

Sept 2021

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- (b) Sketch a hydraulic circuit for a single stabiliser, suitable for a constant pressure system. (5)

Sept 2021

2. Sketch a hydraulic system for adjusting the angle of fin stabilisers, labelling ALL parts. (10)

Sept 2021

3. With reference to load sharing of a.c. generators:
 - (a) state the meaning of the term *speed droop*; (3)
 - (b) explain the effect of running generators in parallel with different speed droop settings for EACH of the following:
 - (i) when the generators are sharing the load equally; (3)
 - (ii) when the load suddenly increases. (4)

Sept 2021

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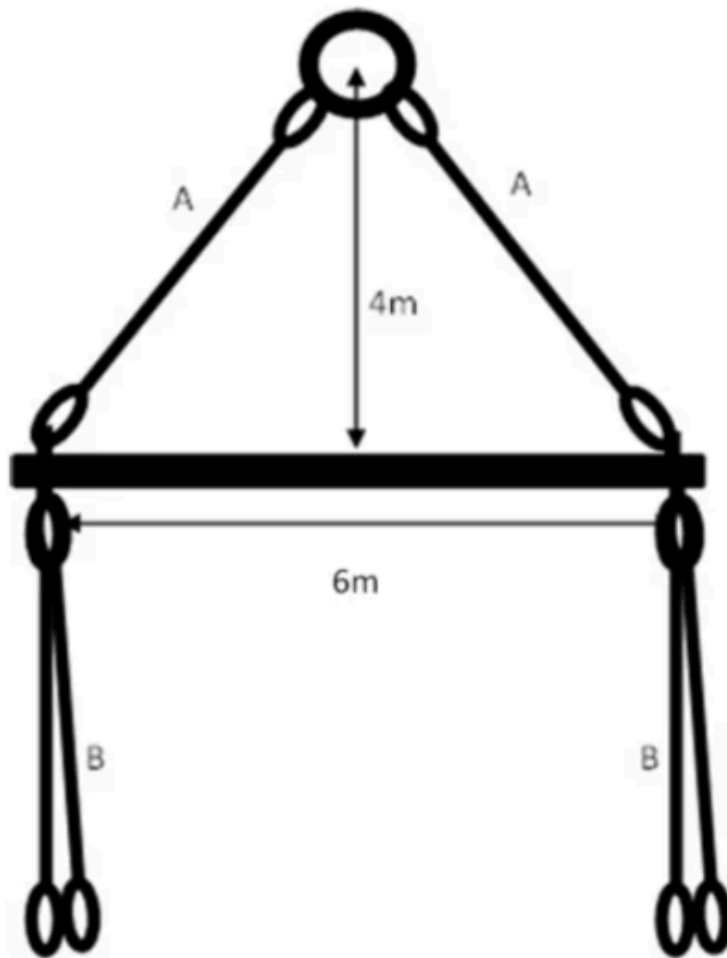
Sept 2021

6. Describe EACH of the following vapour compression refrigeration faults, outlining a possible cause for EACH:
 - (a) undercharge; (3)
 - (b) overcharge; (3)
 - (c) short cycling. (4)

Sept 2021

7. The lifting arrangement shown in the figure, has two slings, A, with a SWL of 5 tonnes, four slings, B, with a SWL of 2.5 tonnes with a ring and beam each of which have a SWL of 12 tonnes.

Explain the suitability or otherwise of this arrangement for lifting a generator engine, including flywheel, weighing 8.5 tonnes that has certified lifting points, 2 at each end of the entablature, 6 m apart. (10)



Sept 2021

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Sept 2021

9. (a) State the purpose of the collision bulkhead and the regulations appertaining to its dimensions and position. (4)
- (b) Explain the difference between A, B and C class bulkheads. (6)

Sept 2021

1. (a) Explain why a hydraulic actuator is preferred for a vessel's stabiliser over an electrical actuator. (5)
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(a) Advantages of Hydraulic Actuators:

