May 2021

May 2021 14th

9. (a) Describe, with the aid of a sketch, the securing arrangement for a pipe passing through a watertight bulkhead. (5)

(b) Sketch an arrangement for a watertight electric cable gland labelling ALL components. (5)

Nov 2018 23rd

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Securing Arrangements for Penetrations in a Watertight Structure

Here's a breakdown of securing arrangements for two common penetrations in a watertight structure:

(a) Pipe Passing Through a Watertight Bulkhead:

To maintain watertight integrity, a pipe passing through a watertight bulkhead requires a special securing arrangement. Here's a typical setup:

1. **Watertight Bulkhead Flange:** A flange is welded or bolted to the bulkhead on either side of the opening. This flange has a machined surface to create a tight seal with the pipe penetration system.
2. **Pipe Penetration Plate:** This plate, often made of steel, is sandwiched between the two bulkhead flanges. It has a central hole sized to accommodate the pipe with some clearance.
3. **Packing Material:** A compressible packing material, like a braided flax or synthetic fiber gasket, is placed in the annular space between the pipe and the penetration plate hole. This packing material is compressed to create a watertight seal around the pipe.
4. **Gland Flange and Follower:** A gland flange with a follower ring is bolted onto one side of the bulkhead flange. The follower ring applies pressure to the packing material, compressing it against the pipe and the penetration plate.
5. **Studs and Nuts:** Studs or bolts secure the gland flange and follower ring to the bulkhead flange, creating the clamping force on the packing material.

Benefits:

- Simple and reliable design.
- Easy to disassemble for pipe maintenance or replacement.

Limitations:

- Requires space on both sides of the bulkhead for flange installation.
- May require retightening of the gland bolts over time as the packing material compresses.

(b) Watertight Electric Cable Gland:

A watertight electric cable gland provides a sealed passage for an electrical cable through a watertight structure like a bulkhead or deck. Here are the key components:

1. **Body:** The main body of the gland is typically made of brass or nickel-plated brass for corrosion resistance. It houses the sealing mechanism and provides a threaded connection for mounting to the bulkhead.
2. **Cable Entry Port:** This sized opening allows the electrical cable to pass through the gland.
3. **Grommet:** A rubber or elastomeric grommet with a central hole sized for the specific cable diameter is inserted into the cable entry port. The grommet creates a tight seal around the cable jacket, preventing water ingress.
4. **Clamping Ring:** A threaded clamping ring is screwed onto the body, compressing the grommet and the cable against the cable entry port, creating a watertight seal.
5. **Locknut:** A locknut is tightened against the body to secure the clamping ring and maintain the compression on the grommet and cable.
6. **Terminal Chamber:** The body may have an internal chamber to accommodate electrical cable terminations (e.g., lugs, crimps) for connecting the cable to other electrical components.

Benefits:

- Compact design, suitable for limited space applications.
- Easy to install and maintain.
- Various sizes and types available for different cable diameters and environmental conditions.

Limitations:

- Limited reusability depending on the type of grommet used.
- May not be suitable for very large cables.

Choosing the right securing arrangement depends on several factors, including the size and type of pipe or cable, the pressure rating required, and the available space. Always consult with the manufacturer's recommendations and relevant regulations for proper installation and use.

June 2023

June 2023

9. *Sketch the device which allows a cable to pass through a watertight bulkhead, labelling the MAIN components.* (10)

The device that allows a cable to pass through a watertight bulkhead while maintaining water integrity is called a **watertight cable gland**. Here's a breakdown of its main components:

1. **Body:** This is the main housing of the gland, typically made of a corrosion-resistant material like brass or nickel-plated brass. The body provides a threaded connection for secure mounting to the bulkhead.
2. **Cable Entry Port:** This is an opening in the body sized to allow the specific electrical cable to pass through.
3. **Grommet:** This is a crucial sealing component, usually made of rubber or another elastomeric material. It has a central hole sized for a specific cable diameter. The grommet fits into the cable entry port and creates a tight seal around the cable jacket, preventing water from entering.
4. **Clamping Ring:** This threaded ring screws onto the body of the gland. Tightening the clamping ring compresses the grommet and the cable against the cable entry port, creating a watertight seal.
5. **Locknut (Optional):** Some cable glands may have a separate locknut that threads onto the body behind the clamping ring. Tightening the locknut provides additional security by holding the clamping ring in place and maintaining the compression on the grommet and cable.

