CASE STUDIES
MARINE INDUSTRY

WSHCOUNCIL

FOREWORD

Every year, more than 300 injuries befall our workers in the marine industry. Some workers who are severely injured face long roads to recovery or suffer from permanent incapacity. Some may never return home to their loved ones. It is our belief that no one should be injured at work. Everyone should go home safely every day, free from harm.

My Committee, comprising of business leaders from the marine sector, has put in a lot of effort to safeguard the workers. Although we have reduced the number of fatalities over the years, such incidents still happen, and sadly, some of these incidents are very similar in nature. Hence, the lessons drawn from these incidents are key to us in preventing the next incident from recurring. That is why we have pooled together our WSH expertise from various companies to compile these case studies.

This booklet is divided into various sections according to incident type for easy reference. The underlying causes of these accidents are carefully examined through root cause analysis. I hope that you will make full use of this compilation, to share these cases at your company's training or toolbox meetings on a regular basis. I also encourage you to study through each case, review its relevancy and context to specific workplace situations, and incorporate the lessons learnt where appropriate.

Let us be reminded that every accident can be prevented and every worker's life matters to us.

Thank you.

Prof Chan Eng Soon
Chairman
Workplace Safety and Health Council
(Marine Industries) Committee

WSHCOUNCIL

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STRUCK BY OBJECTS

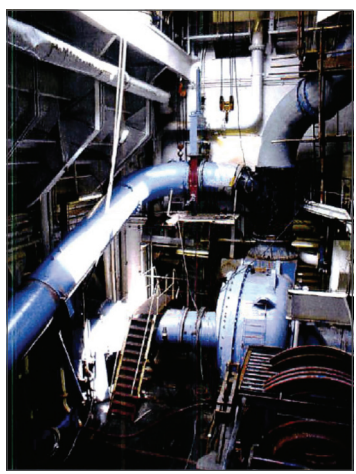
CASE 1

WORKER STRUCK BY LIFTING LUG WHILE REMOVING ELBOW PIPE

Description of Incident

The deceased and three other workers were using a chain sling to remove an elbow pipe from a suction pipeline in a pump room. When the overhead lifting crane raised the elbow pipe, the lifting lug that was welded to the elbow pipe gave way and struck the deceased, causing him to fall off the pipeline he was sitting on. He fell onto the unguarded platform and the impact caused him to roll over and fall again, hitting another pipeline before eventually landing on the floor of the pump room.

The lifting lug gave way along its welding joint, detaching the elbow pipe.



Overview of the accident scene.

Observations and Findings

Man

- The deceased was wearing a safety belt but it was not anchored during the lifting operation.

Method

- The occupier and employer did not provide supervision for the pipe dismantling work.

- The management did not ensure that safety assessment of the work place was conducted before the work was carried out.

Machine

- Not Applicable

Material

- The lifting lug was sent for failure analysis. It was found that the welding between the lifting lug and the elbow pipe was inadequate, and was unable to sustain its load during the lifting operation. As a result of overloading, the elbow pipe detached itself from the lifting lug.

Environment

- The open sides of the platform were not barricaded with guard rails, thus the deceased fell through.

Root Cause Analysis

Evaluation of loss	• 1 worker killed.
Type of contact	• Struck by moving object during lifting operation followed by fall from height.
Immediate cause(s)	• Inadequate welding between the lifting lug and the elbow pipe; and open sides of platform not barricaded to prevent falls.
Basic cause(s)	• Lack of hazard identification training for the lifting lug method to lift the elbow pipe; and lack of supervision when assessing work place safety and implementing safety measures before the work was carried out.
Failure of WSHMS	• Failure to verify the integrity of the lifting lug prior to the lifting operation.

Lessons Learnt and Recommendations

Risk Assessment	• Ensure risk assessment is conducted to mitigate all risks associated with lifting and working at height.
Safe Work Procedure	• To include verification of lifting lug integrity prior to the lifting operation in safe work procedure. • Ensure that safe work procedure is well-communicated at all levels, especially to relevant personnel such as on-site workers. A suitable level of supervision may be required to ensure that Safe Work Procedures are adhered to, in order to prevent unsafe practices and improper work methods. • Whenever reasonably practicable, edge protection such as barricades or guard rails should be installed to prevent people from falling off.
Work Planning	• The supervisor should assess the working area before commencing lifting operations. • Hazardous work must be carried out in the presence of the supervisor.
Equipment and Tools	• Every worker working at height with a risk of falling must be provided with a suitable and individual fall arrest device, such as a safety harness with lanyard attached to a shock absorbing device. The safety harness must be worn correctly and secured to an anchor point or an independent lifeline at all times.

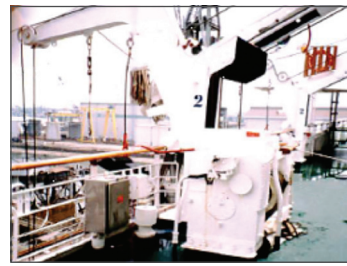
CASE 2

WORKER HIT BY METAL HANDLE IN GEAR SHAFT

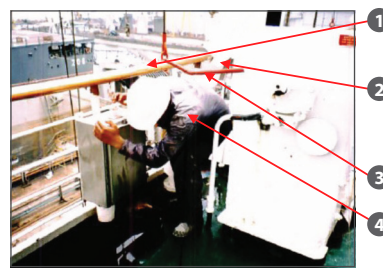
Description of Incident

The deceased and another member of the ship's crew were winching up wire ropes after a lifeboat had been lowered onto the water for testing. During this process, the wire ropes went out of alignment with the slots of the wire drum. The winch motor was stopped and the deceased used a detachable metal handle attached to the gear shaft of the motor to manually ease the tension of the wire ropes.

Upon completion, the deceased crouched as he made his way out of the narrow space between the shipside railing and the winch drum. The detachable metal handle attached to the gear shaft started to move abruptly, hitting the deceased's head. The deceased co-worker immediately pressed the stop button to stop the winch motor.



Winch system which was used to lower the lifeboat.



Deceased was struck on his head by the moving metal handle when he attempted to get out of the narrow space he was working in.

1. Shipside railing.
2. Constrained space.
3. Metal handle.
4. The deceased's position when crouching out & re-enactment.

