April 2021

1. The operating hydraulic circuit for a luffing cylinder for a deck crane is shown in the figure. Explain the purpose and describe the operation of EACH item A, B and C. (10)

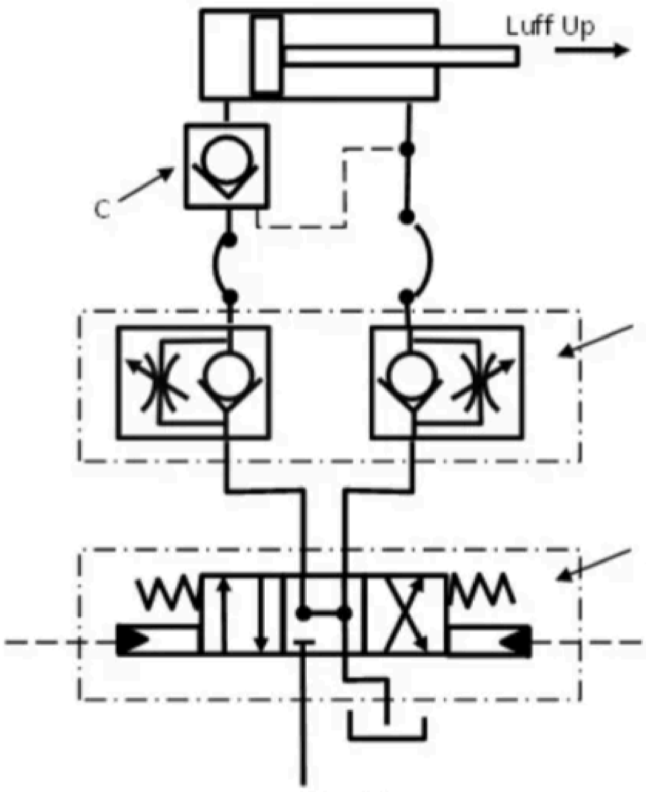

Fig Q1

April 2021

2. With reference to storage batteries, explain EACH of the following:

   (a) the term UPS; (3)

   (b) the operation of an inverter, stating why it may be required; (4)

   (c) the term 150 Ah. (3)

April 2021

3. (a) Sketch the relationship between *true power* (*k*W), *apparent power* (*kVA*), *reactive power* (*k*VAr) *and power factor (cosφ)* in a.c. electrical generation. (4)

   (b) Explain how true power (kW) and reactive power (kVAr) is shared between two generators connected in parallel. (4)

   (c) State how kW and kVAr load sharing stability is achieved. (2)

April 2021

4. Describe, with the aid of a sketch, the operation of the FOUR main components in a simple vapour compression cycle for a refrigeration system. (10)

April 2021

5. (a) State THREE types of damper that may be used to control the airflow in an air conditioning system. (3)

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April 2021

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April 2021

7. (a) A crane is being fitted to deploy and recover a load from a vessel. With reference to the present regulations, state the standards that the crane must comply with before being used on board. (7)

(b) State the information entered on a Proof Load Test certificate. (3)

April 2021

8. State the requirements for the stowage of hand portable petrol containers, in <u>small lockers</u> on open deck. (10)

April 2021

9. With reference to a vessel's hull:

(a) state the meaning of the term *racking*; (2)

(b) explain how racking occurs; (4)

(c) state the structures that resist racking. (4)

April 2021

10. With reference to a vessel's hull:

(a) explain the meaning of EACH of the following:

(i) dynamic stress; (3)

(ii) static stress; (3)

(b) state TWO examples of EACH type of stress explained in part (a). (4)

