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Occupational Hazards in Modern Bulk Carrier Vessel and How to Mitigate the Hazards

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***Abstract*: Occupational hazards are integral hazards which remains present on the vessel with typical work requirements on vessel. Author's approach is to disclose how these hazards are linked with specific nature of work and the methodology to assess these risks in advance for taking of accident preventive measures. Past case studies clearly shows that many accidents, fatal injuries, major or minor injuries happens mostly due to human error and secondly by the machinery or equipment failures. Seafarers are exposed to high diversity of occupational hazards (Marcus Oldenburg, 2010, journal of occupation health: occupational challenges and risk in seafaring profession).**

***Keywords*: Occupational hazards, seafarers, challenges of seafaring profession.**

1. Introduction

Tanks inspection and maintenance is one of the important work on the ship. Tank inspection is directly related to enclose space entry work. Typical Double Bottom Tank design structure has dimension as per formula DBh =1000xbreadth of vessel/20,minimum 760mm (DNV GL rules for classification, page 14, Edition 2015) . If any seafarer has to enter in the D.B. tanks then he has to crawl inside in the narrow tank where height is very limited. Empty D.B. tank which was often used for keeping ballast water will have some muck, wet surfaces and probable lack of oxygen. The main challenge here is the space can be oxygen deficient. A wise seafarer will always test the tank oxygen level. Seafarer must use the enclose space checklist and each such checklist will consist the requirements of checking the level of oxygen inside the tank. Development of such ship specific checklist is encouraged by the International Safety Management code (IMO code: ISM, Resolution A741 (18) entered into force 1 July 1998). Risk assessment is the tool for finding out occupational hazards associate in each critical cum typical works. In this elaboration risk assessment clearly will indicate that one of the main risk is oxygen deficient atmosphere inside the tank. Degree of risk is also high as person entering inside the tank can lose his life due to asphyxiation. To overcome this problem seafarer has to identify the risk in risk assessment and plan the strategy of systematic work in the tool box team meeting. Tool box team meeting is a correct step to instruct men on task for complying procedural steps prior undertaking such tasks. Besides completing risk assessment, tool box team meeting, complying with check list is other important work. Forced ventilation must be deployed in such spaces for substantial hours. Space must be checked for the oxygen level using oxygen analyzer. Prior doing any attempt to enter inside the tank it is important that tank is cleaned, dry, illuminated, and free from obstruction and also checked for the oxygen content. Once space oxygen level reaches to 20.9% by volume in air tank is considered for entry. During entire period of work the ventilation must sustain for the tank. Person entering the space must carry personal oxygen meter, torch, and radio handset with himself. On the ship following spaces must be considered as enclosed spaces: Double bottom tank, Fore peak tank, after peak tank, top side tank, cofferdam spaces, duct keel, fresh water tank, chain locker, empty fuel oil tank, Diesel Oil tank, Lub Oil tank, sewage tank, sludge tank, waste oil empty tank etc. Cargo hold partly filled with logs and wood chip can absorb substantial amount of oxygen from the cargo hold and can cause cargo hold becoming oxygen deficient (Urban Svedberg, Carolini Petrini, Gunner Johanson, 2009,Journal oxygen depletion and formation of toxic gases following sea transportation of logs and wood chips). Cargo hold partly filled with coal cargo also causes oxygen depletion and formation of methane gas. No person should ever enter inside the cargo compartment partly filled with coal cargo. Checking of methane content and oxygen content is required in the carriage of coal cargo. Paper pulp cellulose material is used in the paper mill and transportation of paper pulp is very common in commercial shipping. Paper pulp absorbs oxygen from cargo hold can causes the oxygen depletion (IMSBC IMO Code).Dry Reduced Iron is cargo created by direct reduction of Iron Ore. Dry Reduced Iron absorbs oxygen from the cargo compartment and causes the compartment becoming oxygen deficient. Sulphide Concentrate is a cargo which absorbs oxygen from the compartment and causes the compartment becoming oxygen deficient. Ammonium Nitrate based fertilizer also absorbs oxygen from the cargo hold. No seafarer should enter inside the cargo hold as it can cause asphyxiation. Linseed Cotton Seed is often transported on the merchant vessel. Linseed Cotton Seed can absorb substantial amount of oxygen from the compartment and can create the oxygen depletion. No one can observe or feel