Observations and Findings

Man

- Deceased was in an inappropriate position when operating machine.
- Crew not familiar with the functions of the machine.

Method

- Detachable metal handle was not removed after the alignment work.
- Deceased exited the work area through an unsafe path that exposed him to risks.
- Lack of proper communication or coordination between workers.

Machine

- The safety system failed to function as intended.
- Interlocking device of the winch system failed due to a limit switch overrun. Maintenance and inspection of the limit switches was found to be inadequate and their activation point limits overlooked.

Material

- Not Applicable

Environment

- Not Applicable

Root Cause Analysis

Evaluation of loss	• 1 worker killed.
Type of contact	• Struck by metal handle.
Immediate cause(s)	• Improper position for task.
Basic cause(s)	• Inadequate knowledge of machinery.
Failure of WSHMS	• Inadequate preventive maintenance and inspection.

Lessons Learnt and Recommendations

Risk Assessment	• Risk assessment should identify unsafe areas and SWPs should indicate safe means of access and egress.
Safe Work Procedure	• SWPs to be developed for both operational and maintenance work.
Equipment and Tools	• A maintenance programme for the periodic inspection and maintenance of equipment and machinery can help track their status and ensure they are in a serviceable state.
Training and Awareness	• All operators should know the SWPs of machinery they are operating.

STRUCK BY FALLING OBJECTS

CASE 3

WORKER HIT BY SCAFFOLD TUBES

Description of Incident

The day before the accident, a group of workers was tasked with dismantling the scaffolds inside the tank of a ship. On the day itself, the deceased was at the bottom of the tank tying up a bunch of scaffold tubes which were winched to deck level of the ship. As the tubes were raised, they struck a steel structure causing the tubes to come loose. The tubes subsequently fell and hit the deceased.

At the time of the accident, about 70% of the scaffold had already been dismantled.

The scaffold tubes struck a structure and fell while they were being winched up.

Snap hooks could be left open if not positioned properly.

Observations and Findings

Man

- The deceased and his co-workers had been trained prior to the accident. Their training course had covered the clove hitch half rigging method, and the workers were advised not to stand below suspended loads.

Method

- The scaffold tubes were bundled together using the clove hitch half method, which is common practice. A simulation was conducted after the accident to assess if the rigging method was able to secure the bundle of scaffold tubes adequately. It was discovered that while the method was adequate, the design of the snap hook, in this case could be left partially opened if not positioned carefully.

Machine

- Not Applicable

Material

- Not Applicable

Environment

- The steel structures in the tank presented obstacles for the lifting work.

Root Cause Analysis

Evaluation of loss	• 1 worker killed.
Type of contact	• Struck by falling object.
Immediate cause(s)	• Improper positioning of snap hook.
Basic cause(s)	• Inadequate hazard identification. • Lack of worker training.
Failure of WSHMS	• Failure to identify the hazard (improper orientation of snap hook) that could have contributed to the dislodgement of the snap hook. • The training provided to the workers should have adequately highlighted the proper use of the snap hook.

Lessons Learnt and Recommendations

Equipment and Tools	• Safety features, such as the safety catches of lifting hooks, must be engaged to ensure a safe lift. • Only lifting gears that have been tested and certified by an authorised examiner should be used during lifting. The Workplace Safety and Health (General Provisions) Regulations states that it is the duty of the owner of any lifting gear to ensure that they are properly maintained.
Training and Awareness	• Ensure that safe work procedures are well communicated at all levels, especially to relevant personnel such as on-site workers. Suitable levels of supervision may be required to ensure that Safe Work Procedures are constantly adhered to, to prevent unsafe practices and improper work methods.

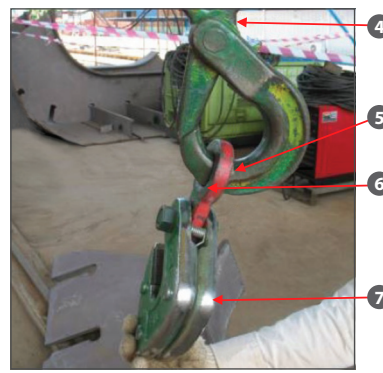
CASE 4

WORKER CRUSHED BY FALLING OBJECT DURING LIFTING OPERATIONS

Description of Incident

The deceased and his co-worker were tasked to shift five web frames using a gantry crane. The web frames were to be inserted and welded onto a curve plate assembly. When the last web frame was being hoisted, the deceased slipped and instinctively grabbed onto the web frame, causing it to dislodge from the horizontal clamp and consequently, the frame pinned the deceased to the ground.

Overview of accident scene.



The clamp used was not compatible with the hook of the chain sling.

1. The fifth web frame which slipped out of the clamp.
2. Location of the horizontal clamp.
3. Position of the deceased.
4. Hook of the chain sling.
5. The horizontal clamp could not "sit" vertically on the hook of the chain sling as the base of the hook is thicker than the eye of the clamp.
6. Eye of the clamp.
7. Horizontal clamp.

Observations and Findings

Man

- Co-worker did not attend the in-house safety induction course, but was permitted to work on the premises.
- Deceased had not undergone the rigger and signalman course before being placed on on-the-job training.

Method

- The control measures stated in the risk assessment, Safe Work Procedures and toolbox briefings were not implemented.
- The rigging method of the web frame was inadequate. Only one horizontal clamp was used when lifting the web frame which, due to the frame's irregular shape, did not allow for a firm grip on it.
- The horizontal clamp could not sit properly on the hook, due to some size incompatibilities between the two parts. The base of the hook was thicker than the eye of the clamp. In this case, a shackle could have been used to secure the clamp to the crane hook and prevented the load from shifting, but this was not implemented.

Machine

- Not Applicable

Material

- Not Applicable

Environment

- Not Applicable

Root Cause Analysis

Evaluation of loss	• 1 worker killed.
Type of contact	• Crushed by falling object.
Immediate cause(s)	• Unsafe act.
Basic cause(s)	• Improper lifting method.
Failure of WSHMS	• Failure to ensure proper and adequate training for workers. • Lifting Supervisor not present during works.