Additional components (might not be present in all designs):

- **Internal Terminal Chamber:** Some glands have an internal chamber within the body to accommodate electrical cable terminations (e.g., lugs, crimps) for connecting the cable to other electrical components.
- **Strain Relief Feature:** Some designs incorporate a strain relief mechanism to prevent excessive pulling forces from being transmitted to the electrical connections within the cable.

Benefits of Watertight Cable Glands:

- **Compact design:** Suitable for use in limited space applications.
- **Easy to install and maintain:** Cable glands can be installed and removed relatively easily for cable replacement or maintenance.
- **Versatility:** Available in various sizes and types to accommodate different cable diameters and environmental conditions.

Choosing the right watertight cable gland depends on several factors, including:

- **Cable diameter:** The gland size needs to be compatible with the specific cable being used.
- **Environmental conditions:** Glands may be rated for different levels of water pressure and may have additional features for specific environments (e.g., explosion-proof).
- **Regulations:** Some applications may have specific regulatory requirements for the type of cable gland used.

Always refer to the manufacturer's recommendations and relevant regulations for proper selection, installation, and use of watertight cable glands.

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.

May 2021 14th

May 2021 14th

8. With reference to Open Flame Gas Installation, describe the safety requirements for the installation of EACH of the following:

   (a) cylinders and attachments; (5)

   (b) fittings and pipework. (5)

Open Flame Gas Installation Safety Requirements:

Here's a breakdown of the safety requirements for open flame gas installations, focusing on cylinders and attachments, fittings, and pipework:

(a) Cylinders and Attachments:

- **Cylinder Storage:**

- Secure cylinders upright in a well-ventilated location away from sources of heat or ignition.
- Use designated cylinder racks or stands to prevent tipping or rolling.
- Store flammable gas cylinders separately from oxidizing gas cylinders (e.g., oxygen) with a minimum safe distance depending on regulations.
- Keep cylinder caps or valve protection guards in place when not in use.

- **Cylinder Valves:**
  - Open and close valves slowly to prevent pressure surges.
  - Never use tools or excessive force to open or close a cylinder valve.
  - Ensure cylinder valves are fully closed when not in use.
  - Leak test cylinder valves and connections with an approved leak detection solution (soap and water) before use.
- **Pressure Relief Devices:**
  - All gas cylinders must have a pressure relief valve to prevent overpressurization.
  - Never tamper with or remove the pressure relief device from a cylinder.
- **Cylinder Attachments:**
  - Use only pressure regulators designed for the specific gas and pressure rating of the cylinder.
  - Ensure proper connections between the cylinder valve outlet and the pressure regulator inlet, using compatible threads and gaskets.
  - Tighten connections securely with appropriate wrenches, avoiding over-tightening.
- **Flashback Arrestors:** (Highly Recommended)
  - Install flashback arrestors in the gas line near the burner to prevent flames from traveling back into the cylinder.

(b) Fittings and Pipework:

- **Pipe Material:**
  - Use only pipe materials approved for the specific gas being used (e.g., steel, copper, approved flexible hoses).
  - Avoid using incompatible materials that could react with the gas or cause leaks.
- **Pipe Sizing:**
  - Use pipes with sufficient diameter to handle the required gas flow without excessive pressure drop.
  - Consult gas pressure tables and manufacturer recommendations for appropriate pipe sizes.
- **Fittings:**
  - Use only pressure-rated fittings designed for the specific gas and pressure being used.
  - Ensure proper thread engagement and use leak-proof jointing compounds where applicable.
  - Avoid using damaged or worn-out fittings.
- **Pipework Installation:**
  - Install pipes securely using brackets or clamps to prevent movement or vibration.
  - Avoid sharp bends or kinks in the pipework that could restrict gas flow or create weak points.
  - Route pipes away from sources of heat, electrical wiring, or sharp objects that could damage them.
- **Leak Testing:**
  - After installation and periodically thereafter, conduct a leak test on the entire gas system using an approved leak detection solution.
  - Tighten any loose connections or replace faulty components as needed.

