May 2021

1. Outline the procedures and arrangements to be put into place before a permit to work is issued for entry into a confined space. (10)

May 2021

2. With reference to unmanned machinery spaces:

   (a) explain why machinery spaces should be visited on a regular basis; (2)

   (b) explain how the human senses are used to monitor conditions in a machinery space; (4)

   (c) outline the procedure to be adopted if a person wishes to enter a machinery space outside normal working hours. (4)

May 2021

3. (a) Explain what is meant by the term *Machinery Abstract.* (4)

   (b) List SIX items which would be recorded in a typical Machinery Abstract. (6)

May 2021

4. (a) State the main pollutant produced when burning a hydrocarbon fuel. (1)

   (b) Explain how the pollutant referred to in part (a) can be reduced. (2)

   (c) State what is meant by an ECA. (1)

   (d) State the current maximum % sulphur content in marine diesel oil in EACH of the following:

      (i) worldwide; (1)

      (ii) in a ECA. (1)

   (e) Describe how SO_x is produced in the combustion process and the effects oxides of sulphur has on the environment. (4)

May 2021

5. With reference to bunkering of marine diesel oil:

   (a) explain why the suppliers' tanks should be dipped prior to and after receiving fuel; (4)

   (b) explain what is meant by a *letter of protest*, and when it must be issued; (4)

   (c) state the person responsible for issuing the letter of protest. (2)

May 2021

6. (a) With reference to MARPOL Annex IV, explain what is meant by the term *sewage*. (4)

   (b) State the current regulations for the discharge of *sewage*. (6)

May 2021

7. (a) State FIVE properties of a refrigeration oil. (5)

   (b) Describe the operation of an Oil Separator in a refrigeration system. (5)

May 2021

8. With reference to fresh water treatment:

   (a) describe the process for superchlorinating the fresh water system, stating relevant periods, times, and chlorine levels; (6)

   (b) explain what is meant by copper staining and the treatment required to prevent it. (4)

May 2021

9. With reference to a machinery space carbon dioxide smothering system:

(a) state the regulation regarding the rate of flooding with respect to time; (4)

(b) state the precautions to be taken before activating the system. (6)

May 2021

10. With reference to ocean going vessels, define EACH of the following:

(a) trim; (1)

(b) freeboard; (1)

(c) camber; (1)

(d) length between perpendiculars; (1)

(e) length overall; (1)

(f) sheer; (1)

(g) stem; (1)

(h) draft marks; (1)

(i) draft; (1)

(j) depth; (1)

May 2021

1. Outline the procedures and arrangements to be put into place before a permit to work is issued for entry into a confined space. (10)

Procedures and Arrangements for Confined Space Entry Permit:

Before issuing a permit for entry into a confined space, a thorough risk assessment and preparation process must be undertaken. Here's an outline of the key steps:

1. Confined Space Identification and Risk Assessment:

- Identify all confined spaces onboard the vessel based on size, access limitations, and potential hazards (oxygen deficiency, flammable atmospheres, toxic fumes).
- Conduct a risk assessment for each confined space, considering:
    - Potential hazards present (flammable, toxic, or oxygen-deficient atmosphere)
    - Required work activities and associated risks
    - Ventilation requirements

2. Permit System Establishment:

- Develop a formal permit system with a designated permit issuer (authorized person) and clear procedures for obtaining a permit.
- The permit should contain details such as:
    - Confined space identification
    - Date and time of permit issuance and expiry
    - Work activities to be undertaken
    - Names of authorized entrants and standby person
    - Atmospheric monitoring plan (testing for oxygen, flammables, toxic gases)
    - Ventilation requirements (natural or mechanical)
    - Personal protective equipment (PPE) required (respirators, safety harnesses)
    - Emergency procedures and rescue plan

3. Pre-Entry Preparations:

- **Isolation:** Isolate the confined space from surrounding machinery or processes that could introduce hazardous substances. Lock out and tag out any equipment that could pose a risk during entry.
- **Ventilation:** Establish adequate ventilation to ensure a safe atmosphere for entry. This could involve natural ventilation by opening hatches for a designated period or utilizing mechanical ventilation systems.
- **Atmospheric Monitoring:** Before entry, conduct atmospheric testing using portable gas detectors to confirm oxygen levels are within safe limits (usually above 19.5%) and there are no hazardous concentrations of flammable or toxic gases.
- **Communication Plan:** Establish clear communication protocols between workers inside the confined space and a designated standby person outside. Ensure the standby person is trained in rescue procedures and has access to communication equipment to raise an alarm in case of an emergency.
- **Briefing:** Brief all authorized entrants and the standby person about the permit details, including the specific hazards, emergency procedures, and communication protocols.