Lessons Learnt and Recommendations

Risk Assessment	• Before any lifting operation, a competent person should verify that the established lifting method is adequate and that the right equipment has been selected for the job.
Safe Work Procedure	• Ensure that safe work procedures are well communicated at all levels, especially to relevant personnel such as on-site workers.
Work Planning	• Newly trained workers must be closely supervised on the job.
Equipment and Tools	• Incompatible use of lifting gear (clamps and hook without shackle).
Training and Awareness	• All persons involved in the work must be adequately trained to be competent at their jobs, as well as aware of the risks and safety precautions required.

CASE 5

STEEL STRUCTURES FELL ON WORKER DURING CUTTING

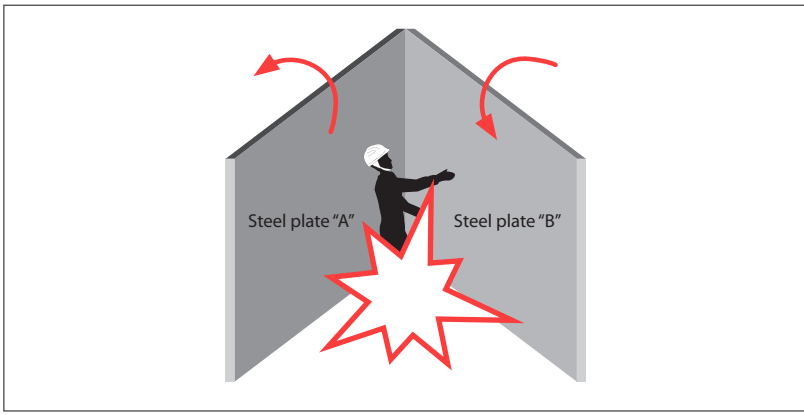
Description of Incident

Approximately three days before the accident, the yard manager tasked the deceased to use an oxy-acetylene torch to cut the plates of the U-shaped scrap steel structure. The cut plates were to be laid on the ground to be used as a base.

Using a forklift to access the required height, the deceased managed to cut one plate (2.4m in height) on the same day. The remaining steel structure was left free standing in an L-shaped manner.

Two days later, while cutting the L-shaped steel structure, one of the plates (measuring approximately 5m x 2.4m, and weighing approximately 1.5 tonnes) fell onto the deceased, killing him.

Close-up view of the other uncut U-shaped scrap steel structure.



Plates A and B were not supported to prevent toppling when the deceased cut through them.

Observations and Findings

Man

- The yard manager had instructed the deceased to use the forklift to support the plates during cutting. However, he did not explain or demonstrate how he intended for the deceased to use the forklift to support the plates during the cutting work.

- The deceased was not a trained forklift operator and it was the first time he had cut such a U-shaped steel structure. The deceased should not have used the forklift to access heights, which is an unsafe act.

Method

- The yard manager claimed that using a forklift to support the cutting of the U-shaped steel structure was in accordance with the yard's safe work procedures (SWP).

- The SWP developed was too general and did not state the type of support needed. There was no support during the cutting of the L-shape plate.

- Based on the size and weight of the structure, a forklift could not have provided sufficient support while cutting.

Machine

- Not Applicable

Material

- Not Applicable

Environment

- Not Applicable

Root Cause Analysis

Evaluation of loss	• 1 worker killed.
Type of contact	• Struck by falling object.
Immediate cause(s)	• Lack of support to prevent toppling.
Basic cause(s)	• Wrong method of work. • Non-compliance with SWP.
Failure of WSHMS	• FSWP developed was too general and did not state the type of support needed.

Lessons Learnt and Recommendations

Risk Assessment	• Risk assessment should be conducted to identify and mitigate risks involved in the work.
Safe Work Procedure	• SWPs must be implemented and followed to ensure effectiveness. • SWP should be more task specific.
Work Planning	• Unstable structures must not be left standing freely. They must be supported by external structures such as breams and struts. • Cutting or breaking down objects can de-stabilise a previously stable object. Means of ensuring stability during and after cutting must be put in place.
Training and Awareness	• Workers must be adequately instructed on how to carry out work safely, especially if the work is non-routine. They must also be made aware of the hazards involved.

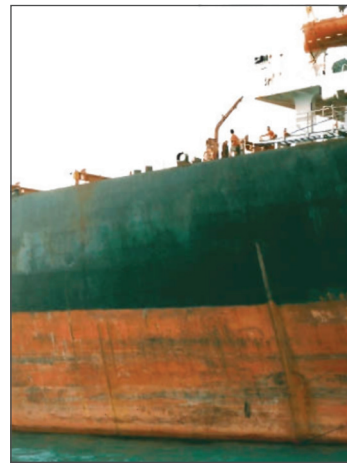
CASE 6

WORKER KILLED BY FALLING OBJECTS

Description of Incident

Four workers were involved in repair works onboard the ship. After completion of the work, the workers left the ship and boarded a boat docked alongside it. Their supervisor rigged nylon bags containing tools to fibre ropes and used them to lower the loads onto the boat. While the deceased was untying the third load, the supervisor lowered the 4th load which comprises a chain-block and wire ropes.

As it was being lowered, the load came loose and dropped approximately 10m before hitting the deceased on the head.



Location of boat and persons onboard during lowering process.

Type of sling bag used.

Observations and Findings

Man

- Despite being a trained lifting supervisor, the supervisor failed to observe safe work practices (SWP).

Method

- The employer did not establish any SWPs for their activities, including works onboard the ship at anchorage. There was also a lack of basic safety measures, such as safety training and/or tool box meetings.
- Although full sets of PPE were provided for employees, the PPEs were not used.
- Lifting equipment was available onboard but not utilised.
- The wrong rigging method was used to secure the nylon bag to the fibre ropes.
- The supervisor lowered the fourth load even though he was aware that the third load was being untied and that there were workers beneath the suspended load.

Machine

- Not Applicable

Material

- Not Applicable

Environment

- Not Applicable

Root Cause Analysis

Evaluation of loss	• 1 worker killed.
Type of contact	• Object falling from height.
Immediate cause(s)	• Using ropes and nylon bags to manually lower items. • Lowering loads above workers on boat. • Improper securing of loads.
Basic cause(s)	• No safe work procedures (SWP) for the activity.
Failure of WSHMS	• Safe work practices on manual lowering of loads were not clearly defined.