Additional Safety Measures:

- **Post clear signage:** Display warning signs indicating the type of gas used and safety precautions in the vicinity of the installation.
- **Training:** Ensure personnel operating the gas equipment are properly trained in safe handling, leak detection, and emergency procedures.
- **Ventilation:** Maintain adequate ventilation in the area where the open flame gas installation is located to prevent gas build-up.
- **Emergency Shut-off Valve:** Consider installing an easily accessible emergency shut-off valve to isolate the gas supply in case of an emergency.

By following these safety requirements and best practices, you can minimize the risk of accidents and ensure a safe open flame gas installation. It's crucial to consult the relevant national regulations and manufacturer's instructions for specific requirements and additional safety considerations.

Sept 2021

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.

Nov 2018

Nov 2018

9. (a) List THREE defects that may be found during an inspection of a fixed bladed propeller, stating the possible cause of EACH. (6)

(b) State the likely consequences if the defects stated in part (a) are not rectified. (4)

Fixed-Bladed Propeller Inspection Defects and Consequences

(a) Potential Defects During Inspection:

1. **Nicks or Dings on Leading Edges:**
- **Possible Cause:** Impact with floating debris, grounding incidents, or cavitation erosion.
- Nicks or dings can disrupt smooth water flow over the blade, affecting propeller efficiency and potentially causing vibration.
2. **Bent or Twisted Blades:**
- **Possible Cause:** Hitting underwater obstacles, collision with another vessel, or severe vibration.
- Bent or twisted blades can cause significant imbalance, leading to excessive vibration, reduced thrust, and potential damage to bearings and shaft.
3. **Surface Cracks:**
- **Possible Cause:** Metal fatigue from cyclic loading, stress concentration points due to nicks or repairs, or corrosion.
- Cracks can compromise the structural integrity of the blade, potentially leading to blade failure and catastrophic consequences.

(b) Consequences of Unrectified Defects:

1. **Nicks or Dings:**
- **Reduced propeller efficiency:** The propeller will require more power to maintain the same vessel speed.
- **Increased vibration:** Uneven water flow over the blades can cause vibration, potentially damaging other components.
- **Potential for further damage:** Nicks can worsen over time due to erosion or fatigue, leading to more serious issues.
2. **Bent or Twisted Blades:**
- **Severe vibration:** This can damage bearings, shaft alignment, and other engine components.
- **Reduced thrust:** Bent or twisted blades may not generate optimal thrust, affecting vessel performance.
- **Loss of control:** In extreme cases, severe blade imbalance can lead to difficulty steering or maneuvering the vessel.
3. **Surface Cracks:**

- **Blade failure:** If left unrepaired, cracks can propagate and lead to complete blade failure. This can cause significant damage to the vessel, nearby equipment, and potential injuries.
- **Unbalanced propeller:** A broken blade will cause severe imbalance and potentially damage other drivetrain components.

It's crucial to address any defects found during a fixed-bladed propeller inspection promptly to maintain propeller efficiency, prevent further damage, and ensure safe vessel operation.

June 2020

June 2020

9. With reference to surface preparation for the painting of a vessels hull in dry-dock, list the advantages and disadvantages of EACH of the following methods:

(a) abrasive blasting; (5)

(b) hydroblasting. (5)

Here's a breakdown of the advantages and disadvantages of abrasive blasting and hydroblasting for surface preparation of a vessel hull in dry dock:

(a) Abrasive Blasting:

Advantages:

- **Effective cleaning:** Abrasive blasting is a highly effective method for removing paint, rust, scale, and other contaminants from the steel surface.
- **Surface profile creation:** The blasting process creates a roughened surface profile that provides good adhesion for the new paint coating.
- **Relatively fast process:** Abrasive blasting can be a quicker method compared to hydroblasting, especially for heavily coated surfaces.