April 2021

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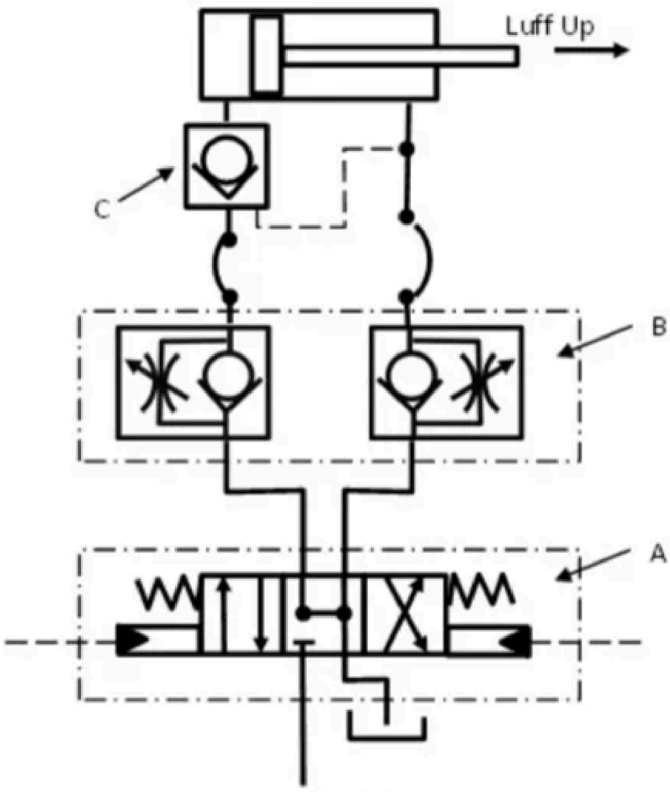

Fig Q1

Item A: Solenoid-Operated Directional Control Valve

- **Purpose:** This valve controls the flow and direction of pressurized hydraulic fluid to the luffing cylinder, ultimately raising or lowering the boom of the deck crane.
- **Operation:** The valve is likely a 4/3 position, solenoid-operated directional control valve. It has multiple spool positions that can be controlled by electrical signals from the crane operator's controls. Here's a breakdown of possible positions:
  - **Center:** Neutral position, fluid flow is blocked within the valve. The luffing cylinder holds its position (usually due to internal pressure).
  - **Port 1:** Directs pressurized fluid from the pump (not shown in the diagram) to the "extend" port of the luffing cylinder. This extends the cylinder rod, causing the boom to raise.
  - **Port 2:** Directs pressurized fluid from the pump (not shown) to the "retract" port of the luffing cylinder. This retracts the cylinder rod, causing the boom to lower.
  - **Relief:** The valve might have a built-in pressure relief function (depending on the specific design) to bypass excess fluid back to the reservoir in case of pressure surges.

Item B: Luffing Cylinder (Double-Acting)

- **Purpose:** This hydraulic actuator converts pressurized fluid into linear motion to raise or lower the crane's boom.

- **Operation:** The cylinder has a piston rod connected to the crane's boom lifting mechanism. By controlling the direction of pressurized fluid flow using the directional control valve (Item A), the cylinder rod can be extended or retracted:
  - **Boom Up (Port 1 Energized):** When Port 1 of the directional control valve is energized, pressurized fluid flows into the "extend" port of the cylinder. This extends the piston rod, pushing the boom upwards through the lifting mechanism.
  - **Boom Down (Port 2 Energized):** When Port 2 of the directional control valve is energized, pressurized fluid flows into the "retract" port of the cylinder. This retracts the piston rod, pulling the boom downwards through the lifting mechanism.

Item C: Pressure Relief Valve

- **Purpose:** This safety valve protects the hydraulic system from excessive pressure build-up.
- **Operation:** The pressure relief valve is usually set to a specific pressure threshold. If the system pressure exceeds this limit (due to pump malfunction or other factors), the valve opens and bypasses excess fluid back to the reservoir, preventing damage to components.

Overall System Operation:

The crane operator controls the boom movement (up or down) through a control panel that sends electrical signals to the solenoid-operated directional control valve (Item A). The valve then directs pressurized fluid to the appropriate port of the luffing cylinder (Item B), causing the piston rod to extend or retract. This extension or retraction translates to boom movement through the crane's lifting mechanism. The pressure relief valve (Item C) acts as a safety measure to safeguard the system in case of pressure spikes.

Note:

- This is a simplified explanation based on the limited information in the black and white diagram. Real systems might incorporate additional valves for specific functions (e.g., check valves for holding pressure) or other components depending on the crane's design and complexity.

