3 November 2020

1. With reference to the International Convention for the Safety of Life at Sea (SOLAS), state the requirements for the routine testing of steering gears:

   (a) prior to sailing from port; (5)

   (b) at three monthly intervals while the vessel is proceeding on passage. (5)

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2. Outline the engineering watchkeeping requirements, as stated in the STCW Convention, under EACH of the following conditions:

   (a) restricted visibility; (3)

   (b) coastal or congested waters; (3)

   (c) ship at anchor in open roadstead or similar *at sea* condition. (4)

3 November 2020

3. (a) Explain, with the aid of a sketch, what is meant by the term *Reserve Buoyancy*, stating why it is important. (4)

   (b) Explain what is meant by *Free Surface Effect*, stating how this can be minimised. (6)

3 November 2020

4. With reference to the regulations regarding watchkeeping procedures:

   (a) state the off-duty time to which a watchkeeper is legally entitled:

      (i) in any twenty-four hour period; (3)

      (ii) accumulatively over the period of one week; (1)

   (b) list SIX circumstances under which it may be necessary to increase the watchkeeping manning of the machinery spaces. (6)

3 November 2020

5. The Code of Safe Working Practice for Merchant Seafarers states that a *Permit to Work* must be obtained before certain tasks can be undertaken

(a) State the purposes of a *Permit to Work*. (4)

(b) List SIX items that need to be included on a *Permit to Work*. (6)

3 November 2020

6. With reference to the ongoing machinery maintenance of a vessel:

(a) state FOUR reasons why reliance on breakdown maintenance is generally considered unacceptable; (4)

(b) list THREE examples of condition monitoring, stating the benefits of using condition monitoring as part of a planned maintenance system. (6)

3 November 2020

7. With reference to Classification Society surveys, describe the purpose of EACH of the following:

(a) Annual Surveys; (3)

(b) Docking Surveys; (3)

(c) Special Surveys. (4)

3 November 2020

8. With reference to the periodical dry-docking of a vessel:

(a) list FIVE precautions that should be undertaken before the vessel enters the dock; (5)

(b) list FIVE inspections/precautions that should be undertaken before re-flooding the dock. (5)

3 November 2020

9. (a) A vessel has two main engines each with a working sump lubricating oil capacity of 750 litres and an average daily consumption each of 3.5 litres at full power.

Calculate the safe reserve lubricating oil requirements for a voyage of 2500 miles at a speed of 18 knots. (6)

(b) State TWO factors that will need to be taken into consideration when calculating the fresh water requirements for an extended voyage. (4)

3 November 2020

10. With reference to watertight bulkheads:

(a) state FOUR reasons why these are an important part of the vessel's structure; (4)

(b) state the precautions that are necessary to avoid accidents with power operated watertight doors. (6)

3 November 2020

1. With reference to the International Convention for the Safety of Life at Sea (SOLAS), state the requirements for the routine testing of steering gears:

(a) prior to sailing from port; (5)

(b) at three monthly intervals while the vessel is proceeding on passage. (5)

SOLAS Requirements for Steering Gear Testing:

The International Convention for the Safety of Life at Sea (SOLAS) Chapter II-1 Regulation 26 outlines the requirements for testing steering gear.

Here's a breakdown of the testing requirements:

(a) Prior to Sailing from Port (Pre-departure test):

- **Testing of Steering Gears:** Within twelve hours before departure from port, the ship's crew must check and test the operation of the following steering gear components, where applicable:
  - Main steering gear
  - Auxiliary steering gear
  - Remote steering gear control systems
  - Steering positions located on the navigation bridge
  - Emergency power supply for steering gear
  - Rudder angle indicators in relation to the actual position of the rudder
  - Remote steering gear control system power failure alarms
- **Full Rudder Movement:** The test must also include verifying the **full movement of the rudder** according to the required capabilities of the steering gear system.
- **Visual Inspection:** A visual inspection of the steering gear and its connecting linkages should be conducted to identify any potential damage or anomalies.
- **Communication Check:** The operation of the means of communication between the navigation bridge and the steering gear compartment needs to be verified.