Disadvantages:

- **Environmental impact:** Abrasive blasting creates a significant amount of dust that requires proper containment and disposal, raising environmental concerns.
- **Health hazards:** Abrasive blasting exposes workers to dust and potentially hazardous blasting media, requiring strict safety precautions.
- **Surface damage:** If not controlled properly, abrasive blasting can damage the underlying steel substrate, especially on thinner plates.
- **Media selection:** Choosing the wrong blasting media can be detrimental, potentially leaving embedded particles or causing excessive etching.

(b) Hydroblasting:

Advantages:

- **Environmentally friendly:** Hydroblasting uses only water, eliminating dust generation and associated environmental concerns.
- **Safer for workers:** Hydroblasting minimizes worker exposure to dust and blasting media, improving safety conditions.
- **Reduced risk of surface damage:** Hydroblasting is gentler on the steel compared to abrasive blasting, minimizing the risk of damaging the substrate.
- **Removal of soluble contaminants:** The high-pressure water can effectively remove water-soluble salts left behind by previous blasting or marine environments, which can compromise paint adhesion.

Disadvantages:

- **Slower process:** Hydroblasting can be slower than abrasive blasting, especially for removing thick coatings.
- **Limited profile creation:** Hydroblasting may not create as pronounced a surface profile as abrasive blasting, potentially requiring additional surface preparation steps for optimal paint adhesion.
- **Flash rust:** Exposure of the cleaned steel to air can lead to rapid formation of flash rust, requiring immediate priming or application of a rust converter to prevent further corrosion.
- **Wastewater management:** The high-pressure water used in hydroblasting creates a large volume of wastewater that may require treatment before discharge, depending on regulations.

Choosing the Right Method:

The selection between abrasive blasting and hydroblasting depends on several factors:

- **Severity of surface contamination:** For heavily coated or heavily rusted surfaces, abrasive blasting might be quicker and more effective for initial cleaning.
- **Environmental regulations:** In areas with stricter environmental regulations, hydroblasting may be the preferred option due to its minimal dust generation.
- **Steel substrate thickness:** For thinner plates, hydroblasting is a safer choice to avoid damaging the steel.
- **Desired surface profile:** If a very rough profile is required for specific paint systems, abrasive blasting might be necessary.
- **Project timelines and budget:** Abrasive blasting may be faster but may have higher disposal costs, while hydroblasting may be slower but potentially more environmentally friendly.

Consulting with a qualified blasting contractor and considering all these factors will help determine the most suitable surface preparation method for your specific vessel painting project in dry dock.

Nov 2020

Nov 2020

9. Describe, with reasons, the features of watertight doors fitted to the weather deck. (10)

Question 9. Mainly well answered

Features:

1. **Construction:**

- **Strong and Corrosion-resistant Material:** Watertight doors are typically made of high-grade steel or other suitable materials with excellent strength and corrosion resistance to withstand harsh weather and seawater exposure.
- **Double Skin Construction (Optional):** Some doors may have a double-skinned design with a cavity filled with a buoyant material for added strength, insulation, and improved fire resistance.

2. **Sealing Mechanism:**

- **Watertight Gasket:** A robust, watertight gasket is installed around the door frame to create a seal against the surrounding bulkhead opening. This gasket is typically made of elastomeric material like rubber or synthetic polymers for flexibility and compression.
- **Closing Mechanism:** The door utilizes a secure closing mechanism, usually a combination of:
    - **Hinges:** The door hinges are robust and designed to withstand slamming forces from waves or wind gusts.
    - **Clamps or Cleats:** Several strategically placed clamps or cleats are used to compress the gasket against the bulkhead opening, ensuring a watertight seal. These may be operated manually with levers or wheels, or hydraulically for larger doors.
    - **Weathertight Dogging:** In some cases, additional weathertight dogging mechanisms may be used for extra security, especially when the door is not in use for extended periods.