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from a distance that tank or cargo hold is oxygen deficient until unless person has device to quantitatively measure the oxygen content inside the tank or cargo hold. This is the reason that oxygen analyzer is required in the bulk carrier vessel as well as in tanker vessel.

Fire Hazard is another major occupational hazard in transportation of flammable cargo. Coal cargo is highly responsible for the spontaneous combustion (M. Onifed and B. Genc, March 2019, Journal: Spontaneous combustion liability of coal and coal-shale: a review of prediction methods). Coal cargo absorbs hydrogen from moisture and oxygen from air and is very responsible for production of unwanted methane gas inside the cargo hold. The Methane Gas is a highly flammable and explosive gas. There have been cases of coal cargo fire in few bulk carrier vessels. Coal itself is a fuel and in present of Methane layer it can be a reason for completion of fire triangle. Fire outbreak is a natural science in completion of fire triangle. In the case of coal cargo, coal is fuel, air is source of oxygen and ignition temperature of coal is the point of disaster. It is important for seafarer to adhere to safety compliance in the carriage of coal cargo. Seafarer carrying the coal cargo must keep cargo area in cool condition. Hosing down of deck and coaming can help in this regard. Surface ventilation is very important important. Seafarer should check the cargo hold temperature three or more times to examine the temperature part of cargo hold. Inspection of Methane level and oxygen level is another work during the voyage. Wood cargo is also a flammable cargo. Wood cargo can catch fire. Seafarer must ensure that no smoking in cargo space regulation is observed throughout the voyage. Do not carry wood in location where double bottom tank is fuel oil tank and subject to heating of oil during the voyage. Sulphur cargo is a flammable cargo. Lot of cargo care is mandatory in carriage of Sulphur cargo. Seafarer must ensure that fixed carbon di oxide cargo hold firefighting system remains operational at all time. It is better to blow through the system with compressed air prior loading of Coal and Sulphur cargo. Drill for cargo hold fire is also important as it provides knowledge of firefighting to seafarer in case of vessel unfortunately catches fire. Grain cargo is a flammable cargo: Wheat, Dry Corn, Flour all are flammable. No smoking in cargo area is very important in carriage of such cargo. Keep cargo hold carbon di oxide flooding system in operational condition. Never do D B tank heating if grain cargo is stowed in the cargo hold as it can cause fire outbreak. Dry Reduced Iron is susceptible to oxidation and it can catch fire due to pyrophoric ignition. Present of rust, iron oxides and residual charge, frictional energy can create fire in the cargo hold. A prudent ship master must carry cargo under supervision with fire safety. Avoid violent rolling of cargo hold as it can create excessive frictional energy. Seafarer must keep cargo hold carbon di oxide flooding system in the readiness. Jute bales and Jute bags are flammable cargo. Keep cargo hold area free from flame hazards. Prudent ship master must keep carbon di oxide flooding system in the readiness. New Paper Print rolls are the cargo which can easily ignite in presence of heat and oxygen therefore no smoking is very important in the area. An experienced ship's captain will keep cargo hold carbon di oxide flooding system in the readiness. It is better to carry out fire drill during voyage simulating how to fight fire if fire takes place in News Paper Print rolls carried in the cargo hold.Flammable paints and chemicals stowed in small drums and in the cargo hold can catch fire. No smoking is extremely important. UN3469 IMDG class 3 /8 is often assigned to paint cargo (IMDG: IMO code). It is very important to follow proper IMDG code in this regard and also ensure cargo hold carbon di oxide flooding system remains in the readiness.