April 2021

2. With reference to storage batteries, explain EACH of the following:

   (a) the term UPS; (3)

   (b) the operation of an inverter, stating why it may be required; (4)

   (c) the term 150 Ah. (3)

Storage Batteries and Power Systems:

Here's an explanation of the terms you requested regarding storage batteries:

(a) UPS (Uninterruptible Power Supply):

A UPS is an electronic device that provides backup power when the primary power source (usually the utility grid) fails or experiences fluctuations. It protects critical equipment from power outages, surges, and sags. Here's its basic operation:

1. **Normal Operation:** During normal operation, the UPS receives power from the utility grid.
2. **Power Conditioning:** The UPS may filter and condition the incoming AC power to provide a cleaner and more stable power supply to the connected equipment.
3. **Battery Charging:** The UPS also uses the AC power to charge its internal battery bank.
4. **Power Outage:** In the event of a power outage, the UPS seamlessly switches to battery power.
5. **Battery Backup:** The stored energy in the batteries provides power to the connected equipment until the utility power is restored or a backup generator can be started.
6. **Power Return:** Once the utility power returns, the UPS automatically switches back to using the grid and resumes battery charging.

(b) Inverter:

An inverter is an electronic circuit that converts DC (direct current) power from a source like a battery into AC (alternating current) power. This AC power can then be used to operate equipment that normally runs on AC electricity.

Why Inverters are Required with UPS:

Most electronic equipment utilizes AC power. However, storage batteries provide DC power. An inverter within the UPS is necessary to convert the stored DC battery power into usable AC power for the connected equipment during a power outage.

(c) 150 Ah (Ampere-hour):

150 Ah (Ampere-hour) is a unit that specifies the capacity of a battery. It indicates the amount of current a battery can deliver over a specific time. Here's how to interpret it:

- **150 Amperes:** This represents the current the battery can provide.
- **Hours (h):** This represents the duration for which the battery can deliver this current.

In simpler terms, a 150 Ah battery can theoretically deliver a current of 1 ampere for 150 hours, or 2 amperes for 75 hours (as long as the voltage remains within the specified operating range). However, battery capacity is not always perfectly linear, and discharge rates can affect the total usable capacity.

In conclusion, UPS systems with inverters and storage batteries play a crucial role in safeguarding equipment from power disturbances and ensuring continued operation during outages.

April 2021

3. (a) Sketch the relationship between *true power* (*k*W), *apparent power* (*kVA), reactive power* (*k*VAr) *and power factor (cosφ)* in a.c. electrical generation. (4)

(b) Explain how true power (kW) and reactive power (kVAr) is shared between two generators connected in parallel. (4)

(c) State how kW and kVAr load sharing stability is achieved. (2)

Power Relationships in AC Electrical Generation:

(a) Relationship Between Power Components:

In AC electrical generation, we deal with three main types of power:

- **True Power (P / kW):** This is the real or usable power delivered by the generator, measured in kilowatts (kW). It represents the actual amount of electrical work being done (e.g., powering lights, motors).
- **Apparent Power (S / kVA):** This reflects the total electrical load placed on the generator, measured in kilovolt-amperes (kVA). It considers both the true power and the reactive power.
- **Reactive Power (Q / kVAr):** This is the non-productive power used to create the magnetic fields necessary for the operation of motors, transformers, etc. It does not contribute to actual work performed but is required for proper functioning.

These three power components are related by the **power triangle** equation:

```
S^2 = P^2 + Q^2
```

Power Factor (cosφ): This is a dimensionless value (between 0 and 1) that represents the efficiency of real power transfer in an AC system. It's calculated as:

```
cosφ = P / S
```

A high power factor (closer to 1) indicates efficient use of apparent power, as most of it is delivered as true power. Conversely, a low power factor (closer to 0) indicates a larger portion of the apparent power is consumed as reactive power, reducing the available true power.

(b) Power Sharing Between Parallel Generators:

When two generators are connected in parallel, they share the total load based on their **governor settings** and **inherent droop characteristics**. Here's how it works:

- **Governor Settings:** Each generator's governor controls its prime mover (engine, turbine) to maintain a specific frequency (e.g., 50 Hz or 60 Hz).
- **Droop Characteristic:** This is an inherent property of a generator that relates its real power output to its speed (frequency). As the generator's load increases, its speed (and frequency) slightly decreases. This is known as "droop."

Power Sharing Process:

1. **Initial Load:** The generators initially share the load based on their droop characteristics. The generator with a steeper droop (larger speed decrease with load increase) will take on a larger portion of the load.
2. **Governor Response:** The governors of each generator sense any deviation from the setpoint frequency.
3. **Adjustments:** The governor of the generator with a lower load (higher frequency) will adjust its prime mover to increase power output, raising its frequency closer to the setpoint. Conversely, the governor of the overloaded generator (lower frequency) will adjust to reduce power output, bringing its frequency back to the setpoint.

