Enclosed Space Problems on Ships

‘Our View’

Who are Mines Rescue?

The formation of the ‘Mines Rescue Service’ followed public outcry in the United Kingdom at the substantial loss of life in Coal Mines during the latter part of the 19th Century. It was noted that the predominance of fatalities was not due to the initiating fire or explosion but to the devastating effects (poisonous and noxious gases) travelling around the mine ventilation system. The resulting ‘Royal Commission on Mines’ recommended that, a suitable breathing apparatus be sourced, suitable personnel be selected and trained to wear this breathing apparatus for rescue purposes and that suitable premises be established to house rescue equipment and train those selected personnel in the use of breathing apparatus and rescue techniques. The first ‘Mines Rescue Station’ was opened in the UK in 1906 with the Coal Mines Act formalising rescue arrangements in 1911.

Since our inception, the mines rescue service has been involved in all of the coal mining disaster situations in the UK throughout the 20th and 21st centuries where the penetration of contaminated and restrictive areas were required in order to save life and property. Gleaning first hand information from these situations over the last 100 years has aided us in the creation of our rescue and extrication techniques and development of our specialist breathing apparatus & rescue equipment. Today, Mines Rescue Service Ltd., (a not for profit organisation), continue our support to the remaining UK coal mining industry whilst simultaneously assisting other companies to resolve their confined space rescue problems in the utility, chemical, industrial and power sectors.

Overview:

The ongoing problem of ‘enclosed space entry’ facing seafarers is one which I am sure concerns all involved, particularly when loss of life occurs. Unfortunately, not only the entrants suffer those dramatic consequences but in some instances potential rescuers have also died. Historically, MRSL have

first hand experience of this situation, indeed, our creation was as a direct consequence. Therefore, following senior level review within MRSL it was decided, as part of our strategic planning programme, to look at the potential for offering a service, related to 'Enclosed Spaces', into the 'Maritime Industry'. In order to maximise our ability to offer any advice and/or assistance, we needed, (as a matter of urgency), to identify any gaps between current practices and what is perceived as best practice in the field of 'Enclosed Spaces'. Although MRSL are recognised on shore as "experts in the field", we are relatively unknown in the maritime industry and have no working knowledge of the problems faced from 'enclosed spaces' on board a ship. By way of addressing this issue, a series of ship board visits were arranged where, 'potential problem areas', were identified, solutions proposed and rescue drills carried out. The findings from our 'ship board visits' are detailed in the following article.

Ship Visits

Understanding the problem was the key issue, on boarding a ship it became apparent that the 'whole of a ship', inside the super structure, was an enclosed space, in many cases their were many enclosed spaces within an enclosed space. The areas which were particularly problematic were identified early, examples being the chain locker, engine room, fore peak, pump room and off course double hulls, others were not so obvious such as the paint locker, refrigerator units etc. What they all have in common, irrespective of their degree of rescue difficulty, is their ability to do serious damage to an entrant if the correct procedures are not implemented to control the risks. Our expertise is in the rescue and extrication of people from difficult environments, therefore, this article will deal with the techniques and equipment we utilised for casualty extrication whilst on board ship.

Enclosed Space Exercise No 1 (double bottom)

Of the examples listed above all have their own peculiarities and levels of difficulty, however, the one perceived to be most challenging, is the situation faced when rescuing a colleague from a double bottom. This requires both a horizontal and vertical extrication. Similarities were observed in the double bottoms of the vessels we visited in that height and width restrictions were evident and bulkheads incorporating lightning holes increased the degree of difficulty by impeding free lateral movement.

The Rescue Scenario

The rescue scenario consisted of a man who was injured whilst carrying out an inspection in the double bottom area of the ship. During our drill session we simulated a live casualty, (mines rescue personnel), with lower leg injuries located several bulkheads inward of the access point. The exercise involved the location, treatment and transportation of this casualty from the double bottom onto the ship's upper deck.

The Rescue Exercise

The exercise began with the rescue crew setting up a tripod and winch system on the upper deck above the access point into the hull. The entry hatch was oval in shape and measured approximately 420mm x 600mm

Plate 1: Entry Hatch

From this point the rescue crew (3 men) entered and travelled through the hull to the entrance to the double bottom, which was of similar dimensions to the deck entry point. Descending a short ladder, the three rescue crew entered the double bottom, testing the atmosphere as they progressed. Locating the casualty, one rescuer checked the casualty's condition whilst the remaining two rescuers prepared the rescue stretcher. When appropriate, the casualty was man handled onto and secured into a rescue stretcher, thereafter, manoeuvred through and out off the double bottom.

