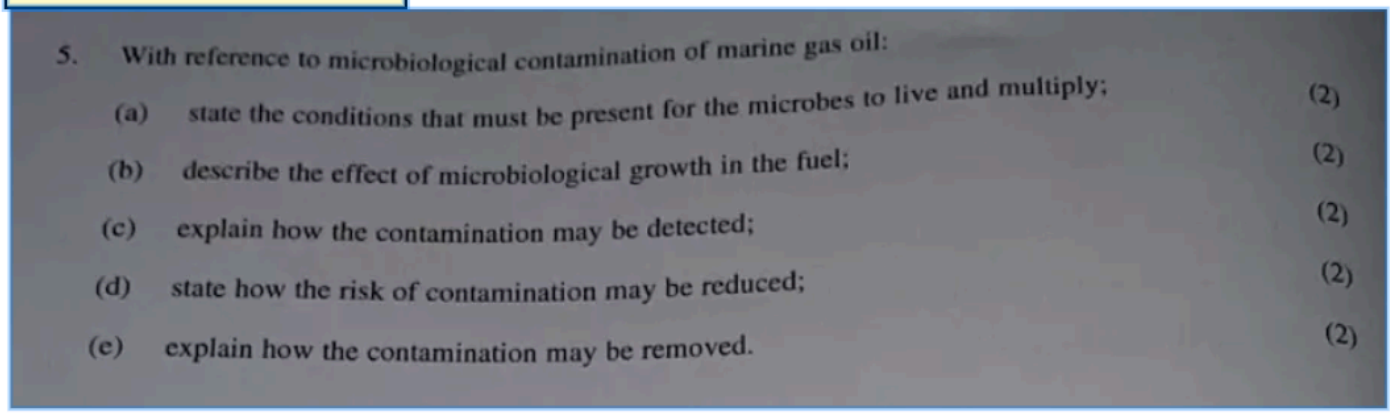
2024 January



5. With reference to microbiological contamination of marine gas oil:

(a) state the conditions that must be present for the microbes to live and multiply; (2)

(b) describe the effect of microbiological growth in the fuel; (2)

(c) explain how the contamination may be detected; (2)

(d) state how the risk of contamination may be reduced; (2)

(e) explain how the contamination may be removed. (2)

Microbiological Contamination in Marine Gas Oil: Causes, Effects, and Solutions

(a) Conditions for Microbe Growth:

Microbes, like bacteria and fungi (often referred to as "diesel bug" or "tank slime"), can thrive in marine gas oil under specific conditions:

- **Presence of Water:** Water is essential for microbial growth. Even small amounts of water trapped at the fuel-oil interface in storage tanks can create a breeding ground for microbes.
- **Warm Temperatures:** Microbial growth accelerates in warmer environments. Elevated fuel temperatures due to ambient conditions or machinery heat can exacerbate contamination.
- **Nutrients:** Trace amounts of organic material or impurities present in the fuel can serve as nutrients for microbial growth.

(b) Effects of Microbiological Growth:

Microbial growth in marine gas oil can lead to several detrimental effects:

- **Reduced Fuel Quality:** Microbes can break down fuel components, reducing its energy content and combustion efficiency. This can lead to increased fuel consumption and reduced engine power output.
- **Blocked Filters:** Microbial biofilms and slimes can clog fuel filters, restricting fuel flow and potentially leading to engine shutdown.
- **Corrosion:** Microbial waste products can be corrosive, causing damage to fuel tanks, pipes, and engine components.
- **Fuel System Sludge:** Microbial growth can contribute to the formation of sludge deposits within the fuel system, further impacting fuel flow and engine performance.

(c) Detection of Contamination:

Several methods can be used to detect microbial contamination in marine gas oil:

- **Visual Inspection:** Discoloration, cloudiness, or the presence of a visible "diesel bug" layer at the fuel-oil interface during tank inspections can indicate contamination.
- **Microbial Testing:** Laboratory testing of fuel samples can accurately identify and quantify the presence of microbial growth.

- **Fuel Analysis:** Changes in fuel properties, such as increased water content or presence of microbial waste products, might suggest contamination.

(d) Reducing the Risk of Contamination:

- **Minimize Water Ingress:** Strict procedures for fuel handling and storage are crucial to prevent water ingress into fuel tanks. This includes proper tank venting, regular tank cleaning, and using clean, dry fuel during bunkering operations.
- **Maintaining Fuel Quality:** Using high-quality fuel with biocide additives can help suppress microbial growth. Regular fuel testing helps monitor quality and identify potential contamination risks early on.
- **Temperature Control:** Maintaining fuel storage at cooler temperatures can slow down microbial activity.
- **Tank Cleaning:** Periodic tank cleaning removes accumulated water and sludge, reducing the habitat for microbes.

(e) Removing Contamination:

If microbial contamination is detected, several methods can be used for removal:

- **Biocide Treatment:** Adding biocides specifically formulated for marine fuels can kill existing microbes and suppress further growth.
- **Fuel Polishing:** Centrifugation or filtration systems can remove microbial biomass and water from the fuel oil.
- **Tank Cleaning:** In severe cases, tanks might require thorough cleaning to remove sludge and residual microbial contamination.