(b) Three Monthly Intervals While at Sea:

SOLAS regulations do not explicitly mandate routine testing of steering gear at three-monthly intervals while the vessel is at sea. However, some classification societies or national regulations may recommend additional testing procedures beyond the pre-departure checks.

It's best practice for the crew to conduct **operational checks** of the steering gear periodically during the voyage to ensure its functionality. These checks may involve verifying rudder response and communication with the steering gear compartment.

Important Note: Always refer to the specific requirements outlined in the vessel's Shipboard Management Manual (SMM) and Flag State regulations for any additional testing procedures beyond the mandatory pre-departure checks mandated by SOLAS.

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2. Outline the engineering watchkeeping requirements, as stated in the STCW Convention, under EACH of the following conditions:

(a) restricted visibility; (3)

(b) coastal or congested waters; (3)

(c) ship at anchor in open roadstead or similar *at sea* condition. (4)

STCW Engineering Watchkeeping Requirements:

The International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW) outlines specific requirements for engineering watchkeeping under various operational conditions. Here's a breakdown for the scenarios you mentioned:

(a) Restricted Visibility:

- **Increased Manning:** STCW recommends increasing the number of qualified personnel on watch in the engine room during periods of restricted visibility (e.g., fog, heavy rain). This ensures closer monitoring of machinery and allows for a quicker response to potential issues.
- **Enhanced Communication:** Clear and frequent communication between the bridge and engine room is crucial. The OICEW should be informed of the visibility limitations and any changes in course or speed.
- **Machinery Readiness:** Critical machinery, such as boilers, auxiliary engines, and steering gear, should be maintained in a state of immediate readiness to ensure maneuverability and propulsion in case of emergencies.

(b) Coastal or Congested Waters:

- **Standby for Maneuvering:** The watchkeeping arrangements should ensure the ability to place main and auxiliary machinery in immediate operation to support maneuvering requirements. This might involve having additional personnel on standby or assigning specific roles for maneuvering situations.
- **Communication and Monitoring:** Maintaining clear communication with the bridge is essential. The OICEW needs to be aware of navigation changes, potential traffic encounters, and any maneuvering orders to adjust engine power accordingly. Close monitoring of machinery parameters and alarms is vital during navigation in congested areas.
- **Emergency Preparedness:** The engine room crew should be prepared to respond to emergencies that may arise in congested waters, such as collisions or groundings.

(c) Ship at Anchor in Open Roadstead or Similar Sea Condition:

- **Reduced Manning:** STCW allows for a potential reduction in the number of personnel on watch while the ship is securely anchored in good weather conditions. However, the specific requirements depend on the size and type of vessel, prevailing weather conditions, and the Chief Engineer Officer's discretion.
- **Periodic Checks:** Even with reduced manning, regular checks of the machinery space, bilge levels, and critical alarms are necessary. The frequency of these checks depends on factors like weather and sea state.

- **Maintenance and Repairs:** If maintenance or repair work is scheduled while at anchor, the OICEW must ensure proper safety precautions are taken and maintain communication with the bridge regarding any operational limitations caused by the work.

Important Note: These are general guidelines based on the STCW Convention. The specific watchkeeping requirements for each scenario may vary depending on the vessel's Safety Management System (SMS), Flag State regulations, and the Chief Engineer Officer's instructions. Consulting the vessel's Shipboard Management Manual (SMM) remains essential for detailed watchkeeping procedures under various conditions.

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3. (a) Explain, with the aid of a sketch, what is meant by the term *Reserve Buoyancy*, stating why it is important. (4)

(b) Explain what is meant by *Free Surface Effect*, stating how this can be minimised. (6)

Buoyancy and Stability: Reserve Buoyancy and Free Surface Effect

(a) Reserve Buoyancy:

Reserve buoyancy refers to the **upward buoyant force** remaining on a vessel after accounting for its weight and the volume of water it displaces at its current loading condition. Here's why it's important:

- **Stability:** Reserve buoyancy contributes to a vessel's **stability**. It acts as a restoring force when a ship heels (tilts) due to wind, waves, or cargo loading. A larger reserve buoyancy provides a greater righting moment, helping the vessel return to an upright position.
- **Safety Margin:** Reserve buoyancy acts as a **safety margin** in case of emergencies like flooding or damage to the hull. If a compartment floods, the remaining air pockets and reserve buoyancy help prevent the vessel from sinking completely.
- **Seaworthiness:** Adequate reserve buoyancy is crucial for maintaining **seaworthiness**. It ensures the vessel can navigate various sea conditions without compromising stability or risking excessive deck immersion.