4. Permit Issuance:

- Once all the above preparations are complete, the authorized person can issue the permit to the party leader (entrant in charge) after verifying their understanding and competence.

5. Work Execution and Monitoring:

- The entrant in charge is responsible for ensuring all permit conditions are met throughout the work process.
- Continuous atmospheric monitoring is crucial during the work, and the standby person should monitor the situation outside the space.
- If any unsafe conditions arise (e.g., changes in atmosphere, equipment malfunction), work must be stopped immediately, and all personnel must evacuate the space.

6. Permit Cancellation:

- Upon completion of the work, the permit must be returned to the authorized person for cancellation, indicating a safe exit of all personnel.

Following these procedures and arrangements ensures a safe working environment for personnel entering confined spaces onboard a vessel. Remember, this is a general outline, and specific regulations or company procedures may have additional requirements.

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2. With reference to unmanned machinery spaces:

(a) explain why machinery spaces should be visited on a regular basis; (2)

(b) explain how the human senses are used to monitor conditions in a machinery space; (4)

(c) outline the procedure to be adopted if a person wishes to enter a machinery space outside normal working hours. (4)

Unmanned Machinery Spaces (UMS): Visits, Monitoring, and Entry Procedures

(a) Reasons for Regular Visits to UMS:

Even though a UMS is designed for autonomous operation, regular visits by qualified personnel are still crucial for several reasons:

- **Safety Checks:** Physical inspections allow for the detection of potential safety hazards that might not be readily apparent through remote monitoring systems. This includes leaks, unusual vibrations, or any signs of overheating.
- **Verification of Equipment Status:** While alarms and sensors provide information, human observation can confirm the actual state of equipment operation. This might involve checking gauges, listening for abnormal noises, or verifying proper functioning of auxiliary systems.
- **Sampling and Analysis:** Certain checks, like oil sampling or testing bilge water content, cannot be effectively performed remotely. These tasks require personnel to be physically present in the UMS to collect samples for analysis.

- **Maintenance Tasks:** While some routine maintenance can be automated, certain tasks still require human intervention. Filters might need changing, components might require adjustments, or minor repairs might be necessary. Regularly scheduled visits allow for these tasks to be carried out.

(b) Using Human Senses to Monitor Conditions in a UMS:

While remote monitoring systems play a vital role, human senses remain valuable tools for monitoring conditions in a UMS during visits:

- **Sight:** Inspecting machinery for leaks, signs of wear and tear, loose components, or smoke can reveal potential problems.
- **Hearing:** Unusual noises, such as grinding, knocking, or excessive vibration sounds, can indicate developing issues with equipment.
- **Touch:** Carefully feeling for excessive heat on components can indicate potential overheating or malfunction. (Caution: prioritize safety and avoid touching hot surfaces directly.)
- **Smell:** Unusual odors, like burning rubber or electrical burning, can be signs of malfunctions or overheating. (Important: prioritize safety and investigate the source cautiously.)

It's important to note that these checks should only be performed by qualified personnel following appropriate safety protocols to minimize risk.

(c) Entering a UMS Outside Normal Working Hours:

Entering a UMS outside normal working hours requires strict adherence to safety procedures to minimize risk:

1. **Obtain Permission:** Authorization from a designated senior officer (Chief Engineer or Officer in Charge of the Watch) is mandatory before entering the UMS outside of normal working hours.
2. **Issue Warning:** Inform the bridge or relevant personnel of the intention to enter the UMS and the estimated duration of the visit.
3. **Double-Check Safety Systems:** Verify that the UMS is in a safe condition for entry. This includes ensuring no alarms are active and all safety systems are functioning properly.
4. **Don Necessary PPE:** Wear appropriate Personal Protective Equipment (PPE) such as safety glasses, gloves, safety boots, and potentially hearing protection depending on expected noise levels.
5. **Work Buddy System:** If possible, work with a partner who can assist in case of emergencies and monitor the situation from outside the UMS if necessary.
6. **Maintain Communication:** Keep the bridge or designated personnel informed of your progress within the UMS and communicate any emerging issues promptly.
7. **Exit Procedures:** Upon completion of the task, ensure the UMS is secure before exiting. Inform the bridge or relevant personnel that you are leaving the UMS.