- **High Power Density:** Hydraulic systems can generate significantly higher force and torque compared to electrical actuators of similar size and weight. This is essential for stabilizers that need to counteract large wave forces acting on the vessel.
- **Fast Response:** Hydraulic systems offer faster response times due to the inherent properties of fluids. This allows the stabilizer fins to react quickly to wave motions and provide more effective stabilization.
- **Load Handling:** Hydraulic systems excel at handling high dynamic loads experienced by stabilizers in rough seas. They can absorb shock loads and provide smoother operation compared to electric motors, which can stall under extreme loads.
- **Simplicity and Reliability:** Hydraulic systems are generally simpler in design compared to complex electric motors with gear reduction units. This translates to potentially higher reliability and easier maintenance at sea.
- **Environmental Resistance:** Hydraulic components can be chosen for their resistance to the harsh marine environment, including salt spray and corrosion.

(b) Hydraulic Circuit for a Single Stabilizer (Constant Pressure System):**Components:**

1. **Reservoir:** Stores the hydraulic fluid and maintains its level.
2. **Pump:** Continuously pressurizes the fluid in the system (driven by an electric motor or diesel engine).
3. **Pressure Relief Valve:** Protects the system from overpressure by bypassing excess fluid back to the reservoir (not shown in all diagrams).
4. **Filter:** Removes contaminants from the fluid to protect system components (recommended but not always shown).
5. **Solenoid-operated Directional Control Valve (4/3 Position, Open Center):** This valve controls the flow and direction of pressurized fluid based on electrical signals from the stabilizer control system. It has multiple positions:
 - **Center:** Neutral position, fluid flows freely back to the reservoir from both pump outlet and actuator (open center).
 - **Port A:** Directs fluid to extend the actuator rod, pushing the stabilizer fin down.
 - **Port B:** Directs fluid to retract the actuator rod, pulling the stabilizer fin up.
 - **Relief:** In case of excessive pressure, the valve may have a built-in relief function to bypass fluid back to the reservoir (depending on specific valve design).
6. **Hydraulic Cylinder (Double-acting):** This actuator converts pressurized fluid into linear motion to position the stabilizer fin. It has a piston rod connected to the fin linkage.
7. **Position Sensor (not always shown):** This sensor (usually linear position transducer) would be mounted on the actuator to provide feedback on the current position of the stabilizer fin to the control system.

Operation:

1. **Control System Input:** The vessel's stabilization control system analyzes sensor data (roll angle, wave motion) and sends electrical signals to the directional control valve.
2. **Valve Actuation:** Based on the electrical signal, the valve moves to the desired position (Port A, Port B, or Center).
 - **Center:** In neutral position, fluid flows freely back to the reservoir from both the pump and the actuator (assuming an open-center valve). The stabilizer fin remains in its current position due to external forces (e.g., spring centering or wave action).
 - **Port A:** When energized, the valve directs pressurized fluid from the pump (not shown) to the "extend" port of the actuator.
 - **Port B:** When energized, the valve directs pressurized fluid from the pump (not shown) to the "retract" port of the actuator.
3. **Actuator Movement:**
 - **Extending the Fin (Port A):** Pressurized fluid entering the "extend" port extends the actuator rod, pushing the stabilizer fin down (counteracting roll in one direction).
 - **Retracting the Fin (Port B):** Pressurized fluid entering the "retract" port extends the other side of the actuator rod, pulling the stabilizer fin up (counteracting roll in the other direction).
4. **Position Feedback (not shown):** In real systems, a position sensor would continuously monitor the actuator rod movement (fin position) and send feedback signals to the control system.
5. **Control Loop:** The control system adjusts the valve position based on the sensor feedback (if applicable) and other sensor data (roll angle, wave motion) to maintain the desired fin position and vessel stability.

Additional Notes:

- This diagram depicts a basic open-center directional control valve. Other valve types with different flow paths might be used in real systems.
- A well-designed system would likely incorporate a filter to remove contaminants from the fluid before it reaches the valve for better protection of components.