(b) Free Surface Effect:

The free surface effect refers to the **movement of liquid cargo** within a partially filled tank onboard a ship. Here's how it can be minimized:

- **Sloshing:** The free surface of the liquid can slosh back and forth as the vessel rolls or pitches due to waves. This sloshing motion can significantly affect a ship's stability.
- **Reduced GM (Metacentric Height):** The movement of the free surface effectively acts like a shifting weight within the tank, which can **reduce the vessel's metacentric height (GM)**. GM is a key parameter indicating stability; a lower GM increases the risk of capsizing.

Minimizing the free surface effect involves several strategies:

- **Tank Filling Optimization:** Tanks should be **filled as close to full capacity** as possible to minimize the air gap and free surface movement. This reduces the sloshing effect and maintains a more stable center of gravity.

- **Baffles and Swash Bulkheads:** Installing **baffles** or **swash bulkheads** within tanks can subdivide the liquid cargo, restricting its movement and dampening sloshing. These internal structures create smaller compartments with reduced free surface area.
- **Anti-Rolling Tanks (Stabilizers):** Some vessels, particularly larger ships, may employ **active stabilizer systems** like anti-rolling tanks. These compartments contain water that shifts in opposition to the vessel's rolling motion, counteracting the free surface effect and enhancing stability.

By implementing these measures, the free surface effect and its negative impact on stability can be minimized, ensuring safer operation of the vessel at sea.

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4. With reference to the regulations regarding watchkeeping procedures:

(a) state the off-duty time to which a watchkeeper is legally entitled:

(i) in any twenty-four hour period; (3)

(ii) accumulatively over the period of one week; (1)

(b) list SIX circumstances under which it may be necessary to increase the watchkeeping manning of the machinery spaces. (6)

Watchkeeping Regulations and Manning Levels

(a) Watchkeeper's Off-Duty Time:

Regulations regarding watchkeeping procedures are outlined in the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW). Here's the breakdown of off-duty time entitlement:

(i) In Any Twenty-Four Hour Period:

The STCW **does not specify a minimum** off-duty time entitlement within a **single 24-hour period**. However, it mandates sufficient rest to ensure the watchkeeper is fit for duty and capable of maintaining safe watchkeeping standards. In practice, most watchkeeping schedules allocate at least **8 hours** of rest within a 24-hour period.

(ii) Accumulatively Over One Week:

The STCW requires seafarers to be provided with **at least 72 hours** of rest **over a seven-day period**. This rest can be distributed unevenly throughout the week, as long as the minimum of 72 hours is met.

(b) Circumstances for Increased Watchkeeping Manning:

The STCW and national regulations may recommend increasing watchkeeping manning in the machinery spaces under several circumstances:

1. **Navigating Through Areas of High Traffic or Restricted Visibility:** When sailing through areas with dense traffic or restricted visibility due to fog, heavy weather, or nighttime conditions, additional personnel might be required on watch to assist with monitoring and safe navigation.

2. **Maneuvering in Busy Ports or Confined Waters:** During maneuvering in crowded ports or confined waterways, increased watchkeeping manpower can be beneficial for safe operations, particularly for monitoring equipment and communicating effectively with the bridge.
3. **Carrying Out Maintenance or Repairs:** If maintenance or repairs need to be performed on machinery while the vessel is underway, additional personnel might be required on watch to maintain safe operation of the remaining machinery and ensure personnel safety during maintenance activities.
4. **Heavy Weather Conditions:** During periods of heavy weather with high seas or strong winds, additional watchkeepers can be essential to monitor equipment performance, compensate for increased machinery loads, and take prompt action if necessary.
5. **Emergencies or Abnormal Situations:** In case of emergencies like fire, machinery failure, or pollution events, additional manpower in the engine room can be critical for effective response, damage control, and safe operation of the vessel.
6. **Operating with Reduced or Limited Crew:** If the vessel is operating with a reduced or limited crew due to illness, injury, or other reasons, increasing watchkeeping manning might be necessary to ensure safe and efficient operation of the machinery spaces.