Following these procedures helps ensure the safety of personnel entering a UMS outside normal working hours and minimizes the risk of accidents or incidents.

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May 2021

3. (a) Explain what is meant by the term *Machinery Abstract.* (4)

(b) List SIX items which would be recorded in a typical Machinery Abstract. (6)

Machinery Abstract Explained:

A Machinery Abstract is a concise document summarizing the essential information about a ship's main propulsion and auxiliary machinery systems. It serves as a quick reference guide for crew members, surveyors, and other personnel who need to understand the vessel's propulsion plant and other important machinery onboard.

Here are some key points about a Machinery Abstract:

- **Content:** It typically includes technical specifications, drawings, diagrams, and performance data for the main engines, generators, pumps, compressors, boilers, and other significant onboard machinery.
- **Purpose:** The Machinery Abstract helps with:
    - **Operational Efficiency:** Providing essential information for optimal machinery operation.
    - **Maintenance and Repair:** Facilitating troubleshooting, maintenance procedures, and repair activities.
    - **Regulatory Compliance:** Meeting regulatory requirements for ship surveying and certification.

Typical Items Recorded in a Machinery Abstract:

1. **Engine Details:** This section would include information about the main propulsion engine(s), such as type (e.g., diesel, gas turbine), manufacturer, model, power output, rated speed, fuel consumption data, and lubrication oil specifications.

2. **Generator Details:** Similar to engine details, this section would list information about the ship's generator sets, including type, manufacturer, model, power output, and auxiliary engine data if applicable.

3. **Auxiliary Machinery:** This section would detail other important machinery onboard, such as pumps (bilge pumps, cooling water pumps, fire pumps), compressors (air compressors, refrigeration compressors), and boilers (if applicable). Information would include type, capacity, and operational parameters.

4. **Piping Systems:** The Machinery Abstract might include diagrams or descriptions of the main piping systems onboard, such as fuel oil piping, lubrication oil piping, cooling water piping, and compressed air piping.

5. **Control Systems:** In some cases, the abstract might include a brief overview of the machinery control systems, specifying whether manual or automated control is used and highlighting any important control features.

6. **Alarm Systems:** The Machinery Abstract may list the main alarms associated with the machinery plant, including a description of the alarm condition each one triggers. This information helps crew members understand and respond to alarm situations effectively.

Note: The specific content of a Machinery Abstract may vary depending on the size and complexity of the vessel and the regulatory requirements of the flag state.

May 2021

4. (a) State the main pollutant produced when burning a hydrocarbon fuel. (1)

(b) Explain how the pollutant referred to in part (a) can be reduced. (2)

(c) State what is meant by an ECA. (1)

(d) State the current maximum % sulphur content in marine diesel oil in EACH of the following:

(i) worldwide; (1)

(ii) in a ECA. (1)

(e) Describe how SO_x is produced in the combustion process and the effects oxides of sulphur has on the environment. (4)

Marine Diesel Oil, Emissions, and Emission Control Areas (ECAs):

(a) Main Pollutant: The main pollutant produced when burning a hydrocarbon fuel like marine diesel oil is **Sulphur Oxides (SOx)**. These are primarily sulphur dioxide (SO2) with smaller amounts of sulphur trioxide (SO3).

(b) Reducing SOx Emissions: Several strategies can be employed to reduce SOx emissions:

- **Low-Sulphur Fuel:** Using marine diesel oil with a lower sulphur content significantly reduces SOx formation during combustion. International regulations and designated Emission Control Areas (ECAs) enforce stricter limits on sulphur content in fuels used by ships.
- **Exhaust Gas Cleaning Systems (EGCS):** Also known as "scrubbers," these systems remove SOx from the exhaust gases after combustion. They can be effective but require additional equipment and maintenance onboard.
- **Alternative Fuels:** Emerging technologies explore cleaner burning fuels like Liquefied Natural Gas (LNG) or biofuels, which can offer significant SOx reduction compared to traditional marine diesel oil.