I hope this comprehensive explanation clarifies the advantages of hydraulic actuators and the operation of a hydraulic circuit for a vessel stabilizer!

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Sept 2021

2. Sketch a hydraulic system for adjusting the angle of fin stabilisers, labelling ALL parts. (10)

Hydraulic System for Adjusting Fin Stabilizer Angle (Constant Pressure System)

This system utilizes pressurized hydraulic fluid to precisely control the position (angle) of fin stabilizers on a vessel, counteracting roll and improving stability. Here's a breakdown of the key components and their operation:

Components:

1. **Reservoir:** This tank stores the hydraulic fluid (usually oil) and maintains its level. It may incorporate a breather filter to allow air exchange and prevent contamination.
2. **Pump:** A positive displacement pump (e.g., gear pump, vane pump) is the heart of the system. Driven by an electric motor or diesel engine, it continuously draws fluid from the reservoir and pressurizes it.
3. **Pressure Relief Valve:** This safety valve protects the system from excessive pressure build-up. It bypasses excess fluid back to the reservoir if the pressure exceeds a set limit.
4. **Filter:** A hydraulic filter removes contaminants from the fluid before it reaches the control valve, protecting system components from wear and tear.
5. **Solenoid-Operated Directional Control Valve (4/3 Position, Closed Center):** This valve plays a crucial role in controlling the flow and direction of pressurized fluid based on electrical signals from the stabilizer control system. It has multiple positions:
 - **Center:** Neutral position, fluid flow is blocked within the valve, and the actuator holds its position (closed center).
 - **Port A:** Directs fluid to extend the actuator rod, pushing the stabilizer fin down (counteracting roll in one direction).
 - **Port B:** Directs fluid to retract the actuator rod, pulling the stabilizer fin up (counteracting roll in the other direction).
 - **Relief:** In case of excessive pressure, the valve may have a built-in relief function to bypass fluid back to the reservoir (depending on specific valve design).
6. **Hydraulic Cylinder (Double-acting):** This actuator converts pressurized fluid into linear motion to adjust the angle of the stabilizer fin. It has a piston rod connected to a linkage mechanism that controls the fin's position.
7. **Position Sensor (Linear Transducer):** Mounted on the actuator, this sensor provides continuous feedback on the current position (angle) of the stabilizer fin to the control system. This is crucial for precise control.

Operation:

1. **Control System Input:** The vessel's stabilization control system analyzes sensor data (roll angle, wave motion, desired fin position) and sends electrical signals to the directional control valve.
2. **Valve Actuation:** Based on the electrical signal:
 - **Center:** In neutral position, the valve blocks the flow of fluid, and the actuator holds the stabilizer fin in its current position (due to internal pressure or external forces like springs).
 - **Port A:** When energized, the valve directs pressurized fluid from the pump (not shown) to the "extend" port of the actuator.
 - **Port B:** When energized, the valve directs pressurized fluid from the pump (not shown) to the "retract" port of the actuator.
3. **Actuator Movement:**
 - **Extending the Actuator (Port A):** Pressurized fluid entering the "extend" port extends the actuator rod, which through the linkage mechanism, pushes the stabilizer fin down to a specific angle.
 - **Retracting the Actuator (Port B):** Pressurized fluid entering the "retract" port extends the other side of the actuator rod, pulling the linkage and stabilizer fin up to a specific angle.

4. **Position Feedback:** The position sensor continuously monitors the actuator rod movement (fin angle) and sends feedback signals to the control system.
5. **Control Loop:** The control system compares the desired fin position with the actual position feedback from the sensor. It then adjusts the directional control valve position (Port A, Port B, or Center) to maintain the precise fin angle required for optimal stabilization.