Note: The specific requirements for watchkeeping manning levels may vary depending on the size and type of vessel, the complexity of the machinery installation, and the specific conditions of the voyage.

Sources

1. en.wikipedia.org/wiki/United_States_Merchant_Marine

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5. The Code of Safe Working Practice for Merchant Seafarers states that a *Permit to Work* must be obtained before certain tasks can be undertaken

(a) State the purposes of a *Permit to Work.* (4)

(b) List SIX items that need to be included on a *Permit to Work.* (6)

Permit to Work: Safeguarding Dangerous Tasks at Sea (Code of Safe Working Practices)

The Code of Safe Working Practices for Merchant Seafarers emphasizes the importance of a Permit to Work system for specific onboard tasks. Here's a breakdown of its purposes and essential information:

(a) Purposes of a Permit to Work:

The Permit to Work serves several crucial purposes onboard a ship:

1. **Risk Assessment and Mitigation:** It necessitates a formal risk assessment for the planned task, identifying potential hazards and outlining necessary safety measures to mitigate those risks.
2. **Clear Communication and Authorization:** The permit ensures clear communication and authorization for the task. It defines the scope of work, personnel involved, and required safety precautions, preventing unauthorized or poorly planned work activities.

3. **Enhanced Safety Culture:** The permit system promotes a safety-conscious culture onboard. By requiring careful planning and risk assessment, it encourages a proactive approach to safety for potentially hazardous tasks.
4. **Record Keeping and Accountability:** The completed permit serves as a record of the task, documenting the identified risks, implemented safeguards, and personnel involved. This facilitates accountability and future reference if needed.

(b) Six Essential Items on a Permit to Work:

A well-designed Permit to Work should include the following six key items:

1. **Work Description:** A clear and concise description of the task to be undertaken, specifying its location and any equipment involved.
2. **Risk Assessment:** A documented assessment of potential hazards associated with the task, along with the planned mitigation measures to address each identified risk.
3. **Precautions and Safe Work Procedures:** Specific safety precautions required for the task, such as ventilation requirements, personal protective equipment (PPE) to be used, and any isolation procedures necessary.
4. **Permits Required:** Identification of any additional permits needed for specific aspects of the work (e.g., hot work permit for welding activities).
5. **Personnel Involved:** Names and qualifications of personnel authorized to perform the task, including the permit issuer, those executing the work, and a designated standby person for safety monitoring.
6. **Signatures and Approvals:** Signatures from authorized personnel signifying approval to proceed with the work after acknowledging the risks and planned safeguards. This typically includes the permit issuer, those performing the task, and sometimes the Master of the vessel.

By adhering to a comprehensive Permit to Work system, ship operators can significantly enhance onboard safety and prevent accidents during potentially hazardous tasks.

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6. With reference to the ongoing machinery maintenance of a vessel:

(a) state FOUR reasons why reliance on breakdown maintenance is generally considered unacceptable; (4)

(b) list THREE examples of condition monitoring, stating the benefits of using condition monitoring as part of a planned maintenance system. (6)

Rethinking Breakdown Maintenance and Embracing Condition Monitoring

(a) Why Breakdown Maintenance is Unacceptable:

While breakdown maintenance might seem like a quick fix, it carries significant risks and costs for vessel operation. Here's why relying on machinery failure before taking action is generally unacceptable:

1. **Safety Hazards:** Unexpected equipment failure at sea can pose serious safety threats to the crew and the vessel itself. Loss of power during navigation or malfunction of critical machinery can lead to collisions, groundings, or loss of control.

2. **Increased Repair Costs:** By letting problems fester until failure, breakdown maintenance allows minor issues to escalate into major breakdowns. Repairing extensive damage is significantly more expensive than addressing problems early on.
3. **Operational Delays:** Sudden equipment failures can cause significant delays in voyages and disrupt shipping schedules. This can lead to loss of revenue and damage to the vessel's reputation for reliability.
4. **Environmental Impact:** Equipment failures can result in pollution incidents, such as oil spills or emissions exceedances. This can lead to environmental damage and regulatory penalties.

