] It is the opinion of the author’s that the term confined space should be used rather than enclosed space. This allows for a broader and more risk based definition, such as the one used by the Australian regulatory framework as listed below:
‘A confined space means an enclosed or partially enclosed space that:

- is not designed or intended primarily to be occupied by a person; and
- is, or is designed or intended to be, at normal atmospheric pressure while any person is in the space; and
- is or is likely to be a risk to health and safety from:
  - an atmosphere that does not have a safe oxygen level, or
  - contaminants, including airborne gases, vapours and dusts, that may cause injury from fire or explosion, or
  - harmful concentrations of any airborne contaminants, or
  - engulfment’. [29]

If the maritime industry enforced the adoption of a more holistic approach and used terms like confined space operations: operations being ‘a process, method or series of acts especially of a practical or mechanical nature’ [19] instead of enclosed space entry, could this lead to greater awareness, increased safety, supporting a reduction in the rate incidents and unnecessary loss of life.

As the broader maritime industry is a truly global industry, it makes perfect sense that an international maritime standard for confined space operations aboard ships be developed. In doing so all regulators, shipping companies, operators and seafarers across the maritime industry could consistently address the issues associated with these high risk operations.

The industry as a whole needs to change its mindset towards how work in, on or around confined spaces is conducted. The starting point for this change must rest with the International Maritime Organisation by laying down mandates followed by a collaborative approach amongst industry stakeholders to reduce the risk. This holistic change should include, but not be limited to, ship designers, safety culture, procedures, equipment, and competence.

7.1 Designers

Wherever possible during the design process and subsequent manufacturing of ships, attention should be given to remove the necessity to enter confined spaces. Where elimination is not a realistic option, spaces should be designed in a manner to reduce the risks associated when entering and working in the space. Consideration needs to be given to ease of access, exiting, retrieval and emergency extrication from such spaces.

7.2 Safety Culture

Most would be aware of situations were errors of judgement or complacency and the outright ignoring of procedures have led to serious injury and/or the loss of life. Some might assume this is the junior seafarers unfortunately this is not the case, even chief officers that should know better, but probably don’t, are making these fatal errors. If senior personnel are exhibiting a lack of knowledge, know how, or promote cutting corners, what message does this send to other crew members.

It is the opinion of the author that in order to support an industry wide improvement in safety culture, there needs to be more specific regulatory frameworks in place underpinned by standards of training and competence levels. A good foundation to support such change is the development and implementation of sound confined space management plans, an outline of which was published in 2013 in the maritime journal Seaways. [20]

7.3 Procedures

Each vessel should have confined space management plans complete with checklists embedded within the Safety Management System that outlines a clearly defined processes that seafarers can work through to safely undertake work in on or around confined spaces. The plan should highlight what is required to
done; before work commences, during occupancy, upon exiting and what to do in the event of a confined space emergency. These procedures should be supported by realistic and relevant training drills and auditing system to validate and monitor compliance on board.

7.4 Equipment Use

Anecdotal evidence identifies in some cases crew members are entering spaces without personal atmospheric detection, leaving them vulnerable and unaware of atmospheric changes. Whilst many vessels have atmospheric detectors of sort, it is as of 1st July this year ‘a new SOLAS regulation XI-1/7 on Atmosphere testing instrument for enclosed spaces, to require ships to carry an appropriate portable atmosphere testing instrument or instruments, capable of measuring concentrations of oxygen, flammable gases or vapours, hydrogen sulphide and carbon monoxide, prior to entry into enclosed spaces’ [30].

There should be a minimum standard of equipment defined by the industry and specific training in the use of the equipment should be mandated. Having the right equipment is one thing knowing how to use it is another, which brings us back to competence of the seafarer.

8. Competence

The definition of competence has been argued for many years and is not the subject of debate in this article, for the purpose of this paper competence will be referred to as the ability to complete a job task efficiently and safely (trained) which is different to knowing how to do it (educated).

‘Education and training are not the only two factors affecting individual competences. Other factors should also be considered. For example, personal characteristics such as ability, experience, cognitive capacities, receptiveness, behaviour, knowledge background etc. Also the environment to which individuals are exposed to; whether in their personal environment or in the organisation environment that they work in are important factors.’ [31]

The citation above supports the concept that competence is an ability based measure which is achieved through the practical application of knowledge and skills over time in a range of circumstances to enhance, maintain and fine tune initial training or education. To this end, someone who has completed a formal training course, is able to apply the principles of that learning back to their work place and able to adapt those principles to the unique nature of the job under initial guidance should be able to work more safely, efficiently and effectively into the future.

It can be argued that personal characteristics, like abilities, change over time based on the opportunity to apply learned knowledge and skills. This trait is often accelerated when similar past experiences are used to support the evolution of those particular work abilities. However, it needs to be acknowledged that workplace guidance from colleagues and supervisors can act as both positive and negative influences on the development and maintenance of initial training based on the attitude, practical skills and level of knowledge that they hold. This raises the question, are the supervisors competent to supervise confined space entry procedures?

9. Recommendation

Current evidence overwhelmingly suggests that something needs to be done and soon. A valuable support mechanism would be the adoption and implementation of an IMO model course with mandatory training outcomes to be agreed at an STCW convention with mandatory refresher training as is the case with other safety based courses.

A three days course that covers at least the following, should form the basis of the mandatory STCW course for confined space operations.
Day 1: the basic knowledge and skills required by an individual to participate as part of a confined space work team including but not limited to: Defining a confined space, roles and responsibilities, hazard identification, risk assessment, control measures, isolation practices, entry and retrieval equipment, permit requirements, stand by attendants, planning for emergencies.

Day 2: gas detection and the use of atmospheric detection equipment and respiratory protection, including self-contained breathing apparatus (SCBA) and airline systems; &

Day 3: theoretical and practical aspect of confined space rescue, specific to shipboard environments.

10. Conclusion

At present there are substandard procedures and practices being undertaking in the maritime industry with devastating effect, which are leading to the loss of seafarers lives. The maritime industry as a whole including: maritime institutions, shipping companies, associations, unions all need to step up and become more proactive in addressing this issue.

There is a clear need to mandate standards of training for confined space operations on board ships/vessels. Training needs to be rigorous enough to ensure that course outcomes achieve what they say they will, and that subsequent assessment of competence is clearly aligned. It is important that seafarers truly understand, what is needed to work safely in, on or around confined spaces and it is especially important that those embarking on their careers have a plan to develop their knowledge and skills beyond routine day to day tasks and to have their knowledge and skills challenged from time to time with appropriate refresher training.

Seafarers invariably leave maritime education facilities with a foundation of knowledge and skills that will almost always need to be developed and adapted to fit a vessels operations and design, let us all make that foundation as strong and resilient as we can.

References