3. **Operational Features:**

- **Quick-acting Opening and Closing:** Watertight doors on the weather deck need to be opened and closed quickly and efficiently in emergency situations. This may involve:
    - **Lever or wheel operation:** Simple levers or wheels allow for manual operation by crew members, even under challenging conditions.
    - **Hydraulic operation:** Large or heavily trafficked doors may use hydraulic closing mechanisms for faster and more effortless operation.
    - **Emergency release mechanisms:** The door may have an emergency release mechanism to allow for quick opening from the inside in case of flooding or fire on the other side.

4. **Location and Accessibility:**

- **Strategic Placement:** Watertight doors on the weather deck are strategically positioned to isolate compartments and prevent water ingress from specific areas in case of breaches or heavy seas.
- **Clear Signage and Lighting:** The doors are clearly marked with appropriate signage to indicate their purpose and operation. They may also have emergency lighting to ensure visibility during low-light conditions.

Reasons for these Features:

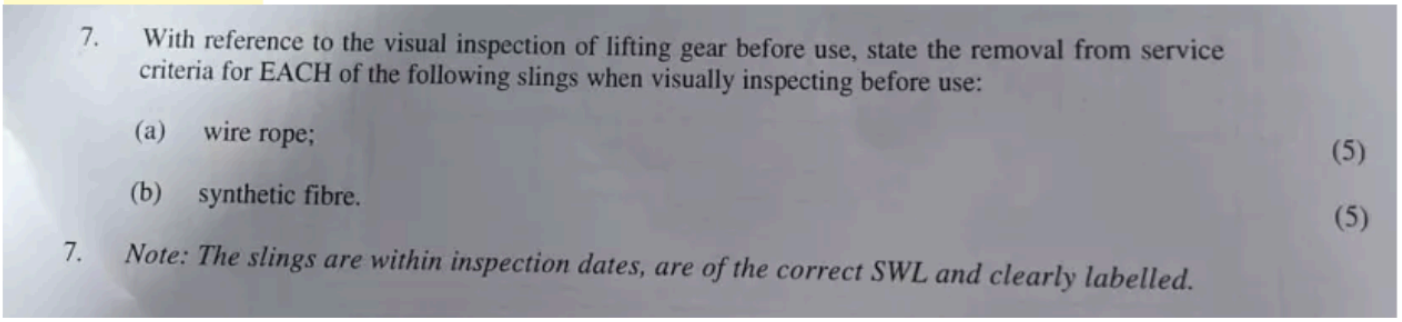
- **Strength and Corrosion Resistance:** To withstand the harsh environment on the weather deck, exposed to seawater, wind, and potential impacts.
- **Watertight Seal:** To prevent water ingress into the vessel's interior in case of heavy seas, wave breaking over the deck, or accidental openings.
- **Quick Operation:** To allow for rapid closure during emergencies or to isolate compartments to minimize flooding.

- **Ease of Use:** To ensure crew members can operate the doors efficiently, even under pressure or challenging conditions.
- **Accessibility and Visibility:** To be easily located and operated during emergencies, regardless of lighting conditions.

By incorporating these features, watertight doors on the weather deck become a crucial line of defense for maintaining a ship's watertight integrity and crew safety during adverse weather and potential flooding scenarios.

June 2023

June 2023



7. With reference to the visual inspection of lifting gear before use, state the removal from service criteria for EACH of the following slings when visually inspecting before use:

(a) wire rope; (5)

(b) synthetic fibre. (5)

7. *Note: The slings are within inspection dates, are of the correct SWL and clearly labelled.*

Removal from Service Criteria for Lifting Slings (Pre-Use Inspection):

Even if slings are within inspection dates, have the correct SWL (Safe Working Load), and are clearly labeled, a thorough visual inspection before each use is crucial. Here's a breakdown of the removal from service criteria for wire rope slings and synthetic fiber slings during such an inspection:

(a) Wire Rope Slings:

- **Broken Wires:** Any number of broken wires within a strand, or a total of 6 or more broken wires in one strand within a 3m length of the sling.
- **Severe Corrosion:** Severe general corrosion that reduces the wire diameter by more than one-third of its original diameter, or localized pitting that exposes more than one-third of the wire core.
- **Bird Caging:** When individual wires break and protrude outwards, resembling a birdcage appearance.
- **Distortion or Kinks:** Any permanent distortion or kinks in the wire rope that deform its original lay pattern.
- **Heat Damage:** Discoloration, melting, or brittleness of the wire rope due to excessive heat exposure.
- **Damaged End Fittings:** Any cracks, deformation, excessive wear, or loose attachment of the end fittings to the wire rope.
- **Missing or Illegible Sling Identification Tag:** A sling without a proper tag displaying its SWL, length, and other relevant information.