This process continues until a stable equilibrium is reached where both generators share the load proportionally to their droop characteristics.

(c) Load Sharing Stability:

Maintaining stable load sharing between parallel generators is crucial for reliable power generation. Here are some factors that contribute to stability:

- **Governor droop settings:** Properly matched droop settings ensure each generator participates proportionally in load changes.
- **Speed regulation:** Precise speed regulation minimizes frequency deviations during load fluctuations.
- **Transient response:** Generators need to respond quickly to changes in load to maintain system stability.
- **Synchronization:** Generators must be synchronized in terms of frequency and phase angle before paralleling to avoid large current surges.

Additional Considerations:

- Load sharing may also involve communication protocols between generators and control systems for more sophisticated load management strategies.
- Protection systems are essential to isolate a malfunctioning generator from the system to prevent cascading failures.

By understanding these relationships and implementing proper control strategies, engineers can achieve stable and efficient power generation with multiple generators operating in parallel.

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April 2021

4. Describe, with the aid of a sketch, the operation of the FOUR main components in a simple vapour compression cycle for a refrigeration system. (10)

In a vapor compression refrigeration cycle, four main components work together to achieve cooling. Here's a breakdown of their operation:

1. **Compressor:**
- **Function:** The heart of the system, the compressor is a mechanical pump that draws in low-pressure, low-temperature refrigerant vapor from the evaporator coil.
- **Operation:** The compressor utilizes a piston or scroll mechanism to compress the refrigerant vapor. This compression process significantly increases the pressure and temperature of the refrigerant.
2. **Condenser:**
- **Function:** The condenser is a heat exchanger where the hot, high-pressure refrigerant vapor released from the compressor releases its heat to the surrounding environment.

- **Operation:** The condenser typically consists of a series of fins and tubes. The hot refrigerant vapor flows through the tubes, while air (air-cooled condenser) or water (water-cooled condenser) is passed over the fins. As the refrigerant loses heat to the air or water, it condenses back into a high-pressure liquid state.

3. **Expansion Valve (or Throttling Device):**

- **Function:** The expansion valve, also known as a throttling device, regulates the pressure of the refrigerant.
- **Operation:** The high-pressure liquid refrigerant from the condenser passes through the expansion valve. The expansion valve has a small orifice that restricts the flow of the liquid. This sudden pressure drop causes the high-pressure liquid to partially vaporize (flashing) and its temperature to decrease significantly. The refrigerant exits the expansion valve as a mixture of liquid and vapor, with the liquid portion at a much lower pressure and temperature.

4. **Evaporator Coil:**

- **Function:** The evaporator coil is another heat exchanger located within the air-conditioning unit or refrigeration compartment. It absorbs heat from the warm air or space that needs to be cooled.
- **Operation:** The low-pressure, cold liquid-vapor mixture from the expansion valve enters the evaporator coil. The refrigerant absorbs heat from the warm air passing over the evaporator coil, causing the air to cool down. As the refrigerant absorbs heat, it evaporates completely and becomes a low-pressure, low-temperature vapor again. This vapor is then drawn back into the compressor, and the cycle repeats continuously.

By working together, these components create a closed-loop system where the refrigerant continuously changes state (liquid to vapor and back) to absorb heat from the cooled space and reject it to the surrounding environment, achieving the desired cooling effect.

April 2021

5. (a) State THREE types of damper that may be used to control the airflow in an air conditioning system. (3)

(b) Describe, with the aid of a sketch, an automatic fire damper installed in a vertical air duct or in those that pass through bulkheads designated as fire boundaries. (7)

You've provided a great explanation of air conditioning dampers and fire safety! Here's the information again for easy reference:

(a) Three Types of Dampers for Airflow Control:

1. **Blade Dampers:** These are the most common type. They consist of a metal blade that pivots within the duct to regulate airflow. The blade angle can be manually adjusted or controlled by a motor for automated operation.
2. **Butterfly Dampers:** These resemble a butterfly valve, with a disc-shaped metal plate rotating on a central axis within the duct. The disc position controls the amount of airflow through the duct. They are often used for complete shutoff or to regulate high-pressure airflow.
3. **Volume Control Dampers (VCDs):** These are specially designed dampers that maintain a constant air pressure throughout the duct system regardless of the damper position. They are particularly useful for balancing airflow in complex duct networks.