(c) Emission Control Area (ECA): ECAs are designated areas around the world where stricter air pollution regulations apply to ships. This includes limitations on the sulphur content of fuels used within these zones.

(d) Maximum Sulphur Content:

(i) **Worldwide:** The current maximum sulphur content in marine diesel oil for use **globally** is **0.5%** by mass, as per MARPOL Annex VI regulations implemented by the IMO.

(ii) **ECA:** In **Emission Control Areas**, the maximum sulphur content is significantly stricter, currently set at **0.1%** by mass. This means ships operating within ECAs must use cleaner burning fuels with lower sulphur content to comply with regulations.

(e) SOx Production and Environmental Effects:

- **Combustion Process:** During the combustion of marine diesel oil, the sulphur present in the fuel reacts with oxygen to form SOx. The exact ratio of SO2 and SO3 depends on various factors like

combustion temperature and air-fuel ratio.

- **Environmental Effects:** SOx emissions contribute to several environmental problems:
    - **Acid Rain:** SOx reacts with water vapor in the atmosphere to form sulphuric acid, a major component of acid rain. This acid rain can damage forests, acidify lakes and rivers, and harm plant and animal life.
    - **Respiratory Issues:** SO2 exposure can irritate the respiratory tract, causing coughing, wheezing, and breathing difficulties, especially for people with asthma or other respiratory conditions.

By implementing stricter regulations and promoting cleaner burning fuels, the impact of SOx emissions from maritime activities can be significantly reduced, leading to a cleaner and healthier environment.

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5. With reference to bunkering of marine diesel oil:

(a) explain why the suppliers' tanks should be dipped prior to and after receiving fuel; (4)

(b) explain what is meant by a *letter of protest*, and when it must be issued; (4)

(c) state the person responsible for issuing the letter of protest. (2)

Bunkering of Marine Diesel Oil: Dipping Tanks, Letters of Protest, and Responsibilities

(a) Importance of Dipping Suppliers' Tanks:

Dipping the supplier's tanks before and after bunkering is a crucial practice for ensuring accurate fuel quantity measurement:

- **Pre-Bunkering Dip:** This establishes the initial volume of fuel present in the supplier's tank before transferring any fuel to the vessel. This initial reading serves as a baseline for calculating the delivered quantity.

- **Post-Bunkering Dip:** Once bunkering is complete, dipping the supplier's tank again provides the final volume remaining. By subtracting the final volume from the initial volume, the actual amount of fuel transferred to the vessel can be determined.

Accurate quantity measurement is essential for several reasons:

- **Billing Verification:** It ensures the vessel is charged only for the fuel actually received, preventing overbilling by the supplier.
- **Fuel Inventory Management:** Accurate records of fuel received help maintain a precise inventory of onboard fuel, enabling better voyage planning and fuel management.
- **Dispute Resolution:** In case of discrepancies between the fuel quantity ordered and the quantity delivered, tank dipping records provide vital evidence for resolving disputes.

(b) Letter of Protest:

A letter of protest is a formal document issued by the ship's Master to the bunker supplier when discrepancies arise regarding the quantity or quality of fuel delivered.

It's a crucial step taken **when there's a significant difference** between the amount of fuel ordered/dipped and the amount delivered/billed, or when there's a suspected issue with the fuel quality.

(c) Issuing the Letter of Protest:

The responsibility for issuing a letter of protest falls on the **ship's Master**. As the person ultimately responsible for the vessel's safety and operations, the Master has the authority to document any concerns about the bunkering process.

The letter of protest should be issued promptly after bunkering is completed and discrepancies are identified. It should clearly state the nature of the issue, including the observed difference in quantity or the suspected quality problem. Preserving tank dipping records and collecting fuel samples (if applicable) for further analysis becomes crucial evidence to support the protest.