Additional Notes:

- This is a simplified representation. Real systems might incorporate additional valves (e.g., check valves for specific functions) or accumulators for improved response during peak loads.
- A closed-center directional control valve is commonly used in stabilizer fin systems to prevent actuator drift due to leakage when in the neutral position.
- The control system plays a crucial role by processing sensor data and issuing commands to the valve for precise and dynamic fin positioning based on sea conditions.

This hydraulic system offers several advantages:

- **High Power and Control:** Hydraulics provide the necessary force to adjust the fins effectively and counter roll even in rough seas.
- **Precise Positioning:** The closed-center valve and position feedback ensure accurate control of the fin angle for optimal stabilization.
- **Fast Response:** Hydraulic systems react quickly to wave motions, allowing for timely adjustments of the fins.
- **Durability:** Hydraulic components can withstand the harsh marine environment and demanding operation.

Sept 2021

3. With reference to load sharing of a.c. generators:
 - (a) state the meaning of the term *speed droop*; (3)
 - (b) explain the effect of running generators in parallel with different speed droop settings for EACH of the following:
 - (i) when the generators are sharing the load equally; (3)
 - (ii) when the load suddenly increases. (4)

Load Sharing and Speed Droop in AC Generators

Here's a breakdown of speed droop and its effect on load sharing in parallel AC generators:

(a) Speed Droop Definition:

Speed droop, also known as governor droop, is a characteristic of a generator's governor system that relates the change in engine speed (RPM) to the change in electrical load. It's expressed as a percentage of the rated speed.

Here's the basic principle:

- **No Load:** When there's no electrical load on the generator, the engine runs at a slightly higher speed (rated speed + droop).
- **Increased Load:** As the electrical load on the generator increases, the engine speed starts to slow down due to the increased demand for power. The governor system detects this decrease in speed.
- **Governor Response:** To maintain the desired frequency, the governor automatically adjusts the fuel supply to the engine. This increases the engine's torque and tries to bring the speed back up towards the no-load speed.

Key Point: The speed droop setting determines how much the engine speed is allowed to droop (decrease) with increasing load.

(b) Effect of Different Speed Droop Settings:

(i) Equal Load Sharing:

- **Scenario:** Two generators with different speed droop settings are initially sharing the load equally.
- **Unequal Response:** When the load remains constant, the generator with a **higher speed droop setting** will experience a **larger speed decrease** compared to the one with a lower droop setting. This is because the governor of the higher droop generator allows the speed to sag more before increasing fuel supply.
- **Automatic Adjustment (Potential):** The load-sharing switchboard (if equipped) might detect the unequal speed and adjust internal controls to compensate. It could slightly shift load to the generator with the lower droop to maintain a more balanced distribution.

Important Note: Not all load-sharing switchboards have the capability to actively adjust load based on speed droop.

(ii) Sudden Load Increase:

- **Scenario:** Both generators are operating in parallel, and the total load suddenly increases.
- **Governor Response:** The governors of both generators will react by increasing fuel supply to their respective engines.
- **Impact of Droop Settings:** The generator with the **lower speed droop setting** will experience a **smaller speed dip** compared to the one with a higher droop setting. This is because the governor with the lower droop responds more aggressively to maintain speed with a smaller allowable deviation.
- **Load Sharing Adjustment:** As a result of the unequal speed response, the load-sharing switchboard (if equipped) will automatically adjust to shift more of the additional load onto the generator with the lower droop setting. This is because this generator can handle the increased load while maintaining a speed closer to the desired value.

Overall:

- Generators with lower speed droop settings tend to take on a larger share of the load, especially during sudden load increases, as their governors prioritize maintaining speed with minimal droop.
- Conversely, generators with higher speed droop settings will contribute less to sudden load increases but may experience larger speed dips.

In practice: Speed droop settings are carefully chosen to ensure stable operation and balanced load sharing between parallel generators. The specific settings depend on the characteristics of the generators and the overall system requirements.