(b) Synthetic Fiber Slings:

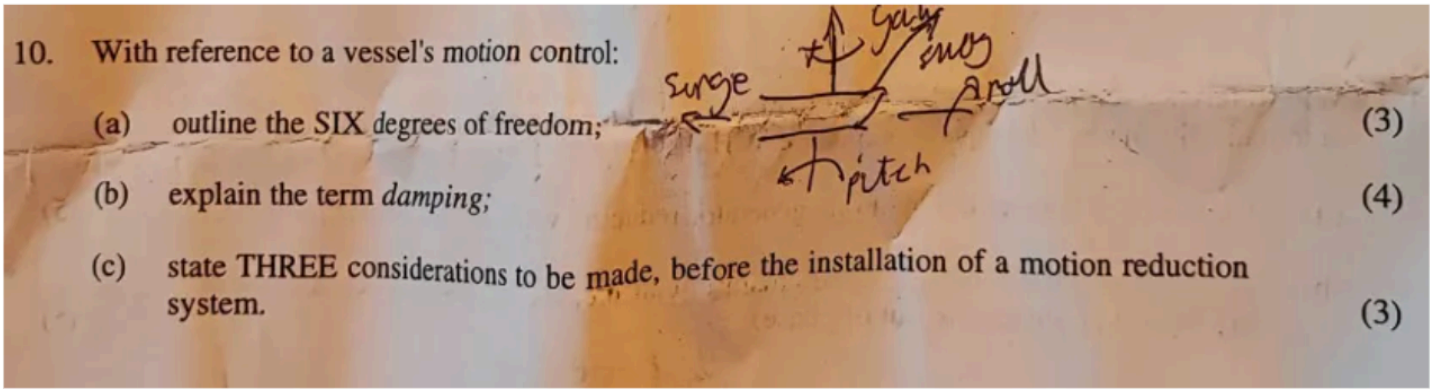
- **Cuts or Snags:** Any deep cuts, tears, snags, or punctures that penetrate more than 10% of the sling's thickness.
- **Abrasion Damage:** Excessive wear or abrasion that significantly reduces the sling's cross-sectional area or exposes underlying yarns.
- **Melting, Charring, or Chemical Damage:** Signs of melting, charring, or deterioration due to heat, chemical exposure, or UV radiation.
- **Acid or Alkali Burns:** Visible damage caused by contact with acids or alkalis.
- **Broken or Worn Stitches:** Broken or excessively worn stitching in the webbing, especially in load-bearing areas.
- **Knots:** Any knots tied in the webbing, as they significantly reduce the sling's strength.
- **Exposed Red Core Yarn (if applicable):** In some slings, a red core yarn indicates internal damage. If the red core is visible, the sling should be removed from service.
- **Distortion or Excessive Wear of Fittings:** Deformation, cracking, or excessive wear of the end fittings attached to the webbing.
- **Missing or Illegible Sling Identification Tag:** Similar to wire rope slings, a synthetic fiber sling without a proper tag for identification needs to be removed from service.

Remember, this is not an exhaustive list, and it's crucial to consult the manufacturer's instructions and relevant regulations for the specific type of sling being used. A sling should be removed from service if the inspector has any doubts about its safety or integrity.

By conducting thorough visual inspections before each use and removing any damaged slings from service, operators can significantly reduce the risk of lifting accidents and ensure the safe operation of lifting equipment.