May 2021

6. (a) With reference to MARPOL Annex IV, explain what is meant by the term *sewage*. (4)

(b) State the current regulations for the discharge of *sewage*. (6)

MARPOL Annex IV and Sewage Regulations

(a) Sewage Definition according to MARPOL Annex IV:

MARPOL Annex IV, titled "**Regulations for the Prevention of Pollution by Sewage from Ships**," defines sewage as:

- **Human body waste** and the drainage from toilets and urinals.
- **Scum** originating from galley, pantry, bar, sick bay, laundry, dishwasher or similar provisions.
- **Drainage** from sinks, washbasins, **laundry machines** and **baths** (**greywater** is sometimes included in this category depending on the specific regulations).

In essence, MARPOL Annex IV considers sewage to be any wastewater generated on a ship from human activities, excluding bilge water (engine room drainage) and cargo residues.

(b) Current Regulations for Sewage Discharge:

MARPOL Annex IV sets out regulations for the discharge of sewage from ships to minimize pollution and protect the marine environment. Here's a summary of the key points:

- **General Prohibition:** The discharge of **untreated sewage** from ships is generally **prohibited**. Exceptions are allowed only in specific circumstances, with strict distance requirements from land. These distances vary depending on the ship type and location.

- **Treatment Requirements:** Ships can discharge **comminuted and disinfected sewage** or **treated sewage** from approved sewage treatment plants when meeting specific conditions. These conditions include:

    - **Comminuted and Disinfected Sewage:** Solid particles are shredded and the effluent is disinfected before discharge. This is allowed further from land compared to untreated sewage.
    - **Treated Sewage:** Sewage undergoes a biological treatment process in an approved sewage treatment plant, resulting in significantly reduced organic matter and bacterial content. This allows for discharge closer to land compared to other options.
- **Special Areas:** For particularly sensitive areas like the Baltic Sea, even stricter regulations apply. Discharges of treated sewage from passenger ships may be further restricted or even prohibited entirely.

- **Discharge Records:** MARPOL requires ships to maintain an **Oil Record Book (ORB)**. This record book also includes a section for recording sewage discharges, including date, time, location, quantity, and operational conditions. This allows for monitoring and enforcement of the regulations.

By adhering to these regulations, ships can minimize their impact on the marine environment and contribute to cleaner seas.

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May 2021

7. (a) State FIVE properties of a refrigeration oil. (5)

(b) Describe the operation of an Oil Separator in a refrigeration system. (5)

Refrigeration Oil Properties

(a) Five Key Properties:

1. **Viscosity:** Refrigeration oil needs to maintain a proper viscosity across a wide temperature range. It must be thin enough to flow freely at low temperatures (during system startup) and thick enough to provide adequate lubrication at high compression temperatures.
2. **Miscibility:** The oil should be miscible (easily mix) with the refrigerant used in the system. This ensures good circulation and heat transfer within the compressor.
3. **Thermal and Chemical Stability:** The oil must resist breakdown due to high temperatures and pressure within the system. It should also be chemically stable to prevent unwanted reactions with the refrigerant or compressor materials.
4. **Hygroscopic性 (xìng) (xìng):** (Hygroscopicity) The oil should have low water absorption. Water contamination can lead to ice formation in the system, impacting performance and causing potential damage.
5. **Non-foaming:** The oil should not form excessive foam during operation. Foam can reduce lubrication efficiency and hinder heat transfer.

(b) Oil Separator Operation:

An oil separator is a component found in some refrigeration systems, particularly those with large compressors or using specific refrigerants. Its function is to remove excess oil from the refrigerant vapor leaving the evaporator before it reaches the compressor.

Here's how it works:

- The oil-refrigerant mixture exits the evaporator.
- The separator uses various methods (like centrifugal force, baffles, or mesh screens) to separate the oil from the refrigerant vapor due to their different densities.
- The separated oil is then returned to the crankcase of the compressor for proper lubrication.
- The oil-free refrigerant vapor continues to the compressor inlet.

Benefits of using an Oil Separator:

- Reduces oil circulation in the system, improving system efficiency.
- Prevents oil accumulation in the condenser, which can hinder heat transfer.
- Protects the compressor from excessive oil dilution, which can affect lubrication and wear properties.