Lessons Learnt and Recommendations

Risk Assessment	• Proper risk assessment must be done before any work commences.
Safe Work Procedure	• SWP on manual lifting/lowering of loads must be established.
Work Planning	• No persons are allowed to work under a suspended load.
Equipment and Tools	• The ship's crane or derrick should be used to lift/ lower loads, instead of manual lifting. • Proper sling bags and correct rigging methods must be used.
Training and Awareness	• Workers must be briefed on SWPs and personal safety requirements during tool-box meetings prior to work commencement.
Coordination and Communication	• Proper work coordination and communication to be established prior to and during work execution.

CASE 7

WORKERS HIT BY STEEL PIPE DURING LIFTING OPERATIONS

Description of Incident

A crawler ringer crane was used to lift a 182 ton spud can. As the crane operator slewed the spud can into its final position, the crane experienced resistance and the boom could not be extended further. The operator attempted to overcome the resistance by increasing power to the boom, causing the crane to collapse to the ground. The spud can fell onto the starboard main deck of the oil rig and landed on an excavator.

Shows accident site from seaward view.

As a result, three workers were killed immediately and another three sustained varying degrees of injuries.

Observations and Findings

Method

- There were no physical barriers erected at all possible points of entry to keep all workers and vehicles away. While working, the scaffolders were asked to stop work by the lifting supervisors and riggers, who were also aware of the lifting process. However, once the suspended spud was a distance away, the scaffolders resumed work.

- Works on the oil rig were permitted to continue working within the lifting zone. Lifting personnel would sound the crane's horn and whistles, which proved to be ineffective in getting workers to evacuate the lifting zone.

Machine

- It was found that the crane was placed on inclined ground, and that it exceeded 18 times the tolerance limit. Also, the leveling indicators used to ensure that the ringer was kept level were not precise or sensitive enough to be able to detect that the inclination was beyond 0.1 degrees which was the manufacturer's recommended equipment for such a purpose was the manometer.

Material

- Not Applicable

Root Cause Analysis

Evaluation of loss	• 3 workers killed and 3 workers injured.
Type of contact	• Struck by falling objects (falling crane boom).
Immediate cause(s)	• Failure to use appropriate equipment to ensure that the crane erected was level.
Basic cause(s)	• Failure to keep workers away from the lifting zone during lifting operations.
Failure of WSHMS	• Safe work procedure (SWP) – failure to cordon off lifting zone and failure to coordinate with other works in lifting zone.

Lessons Learnt and Recommendations

Safe Work Procedure	• Access to areas affected by lifting should be prohibited for the duration of the work. Such areas must be cordoned off to ensure no unintentional entry occurs.
Work Planning	• Do not allow work activities within the lifting zone.
Equipment and Tools	• Set up of crane to follow crane manufacturer's installation manual.
Training and Awareness	• Crane operator must cease operations when experiencing unusual operating conditions.

CASE 8

FALLING SCRAP MATERIALS KILLED WORKER

Description of Incident

During scrap metal disposal work, an overhead travelling crane was used to hoist scrap boxes onto a dumping container.

The scrap box was hoisted onto the dumping container and placed on top of a heap of scrap metals in the container. The deceased proceeded to release the chain slings attached to the base of the scrap box. After he released the hook from the base of the scrap box and reattached it to the top of the scrap box, the scrap box became unstable and slid towards him. Some scrap metals fell from the top of the box and struck the deceased, pinning him against the dumping container.

Side view of the overhead crane, chain sling, scrap box and dumping container.

Showing scrap box and dumping container.

Observations and Findings

Man

- Not Applicable

Method

- The worker was required to adopt an unsafe position during the disposal of scrap metals.

- The scrap boxes were designed such that their contents were discharged from the base. When being lifted, the hooks of the hoisting chains would be attached to the base of the box, keeping the box closed so it could

be hoisted onto the top of the scrap heap. Workers would then proceed to the dumping containers placed on top of the heap of metals to release the hooks of the hoisting chains from the base of the scrap box. They then attached these hooks to the top of the box. The box would then be hoisted up and the contents of the box will be discharged by gravity.

- The foundation upon which the scrap boxes were placed was unstable.
- Inadequate hazard analysis failed to reveal that the foundation was not stable and that the design of the box exposed workers to the dangers of falling debris.

Machine
- Not Applicable

Material
- Not Applicable

Environment
- Not Applicable

Root Cause Analysis

Evaluation of loss	• 1 worker killed.
Type of contact	• Struck by falling objects.
Immediate cause(s)	• Unsafe work procedure.
Basic cause(s)	• Inadequate identification and evaluation of loss exposures.
Failure of WSHMS	• Inadequate hazard analysis/safe work practices.

Lessons Learnt and Recommendations

Risk Assessment	• Risk assessment should be done prior to the commencement of any work. • Where practicable, risk assessment should be done at the design stage.
Safe Work Procedure	• Safe work procedures should be developed to ensure work is carried out safely. • Large or heavy loads must not be placed on unstable or uneven surfaces where they may topple or fall.
Equipment and Tools	• Equipment should be designed such that workers do not need to be exposed to hazards while working.

CASE 9

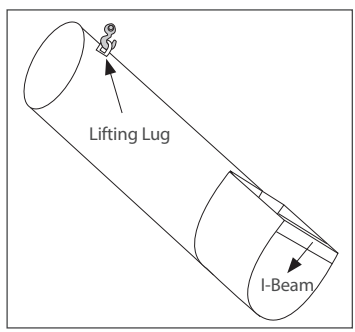
WORKER HIT BY STEEL PIPE DURING LIFTING OPERATIONS

Description of Incident

As part of repair works, an inner steel pipe was lifted onto a vessel. The lifting operation was conducted to reinstall an inner steel pipe into a steel fall pipe. The initial attempt, however, failed as the inner pipe was unable to fit into the steel fall pipe. After deliberation, to alter the lifting, the pipe was lifted at an inclined angle to allow one end of the pipe to fit into the fall pipe.

After being lifted 2-3m, one end of the pipe dislodged and struck the deceased. He succumbed to his injuries the same day.

Insufficient clear working area and lack of barricades while working next to barges.



Following an initial failed attempt, the pipe was lifted at an angle in an effort to fit it into the desired location on board the vessel.