Nov 2023

Nov 2023



10. With reference to a vessel's motion control:

(a) outline the SIX degrees of freedom; (3)

(b) explain the term *damping*; (4)

(c) state THREE considerations to be made, before the installation of a motion reduction system. (3)

March 2021

March 2021

9. With reference to a vessel's motion control:

(a) outline the SIX degrees of freedom; (3)

(b) explain the term *damping;* (4)

(c) state THREE considerations to be made, before the installation of a motion reduction system. (3)

Vessel Motion Control:

(a) Six Degrees of Freedom:

A vessel at sea can move in six degrees of freedom. These six independent motions are crucial to understand when considering a vessel's motion control:

1. **Surge:** Movement forward and backward (along the vessel's longitudinal axis).
2. **Sway:** Movement sideways (to port or starboard, along the vessel's transverse axis).
3. **Heave:** Vertical movement (up and down).
4. **Roll:** Rotational movement about the longitudinal axis (vessel tilting to port or starboard).
5. **Pitch:** Rotational movement about the transverse axis (vessel tilting forward or aft).
6. **Yaw:** Rotational movement about the vertical axis (vessel turning left or right).

(b) Damping:

In vessel motion control, damping refers to the process of reducing or suppressing the amplitude of a vessel's motion. This can be achieved through various methods, including:

- **Hydrodynamic damping:** The inherent resistance of the water to the vessel's movement.
- **Bilge keels:** Protruding fins attached to the hull that increase drag and reduce roll.
- **Active fins or rudders:** Controllable fins or rudders that generate opposing forces to counteract wave-induced motions.
- **Stabilizers:** Retractable fins or tanks filled with liquid that extend outward and move in opposition to wave motions, reducing roll.

(c) Considerations Before Installing a Motion Reduction System:

Before installing a motion reduction system on a vessel, several factors need to be carefully considered:

1. **Operational Needs:** The specific needs of the vessel's operation should be evaluated. For example, a research vessel might prioritize minimizing roll for stable sensor readings, while a passenger ferry might focus on reducing pitch for passenger comfort.
2. **Sea State Conditions:** The typical sea state conditions the vessel will encounter should be considered. Different systems may be more effective in specific wave types or frequencies.
3. **Cost and Size:** Motion reduction systems can be complex and expensive. The size and weight of the system need to be compatible with the vessel and its available space.

4. **Impact on Performance:** Some systems, like active fins or rudders, may require additional power consumption or introduce drag that could affect vessel speed or fuel efficiency.
5. **Maintenance Requirements:** The complexity of the system will determine its maintenance needs. These costs and crew expertise requirements should be factored in.

By carefully evaluating these considerations along with the specific vessel and its operational profile, choosing the most suitable motion reduction system can significantly improve seaworthiness, crew and passenger comfort, and operational efficiency.

Nov 2018 23rd

Nov 2018 23rd

8. With reference to the storage of volatile fuels, describe the construction and placement requirements of the storage tanks for aviation fuel, including tank ventilation. (10)

Aviation Fuel Storage Tanks: Construction, Placement, and Ventilation

Aviation fuel is a highly flammable liquid, and its storage requires strict regulations to ensure safety. Here's a breakdown of the key points regarding construction, placement, and ventilation of aviation fuel storage tanks:

Construction:

- **Material:** Tanks are typically constructed from high-quality, welded steel to ensure strength and minimize leakage. Some may use fiberglass for specific applications.
- **Double-walled Design (Preferred):** Double-walled tanks provide an extra layer of protection. The inner tank holds the fuel, while the outer wall acts as a secondary containment in case of a leak from the inner tank. The space between the walls is monitored for leaks.
- **Venting:** Storage tanks require proper venting to allow for:
    - **Pressure relief:** Vents release pressure buildup within the tank due to temperature changes or filling operations.
    - **Fuel vapor displacement:** Vents allow air to enter the tank as fuel is withdrawn, preventing a vacuum and potential tank collapse.
- **Fire Protection:** Tanks may be equipped with fire protection systems such as firewalls, fireproofing materials, and foam suppression systems for added safety.
- **Capacity:** Aviation fuel storage tanks come in various sizes, depending on the airport's needs and refueling requirements.