(b) Automatic Fire Damper in Air Ducts:

An automatic fire damper is a crucial safety device installed in air conditioning systems to prevent the spread of fire and smoke through ventilation ducts. They are typically located:

- **Vertical air ducts:** These are vertical shafts within the building that carry conditioned air to different floors. Fire dampers are installed at regular intervals along the vertical duct to isolate any fire section.
- **Ducts passing through bulkheads designated as fire boundaries:** Bulkheads are vertical walls within a building that can act as fire barriers. Fire dampers are installed where air ducts penetrate these fire-rated bulkheads to prevent flames and smoke from traveling through the duct system to other compartments.

Functioning of a Fire Damper:

- **Normal Operation:** During normal operation, the fire damper blade remains open, allowing conditioned air to flow freely through the duct.
- **Fire Detection:** When a fire is detected (through heat sensors or smoke detectors), a signal is sent to a fusible link or electrical mechanism connected to the damper blade.
- **Automatic Closure:** The fusible link melts or the electrical mechanism activates, causing the damper blade to automatically close and seal the duct opening. This isolates the fire and smoke within the affected zone, preventing them from spreading to other parts of the building through the ductwork.

Importance of Fire Dampers:

Fire dampers play a vital role in building safety by:

- **Compartmentalization:** They compartmentalize the building by isolating fire and smoke within a specific zone, preventing them from traveling through the ventilation system.
- **Life Safety:** By containing the fire and smoke, fire dampers help protect occupants by providing them with more time to evacuate safely.
- **Reduced Property Damage:** Limiting the spread of fire and smoke minimizes damage to unaffected areas of the building.

Note: Fire dampers require regular inspection and maintenance to ensure they function properly in case of a fire emergency.

April 2021

6. Explain the maintenance and inspection that should be carried out on SCUBA cylinders. (10)

SCUBA cylinders require regular maintenance and inspection to ensure diver safety. Here's a breakdown of the key procedures:

Visual Inspection (Annual):

- **Frequency:** Performed annually by a qualified technician trained in cylinder inspection.
- **Process:** The technician will thoroughly inspect the cylinder's exterior for any signs of damage, including:

  - Dents, gouges, cracks, or bulges
  - Corrosion or pitting
  - Damage to threads or valve connection points
  - Fading or peeling of paint or markings (may indicate underlying corrosion)
- **Internal Inspection (Optional):** In some cases, an internal inspection using a borescope or other specialized tools may be recommended, especially for older cylinders or those with a history of heavy use.

Hydrostatic Testing (Every 5 Years):

- **Frequency:** Required every five years by most diving regulations.
- **Process:**
  - The cylinder is emptied of any remaining air.
  - It is filled with water to a pressure exceeding its normal working pressure (typically by a factor of 1.5).
  - The cylinder is carefully examined for any signs of permanent deformation or leaks during pressurization.
  - If the cylinder passes the test, it will be stamped with the new test date.

Valve Maintenance:

- **Frequency:** Regular maintenance is recommended, typically every year or two, by a qualified technician.
- **Process:** The technician will disassemble, clean, lubricate, and inspect the valve components for wear or damage. They will also ensure proper operation and replace any worn components if necessary.

Additional Maintenance Tips:

- **Record Keeping:** Maintain a logbook to record all inspections, maintenance procedures, and test results performed on the cylinder.
- **Proper Storage:** Store cylinders in a cool, dry, and well-ventilated area away from direct sunlight and excessive heat.
- **Handling:** Always handle cylinders with care to avoid any damage. Use proper lifting techniques and avoid dropping or dragging them.
- **Diver Responsibility:** Divers should visually inspect their cylinders before each dive for any obvious signs of damage.

Importance of Maintenance:

Regular maintenance and inspection of SCUBA cylinders are critical for diver safety. These procedures help identify any potential weaknesses or damage that could lead to a catastrophic failure during a dive. By following these guidelines and using reputable dive centers that maintain their equipment properly, divers can minimize risks and ensure a safe and enjoyable diving experience.