Sept 2021

5. (a) List FOUR reasons for a refrigeration compressor to stop unexpectedly, after running for a short period. (4)
- (b) Describe the faults which lead to TWO of the reasons for the stoppage, listed in part (a). (6)

Refrigeration Compressor Unexpected Stoppage: Reasons and Faults

(a) Four Reasons for Unexpected Compressor Stoppage:

1. Electrical Faults:

- Issues like tripped circuit breakers, blown fuses, or internal motor malfunctions can interrupt power supply to the compressor, causing it to stop unexpectedly.

2. Low Suction Pressure:

- If the pressure on the suction side of the compressor drops below a certain level, it may activate a safety mechanism to prevent damage. This could be due to factors like a refrigerant leak, clogged suction line, or malfunctioning expansion valve.

3. High Discharge Pressure:

- Conversely, excessively high pressure on the discharge side can also trigger a safety shutdown to protect the compressor. This might be caused by a dirty condenser coil, a blocked capillary tube (in some systems), or a faulty pressure relief valve.

4. Overload Protection:

- Modern compressors often have built-in overload protection that cuts off power if the motor gets too hot. This can be caused by excessive load on the compressor due to high ambient temperatures, insufficient airflow over the condenser, or internal mechanical issues.

(b) Description of Faults for Two Reasons:

1. Low Suction Pressure:

● Possible Faults:

- **Refrigerant Leak:** A leak in the refrigerant line allows the refrigerant to escape, reducing the pressure in the system and causing the compressor to shut down on low suction pressure. Identifying and repairing the leak is crucial before restarting the system.
- **Clogged Suction Line:** A blockage in the suction line due to debris or ice buildup restricts the flow of refrigerant, leading to a drop in suction pressure and

compressor stoppage. The blockage needs to be located and cleared to restore proper flow.

- **Malfunctioning Expansion Valve:** A faulty expansion valve can over-expand the refrigerant, causing too much liquid refrigerant to enter the evaporator. This can lead to insufficient suction pressure and compressor shutdown. The expansion valve may need to be repaired or replaced.

2. High Discharge Pressure:

- **Possible Faults:**

- **Dirty Condenser Coil:** Dust, dirt, or debris accumulated on the condenser coil reduces its ability to dissipate heat effectively. This causes the discharge pressure to rise, leading to compressor shutdown on high-pressure protection. The condenser coil needs to be cleaned thoroughly to ensure proper heat rejection.
- **Blocked Capillary Tube (in some systems):** A capillary tube is a small-diameter tube used in some refrigeration systems to meter the flow of refrigerant. A blockage within the capillary tube restricts the flow of refrigerant, leading to a rise in discharge pressure and compressor shutdown. The capillary tube may need to be replaced.

Note: These are just a few examples, and the specific cause of the compressor stoppage will depend on the individual refrigeration system and its operating conditions. A qualified technician can diagnose the exact fault and recommend the appropriate repair or replacement action.

021 2021

Sept 2021

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- (a) undercharge; (3)
- (b) overcharge; (3)
- (c) short cycling. (4)

Vapour Compression Refrigeration Faults and Causes:

(a) Undercharge (Insufficient Refrigerant):

- **Description:** An undercharge situation occurs when there is less refrigerant in the refrigeration system than the manufacturer's recommended amount.
- **Possible Cause:**
 - **Leak:** The most common cause is a leak in the refrigerant line, allowing the refrigerant to escape gradually over time. Regular leak detection and repair are crucial to prevent undercharge.

(b) Overcharge (Excessive Refrigerant):

- **Description:** An overcharge situation exists when there is more refrigerant in the system than recommended.
- **Possible Cause:**
 - **Improper Charging:** Adding too much refrigerant during the charging process is a primary cause. Always use a refrigerant scale and follow the manufacturer's charging guidelines.