Observations and Findings

Man

- Lifting supervisor not appointed.
- Rigger not properly briefed on work procedures.
- Rigger positioned himself within lifting zone.

Method

- There were no hazard analysis or risk assessments done for the lifting operations.
- There were no specific written procedures on how to remove or install the inner pipe of the fall pipe.
- The lifting angle exceeded those recommended by the sling manufacturer.
- The hook latch used to hold the O-ring was securing the tow lifting chains to one end of the inner pipe. According to the crane manual, however, the latch was not meant to support any loads.

Machine

- Not Applicable

Material

- Not Applicable

Environment

- Restricted work area.

Root Cause Analysis

Evaluation of loss	• 1 worker killed.
Type of contact	• Struck by falling pipe.
Immediate cause(s)	• Improper rigging method.
Basic cause(s)	• Lack of supervision and Safe Work Procedure during lifting operations. • Use of inappropriate lifting gear.
Failure of WSHMS	• Lack of risk assessment. • Lack of safe work procedure.

Lessons Learnt and Recommendations

Risk Assessment	• Risk assessment must be implemented and communicated to all parties involved.
Safe Work Procedure	• Safe work procedures must be established.
Work Planning	• Before any lifting operation, a competent person should verify that the established lifting method is adequate and the right equipment has been selected for the job. A lifting plan should also be established and implemented. • Ensure that proper rigging methods are used before commencing with the lift.
Training and Awareness	• All persons should keep clear of the lifting zone.
Coordination and Communication	• A lifting supervisor must be appointed to supervise the lifting operation to ensure that the lifting plan and Safe Work Procedures are adhered to.

SUFFOCATION

CASE 10

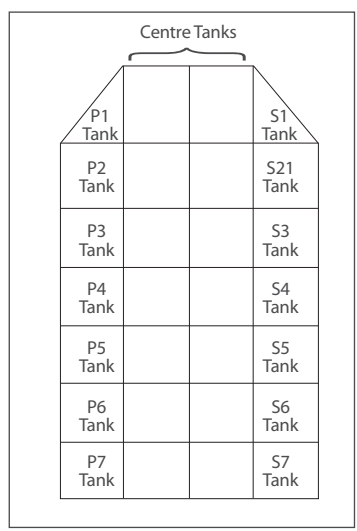
SURVEYOR SUFFOCATED DUE TO LACK OF OXYGEN IN CONFINED SPACE

Description of Incident

The deceased was inspecting the barge to determine if it was suitable for material transportation. The day before, he had only managed to survey the external areas of the barge. Thus, it was requested that the manholes of the tanks be opened up the following day for inspection.

The next day, about three hours after conducting the inspections alone, the deceased was found lying inside one of the tanks in the barge. The cause of death was cited as 'suffocation from breathing in a vitiated atmosphere'.

Manhole entry point of port number 6 tank.



The body of deceased was found in port number 6 Tank.

Observations and Findings

Man

- The deceased was supposed to liaise with an employee of the representatives of the barge owner when conducting the survey. However, due to rainfall, the employee and the deceased did not manage to meet up.

Method

- The survey was agreed upon between the representative of the barge owner and the employer of the deceased. However, the shipyard (occupier) was not informed of or involved in the survey. As a result, the shipyard was not informed of the arrival of the deceased.

- It should have been made known that a survey was being conducted, thus ensuring that the barge tanks would be adequately ventilated when tank inspections were conducted.

- The representatives of the barge owner were not kept informed of the tank inspections and the need for internal inspections. However, an email was sent to communicate the need for inspection of the tanks one day prior to the incident.

- The tanks were inadequately ventilated. No permit to work for confined space entry was displayed on the tanks to indicate that they were safe to enter.

Machine

- Not Applicable

Material

- Not Applicable

Environment

- The occupier did not have a proper emergency response plan in place and did not have a functioning breathing apparatus (BA) set for emergency rescue of persons in confined spaces. One hour after the occupier was alerted of the incident, they were able to locate the body within the tank but had to borrow BA sets from a tanker.

- The measured oxygen level within the tank was only 10% by volume.

- A competent person should have tested the tanks and certified that they contained an adequate supply of oxygen and that it was safe to enter them without BA sets before allowing any persons to enter.

Root Cause Analysis

Evaluation of loss	• 1 worker killed.
Type of contact	• Suffocation due to lack of oxygen.
Immediate cause(s)	• Unsafe environment.
Basic cause(s)	• Lack of communication/clarity on the scope of the survey work. • Lack of participation of the occupier of the premises in the survey work.
Failure of WSHMS	• Failure to ensure that visitors' scope of work was recorded. • Failure to ensure that arrangements made to ensure such works were done safely. • Failure to put in place an adequate emergency response plan for the rescue of persons in confined spaces.

Lessons Learnt and Recommendations

Risk Assessment	• Before entering any confined space, all workers should ensure that a permit to work has been issued by a competent person, certifying that all hazards have been assessed and that the confined space is safe for entry. Workers should also check the validity period of the permit.
Safe Work Procedure	• A competent person must test the atmosphere of the confined space for oxygen, flammable and/or toxic gases and/or vapour and certify that the space is safe for entry before commencing work. The atmosphere needs to be monitored constantly to ensure it remains within safety limits while the work is carried out. Among other criteria, the confined space can only be certified safe for entry if: – The oxygen level is within 19.5% to 23.5%. – The level of flammable gas is less than 10% of the Lower Exposure Limit (LEL). – The concentration of toxic vapour and gas is below the Permissible Exposure Limit (PEL).

Work Planning	• For work involving confined spaces, an emergency response plan (ERP), including rescue equipment, should to be put in place. Among other requirements, the plan should include the following: – Make retrieval devices and BA sets readily available for use in case of an emergency. – Ensure that the retrieval devices and BA sets undergo regular maintenance. – Conduct emergency response training for supervisors, workers and other personnel. – Remind workers that they must follow the ERP in emergency situations, and not be hasty in their rescue efforts as doing so might endanger their own lives. – Maintain a group of well-trained and fully equipped rescuers to ensure a speedy response in the event of an emergency. Only these trained rescuers should be allowed to enter any confined spaces. – Conduct emergency drills at least once a year.
Equipment and Tools	• Gas monitoring devices should be regularly maintained and their accuracy verified with calibrated functional (bump) tests. Workers working in confined spaces should also carry fully charged and calibrated personal gas detectors, in order to detect any significant changes in the air quality of the working environment.
Training and Awareness	• Employers must provide adequate training and communication to all personnel on the risk of working in such an environment, and educate personnel on precautionary measures necessary during work and emergencies.