April 2021

7. (a) A crane is being fitted to deploy and recover a load from a vessel. With reference to the present regulations, state the standards that the crane must comply with before being used on board. (7)

(b) State the information entered on a Proof Load Test certificate. (3)

Crane Regulations and Proof Load Test Certificates

(a) Crane Standards for Vessel Use:

Before a crane can be used to deploy and recover a load from a vessel, it must comply with several international and national regulations. Here are some key standards to consider:

- **International Maritime Organization (IMO):**
  - **Code of Safe Practice for Ships in Cargo Handling (CSS Code):** This code outlines various safety requirements for cargo handling operations, including the use of cranes onboard ships. It addresses aspects like crane design, stability considerations, operator training, and safe working practices.
  - **Safe Work at Height (SWAH) Code:** This code provides recommendations for working at heights onboard ships, including safe access and egress for crane operators when using elevated cabs.
- **International Organization for Standardization (ISO):**
  - **ISO 4878 - Cranes - Principles of design and verification:** This standard establishes general principles for the design and verification of cranes, including structural strength, stability, and fatigue considerations.
  - **ISO 14439 - Cranes - Lifting performance - Part 1: General:** This standard specifies requirements for the determination of lifting performance of cranes, including proof load testing and load charts.
- **National Regulations:** In addition to international standards, many countries have their own national regulations governing the use of cranes onboard vessels. These regulations may adopt or modify international standards and may include additional requirements specific to the country's maritime industry.

It's crucial to consult the relevant classification society (e.g., American Bureau of Shipping (ABS), Lloyd's Register) and the national maritime authority for the specific regulations applicable to your location and the type of vessel the crane will be used on.

(b) Information on a Proof Load Test Certificate:

A Proof Load Test Certificate documents the results of a load test performed on a crane to verify its lifting capacity and structural integrity. Here's some of the information typically included on a Proof Load Test Certificate:

- **Crane Identification:** This includes details like the crane manufacturer, model number, and serial number.
- **Test Date and Location:** Date and location where the proof load test was conducted.

- **Test Authority:** Information about the accredited testing company or organization that performed the test.
- **Test Conditions:** This may include details like ambient temperature, wind speed, and any special test configurations used.
- **Test Loads:** The certificate will specify the test loads applied to the crane during the test, typically expressed as a percentage of the crane's rated lifting capacity (e.g., 110% of SWL).
- **Test Results:** The certificate will record the outcome of the test, confirming whether the crane passed or failed the test with respect to its rated capacity.
- **Inspector's Signature:** The certificate will be signed by a qualified inspector who witnessed the test and reviewed the results.

The specific format and content of a Proof Load Test Certificate may vary depending on the testing company and the regulations they follow. Always ensure the certificate is issued by a reputable testing organization and meets the requirements of the relevant classification society and national maritime authority.

2021

April 2021

8. State the requirements for the stowage of hand portable petrol containers, in <u>small lockers</u> on open deck. (10)

Here are the requirements for the stowage of hand portable petrol containers in small lockers on an open deck:

Location and Construction:

- **Lockers:** The containers should be stored in small, dedicated lockers specifically designed for flammable liquids. These lockers should be:
  - **Constructed from non-combustible materials:** This could be sheet metal, fiberglass reinforced plastic (GRP), or other approved materials that resist fire and heat.
  - **Located away from high-risk areas:** Keep the lockers away from heat sources like engines, exhausts, or electrical equipment. Open flames and welding areas should also be far from these lockers.
  - **Clearly marked:** The lockers should be clearly labeled with signage indicating "Flammable Liquids" or "Petrol" to warn of the contents.

Ventilation:

- **Natural ventilation:** The lockers must have natural ventilation openings at the top and bottom to allow for air circulation and prevent the buildup of petrol fumes. These openings should be designed to prevent sparks or flames from entering.
- **No forced ventilation:** Avoid using forced ventilation systems within the lockers, as they could ignite any petrol vapors present.

Securing Containers:

- **Means of securing:** The lockers should have a way to secure the petrol containers to prevent them from shifting or tipping over during rough seas. This could involve straps, hooks, or shelves designed to hold the containers in place.

Quantity Limitations:

- **Maximum quantity:** Regulations may limit the total amount of petrol allowed to be stored in such lockers on the open deck. This will depend on the specific regulations of your country or governing body. 50 liters or 13.2 gallons is a common maximum limit, but it's best to check the relevant regulations.