Placement:

- **Distance from Buildings and Aircraft:** Regulations dictate minimum distances between fuel storage tanks and buildings, aircraft parking areas, and other potential ignition sources.
- **Bunding:** Aboveground tanks are often placed within a bund (containment area) designed to hold the entire volume of the tank in case of a leak or rupture. This bund may be constructed from concrete or masonry.

- **Drainage:** The bunded area should have a proper drainage system to prevent rainwater accumulation and potential contamination.
- **Security:** Fuel storage facilities should have security measures like fences, access control systems, and CCTV monitoring to deter unauthorized access and potential theft.

Tank Ventilation:

- **Types of Vents:** Two main types of vents are commonly used:
  - **Vacuum and Pressure Relief Vents:** These vents automatically open to release pressure or allow air intake as needed to maintain atmospheric pressure within the tank.
  - **Flame Arrestors:** These are installed on vents to prevent flames from entering the tank in case of an external fire.
- **Vent Location:** Vents are typically located on the highest point of the tank to allow for proper air exchange and prevent fuel accumulation within the vent system.
- **Vent Discharge:** Vent discharge should be directed away from potential ignition sources and personnel working areas.

Additional Considerations:

- **Regulations:** Storage tank construction, placement, and ventilation must comply with relevant national and international regulations (e.g., NFPA 30, API 653).
- **Inspections and Maintenance:** Regular inspections and maintenance of tanks, vents, and associated equipment are crucial to ensure their integrity and functionality.

By adhering to these construction, placement, and ventilation requirements, aviation fuel storage facilities can minimize the risk of fires, spills, and environmental damage, ensuring safe and efficient storage of this vital fuel for aircraft operations.

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6. With reference to a reciprocating air compression:

   (a) define the term *Volumetric Efficiency*; (4)

   (b) explain how the operation of the suction and delivery valves affect the volumetric efficiency of the compressor. (6)

Reciprocating Air Compressor: Volumetric Efficiency and Valve Effects

(a) Volumetric Efficiency:

Volumetric efficiency (VE) in a reciprocating air compressor is a dimensionless parameter that compares the actual volume of air drawn into the cylinder during the intake stroke with the theoretical displacement volume of the piston.

Here's the formula for volumetric efficiency:

```
VE = (Actual Air Intake Volume) / (Theoretical Piston Displacement Volume)
```

A perfect compressor with no leakage or losses would have a VE of 1 (100%). In reality, however, there are always some losses, resulting in a VE value less than 1.

(b) How Suction and Delivery Valves Affect Volumetric Efficiency:

The operation of suction and delivery valves significantly impacts the volumetric efficiency of a reciprocating air compressor. Here's how:

Suction Valve:

- **Opening Time:** The suction valve needs to open promptly at the beginning of the intake stroke to allow air to flow into the cylinder. A delayed opening reduces the time available for air intake, lowering VE.
- **Valve Design:** The design of the suction valve should minimize flow resistance. A restrictive valve opening creates a pressure drop across the valve, hindering air intake and reducing VE.
- **Leakage:** A leaky suction valve allows air to escape back out of the cylinder during the intake stroke, further reducing the actual air intake volume and lowering VE.

Delivery Valve:

- **Closing Time:** The delivery valve needs to close promptly at the end of the compression stroke to prevent compressed air from flowing back into the cylinder. A delayed closure allows some compressed air to leak back, reducing the final pressure and VE.
- **Valve Design:** Similar to the suction valve, the delivery valve needs to be designed for minimal flow resistance. Excessive resistance during the discharge stroke can lead to some compressed air remaining in the cylinder, reducing the effective volume available for the next intake stroke and lowering VE.
- **Leakage:** A leaky delivery valve allows compressed air to escape back into the cylinder during the intake stroke, reducing the pressure differential for air intake and lowering VE.

Summary:

Well-designed and properly functioning suction and delivery valves are crucial for maximizing volumetric efficiency. Early opening and prompt closing of valves, combined with minimal flow resistance and leak-proof operation, ensure the compressor takes in the maximum possible air volume during the intake stroke and efficiently discharges the compressed air during the compression stroke. This translates to a higher volumetric efficiency and better overall compressor performance.