Aug 2021

1. With reference to the International Safety Management code, describe EACH of the following:

   (a) the Safety Management System (SMS); (5)

   (b) the role of the Designated Person (DP). (5)

Aug 2021

2. Describe the immediate action that should be taken in the event of EACH of the following occurring, stating a possible consequence if the action is not carried out:

   (a) a high pressure fuel leak on the main engine; (4)

   (b) severe vibration from the main engine; (3)

   (c) high cooling water temperature alarm on generator engine. (3)

Aug 2021

3. With reference to MARPOL Annex V, garbage record book:

   (a) state the type of vessel to which the regulation applies; (1)

   (b) list the NINE categories into which garbage is grouped for the purpose of the *garbage record book*. (9)

Aug 2021

4. With reference to bunkering fuel oil, list the actions that should be taken if a spillage occurs. (10)

Aug 2021

5. With reference to sewage treatment plants:

   (a) describe the biological operating principle of an aerobic sewage treatment plant, explaining the dangers if a supply of oxygen is not present; (8)

   (b) state how a sufficient supply of oxygen is ensured. (2)

Aug 2021

6. With reference to the risk of legionella bacteria in air conditioning plants:

   (a) state FOUR main areas which are considered to be a breeding ground for the bacteria, outlining a reason for EACH; (8)

   (b) describe how the risks of the existence of the bacteria can be reduced. (2)

Aug 2021

7. Sketch a line diagram of a single pass reverse osmosis plant. (10)

Aug 2021

8. With reference to the motion of a vessel in the water:

   (a) list the SIX degrees of freedom, describing the meaning of EACH term; (6)

   (b) sketch the position of a *bilge keel,* describing how it reduces vessel motion. (4)

Aug 2021

9. (a) Describe, with the aid of a sketch, how a pressurised system sprinkler head is constructed. (5)

   (b) Explain the operation of the sprinkler head and bulb assembly described in part (a), stating how the alarm is initiated. (5)

Aug 2021

10. Explain the meaning of EACH of the following terms:

   (a) LOA; (2)

   (b) displacement; (2)

   (c) load line; (2)

   (d) draught; (2)

   (e) breadth. (2)

Aug 2021

1. With reference to the International Safety Management code, describe EACH of the following:

(a) the Safety Management System (SMS); (5)

(b) the role of the Designated Person (DP). (5)

International Safety Management Code (ISM) and Key Roles:

The International Safety Management (ISM) Code is an international regulation established by the International Maritime Organization (IMO) to ensure the safety of ship operation and pollution prevention. Here's a breakdown of two key elements within the ISM Code:

(a) Safety Management System (SMS):

The SMS is a comprehensive framework that a shipping company must implement to manage safety risks onboard their vessels. It's a documented system with policies, procedures, and practices aimed at:

- **Accident Prevention:** Identifying potential hazards associated with ship operation and implementing measures to prevent accidents and injuries.
- **Pollution Prevention:** Minimizing the risk of pollution from the ship, including operational discharges, spills, and waste disposal.
- **Continuous Improvement:** The SMS is a dynamic system that requires regular review, evaluation, and improvement based on experience and identified shortcomings.

The core components of an SMS typically include:

- Safety Policy: A company-wide statement outlining the commitment to safety and pollution prevention.
- Procedures: Detailed instructions for safe operation of the ship, covering various aspects like navigation, cargo handling, maintenance, and emergency response.
- Training: Programs to ensure crew members are adequately trained and competent in their roles and emergency procedures.
- Reporting: A system for reporting incidents, accidents, near misses, and unsafe situations.
- Recordkeeping: Maintaining documentation related to the SMS, including policies, procedures, training records, and incident reports.

(b) Designated Person (DP):

The Designated Person (DP), also known as the Designated Person Ashore (DPA), plays a crucial role in the effective implementation of the SMS. They are a shore-based company representative with the authority and resources to ensure the company's safety policies are followed onboard their vessels. Key responsibilities of the DP include:

- **Maintaining SMS:** The DP is responsible for ensuring the SMS is kept up-to-date, reflecting changes in regulations, company practices, or identified risks.
- **Monitoring Ship Compliance:** The DP monitors the company's ships to ensure they are adhering to the SMS requirements. This might involve reviewing reports, conducting audits, and maintaining communication with the ship's officers.
- **Providing Resources:** The DP ensures the company provides necessary resources for safe ship operation. This could include funding for training, spare parts for maintenance, or technical assistance in case of emergencies.
- **Reporting to Management:** The DP keeps the company's management informed about safety issues, accidents, or any concerns regarding the SMS implementation onboard ships.
- **Liaison with Authorities:** The DP may act as a liaison between the company, shipboard personnel, and maritime authorities regarding safety matters.