Additional Considerations:

- **Drainage:** The lockers may require a drainage system to channel away any spills or leaks. This drainage should not lead directly overboard but to a designated collection point to prevent environmental contamination.
- **Firefighting Equipment:** Consider having a portable fire extinguisher suitable for fighting petrol fires readily available near the lockers.

By following these requirements, you can ensure the safe storage of hand portable petrol containers on the open deck of a vessel, minimizing the risk of fire hazards and environmental damage. It's important to consult the relevant regulations of your country's maritime authority for the most up-to-date and specific requirements for stowing petrol on board a vessel.

April 2021

9. With reference to a vessel's hull:

(a) state the meaning of the term *racking*; (2)

(b) explain how racking occurs; (4)

(c) state the structures that resist racking. (4)

Racking in a Ship's Hull

(a) Racking Definition:

Racking refers to a distortion of the ship's hull structure caused by **transverse stresses** acting in a horizontal plane. Imagine the hull twisting slightly out of shape, like a rectangle warping into a parallelogram.

(b) How Racking Occurs:

Racking typically occurs when a vessel is subjected to forces that act perpendicular to the longitudinal axis (length) of the hull. These forces can arise from various situations:

- **Wave Action:** In rough seas, waves can exert uneven buoyant forces on different sides of the hull, particularly when encountering waves at an angle. This uneven loading can cause the hull to twist slightly, inducing racking stresses.

- **Shifting Cargo:** If cargo is not properly secured within the vessel, sudden movements or shifting of cargo can create unbalanced forces that lead to racking.
- **Grounding:** When a vessel accidentally runs aground and impacts the seabed unevenly on one side, the resulting forces can cause significant racking stresses.

(c) Structures Resisting Racking:

Several key structures within the ship's hull work together to resist racking stresses:

- **Transverse Bulkheads:** These are vertical partitions dividing the hull into watertight compartments. They act like internal walls, providing significant rigidity and resisting the forces trying to twist the hull out of shape.
- **Double Bottom (if present):** A double bottom acts like a horizontal diaphragm, adding transverse stiffness and strength to the hull. It helps distribute loads more evenly across the width of the vessel and resists racking forces.
- **Longitudinal Stiffeners:** While primarily designed for longitudinal strength, longitudinal stiffeners (vertical beams) running along the hull sides can also contribute to resisting racking to some extent by providing additional stiffness against transverse deformation.
- **Deck Girders and Web Frames:** These horizontal and vertical structures within the deck and inner hull can help distribute loads transversely and provide additional resistance to racking forces acting on the upper sections of the hull.

Overall Design: The overall design and scantling (thickness) of the hull plating also play a role. Adequate thickness of plating, particularly in areas prone to racking stresses, can improve the hull's resistance to twisting deformation.

April 2021

10. With reference to a vessel's hull:

(a) explain the meaning of EACH of the following:

(i) dynamic stress; (3)

(ii) static stress; (3)

(b) state TWO examples of EACH type of stress explained in part (a). (4)

Stresses Acting on a Ship's Hull: Dynamic vs. Static

(a) Types of Stress:

(i) Dynamic Stress:

Dynamic stress refers to a time-varying force acting on a material that causes the material to deform or vibrate. The magnitude and direction of the stress can change rapidly over time. In a ship's hull, dynamic stresses are primarily caused by the interaction with waves and the ever-changing sea environment.

(ii) Static Stress:

Static stress refers to a constant force acting on a material that tends to deform the material without any significant change over time. In a ship's hull, static stresses are caused by constant or slowly changing loads.

(b) Examples of Dynamic and Static Stress:

(i) Dynamic Stress Examples:

1. **Wave-Induced Bending:** As waves pass, the hull experiences a dynamic bending moment due to the varying buoyancy forces acting along its length. This bending creates dynamic stresses that can cause the hull to flex.
2. **Slamming:** When encountering a large wave crest, the vessel's bow might slam against the water surface. This sudden impact generates a high-intensity, short-duration dynamic stress concentrated at the point of contact.

(ii) Static Stress Examples:

1. **Cargo Weight:** The weight of the cargo acting downwards on the hull bottom creates a static stress that needs to be supported by the hull structure. The distribution of cargo weight can also influence the magnitude and location of static stresses.
2. **Self-Weight:** The weight of the vessel itself, including its machinery, equipment, and structure, acts as a constant downward force on the hull. This self-weight creates a static stress that is evenly distributed throughout the hull