Plate 2: Casualty Man Handled to Stretcher

Plate 3: Casualty on Rescue Stretcher

The exercise concluded by transporting the casualty through the hull of the ship to a position below the deck access hatch where the stretcher was attached to a mechanical winch system and raised vertically onto the deck.

The rescue crew consisted of 3 personnel, employing the following equipment:

1. Tripod
2. Winch (37m)
3. Rescue stretcher
4. Multi-gas monitor
5. First aid equipment

Enclosed Space Exercise No 2 (No 4 Tank)

The No 4 tank is accessed via a raised rectangular bolted hatch located on the lower deck, incorporated into the hatch is a restrictive oval entrance, (measuring approximately 600mm by 400mm). This hatch allows the entrant to penetrate the tank by descending a fixed ladder to the steel floor of the upper compartment, access to the lower compartment is gained through a similar sized oval aperture, (which was slightly offset from the deck hatch), and second vertical fixed ladder.

Upper compartment – 1m broad by 5.5 m deep and is approximately 7m wide.

Lower compartment – 0.92m broad by 5m deep and is approximately 7m wide. Movement in the lower compartment was further restricted by a 300mm pipe (located 1.3m from the floor) and a 100mm pipe (located 4m from the floor), both pipes run across the compartment and were attached to bulkheads on opposite sides.

Plate 4: Access to No 4 Tank from deck level

Plate 5: Access to Lower Compartment

The Rescue Scenario

The rescue scenario consisted of a man who was injured whilst working beneath the 300mm pipe situated in the lower compartment, he subsequently collapses between steel strengthening webs under the pipe which causes further obstruction. This scenario fits well with our remit of rescue from an enclosed space combined with vertical casualty extrication.

The Rescue Exercise

A live casualty was placed in the area identified above. He was and remained conscious throughout the exercise and had sustained lower leg injuries, when located he was sitting with his back to the bulkhead opposite the fixed access ladder.

Two rescuers entered No 4 tank monitoring the atmosphere and running out a fixed wire communications system whilst they progressed, a third rescuer meanwhile erected a tripod on deck and attached a 37m winch system, (as

their were no height restrictions, the tripod was erected to full extension). The first two rescuers descended both ladders and located the casualty in the position identified (see plate 6).

One rescuer climbed down to assisted the casualty from beneath the pipe whilst the second rescuer pulled the casualty upward and over the pipe. The prepared rescue stretcher, in the mean time, had been lowered via the winch from the deck into the lower compartment in preparation for transportation of the casualty. The rescue stretcher was then positioned behind the casualty and both rescuers secured the casualty to the stretcher in an upright position (plate 7).

Plate 6: Casualty located under 300mm pipe

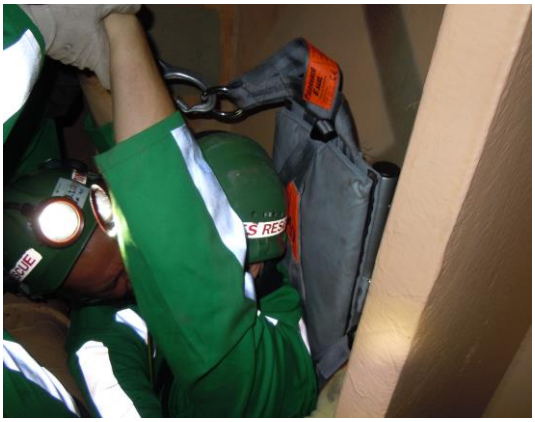

Plate 7: Rescuers attaching the casualty to stretcher

The stretcher was then attached to the winch system and casualty lifted from behind the pipe, (whilst being supported by both rescuers), and manoeuvred toward the lower compartment access hatch. One of the rescue personnel climbed into the upper compartment prior to raising the casualty thereby guiding the stretcher top and bottom.

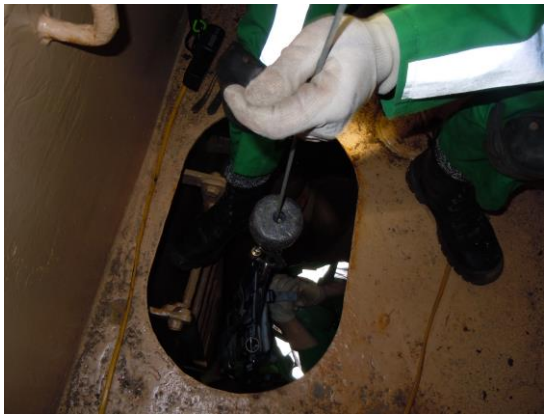

Plate 8: Casualty being raised into upper compartment

Plate 9: Casualty emerging into the upper compartment

The access hatch, (as shown on plate 8), although snug, allowed the stretcher and casualty to be extricated comfortably into the upper compartment. Positioning of his arms above his head, (see plate 9), assisted in that process.