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May 2021

8. With reference to fresh water treatment:

(a) describe the process for superchlorinating the fresh water system, stating relevant periods, times, and chlorine levels; (6)

(b) explain what is meant by copper staining and the treatment required to prevent it. (4)

Fresh Water Treatment: Superchlorination and Copper Staining

(a) Superchlorination Process:

Superchlorination is a shock treatment method used to disinfect a freshwater system on board a ship and eliminate any potential bacterial growth, particularly Legionella bacteria. Here's a breakdown of the process:

- **Preparation:**
    - Isolate the freshwater system from other onboard water supplies to prevent contamination.
    - Ensure proper ventilation in pump rooms and other enclosed spaces where chlorine will be used.
    - Crew members involved should wear appropriate personal protective equipment (PPE) like gloves, goggles, and respirators.
- **Chlorine Dosing:**
    - Introduce a high concentration of chlorine into the freshwater system, typically exceeding 1 mg/L (milligrams per liter) free chlorine residual.
    - This can be achieved through various methods:
        - Sodium hypochlorite (bleach) solution
        - Electrolytic generation of chlorine
        - Chlorine gas (used less frequently due to safety concerns)
- **Contact Time:**

    - Maintain the high chlorine concentration for a specific period, typically between 1-4 hours. This allows sufficient time for the chlorine to come into contact and inactivate bacteria throughout the system.
- **Dechlorination:**
    - After the contact time, the chlorine residual needs to be neutralized to prevent taste issues and pipe corrosion. This is done by adding a dechlorination agent like sodium thiosulfate.
- **Flushing and Testing:**
    - The entire system is thoroughly flushed with clean water to remove any residual chlorine or dechlorination byproducts.
    - Water samples are taken at various points in the system for microbiological testing to ensure the absence of harmful bacteria before the system is returned to service.

Important Notes:

- The specific chlorine concentration, contact time, and dechlorination procedures might vary depending on regulations, the type of chlorine used, and the initial water quality.
- It's crucial to follow established protocols and manufacturer's recommendations for safe and effective superchlorination.

(b) Copper Staining and Prevention:

Copper Staining:

This refers to the appearance of blue-green or turquoise stains on fixtures and surfaces that come into contact with the ship's freshwater. These stains are caused by the corrosion of copper pipes or fittings within the system.

Causes:

- **Low pH:** When the freshwater is slightly acidic (low pH), it can become corrosive to copper pipes.
- **High Oxygen Levels:** Dissolved oxygen in the water can also accelerate copper corrosion.

Prevention:

Several strategies can be implemented to prevent copper staining:

- **pH Adjustment:** Maintaining a slightly alkaline pH level (around 7.0-8.5) in the freshwater can help reduce copper pipe corrosion. This can be achieved by adding hydrated lime (calcium hydroxide) during water treatment.
- **Corrosion Inhibitors:** Phosphate-based corrosion inhibitors can be added to the freshwater system to form a protective film on the copper surfaces, slowing down corrosion.
- **Cathodic Protection (Optional):** In some cases, a cathodic protection system might be used to electrically protect the copper pipes from corrosion.

By implementing these preventive measures, shipboard water treatment systems can minimize the risk of copper staining and ensure the aesthetic quality and safety of the freshwater supply.

May 2021

9. With reference to a machinery space carbon dioxide smothering system:

(a) state the regulation regarding the rate of flooding with respect to time; (4)

(b) state the precautions to be taken before activating the system. (6)

CO2 Smothering System in Machinery Spaces: Regulations and Precautions

Here's a breakdown of the regulations and precautions regarding CO2 smothering systems for machinery spaces on marine vessels:

(a) Rate of Flooding Regulation:

There are two main regulatory bodies that set guidelines for CO2 flooding systems:

- **International Maritime Organization (IMO):** The **International Code for Fire Safety Systems (FSS Code)** by the IMO doesn't explicitly specify a set rate of flooding. However, it requires the system to achieve an effective CO2 concentration (typically around 30-35% by volume) within the machinery space in a timeframe sufficient to extinguish the fire. This timeframe should be based on the specific volume of the machinery space and the CO2 discharge capacity of the system design.

- **National Regulations:** Many countries have national regulations that may provide more specific requirements regarding the rate of flooding. These regulations might reference standards set by classification societies (e.g., Lloyd's Register, American Bureau of Shipping). In general, the goal is to achieve an effective CO2 concentration quickly, but also allow enough time for safe evacuation of personnel.