CASE 11

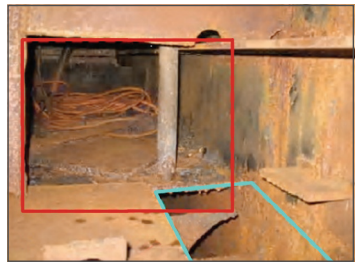
WORKERS SUFFOCATED TO DEATH DUE TO FIRE CAUSED BY HOT WORKS

Description of Incident

In the void space of the vessel, workers were employed by three different companies to carry out various works. At the port and starboard side of the topside tank, some other workers were carrying out steel renewal work.

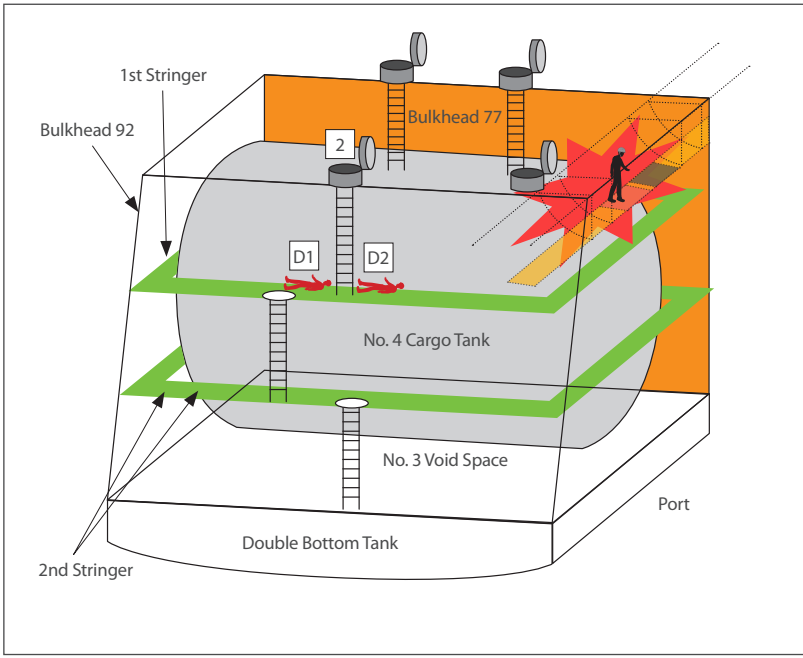
While carrying out steel renewal works, sparks from hot works ignited the exposed insulation surrounding the cargo tank, resulting in thick smoke at the port side of the void space.

While most of the workers were evacuated immediately, two workers were later found at the access point of the vessel and subsequently succumbed at the hospital.



Steel removal work done on top side tank.

New steel plate to be fitted to the bottom of top side tank.



Deceased 1 (D1) and deceased 2 (D2) found near manhole 2.

Observations and Findings

Man

- No fire watchmen were deployed for the intended hot works.

Method

- Insulation material in way of the hot works was not properly covered by fire cloth.

Machine

- Not Applicable

Material

- Polyurethane insulation is highly flammable but was not properly covered.

Environment

- Work space was congested and restricted.

Root Cause Analysis

Evaluation of loss	• 2 workers killed.
Type of contact	• Suffocation.
Immediate cause(s)	• Asphyxiation due to smoke inhalation.
Basic cause(s)	• Sparks came into contact with an unprotected part of insulation materials.
Failure of WSHMS	• Failure to ensure fire cloth adequately covered exposed insulation material. • Failure to deploy fire watchmen at hot work locations.

Lessons Learnt and Recommendations

Risk Assessment	• Under RA, control measures such as the deployment of fire watchmen should be fully implemented.
Safe Work Procedure	• Ensure flammable materials are adequately covered.
Work Planning	• Daily checks should be carried out prior to work commencement.
Equipment and Tools	• Fire watchmen are to be properly equipped with firefighting equipment.
Training and Awareness	• Familiarise personnel with emergency evacuation procedures.

FIRE/EXPLOSION

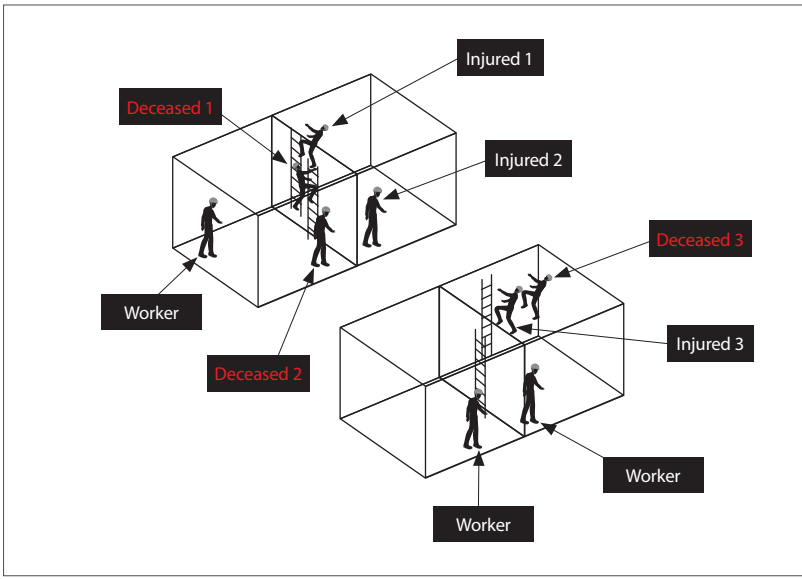
CASE 12

FLASH FIRE DURING SPRAY PAINTING KILLED THREE WORKERS, INJURED ANOTHER SIX

Description of Incident

On the day of the accident, permits were issued to spray paint four ballast tanks. Ventilation of the ballast tanks was arranged prior to the spray painting. During the spray painting works, portable explosion-proof handheld lamps were hung near the tank hatch openings while the painters inside the tanks used battery-operated torches. A flash fire broke out in one of the tanks leaving three workers dead due to injuries sustained in the fire and injuring another six.