(c) Short Cycling:

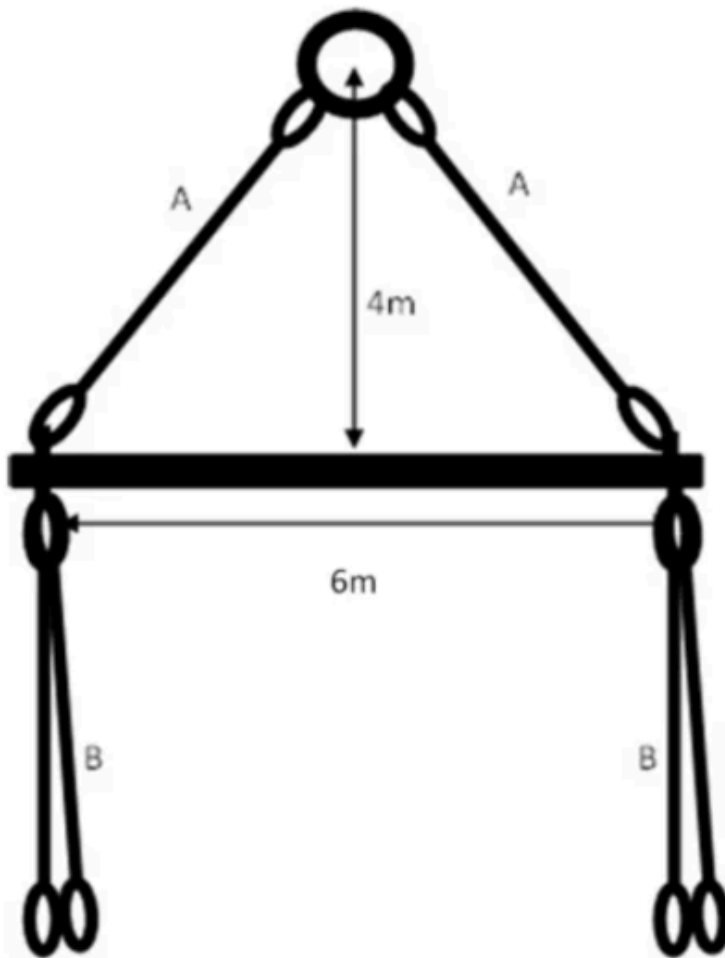
- **Description:** Short cycling refers to a condition where the compressor starts and stops frequently, failing to complete a full refrigeration cycle. This can significantly reduce efficiency and shorten compressor life.
- **Possible Causes:**
 - **Low Suction Pressure:** As mentioned earlier, a low suction pressure can trigger the compressor to shut down prematurely. Refer to the explanation in the previous answer (b) of question 4 for possible causes of low suction pressure.
 - **Defective Thermostat:** A faulty thermostat that cycles on and off too frequently can cause short cycling. The thermostat may need to be replaced.
 - **Defrost Timer Issue (if applicable):** In systems with automatic defrost cycles, a malfunctioning defrost timer can lead to short cycling if the defrost cycle is not properly initiated or terminated.

Sept 2021

7. The lifting arrangement shown in the figure, has two slings, A, with a SWL of 5 tonnes, four slings, B, with a SWL of 2.5 tonnes with a ring and beam each of which have a SWL of 12 tonnes.

Explain the suitability or otherwise of this arrangement for lifting a generator engine, including flywheel, weighing 8.5 tonnes that has certified lifting points, 2 at each end of the entablature, 6 m apart.

(10)



Based on the information provided and the image of the lifting arrangement, the lifting arrangement **might be suitable** for lifting the 8.5-tonne generator engine, but a more detailed analysis is needed to confirm. Here's a breakdown of the factors to consider:

Available Lifting Capacity:

- Total capacity of slings A: 2 slings * 5 tonnes/sling = 10 tonnes
- Total capacity of slings B: 4 slings * 2.5 tonnes/sling = 10 tonnes
- Minimum capacity of ring and beam (whichever is lower): 12 tonnes

At first glance, it appears there's sufficient capacity:

- Minimum sling capacity (A or B) + ring/beam capacity = 10 tonnes + 12 tonnes = 22 tonnes
- This is greater than the weight of the engine (8.5 tonnes).