(b) Precautions Before Activation:

CO2 smothering systems are powerful tools, but their use poses a serious risk of suffocation to personnel trapped within the machinery space during discharge. Here are some crucial precautions to take before activating the system:

1. **Fire Alarm Activation:** Ensure the fire alarm has been activated to alert personnel and initiate evacuation procedures.
2. **Evacuation and Muster:** All personnel must evacuate the machinery space and surrounding areas at risk of CO2 exposure. A muster point should be designated for headcount to ensure everyone has cleared the area.
3. **Stoppage of Machinery:** If possible, stop all machinery operation within the space to minimize potential hazards from equipment malfunctions during CO2 discharge.
4. **Ventilation System Shutdown:** Close all ventilation openings to prevent CO2 gas from escaping the machinery space and potentially affecting other compartments.
5. **Confirmation of Evacuation:** Verify that the machinery space and surrounding areas are clear of personnel before initiating CO2 discharge.

Additional Considerations:

- **Training:** Crew members must be properly trained on the operation of the CO2 smothering system and emergency procedures.
- **Warning Signs:** Clear warning signs should be posted at the entrance to the machinery space indicating the presence of a CO2 smothering system.
- **System Testing and Maintenance:** Regular testing and maintenance of the CO2 smothering system are crucial to ensure its functionality and safety.

Following these regulations and precautions ensures the safe and effective use of CO2 smothering systems for fire suppression in machinery spaces while minimizing risks to personnel.

May 2021

10. With reference to ocean going vessels, define EACH of the following:

(a) trim; (1)

(b) freeboard; (1)

(c) camber; (1)

(d) length between perpendiculars; (1)

(e) length overall; (1)

(f) sheer; (1)

(g) stem; (1)

(h) draft marks; (1)

(i) draft; (1)

(j) depth; (1)

(a) **Trim:** The longitudinal balance of a vessel. It refers to the difference in water depth at the bow (forward) and stern (aft) perpendiculars.

- **Even Trim:** The vessel floats level with equal water depths at bow and stern.
- **By the Bow:** The vessel sits deeper in the water at the bow than the stern.
- **By the Stern:** The vessel sits deeper in the water at the stern than the bow.

(b) **Freeboard:** The vertical distance between the waterline and a specific deck on the vessel's side, typically the uppermost continuous deck exposed to weather. It's a safety measure ensuring sufficient buoyancy and preventing excessive wave washing over the deck.

(c) **Camber:** The slight upward curvature of a ship's deck from the centerline towards the sides. This curvature provides structural strength and helps shed water overboard.

(d) **Length Between Perpendiculars (LBP):** The horizontal distance measured along the waterline between the forward perpendicular (FP) and the aft perpendicular (AP). It represents the length of the vessel's underwater hull and is a constant value for a specific ship.

(e) **Length Overall (LOA):** The horizontal distance between the extreme forward point (usually the stem) and the extreme aft point (usually the rudder post) of the vessel. Unlike LBP, LOA can vary slightly depending on the design of the bow and stern.

(f) **Sheer:** The longitudinal curvature of a vessel's deck from bow to stern. The deck is typically higher at the bow and stern compared to the midships section. This curvature helps shed water, improves seakeeping, and can offer some structural benefits.

(g) **Stem:** The forwardmost vertical structure of a vessel that cuts through the water. The shape of the stem can influence wave-piercing ability and overall hydrodynamic efficiency.

(h) **Draft Marks:** Permanent markings on the port and starboard sides of the vessel amidships. These markings indicate the depth of the vessel's underwater hull, with a reference line corresponding to the unloaded draft (sometimes called "light ship draft"). Additional markings may indicate different draft depths based on the vessel's load condition.

(i) **Draft:** The vertical distance between the waterline and the bottom of the vessel's keel. It represents the depth of the vessel underwater and is influenced by the vessel's weight and cargo load. A deeper draft indicates a heavier loaded vessel.

(j) **Depth:** In this context, refers to the overall vertical distance from the water surface to the seabed. It's a crucial measurement for navigation to avoid grounding the vessel on underwater obstacles. Draft should always be considered when determining safe navigation depth.