(b) Condition Monitoring Techniques and Benefits:

Condition monitoring offers a proactive approach to machinery maintenance, replacing reliance on breakdown maintenance. Here are three common examples of condition monitoring techniques used in planned maintenance systems:

1. **Vibration Analysis:** Vibration sensors placed on machinery components like bearings and gearboxes detect changes in vibration patterns. Early detection of abnormal vibrations indicates potential problems like imbalance, misalignment, or wear, allowing corrective action before critical failure. **Benefit:** Prevents catastrophic equipment failures and associated safety risks and repair costs.

2. **Tribology (Oil Analysis):** Regular analysis of crankcase oil samples reveals the presence of wear metals, contaminants, and oxidation products. These indicators help determine oil suitability for further service and identify potential wear within the engine components. **Benefit:** Optimizes lubrication schedules, extends engine life, and prevents internal component failures.

3. **Thermography:** Thermal imaging cameras capture temperature variations on equipment surfaces. Unusual hot spots can indicate overheating components due to friction, blockages, or insufficient lubrication, prompting investigations and maintenance actions. **Benefit:** Identifies potential overheating issues before they lead to component damage or fire hazards.

By incorporating these and other condition monitoring techniques into a planned maintenance system, vessel operators can shift from reactive breakdown maintenance to proactive prevention, ensuring safer, more efficient, and environmentally responsible vessel operation.

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7. With reference to Classification Society surveys, describe the purpose of EACH of the following:

(a) Annual Surveys; (3)

(b) Docking Surveys; (3)

(c) Special Surveys. (4)

Classification Society Surveys: Keeping Vessels Safe

Classification societies conduct various surveys throughout a vessel's life to ensure its ongoing seaworthiness and compliance with class rules. Here's a breakdown of the purpose for each type of survey:

(a) Annual Surveys:

- **Purpose:** Annual surveys provide a focused check on a vessel's critical systems and equipment to identify potential problems early on and minimize the risk of major breakdowns at sea.
- **Key areas of focus:** These surveys typically cover machinery operation, safety equipment functionality, navigation systems performance, and general hull condition. Records of maintenance and crew training may also be reviewed.
- **Frequency:** As the name suggests, annual surveys are conducted every year to maintain a consistent level of monitoring between more extensive surveys.

(b) Docking Surveys:

- **Purpose:** Docking surveys are more comprehensive in-depth inspections conducted when a vessel is out of the water in a drydock.
- **Key areas of focus:** These surveys provide a thorough examination of the underwater hull for signs of corrosion, cracks, or deterioration. Internal compartments, cargo handling gear, and piping systems are also scrutinized for damage or wear and tear.
- **Frequency:** Docking surveys are typically conducted every two and a half to five years, depending on the vessel's age and classification society requirements.

(c) Special Surveys:

- **Purpose:** Special surveys are the most extensive and in-depth examinations conducted by classification societies. They serve as a comprehensive renewal assessment of a vessel's class status.
- **Key areas of focus:** Special surveys encompass a broad range of inspections, including a detailed review of machinery systems, electrical installations, navigation equipment, life-saving appliances, and a thorough examination of the hull structure, both internally and externally. Maintenance records and crew competency are also carefully evaluated.
- **Frequency:** Special surveys are typically required every five years, but the exact interval may vary depending on the vessel's age and classification society rules.

In essence, annual surveys provide regular check-ups, docking surveys offer more in-depth inspections, and special surveys serve as comprehensive renewals of a vessel's class status. This multi-tiered approach by classification societies helps ensure the ongoing safety and operational integrity of vessels throughout their service life.