However, we need to consider additional factors:

- **Derating factor (if applicable):** Some slings might have a derating factor applied depending on the lifting angle. This reduces their safe working load (SWL) at angles other than vertical. Check the sling specifications for any derating factors.
- **Weight distribution:** Since there are slings at both ends (6 meters apart) with a spreader beam, the weight distribution might not be perfectly equal. This can affect the loading on each sling. A proper sling angle calculator should be used to determine the exact load on each sling considering the spreader beam configuration and lifting angle.
- **Lifting point limitations:** The certified lifting points on the engine might have a lower capacity than the slings or ring/beam. Verify the lifting capacity specified by the engine manufacturer for the designated lifting points.

Based on these considerations:

- If there's no derating factor for the slings at the intended lift angle,
- The weight is evenly distributed between the slings due to the spreader beam, and
- The engine's lifting points can handle the load,

then the lifting arrangement appears suitable.

Recommendations:

- Consult a qualified lifting professional to assess the specific lifting arrangement and ensure it complies with relevant regulations.
- Use a sling angle calculator to determine the exact load on each sling based on the spreader beam configuration and lifting angle. Refer to the image you sent for the spreader beam configuration details.
- Verify the lifting capacity of the engine's certified lifting points as specified by the manufacturer.
- Never exceed the SWL of any lifting component in the arrangement.

Additional Considerations:

- **Spreader Beam:** Ensure the spreader beam used has a sufficient capacity and is suitable for the lifting points on the engine. The spreader beam in the image appears to be a double beam spreader beam, which can help with equal distribution of the load between the slings.
- **Rigging:** Double-check all rigging components (shackles, hooks, etc.) for compatibility and adequate capacity.
- **Inspection:** Before lifting, ensure all slings, spreader beam, and other lifting equipment are thoroughly inspected for any signs of damage or wear and tear.

By carefully considering these factors and consulting with a lifting professional, you can ensure the safe and successful lifting of the generator engine.

Sept 2021

8. Describe the annual airtight integrity test and examination that is required to be carried out on an inflatable or rigid inflatable craft. (10)

Inflatable and rigid inflatable craft (RIBs) rely on airtight compartments for buoyancy and stability. To ensure their safety and seaworthiness, annual airtight integrity tests and examinations are mandatory. Here's a breakdown of the typical procedures involved:

Annual Airtight Integrity Test:

- **Preparation:**
 - The inflatable tubes and chambers of the craft are thoroughly cleaned and dried to remove any dirt, debris, or moisture that could interfere with the test.
 - All access points to the inflatable compartments are identified and made readily accessible.
- **Inflation:**
 - The inflatable tubes and chambers are inflated to their designated pressure using a calibrated air pressure gauge.
 - The pressure may be held constant for a specific duration (e.g., 10 minutes) to allow for observation of any pressure loss.
- **Leak Detection:**
 - **Soap and Water Method:** A soap and water solution is applied to the seams, valves, and other connection points of the inflatable structure. The formation of bubbles indicates a potential leak in that area.
 - **Electronic Leak Detectors (Optional):** Some inspectors may use specialized electronic leak detectors to pinpoint even very small leaks that might not be readily visible with the soap and water method.
- **Pressure Drop Measurement:** The pressure in each inflatable compartment is monitored for a specific period (e.g., 30 minutes) to assess any pressure loss exceeding a set limit (e.g., 10% or as specified by the manufacturer or regulations).

Annual Examination:

- **Visual Inspection:** A thorough visual inspection of the entire inflatable structure is conducted, focusing on:
 - **Fabric:** Checking for any signs of wear and tear, cuts, abrasions, or UV degradation.
 - **Seams:** Inspecting for proper stitching, delamination, or adhesive failure.
 - **Valves:** Verifying proper operation, secure attachment, and absence of leaks.
 - **Transom:** Examining for cracks, delamination, or damage that could affect structural integrity.
 - **Lifting points, D-rings, and other attachments:** Checking for secure attachment, corrosion, or deformation.
- **Functional Tests:** Operational checks of essential components may be performed, including:
 - Inflation and deflation systems.
 - Pressure relief valves (if applicable).
 - Lifelines and handholds.