The DP role is critical in bridging the gap between shore-based management and shipboard operations, ensuring a strong safety culture and effective implementation of the SMS for a safer maritime environment.

ug 202121

Aug 2021

2. Describe the immediate action that should be taken in the event of EACH of the following occurring, stating a possible consequence if the action is not carried out:

(a) a high pressure fuel leak on the main engine; (4)

(b) severe vibration from the main engine; (3)

(c) high cooling water temperature alarm on generator engine. (3)

Here's a breakdown of the immediate actions and potential consequences for each scenario:

(a) **High Pressure Fuel Leak on the Main Engine:**

- **Immediate Action:**
  - Shut down the main engine immediately. This removes the source of the fuel leak and minimizes the risk of fire or explosion.
  - Identify the source of the leak and isolate it if possible.
  - Activate the appropriate fire alarm system if necessary.
  - Inform the bridge and other relevant personnel about the situation.
- **Possible Consequence of Not Taking Action:**
  - Continued operation with a high-pressure fuel leak can lead to a fire or explosion. This could cause serious injury or death to personnel onboard, significant damage to the engine, and potential loss of propulsion control.

(b) **Severe Vibration from the Main Engine:**

- **Immediate Action:**
  - Reduce engine speed gradually if possible. Excessive vibration can damage engine components.
  - Investigate the cause of the vibration. This might involve checking for loose components, misalignment, or mechanical issues.
  - If the vibration persists or worsens, shut down the main engine as a precaution.

- Inform the bridge and other relevant personnel about the situation.

- **Possible Consequence of Not Taking Action:**
  - Severe vibration can lead to component failures within the engine, potentially causing further damage and downtime. In extreme cases, it could result in a catastrophic engine seizure, leaving the vessel without propulsion.

(c) **High Cooling Water Temperature Alarm on Generator Engine:**

- **Immediate Action:**
  - Investigate the cause of the high temperature. This might involve checking coolant levels, inspecting for blockages in the cooling system, or verifying proper functioning of pumps and thermostats.
  - Reduce engine load if possible, allowing the engine to cool down.
  - If the temperature remains high or continues to rise, shut down the generator engine as a precaution to prevent overheating and potential damage.
  - Inform the bridge and other relevant personnel about the situation.
- **Possible Consequence of Not Taking Action:**
  - Continued operation with high cooling water temperature can lead to engine overheating, potential component seizure, and even engine failure. This could leave the vessel without a secondary source of electricity, impacting critical systems onboard.

Aug 2021

3. With reference to MARPOL Annex V, garbage record book:

(a) state the type of vessel to which the regulation applies; (1)

(b) list the NINE categories into which garbage is grouped for the purpose of the *garbage record book*. (9)

MARPOL Annex V and Garbage Record Book

(a) Applicability:

The MARPOL Annex V regulation on garbage record keeping applies to:

- **All sea-going vessels of 400 gross tonnage and above** engaged on international voyages.
- **Every ship certified to carry 15 or more persons** engaged on international voyages.

(b) Nine Garbage Categories:

MARPOL Annex V categorizes garbage into nine groups for record-keeping purposes in the Garbage Record Book. These categories are:

1. **Food Wastes:**Includes all galley waste, leftovers from meals, vegetable matter, fruit peels, and other biodegradable food waste.
2. **Plastics:**Encompasses all plastics generated on board, including packaging materials, utensils, ropes, fishing gear, and plastic debris.
3. **Paper:**This category includes paper products like newspapers, cardboard boxes, paper towels, and office waste.

Glass: Broken or unbroken glass waste generated on board, including bottles, tableware, and laboratory glassware.