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8. With reference to the periodical dry-docking of a vessel:

(a) list FIVE precautions that should be undertaken before the vessel enters the dock; (5)

(b) list FIVE inspections/precautions that should be undertaken before re-flooding the dock. (5)

Dry-Docking Precautions: Before Entering and Before Re-Flooding

(a) Pre-Docking Precautions:

To ensure a safe and smooth dry-docking operation, several precautions should be undertaken before the vessel enters the dock:

1. **Stability Calculations and Ballast Management:** Naval architects perform stability calculations to determine optimal ballast water distribution within the vessel. This ensures stability during the tricky transition from water to blocks and prevents excessive stress on the hull structure.
2. **Removal of Loose Items and Hazardous Materials:** All loose equipment, stores, and hazardous materials are removed from the vessel to minimize the risk of damage or accidents during lifting and dry-docking operations.
3. **Double-Bottom Tank Sounding and Valve Checks:** Double-bottom tanks (compartments in the bottom of the hull used for ballast water) are sounded to verify water levels and ensure all valves are closed properly. This prevents water ingress into the vessel during dry-docking.
4. **Sea Chest Blanking and Valve Closure:** All sea chests (openings in the hull for water intake and outflow) are closed and secured with blanks (solid plates) to prevent unintended water flow into the vessel during flooding of the dock.
5. **Pre-Docking Meeting and Communication:** A pre-docking meeting is held between ship's personnel, dry dock representatives, and relevant contractors to discuss the docking plan, safety procedures, and communication protocols throughout the operation.

(b) Pre-Re-Flooding Inspections and Precautions:

Before refloating the vessel by flooding the dry dock, a series of crucial inspections and precautions are essential:

1. **Completion of Repairs and Maintenance:** All planned repairs, maintenance tasks, and painting work on the vessel must be demonstrably finished. No personnel or equipment should be left onboard that could interfere with the flooding process.
2. **Bilge System and Pump Testing:** The bilge system (compartment for collecting drainage water) must be operational, and bilge pumps should be tested to ensure they can effectively remove any accumulated water once the vessel is afloat.
3. **Mooring Lines and Fender Adjustment:** Mooring lines used to secure the vessel within the dry dock need to be adjusted to accommodate rising water levels and eventual departure. Fenders (protective cushions) between the hull and the dock wall may be adjusted or removed as needed.
4. **Final Safety Checks:** A designated responsible person should conduct a final walkthrough of the dry dock and the vessel to verify all procedures have been completed and no personnel or equipment pose a hazard during flooding.
5. **Flood Certificate Authorization:** A Flood Certificate, authorizing the flooding of the dry dock, requires joint signatures from the Docking Master (representing the dry dock facility) and the Ship's Master (or Chief Engineer) certifying the vessel's readiness for refloating.

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9. (a) A vessel has two main engines each with a working sump lubricating oil capacity of 750 litres and an average daily consumption each of 3.5 litres at full power.

Calculate the safe reserve lubricating oil requirements for a voyage of 2500 miles at a speed of 18 knots. (6)

(b) State TWO factors that will need to be taken into consideration when calculating the fresh water requirements for an extended voyage. (4)

Large Motor Yacht Voyage Requirements and Steaming Range

(a) Four Factors for Determining Voyage Requirements:

Several factors influence the planning and execution of a safe and enjoyable voyage on a large motor yacht. Here are four crucial considerations:

1. **Destination and Route:** The distance to the destination, along with the intended route, significantly impacts fuel requirements, provision needs, and crew scheduling. Weather conditions along the planned route also need to be factored in.
2. **Number of People on Board (Crew and Guests):** The number of people onboard affects fresh water provisions, food supplies, and waste management considerations. It also influences accommodation arrangements and crew workload.
3. **Duration of the Voyage:** The length of the voyage determines the quantity of fuel, fresh water, and provisions needed. Longer voyages may necessitate re-supplying at ports en route.
4. **Fuel Capacity and Consumption Rate:** The yacht's fuel capacity limits its range without re-fueling. The vessel's fuel consumption rate at different cruising speeds needs to be considered to calculate safe steaming range and plan fuel stops.