Documentation:

- The results of the airtight integrity test and examination are documented in a formal report.
- The report typically includes details like:
 - Date of the test and examination.
 - Name and qualifications of the inspector.
 - Identification of the inflatable craft.
 - Test procedures used.
 - Observed pressure readings and any pressure loss measured.
 - Detailed findings from the visual inspection.
 - Any repairs or replacements recommended.

Additional Considerations:

- The specific requirements for annual airtight integrity tests and examinations may vary depending on the regulations of your country or the classification society the inflatable craft is certified under.
- It's crucial to consult the manufacturer's recommendations and relevant regulations for the specific inflatable or RIB being tested.
- Always use qualified personnel with experience in inflatable boat testing and inspection to perform these annual procedures.

By conducting these annual tests and examinations, inflatable and RIB owners can ensure the seaworthiness of their craft and the safety of those onboard.

Sept 2021

9. (a) State the purpose of the collision bulkhead and the regulations appertaining to its dimensions and position. (4)
- (b) Explain the difference between A, B and C class bulkheads. (6)

Collision Bulkhead and Watertight Bulkhead Classification

(a) Collision Bulkhead:

Purpose:

A collision bulkhead is a crucial safety feature in a ship's structure. It's the **first watertight barrier** located at the forward end of the vessel. Its primary purpose is to:

- **Minimize flooding** in case of a head-on collision or grounding by preventing water ingress from the damaged bow area into the rest of the ship.
- **Maintain buoyancy and stability** by limiting the flooded volume in the forward compartment. This allows the vessel to remain afloat and potentially maneuver even after sustaining damage.

Regulations:

The dimensions and positioning of collision bulkheads are governed by international regulations set by the International Maritime Organization (IMO). The main regulation is:

- **SOLAS (International Convention for the Safety of Life at Sea):** Chapter II-1, Part A, Regulation 13 specifies requirements for subdivision and stability, including the collision bulkhead.

Key Points of the Regulations:

- The collision bulkhead must be positioned at a minimum distance aft of the forward perpendicular (stem) of the ship. This distance is typically:
 - **Not less than 5% of the ship's length** measured along the waterline.
 - **Not more than 8% of the ship's length** or a specific value (e.g., 3 meters) greater than 5% length, whichever is greater.
- The location should also consider maximizing cargo storage capacity within safety limitations.
- The collision bulkhead must be watertight up to a certain height above the waterline, typically the bulkhead deck.

(b) Classification of Watertight Bulkheads:

Watertight bulkheads within a ship are classified based on their **fire resistance** and **structural integrity**. Here's a breakdown of the most common classifications:

- **A-Class Bulkhead:**
 - Offers the highest level of fire resistance, typically for at least one hour.
 - Maintains structural integrity even when exposed to fire on one side.
 - Used in critical areas like engine rooms, boiler rooms, and main vertical escape routes (stairwells).
- **B-Class Bulkhead:**
 - Provides a moderate level of fire resistance, typically for at least 30 minutes.
 - May not maintain complete structural integrity during a fire but can help contain it and prevent rapid spreading.
 - Used in accommodation spaces, passageways, and other areas requiring some level of fire protection.
- **C-Class Bulkhead:**
 - Offers minimal fire resistance or may not be fire-rated at all.
 - Primarily functions as a watertight barrier to prevent flooding between compartments.
 - Used in auxiliary spaces, stores, and other areas where fire protection is less critical.

Additional Notes:

- The specific fire resistance ratings for each class can vary depending on the regulations and the specific application.
- Some regulations may have additional classifications for watertight bulkheads with specific properties (e.g., D-Class for weathertight bulkheads).
- Always refer to the relevant regulations and classification society guidance for the specific requirements for watertight bulkheads on a particular vessel.