4. **Metal:**Includes scrap metal, used metal containers, and other metallic waste generated during ship operations or maintenance activities.
5. **Vegetable Oils:**Used cooking oils, lubricating oils, and other oily residues from machinery operation or bilge cleaning.
6. **Cargo Residues:**Any solid material remaining from cargo handling operations, such as dunnage, lining materials, packing materials, or cleaning residues.
7. **Fishing Gear:**Lost or discarded fishing gear, including nets, lines, hooks, and other fishing equipment.
8. **Other Garbage:**This category includes any garbage that doesn't fall into the above categories, such as batteries, electronic waste, inert grinding materials, and harmful substances.

By maintaining a Garbage Record Book with these categorized entries, ship operators can effectively track waste generation onboard, ensuring proper waste management practices and compliance with MARPOL Annex V regulations.

2021

Aug 2021

4. With reference to bunkering fuel oil, list the actions that should be taken if a spillage occurs. (10)

Actions in Case of Bunkering Fuel Oil Spillage:

A bunkering fuel oil spill can have serious environmental and financial consequences. Here's a breakdown of the actions that should be taken if a spillage occurs:

Immediate Actions:

1. **Stop Bunkering Operation:** The immediate priority is to stop the source of the spill. This involves shutting down bunkering pumps and hoses as quickly and safely as possible.

2. **Contain the Spill:** Efforts should be directed towards containing the spilled fuel to minimize its spread. Deploying spill containment booms around the spill area is crucial.

3. **Alert Relevant Authorities:** The ship's Master and shore personnel involved in bunkering should immediately notify the relevant authorities, including the Coast Guard and port authorities. This is a mandatory requirement under international maritime regulations (MARPOL Annex I).

4. **Personal Safety:** Ensure the safety of personnel in the vicinity of the spill. Depending on the severity, this might involve evacuating non-essential personnel and implementing appropriate safety protocols to minimize exposure to spilled fuel.

5. **Assess the Situation:** Once the immediate actions are taken, assess the extent of the spill, the type of fuel oil involved, and any potential risks to the environment or personnel.

Reporting and Cleanup:

1. **Incident Reporting:** Complete all necessary incident reports as required by the vessel's Safety Management System (SMS) and notify the ship's owner and insurance company.

2. **Spill Cleanup:** Arrange for a professional oil spill response team to clean up the spilled fuel. The specific cleanup methods will depend on various factors, but might involve skimming, dispersants, or absorbent materials.

3. **Waste Disposal:** Ensure proper disposal of recovered oil and contaminated materials according to local and international regulations.

4. **Investigate Cause:** The cause of the spill needs to be thoroughly investigated to prevent similar incidents in the future. This might involve reviewing bunkering procedures, equipment checks, and communication breakdowns.

Additional Considerations:

- **Minimize Fire Risks:** Bunkering fuel oil is flammable. Eliminate all ignition sources in the vicinity of the spill to prevent fire hazards.
- **Documentation:** Maintain detailed records of the incident, including the extent of the spill, cleanup activities undertaken, and communication with authorities. This documentation might be crucial for future investigations and insurance claims.

By taking prompt and effective action in case of a bunkering fuel oil spill, the environmental impact can be minimized, and regulatory requirements can be met. Remember, prioritizing safety and adhering to reporting protocols are crucial aspects of proper spill response.

ug 2021

Aug 2021

5. With reference to sewage treatment plants:

   (a) describe the biological operating principle of an aerobic sewage treatment plant, explaining the dangers if a supply of oxygen is not present; (8)

   (b) state how a sufficient supply of oxygen is ensured. (2)

Aerobic Sewage Treatment: Process, Dangers, and Oxygen Supply

(a) Biological Principle and Dangers of Oxygen Depletion:

Aerobic sewage treatment plants rely on the activity of **aerobic microorganisms** for efficient wastewater treatment. Here's a breakdown of the process and the dangers of insufficient oxygen:

Biological Principle:

1. **Primary Treatment:** Initially, sewage undergoes a physical separation process to remove larger solids.
2. **Biological Treatment (Aerobic Process):** The pretreated wastewater enters the aeration tank, where:

- **Aerobic bacteria** are present in abundance.
- **Air is continuously bubbled** through the tank to maintain a dissolved oxygen supply.
- These bacteria feed on the organic matter in the wastewater, breaking it down into simpler compounds like carbon dioxide and water.
- This process is similar to natural biodegradation that occurs in well-oxygenated environments.