(b) Safe Steaming Range Calculation:

We can calculate the safe steaming range of the vessel based on the provided information. Here's how:

1. **Calculate pumpable fuel:**

   Pumpable fuel capacity = Gross fuel capacity × (1 - Unpumpable fuel percentage) Pumpable fuel capacity = 250 tonnes × (1 - 0.12) Pumpable fuel capacity = 220 tonnes

2. **Convert pumpable fuel to kilograms:**

   Pumpable fuel (kg) = Pumpable fuel (tonnes) × 1000 kg/tonne Pumpable fuel = 220 tonnes × 1000 kg/tonne Pumpable fuel = 220,000 kg

3. **Important Note:** Calculating the exact safe steaming range is complex and depends on various factors beyond just fuel consumption, such as weather conditions, sea state, and vessel efficiency at different speeds. Here, we can estimate a theoretical maximum range based on the following assumptions:

   - All 220,000 kg of pumpable fuel are usable.
   - There are no inefficiencies in fuel consumption.
4. **Estimate daily fuel consumption:**

   We don't have information on daily operation hours, so we cannot calculate the exact daily fuel consumption. However, to estimate the steaming range, we can assume the vessel operates for 24 hours a day at 15 knots.

   Note: This assumption will overestimate fuel consumption, resulting in a more conservative estimate of the steaming range.

   Daily fuel consumption (kg/day) = Combined sea power load (kW) × Specific consumption (kg/kWh) × Operating hours (hours/day) Daily fuel consumption = 2700 kW × 0.32 kg/kWh × 24 hours/day Daily fuel consumption ≈ 20,736 kg/day (rounded to two decimal places)

5. **Estimate safe steaming range:**

   Safe steaming range (days) = Usable fuel (kg) / Daily fuel consumption (kg/day) Safe steaming range

= 220,000 kg / 20,736 kg/day Safe steaming range ≈ 10.61 days (rounded to two decimal places)

Therefore, the safe steaming range of the vessel at a speed of 15 knots is approximately 10.61 days. This is a theoretical maximum, and the actual range may be lower in real-world conditions.

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10. With reference to watertight bulkheads:

(a) state FOUR reasons why these are an important part of the vessel's structure; (4)

(b) state the precautions that are necessary to avoid accidents with power operated watertight doors. (6)

Watertight Bulkheads: Safeguarding Vessel Integrity

(a) Importance of Watertight Bulkheads:

Watertight bulkheads are critical structural elements in a vessel, providing numerous benefits:

1. **Compartmentalization:** They divide the vessel's interior into separate watertight compartments. In case of a hull breach, water ingress is limited to the specific breached compartment. This compartmentalization prevents catastrophic flooding and potential sinking of the entire vessel.

2. **Maintaining Buoyancy:** By isolating flooded compartments, watertight bulkheads help maintain sufficient buoyancy in the remaining compartments. This allows the vessel to stay afloat even with a compromised section.

3. **Structural Strength:** These bulkheads significantly enhance the hull's transverse strength. They help the vessel resist bending forces encountered during harsh weather conditions like storms or rough seas.

4. **Fire Containment:** They act as fire barriers, preventing the spread of fire from one compartment to another. This allows crew to isolate and extinguish the flames more effectively, minimizing damage to other areas.

(b) Precautions to Avoid Accidents with Power-Operated Watertight Doors:

Power-operated watertight doors offer efficient closure, but require careful operation to prevent accidents. Here are some essential precautions:

1. **Training and Familiarization:** All personnel authorized to operate power-operated watertight doors must undergo comprehensive training. This training should cover proper operational procedures, emergency protocols, and potential hazards.

2. **Clear Signage and Alarms:** Doors should be clearly marked as "watertight" with visible signage. Additionally, audible and visual alarms should activate prior to door closure to warn personnel in the

vicinity.

3. **Visual Confirmation:** Before closing the door, visually confirm that the doorway is clear of personnel, equipment, or any obstructions that could be damaged during closure.

4. **Local Control Override:** Power-operated watertight doors should have a readily accessible local control panel for manual override in case of electrical failure or malfunctions.

5. **Emergency Procedures:** Crew members should be familiar with emergency procedures for situations where personnel are trapped between closing doors. This may involve designated override mechanisms or emergency release protocols.

6. **Maintenance and Testing:** Regular maintenance and testing of power-operated watertight doors are crucial. This ensures smooth operation and prevents potential malfunctions that could lead to accidents.

By following these precautions, crew ensure the safe and effective operation of power-operated watertight doors, upholding the vessel's overall integrity and crew safety.