Once into the upper compartment, the casualty was stabilised whilst both rescuers again moved position to ensure ease of movement to deck level. The casualty was finally winched through the upper compartment access and onto the lower deck of the ship completing the exercise.

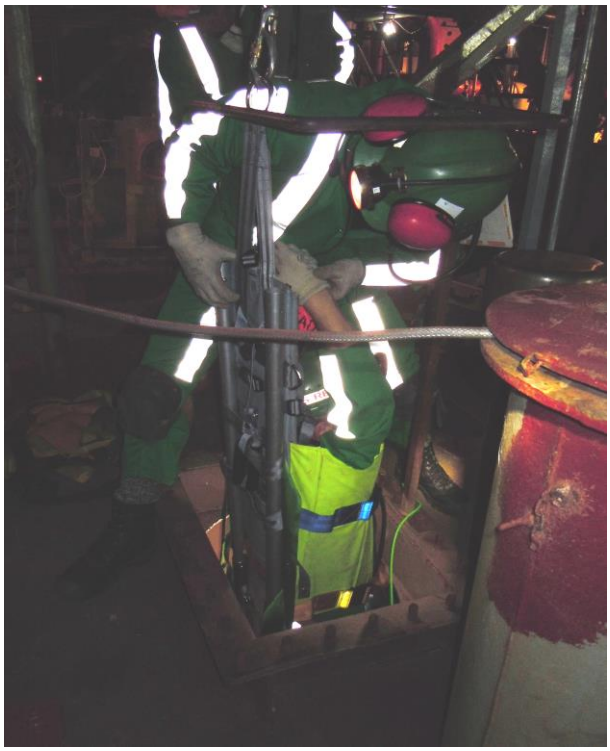

Plate 10: Casualty being recovered onto main deck

The rescue crew consisted of 3 personnel, 2 rescuers and 1 winch man, employing the following equipment:

1. Tripod
2. Winch (37m)
3. Rescue stretcher
4. Multi-gas monitor
5. Communications equipment (Hard Wire System & Radios with head sets)
6. First aid equipment

Enclosed Space Exercise 3 (pump room)

The ship's pump room is accessed from the upper deck level via a hinged rectangular door and has 4 internal decks extending from the upper deck to the ship's hull. Each internal deck is constructed of Kennedy Grating with an inclined ships stairwell leading to the next level. All walkways on all levels have hand rails fitted in order to help prevent inadvertent slips, trips and falls occurring. The lower, (or bottom), deck is fitted with 6mm steel anti slip floor plates. Beneath the deck plates, (bilge area), are several large bore pipes and valves with bulkheads containing lightning holes to aid access into the more enclosed space areas of the bilge.

The Rescue Scenario

For the purpose of this exercise, a casualty has been injured whilst painting inside the bilge area. The remit given to the rescue team is to locate treat and recover the casualty to the upper deck where he can be handed over to the medical team.

The Rescue Exercise

A live casualty was placed in the area identified above, he is semi conscious and in need of immediate evacuation. The drill was initiated whilst the team were viewing the lower deck, (bilge area) and had therefore no rescue equipment to hand.
The rescue team, formed up, discussed a plan of action and gathered all relevant rescue equipment from the upper deck. A 37m winch was attached to a suitable temporary anchorage point, and rescue stretcher opened and laid out on the deck plates ready to receive the casualty. At the same time, one of the rescue personnel entered the bilge carrying a rescue harness and gas monitor. The atmosphere was checked and rescue harness fitted securely to the casualty.

Plate 11: Harness fitted and casualty removed through lightning hole

A second member of the rescue crew then climbed into the bilge area and assisted with the horizontal removal of the casualty from the enclosed space (plate 11 & 12). Manually handling the casualty out of the enclosed space was made easier by having one rescuer inside and one rescuer outside of the enclosed space to receive the casualty. Having eased the casualty out of the enclosed space his harness was attached to the winch and slowly & carefully raised to the lower deck, (guided by both rescuers plate 13). At lower deck level, the casualty was laid onto and secured into the rescue stretcher in preparation for the next phase of the exercise (plate 14).