Dangers of Insufficient Oxygen Supply:

If the oxygen supply to the aeration tank is insufficient, several problems can arise:

- **Inefficient Breakdown:** Aerobic bacteria become inactive or die in the absence of oxygen. This hinders the breakdown of organic matter, leading to the accumulation of pollutants in the wastewater.
- **Anaerobic Processes Take Over:** Anaerobic microorganisms, which don't require oxygen, can take over in the low-oxygen environment. However, their waste products include methane, a potent greenhouse gas, and other potentially harmful substances.
- **Increased Odors:** Anaerobic processes often generate unpleasant odors due to the production of hydrogen sulfide gas.

These issues can significantly compromise the effectiveness of the sewage treatment plant and pose environmental concerns.

(b) Ensuring Sufficient Oxygen Supply:

Here are some key methods to ensure a sufficient oxygen supply in the aeration tank of a sewage treatment plant:

- **Diffusers:** Fine bubble diffusers are commonly used to disperse compressed air efficiently throughout the tank volume, maximizing oxygen transfer to the wastewater.
- **Blowers:** Powerful blowers provide the compressed air necessary for the diffusers to function effectively.
- **Monitoring and Control:** Dissolved oxygen levels in the aeration tank are continuously monitored. If levels drop below a set point, alarms can trigger, and air supply can be adjusted to maintain optimal conditions.

By implementing these measures, sewage treatment plants can ensure a healthy environment for aerobic microorganisms and achieve efficient wastewater treatment.

20212021

Aug 2021

6. With reference to the risk of legionella bacteria in air conditioning plants:

(a) state FOUR main areas which are considered to be a breeding ground for the bacteria, outlining a reason for EACH; (8)

(b) describe how the risks of the existence of the bacteria can be reduced. (2)

Legionella in Air Conditioning Systems: Breeding Grounds and Risk Reduction

(a) Legionella Breeding Grounds in Air Conditioning:

Legionella bacteria can thrive in specific areas within air conditioning (AC) systems, posing a health risk. Here are four key breeding grounds and the reasons for their suitability:

1. **Cooling Towers:** These large structures cool water used in AC systems. The combination of warm water, spray, and scale buildup creates a perfect environment for Legionella growth.

2. **Evaporative Condensers:** Similar to cooling towers, these use water evaporation for heat exchange. The presence of warm water and potential for mist formation can harbor Legionella.

3. **Air Handling Units (AHUs):** These units contain humidifiers or spray chambers for humidity control. Stagnant water, especially with organic matter or biofilm buildup, can provide a breeding ground for the bacteria.

4. **Domestic Hot Water Systems:** Legionella can also multiply in hot water tanks or poorly maintained domestic hot water systems connected to AC units, particularly if the water temperature doesn't reach sufficiently high levels for disinfection.

(b) Reducing Legionella Risks in AC Systems:

Several strategies can be implemented to minimize the risk of Legionella growth in air conditioning systems:

1. **Temperature Control:** Maintaining water temperatures below 20°C (68°F) or above 60°C (140°F) in cooling towers, evaporative condensers, and hot water systems hinders Legionella growth.

2. **Disinfection:** Regular disinfection with chlorine, ozone, or ultraviolet (UV) light can effectively kill Legionella bacteria present in the water systems.

3. **Water Treatment:** Implementing water treatment programs that control scale, biofouling (organic buildup), and corrosion within the AC system can reduce the availability of nutrients and attachment sites for Legionella.

4. **System Maintenance:** Regular cleaning and maintenance of cooling towers, AHUs, and associated water systems help prevent stagnant water and biofilm formation, which can harbor Legionella. This includes inspections for scale buildup and proper drainage to avoid water accumulation.

5. **Monitoring and Testing:** Regular monitoring of water temperature and implementing Legionella testing protocols can help detect potential problems before they cause an outbreak.

By implementing these control measures, building owners and managers can significantly reduce the risk of Legionella growth within their air conditioning systems and protect public health.