Shattered battery operated torch found in the water ballast tank.



Location of workers involved in spray painting works shown in four different ballast tanks.

Observations and Findings

Man

- The foreman did not read the permit to work, where it was indicated that the use of torch lights were forbidden during spray painting.

Method

- Forced ventilation used to introduce atmospheric air did not adequately lower the concentration of flammable gas within the tank.

Machine

- Non-intrinsically safe torches were provided for use within a flammable environment.

Material

- Not Applicable

Environment

- Not Applicable

Root Cause Analysis

Evaluation of loss	• 3 workers killed, 6 workers injured.
Type of contact	• Extreme temperature.
Immediate cause(s)	• Ignition of flammable environment.
Basic cause(s)	• Use of non-intrinsically safe torches.
Failure of WSHMS	• Safe work procedure was not adhered to.

Lessons Learnt and Recommendations

Risk Assessment	• Hazards and control measures must be adequately identified during the risk assessment.
Work Planning	• Forced and exhaust ventilation should be used to lower the concentration of flammable gases within the confined space.
Equipment and Tools	• Where flammable vapours are present, all tools used must be intrinsically safe.

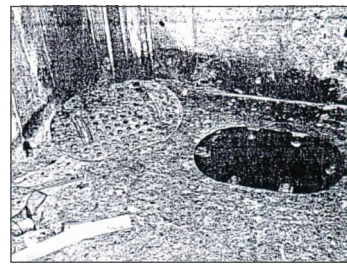
CASE 13

WORKER KILLED IN EXPLOSION DURING REPAIR WORKS

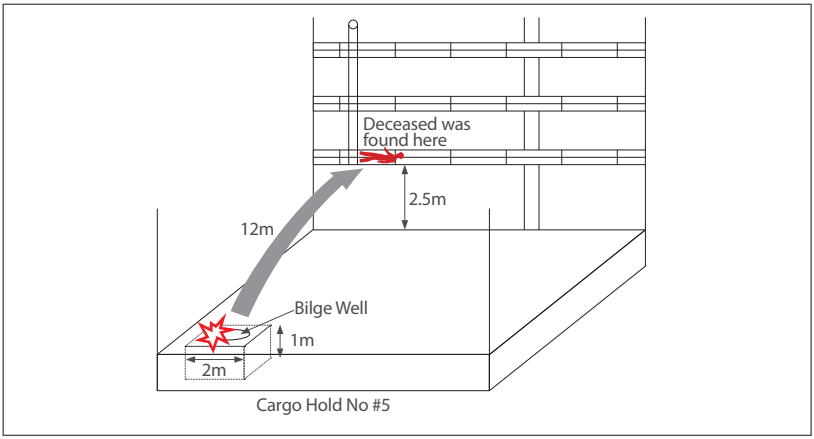
Description of Incident

The deceased and his co-worker were tasked to cut and remove the bolts and nuts of a check valve within a bilge well (2m length x 1m breadth x 1m height) of the cargo hold. The deceased carried out the cutting work while his co-worker was acting as the fire watchman.

After removing two sets of bolts and nuts, the deceased stopped work to take a break. During his break, gas leaked out from the LPG supply he had been using and accumulated within the bilge well. Upon resuming work, the deceased lit the oxygen-LPG torch near the manhole opening of the bilge well, causing an explosion and a fire. The blast threw the deceased 12m away at an elevated height of 2.5m from the bilge well.



Showing the bilge well of the cargo hold.



Showing where the deceased was found.

Observations and Findings

Man

- The co-worker was not trained to operate the gas meter and therefore did not conduct a gas check before resuming work.

- The project manager and the safety engineer failed to recognise that the bilge well is categorised as a confined space.

Method

- Measures for safe work in confined spaces were not implemented.

- LPG should not be used for any hot work carried out below deck.

Machine

- It was found that it was difficult to shut off the LPG supply completely. There was also a small cut on the LPG hose; however, the amount of LPG vapour released from this cut would not have been enough to create an explosion. As a result, it was inferred that the explosive mix of gases had probably accumulated during break time due to leakage from the deceased's oxygen-LPG torch.

Material

- Not Applicable

Environment

- Work area was not ventilated.

Root Cause Analysis

Evaluation of loss	• 1 worker killed.
Type of contact	• Explosion and Fire.
Immediate cause(s)	• Unsafe hot work operation.
Basic cause(s)	• Inadequate hazard identification.
Failure of WSHMS	• Safe work procedure (SWP).

Lessons Learnt and Recommendations

Risk Assessment	• Proper risk assessment must be carried out prior to commencement of work. All confined spaces must be identified and appropriate measures must be implemented to ensure worker safety.
Safe Work Procedure	• Gas checks must be carried out by a competent person prior to any work done in a confined space. This also applies when work is suspended for longer than 30 minutes, as conditions may have changed. Workers must be briefed on this SWP.
Equipment and Tools	• A maintenance programme should be in place to ensure that all equipment and tools are in good, working condition. • Confined spaces must be adequately ventilated, exhausted and/or purged before any hot work commences.
Training and Awareness	• Workers must conduct pre-use checks on equipment. • At least one worker per working group working in confined spaces must be trained in the use of portable gas meters.

DROWNING

CASE 14

WORKER FELL FROM HEIGHT WHILE DISMANTLING HANGING SCAFFOLD

Description of Incident

The deceased and group of workers were dismantling a two-tier hanging scaffolding outside a door at the starboard side forward bow area of the vessel. They were not wearing any life vests. The deceased anchored his safety harness to the transom pipe that he and his co-worker were sitting on. When dismantling the lower tier of the hanging scaffold, the transom pipe he was sitting on gave way and he fell into the sea, resulting in the loss of his life.

Top view of scene.

Hanging scaffold that the deceased and his co-worker were dismantling, on the bow of a vessel.

Observations and Findings

Man

- The worker assisting the deceased was not a trained scaffold erector.
- Both the deceased and his co-worker were not wearing life vests while working.
- The deceased had secured his body harness onto the transom pipe that he was sitting on.