Plate 12: Casualty assisted out of bilge area

Plate 13: Casualty hoisted to Lower Deck level

Plate 14: Casualty secured to rescue stretcher and prepared for lifting

The second phase of the exercise was difficult and arduous as it consisted of locating or manufacturing anchorage points at each subsequent deck level, securing the winch and lifting the stretcher up each stairwell whilst being guided by two rescuers. On each occasion, the winch cable was attached to the head end of the rescue stretcher and the stretcher pulled up the inclined stairwell (plate 15). At all times we endeavoured to have three points of contact with the casualty in order to prevent any accidental movement of the stretcher.

As the stretcher and casualty reached each level it was found easier to manoeuvre the stretcher manually to the next lifting position where it was re attached to the winch and the lifting procedure repeated. The exercise culminated with a final lift onto the top deck. This was the most difficult component of phase 2 as the stairwell terminated near the entrance door and no suitable anchorage point could be found at that location. The final lift therefore was achieved by means of attaching two strops and karabiners to the head end of the stretcher and heaving from the top whilst the third rescuer lifted and pushed the stretcher from below. At all times the stretcher was stabilised by the rescuer situated below the stretcher preventing lateral movement. The exercise concluded, when the casualty was transported onto the upper deck through the access door.

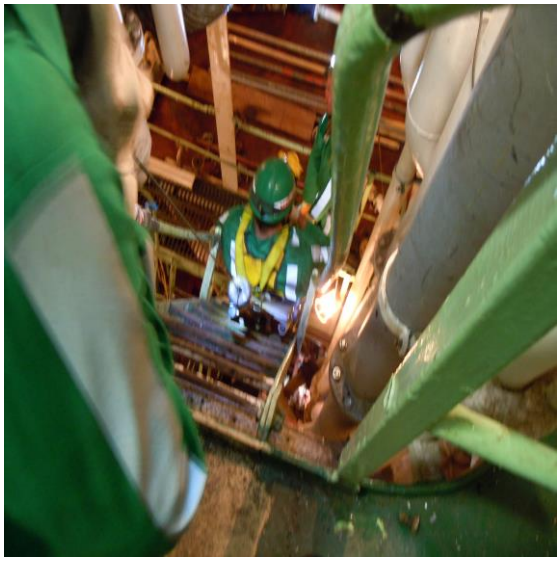

Plate 15: Casualty being winched up stairwell

The rescue crew consisted of 3 personnel, 2 rescuers and 1 winch man, employing the following equipment:

1. Winch (37m)
2. Rescue stretcher
3. Multi-gas monitor
4. Rescue harness

As stated earlier, each of the exercises in turn had their own unique problems to overcome, what did become apparent was that the more obvious enclosed space areas (double bottom and No 4 tank) did not present the most physically demanding situation. Perception should also be guarded against, it is not always the areas which look obviously enclosed which can be dangerous, a good example being the pump room which is open, light and large in volume. Lurking behind sealed doors are invisible risks such as gas and fumes which may be given off from various sources, therefore, always check the atmosphere before entry and safe guard yourself.

Following each exercise we held a de-briefing session with all involved, the following points were discussed as learning points for us for the future, I hope they can help you when compiling your own training programmes and rescue drills in the future.

Conclusions:

1. Exercise 1, (carried out in the 'double bottom'), proved to be rather challenging, predominantly due to the 'lightning hole' dimensions limiting movement of the stretcher. We found that:
    a) fitting a 'rescue harness' to the casualty assisted with the manual handling process.
    b) transporting the casualty head first was advantageous.
    c) positioning of the rescuers, in relation to the casualty, was of paramount importance
    d) forward planning was an essential element of the rescue
    e) team work and effective communication was essential.

    Given our unfamiliarity with the environment, a second exercise was undertaken which improved both our efficiency and casualty extrication techniques, thereby reducing the time taken significantly.

2. Exercise 2, (No 4 tank rescue), proved to be more restrictive than the previous exercise, in that, the positioning of pipes and general tank width, (of 0.95m), limited movement. However, we found that;
    a) an optimum number of 2 rescuers was required in this instance.
    b) communication between deck and rescuers played an important part as the opened stretcher had to be lowered into place when required.
    c) Modifying the casualty's position on the stretcher assisted in the extrication process.
    d) Again, positioning of the rescuers during the recovery operation was essential, one above one below.
    e) A 'bottom lift' was required to give the additional clearance required onto the deck.