Aug 2021

7. Sketch a line diagram of a single pass reverse osmosis plant. (10)

A single-pass reverse osmosis (RO) plant is a simplified system for purifying water. Here's a breakdown of its operation:

Components:

1. **Feed Water Inlet:** Raw water enters the plant, often from a well, brackish water source, or municipal supply.
2. **Pre-treatment (Optional):** Depending on the feed water quality, some pre-treatment steps like multimedia filtration or activated carbon filtration might be included to remove impurities that could damage the membrane.

3. **High-Pressure Pump:** This pump increases the pressure of the pre-treated water to overcome the natural osmotic pressure and drive water through the membrane.
4. **Spiral Wound Membrane Module:** This module houses the semi-permeable membrane that allows water molecules to pass through while rejecting contaminants. A single-pass system typically uses one or a few modules.
5. **Permeate Tank:** The filtered, low-salinity water (permeate) is collected in this pressurized tank.

Operation:

- Pre-treated water is pressurized by the pump.
- The high-pressure water enters the spiral wound membrane module.
- Water molecules pass through the membrane due to the pressure difference, leaving the dissolved salts and other contaminants behind.
- This filtered water (permeate) is collected in the permeate tank.
- The remaining concentrated solution, containing the rejected impurities, exits the system as a waste stream (reject or brine). This stream typically represents 20-25% of the original feed water volume.

Benefits:

- Simpler design compared to multi-pass systems.
- Lower initial investment cost.

Limitations:

- Lower water recovery rate: A significant portion of the feed water becomes waste due to single-pass operation. This can be a disadvantage in areas with limited water resources.
- Lower permeate quality: Single-pass systems may not achieve the same level of purity as multi-pass systems that recycle some of the permeate for further treatment.

Applications:

- Single-pass RO is suitable for applications where lower water recovery is acceptable and moderate water quality improvement is sufficient.
- Examples include pre-treatment for other purification systems, industrial process water, or brackish water desalination in areas with less stringent water quality requirements.

g 20212021

Aug 2021

8. With reference to the motion of a vessel in the water:

(a) list the SIX degrees of freedom, describing the meaning of EACH term; (6)

(b) sketch the position of a *bilge keel,* describing how it reduces vessel motion. (4)

Ship Motions and Bilge Keels

(a) Six Degrees of Freedom:

A vessel's motion in the water can be described by six degrees of freedom, which represent the independent ways a rigid body can move in three-dimensional space. These terms are crucial for understanding a ship's behavior at sea.

1. **Surge:** This refers to the linear movement of the vessel forwards or backwards along its longitudinal axis (from bow to stern).

2. **Sway:** This describes the lateral movement of the vessel sideways, to port (left) or starboard (right).
3. **Heave:** This refers to the vertical movement of the vessel, up and down. The ship rises and falls due to waves or other factors.
4. **Roll:** This describes the rotational movement of the vessel about its longitudinal axis. The ship rolls from side to side, with the deck tilting to port or starboard.
5. **Pitch:** This refers to the rotational movement of the vessel about its transverse axis (横向軸 héng xiàng zhóu). The bow rises and falls relative to the stern, causing the deck to tilt up or down at the bow and stern.
6. **Yaw:** This describes the rotational movement of the vessel about its vertical axis. The entire vessel turns left or right, changing its heading.

(b) Bilge Keel Position and Motion Reduction:

Bilge keels are long, narrow fins attached to the **bilge** (the curved area where the hull meets the bottom) of a vessel, typically on both sides. Here's how their position helps reduce vessel motion:

- **Position:** Bilge keels are positioned **longitudinally** (running along the length of the hull) just below the bilge area. This placement offers several advantages for mitigating rolling motion:
    - **Maximum Leverage:** The longitudinal position creates the greatest **lever arm** to counteract rolling. The bilge keels act like underwater fins, generating a resisting force when the vessel starts to roll. As the ship rolls to one side, the bilge keel on the submerged side creates lift that pushes the hull back upright, reducing the rolling angle.
    - **Minimal Draft Impact:** By positioning them near the bilge, the bilge keels have minimal impact on the vessel's **draft** (the depth of the hull underwater). This allows for operation in shallower waters compared to other stabilization methods like deep keels or outriggers.

In essence, bilge keels act as passive stabilizers, dampening the rolling motion induced by waves. They don't completely eliminate rolling, but they significantly reduce the rolling angle, enhancing passenger comfort and safety, and improving overall vessel stability.