Liquefaction is another occupational hazard in transportation of few bulk cargoes like slurry coal, wet iron ore. Liquefaction is a phenomenon in which soil like material abruptly transforms into liquid/ semi liquid state (DNV guidelines for liquefaction) Every prudent ship master knows that high moisture content present in the cargo can cause problem in the voyage. Liquefaction can cause progressive listing of vessel due to transverse shifting of cargo center of gravity and might lead to finally capsizing of bulk vessel. A prudent ship's master will always keep shipper's declaration and cargo analysis report in case vessel is going to load sensitive cargoes. Can test should be performed by the experienced chief officer in the subject matter. Take a one liter can with about eighty percent full of cargo. Stand near the wooden strong table and make a successive twenty to thirty impact of can raising it about two feet high from table floor and banging it again and again in table. After that use naked eye and also convex hand lens to find out presence of moisture on the cargo surface.

Occupational Hazards of dry cargo (grain) shift in the bulk grain transportation. Grain Cargo is very dangerous if transported through high seas without calculation of grain stability. Transverse shifting of grain center of gravity is most common occurrence during the voyage. A knowledgeable ship's master knows well that how to transport grain cargo through high seas. Trimming is very important in the grain cargo. If cargo is planned for full in each hold then it is better for the ship as it will prevent requirement of grain securing by means of saucer making, strapping or securing with wire mess. Grain must be full to hundred percent capacity in the cargo hold and it should be trimmed. Grain healing moment can be calculated by formula Grain healing moment=Volumetric heeling moment /stowage factor. Metacentric height must remain more than 0.30 at all stages during the voyage and total healing moment must remain less than maximum allowable healing moment in all stages of cargo transportation (IMO grain code-refer). Steel plates, hot rolled coil and cold roll coil cargo requires proper loading and securing of cargo. Heavy cargo shifting can cause damage to the cargo hold and it can either puncture the lower hopper tank of can damage to hull plate. For safety of ship, cargo and crew most important part is outstanding securing of this cargo.

Work related occupational hazards in the bulk carrier vessel: Working aloft is an important work on the ship. Maintenance on superstructure, crane column, funnel column, vertical masts and below bridge wings are the high areas. Crew need to work in these areas on the stages hanging high from the deck. Risk assessment and tool box team meeting is very important in such work. Seafarer should use working aloft check list and should

ensure that all safety points are complied with. Here risk is fatal injury or death can take place if a seafarer falls from the height. A prudent chief officer must ensure followings: good stage, use of full body harness, supervision during work, rigging of safety net below work area. Working aloft work must not be carried out in rough sea, at night and in fog condition (U K MCA code of safe work practices, edition September 2015).

Work in over side (ship side) is another high risk occupation work on the ship. Over side work involves seafarer to work on the stages in the ship side. Here the biggest risk is man becoming man over board and might sink into sea. Ship master and chief officer must ensure that risk assessment, tool box team meeting and complying with safeties is carried out prior undertaking suck work. Here the points of safeties are followings: stage must be in good order, seafarer must get supervision, rigging of life buoy up to water line, use of safety harness and working life jacket is required. (U K MCA code of safe working practices, edition 2015). Hot work, cutting, welding are occupational work on the ship. Here main risk is fire and secondary risk is body burn, injury. Proper supervision is required in the hot work. Ship's captain and mate should ensure that risk assessment is completed. Tool box team meeting is also required and followed by checking of all safeties and their deployment. In hot work practices it is very important to check that proper use of oxygen, acetylene gas should be carried out. Oxygen, Acetylene bottle must have flask back arrestor, welder must use personal protection gear during the work, readiness of location with respect to fire safety is very important.

2. Conclusion

Seafaring profession consists certain occupational risks therefore it is extremely important to carry out risk assessment prior undertaking of critical works. Safe practices can mitigate these occupational risks to great extent.

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