3. Exercise 3, (pump room), proved to be the most physically arduous, in that, the casualty had to be removed from the bilge and lifted vertically onto the bottom deck before being lifted a further three decks to the main deck level. In this instance we found that:
    a) Fitting a ‘rescue harness’ was advantageous
    b) Lack of suitable anchorage points limited progress
    c) Inclination of ladders and narrow walkways limited progress
    d) Manpower (3 rescuers) made the exercise physically demanding

4. In all of the exercises, a significant part of the extrication process was carried out by a portable mechanical winch system, this was found to be particularly advantageous and minimised the manual handling process. The winch system is user friendly, employed a ‘fishing rod’ design, lightweight, easy to use, portable but most of all versatile as it only required one anchorage point.

5. Tripods are frequently used as portable anchorage points by rescue teams ashore, in general ‘suitable anchorage points’, (for attaching a lifting equipment) were limited. The system used provided stability, height versatility and matched the requirements of the mechanical winch system.

6. Rescue harness used throughout the exercises proved invaluable to the rescuers as a means of manual handling and lifting the casualty. These were taken in with the rescuers and fitted to the casualty, they are not generally part of the PPE worn by seafarers when entering these spaces at sea.

7. Portable lighting used throughout the rescue exercises was of a type worn on the helmet. Unlike a hand torch which is generally used, this type of lighting allowed the rescuers to locate the casualty and view the surroundings, ‘hands free’.

8. The flexibility of the stretchers used during the exercises allowed the rescuers more scope when dealing with the different situations. Both types used were versatile and allowed for a horizontal as well as a vertical rescue operation.

9. Communication in any rescue situation is invaluable, two systems were employed (one radio and one hard wire) allowing rescuers and deck to maintain contact during the various exercises.

10. Access points to the enclosed spaces (i.e. lighting holes etc.), are very restrictive, (some measuring only 450mm x 600mm) therefore rescue personnel had to be selected for the exercise.

11. All exercises were undertaken in a ‘fresh air environment’ should the use of full breathing apparatus be required this would undoubtedly extend the extraction process.

Recommendations

Equipment Appraisal

1. I have no doubt that the equipment used for both exercises was fit for purpose and that any future 'on board' enclosed space rescue would benefit from using the following equipment:

- Winch/Hoist System - the design of the equipment lent itself well to the tasks asked of it and made lifting a heavy weight easier.
- Tripod - although of limited use, it made a good anchorage point in the first exercise.
- Communications - an essential component of enclosed space equipment, the combination of hard wire and radio worked well, each with their own merits. In the case of the radio system the head set had the added advantage of being hands free.
- Rescue Stretcher - we decided on the paraguard stretcher for both exercises, it was versatile and ideally suited to both vertical & horizontal rescue scenarios.
- Portable Lighting - undoubtly, the enclosed spaces found on board are dark or poorly lit areas, by adopting head lamps it made for a hands free operation.
- Rescue Harness - the rescue harness gave another dimension to our rescue, it gave the rescuer the necessary flexibility when combining a horizontal and vertical extrication as experienced in the second exercise.

Exercise Observations

2. Hands free communication equipment and personal portable lighting were undoubtly advantageous and should be adopted principles for reasons of safety when entering enclosed spaces.

3. Adjustments should be made to the stretcher lifting point, for the final lift in order to gain the additional height necessary to clear tank entry points.

4. The dimensions of lightening holes make it difficult for man access let alone rescue. Consideration should be given to this when designing man access into tanks and enclosed spaces.

5. Suitable and specific anchorage points are insufficient in number, consideration should always be given to casualty evacuation, (anchorage points), at the design or modification stages of a ships life.

6. Although limited numbers of rescuers could only work in some extremely enclosed spaces, at the point of exit additional help should be made available to assist with any rescue operation when in a safe environment.

Closing Comments:

Although documenting only three exercises for the reader, many other enclosed space areas of the ships visited were viewed and potential problems discussed. Several of which, offering up the same general problems, that of space and height restrictions. These, (challenges), were overcome by a combination of having many years experience in perfecting our rescue techniques from enclosed spaces and just as importantly by employing equipment which is 'fit for purpose'. Having now experienced at first hand some of these 'enclosed space' situations, I have no doubt that effecting a rescue from these environments will test the ability of even the most seasoned seafarer. I only hope that from the enclosed text the reader may glean some information from the techniques performed by Mines Rescue which will help to reduce or eliminate the accident rate from enclosed space entry at sea.

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