Aug 2021

9. (a) Describe, with the aid of a sketch, how a pressurised system sprinkler head is constructed. (5)

(b) Explain the operation of the sprinkler head and bulb assembly described in part (a), stating how the alarm is initiated. (5)

Pressurized System Sprinkler Head Construction and Operation

Here's a breakdown of a pressurized system sprinkler head construction and operation, focusing on the heat-sensitive bulb assembly and alarm initiation:

Construction:

- **Frame:** The frame is typically made of metal and provides a connection to the sprinkler piping system. It houses the internal components.
- **Sealing Element:** This is the heat-sensitive component responsible for triggering water flow. There are two main types:
    - **Glass Bulb:** A small, frangible glass bulb filled with a liquid that expands rapidly at a specific temperature (typically around 57°C to 74°C or 135°F to 165°F).

    - **Bi-metallic Strip:** A strip composed of two different metals with different thermal expansion rates. As the temperature rises, the strip bends due to the unequal expansion, releasing a mechanical latch.
- **Sprinkler (Optional):** Some sprinkler heads incorporate a small sprinkler within the frame. This pre-discharge sprinkler might release a misting spray upon activation to suppress the fire in its early stages before full water flow begins.
- **Deflector:** Once the sealing element ruptures or releases, the deflector distributes the discharged water in a predetermined spray pattern to effectively cover the designated area.

Operation:

1. **Normal State:** In normal conditions, the sprinkler system is pressurized with water. The sealing element (glass bulb or bi-metallic strip) keeps the sprinkler head outlet closed, preventing water flow.
2. **Fire and Heat Rise:** When a fire breaks out, the surrounding temperature increases.
3. **Heat-Sensitive Activation:**
    - **Glass Bulb:** The liquid inside the glass bulb expands rapidly at its designated activation temperature, shattering the bulb.
    - **Bi-metallic Strip:** As the temperature rises, the bi-metallic strip bends due to the unequal expansion of the two metals. This bending triggers the release of a mechanical latch holding the sealing mechanism in place.
4. **Water Discharge:** With the sealing element no longer in place, the pressurized water from the sprinkler system flows through the opened sprinkler head.
5. **Water Distribution:** The deflector directs the water flow in a specific spray pattern to suppress the fire.
6. **Alarm Initiation:** When a sprinkler head activates and water flow starts, a **waterflow alarm** is triggered. This alarm is typically connected to the fire alarm system, alerting occupants to the fire and initiating emergency procedures.

Additional Considerations:

- The specific activation temperature of the sprinkler head depends on the application and potential fire hazards.
- Some sprinkler heads might have a combination of a heat-sensitive element and a mechanical trigger for added functionality.
- Regular inspection and maintenance of sprinkler heads are crucial to ensure their proper operation in case of a fire.

In summary, pressurized system sprinkler heads rely on a heat-sensitive element to initiate water flow when a fire raises the surrounding temperature. The ruptured bulb or released latch allows pressurized water to flow through the head and be distributed by the deflector to extinguish the fire. The water flow also triggers a waterflow alarm, alerting occupants to the emergency.

Aug 2021

10. Explain the meaning of EACH of the following terms:

(a) LOA; (2)

(b) displacement; (2)

(c) load line; (2)

(d) draught; (2)

(e) breadth. (2)

(a) LOA (Length Overall): This refers to the horizontal distance between the extreme forward point (usually the stem) and the extreme aft point (usually the rudder post) of the vessel. It represents the total length of the vessel.

(b) Displacement: Displacement refers to the total weight of water displaced by the vessel when floating at a specific trim and draft. In simpler terms, it's the weight of water the vessel pushes aside to float. Displacement is equal to the total weight of the vessel itself (lightweight) plus the weight of everything onboard (cargo, fuel, passengers, crew, and stores).

(c) Load Line (Plimsoll Mark): The load line is a series of markings etched on the side of a vessel amidships. These markings indicate the maximum safe draft a vessel can have under different loading conditions (e.g., freshwater, saltwater, summer, winter). Exceeding the load line draft can compromise the vessel's stability and seaworthiness.

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

(e) Breadth: Breadth, also commonly referred to as beam, refers to the horizontal transverse width of a vessel at its widest point. It represents the width of the vessel and is an important factor for stability and cargo capacity.