Method

- Occupier (who is also the employer) was not an Approved Scaffold Contractor but went ahead with the dismantling of the hanging scaffold.
- The supervisor of the scaffolding work was not present and he was not a trained scaffold supervisor.
- While the occupier had safe work procedures (SWP) in place to ensure the workers' safety, the SWPs were not effectively communicated to the workers. Risk assessments were not conducted for the task of dismantling of hanging scaffolds.
- Workers were not trained on how to respond during emergency situations.

Machine

- Not Applicable

Material

- Life-lines provided could not be hooked up to the lower tier of the scaffold.
- Workers were not provided with life vests.

Environment

- Not Applicable

Root Cause Analysis

Evaluation of loss	• 1 worker killed.
Type of contact	• Drowning.
Immediate cause(s)	• Wrong method of work.
Basic cause(s)	• Incompetent persons working on scaffold dismantling. • Dismantling hanging scaffold without proper supervision. • Lack of proper anchorage point for safety harness. • No life vests provided.
Failure of WSHMS	• Failure to communicate known risks to workers involved.

Lessons Learnt and Recommendations

Risk Assessment	• Prior to the start of any work, conduct a risk assessment to identify all hazards and risks involved. Control measures and Safe Work Procedures must be established and implemented.
Safe Work Procedure	• All hanging scaffold erection and dismantling must be undertaken by an Approved Scaffold Contractor.
Work Planning	• A fall prevention plan should be established and implemented for work at height before commencing work.
Equipment and Tools	• Workers working at height should be equipped with PPE for working at height for the entire duration and range of their work. • Workers should wear life vests if they are at risk of drowning when working near large bodies of water.
Training and Awareness	• All persons involved in the work must be adequately trained to be competent in their jobs, as well as aware of the risks and safety precautions required of them.
Coordination and Communication	• Communicate risk assessment and safe work procedures to workers via tool box meetings.

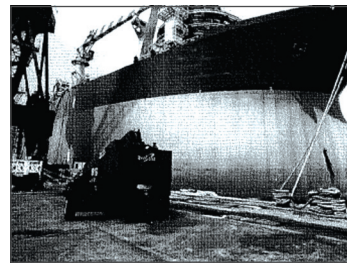
CASE 15

WORKER DROWNED WHEN BOOM LIFT PLATFORM SUBMERGED INTO SEA

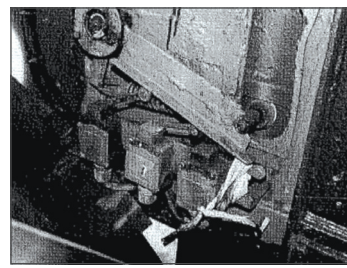
Description of Incident

The deceased was tasked to operate a boom lift so that his co-worker could paint the ship's anchor. At the time of the accident, the deceased was operating the boom lift, while his co-worker stood beside him to paint the anchor. During the process, the boom lift toppled, causing the platform to fall into the sea. The platform rapidly submerged after entering the water.

As a result, both workers fell into the sea. The co-worker survived by freeing himself from his safety belt while the deceased drowned.



Location of boom lift next to ship anchor.



Limit switch being bypassed.

Observations and Findings

Man

- At the boom lift course attended by the workers, they were not taught how to extend the outriggers for boom lifts. The boom lifts used in the training course did not have outriggers and were of different models from the one involved in the accident. Therefore, the worker had insufficient knowledge on the outriggers of the boom lift he was operating.

- The deceased and his co-worker did not conduct a pre-usage check before using the boom lift.

Method

- The project manager did not conduct risk assessment for the workplace as he felt it was safe to use the boom lift and anchor painting was common work in the yard.

- Both workers were not provided with life jackets although they were working directly above a large body of water. The project manager felt they did not require life jackets as they were situated on the platform of the boom lift, which had been provided with railings.

- Due to a breakdown in communication between the boom lift vendor and the shipyard, no mechanics were sent to the worksite to carry out a functional check on the boom lift that was to be used.

- The checks on the mobile elevated work platforms involved functional checks to ensure that the movements of the boom lifts could be executed smoothly. The checks done did not include checking on the limit switch boxes. It was the responsibility of the boom lift operator to conduct functional checks on the boom lift before use.

- There was no control of access to the boom lifts. The boom lifts were parked at an open parking bay which was easily accessible to everyone. In addition, the boom lift keys were left on the control panel at all times.

Machine

- At the time of the accident, the working radius of the boom lift had been exceeded substantially.

- One of the limit switches detecting the boom extension length had been bypassed using masking tape. As a result of this alteration, the boom could be extended beyond its normal limits. In normal use, when the boom overextended, the power supply would be cut off. This measure would have prevented the overloading and toppling of the boom lift.

Material

- Not Applicable

Environment

- Not Applicable

Root Cause Analysis

Evaluation of loss	• 1 worker killed.
Type of contact	• Drowning.
Immediate cause(s)	• Boom lift toppled and its platform submerged into the sea with the workers.
Basic cause(s)	• One of the limit switches for detecting boom extension had been bypassed.
Failure of WSHMS	• Failure to conduct risk assessment and job hazard analysis for anchor painting at the wharf using a boom lift. • Failure to institute and implement a safe work procedure for anchor painting. • Failure to properly train the boom lift operators to operate boom lifts with outriggers in the yard. • Failure to ensure a proper system was set up to control and manage the boom lifts to prevent unauthorised usage and tampering with the limit switches (and other safety devices).

Lessons Learnt and Recommendations

Risk Assessment	• Risk assessment is required to identify and assess risks so that adequate control measures can be implemented to make work safe.
Safe Work Procedure	• A system should be implemented to control access to and use of machinery. This is to prevent unauthorised usage and tampering of safety features such as limit switches. • Safe work procedures should be developed for all work activities.
Work Planning	• The anchor chain could have been lowered onto a barge to eliminate the need for workers to work at height. • It is important to select the right machine for the situation. In this case, a machine that can bring the workers safely to the desired work location should have been used.
Equipment and Tools	• Where workers are at risk of falling into water and drowning, flotation devices such as life jackets shall be made available to them.
Training and Awareness	• Workers must be adequately trained and authorised to operate machinery. As boom lifts differ in design, it is recommended for operators to undergo a familiarisation process before operation. • Workers operating machinery must not bypass or modify safety features.

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