By implementing a combination of preventive measures and appropriate treatment methods, the risk of microbiological contamination in marine gas oil can be effectively managed, ensuring optimal fuel quality and reliable engine performance.

aug 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.

aug 2020

Aug 2020

5. (a) State FOUR possible contaminants that may be present in marine gas oil. (4)

(b) Describe a means of dealing with THREE of the contaminants listed in part (a). (6)

Marine Gas Oil Contaminants and Treatment Methods:

(a) Four Possible Contaminants in Marine Gas Oil:

1. **Water:** Even small amounts of water can create a breeding ground for microbes and accelerate corrosion within the fuel system.

2. **Sediments:** Dirt, rust, and other debris entering the fuel during bunkering or storage can clog filters and injectors, impacting engine performance.

3. **Asphaltenes:** These are complex hydrocarbon molecules that can precipitate from the fuel, especially during cold conditions, leading to sludge formation and filter blockage.

4. **Microbes (Bacteria and Fungi):** In the presence of water and warm temperatures, microbes can multiply in fuel, forming biofilms and slimes that clog filters and reduce fuel quality.

(b) Dealing with Contaminants:

1. Water:

- **Settling Tanks:** Allowing fuel to settle in designated tanks can separate water from the oil due to their differing densities. The water can then be drained from the bottom of the tank.
- **Centrifugation:** Fuel can be passed through a centrifuge that separates water from the oil based on their different weights at high rotational speeds.
- **Desiccants:** Moisture-absorbing materials like silica gel can be used in fuel storage tanks to remove trace amounts of water from the air and prevent condensation.

2. Sediments:

- **Primary Filters:** Coarse filters at the bunkering point and tank inlets can trap larger particles of dirt and debris before they enter the fuel system.
- **Secondary Filters:** Finer filters located throughout the fuel system remove any remaining sediment particles before they reach the engine. These filters require regular cleaning or replacement based on maintenance schedules and operational conditions.
- **Tank Cleaning:** Periodic cleaning of fuel storage tanks removes accumulated sludge and sediment deposits that could re-enter the fuel system.

3. Asphaltenes:

- **Fuel Heating:** Heating fuel storage tanks during cold weather can help keep asphaltenes in solution and prevent them from precipitating. However, this requires careful temperature control to avoid exceeding safety limits.
- **Fuel Additives:** Specific additives can be used to modify the properties of asphaltenes, preventing them from agglomerating and forming sludge. The selection of appropriate additives depends on the specific type of fuel and operating conditions.
- **Centrifugation:** As mentioned for water removal, centrifugation can also be effective in separating asphaltene particles from the fuel oil.

By employing these methods, the presence of contaminants in marine gas oil can be minimized, preventing equipment damage and ensuring optimal engine performance. It's important to note that the specific treatment methods chosen will depend on the severity of contamination, type of contaminant, and the onboard equipment available.

april 2021

April 2021

5. List FIVE precautions to be observed before taking on bunkers, stating a reason for EACH precaution. (10)

June 2021

5. List FIVE precautions to be observed before taking on bunkers, stating a reason for EACH precaution. (10)

Here are five precautions to be observed before taking on bunkers, along with the reason for each precaution:

1. **Review Bunker Delivery Note (BDN) and Analyze Fuel Certificate:**
- **Reason:** This ensures the fuel being delivered matches the specifications ordered (e.g., grade, sulfur content, viscosity). Mismatched fuel can have detrimental effects on engine performance and compliance with emission regulations.
2. **Physically Inspect Bunkering Manifolds and Hoses:**
- **Reason:** To identify any visible leaks, damage, or worn-out components. Using faulty hoses or connections increases the risk of spills during bunkering.
3. **Verify Vessel's Bunkering Tanks Capacity and Ullage:**
- **Reason:** Prevents overfilling of tanks, which can lead to overflows and environmental pollution. Ullage refers to the empty space remaining in a tank, ensuring sufficient capacity for the planned bunker quantity.
4. **Double-Check Bunkering Procedures and Communication Protocols:**
- **Reason:** Clear communication between vessel crew and bunker supplier personnel minimizes misunderstandings and ensures a smooth, safe bunkering operation. This includes confirming hose connections, agreed flow rates, and emergency shutdown procedures.
5. **Ensure All Necessary Personnel are Briefed and PPE is Worn:**
- **Reason:** Proper briefing on safety protocols and usage of Personal Protective Equipment (PPE) like gloves, safety glasses, and respirators protects personnel from potential hazards during bunkering, such as fuel spills or exposure to fumes.

sept 2020

Sept 2020

4. With reference to the safe bunkering of marine gas oil fuel:

(a) list SIX actions that should be taken prior to and during the loading; (6)

(b) state FOUR tests to be carried out on the fuel to ensure that it is uncontaminated. (4)

(a) Actions Before and During Bunkering:

1. **Pre-Bunkering Preparations:**

- **Review Bunker Delivery Note (BDN):** Ensure the fuel specifications (grade, sulfur content, viscosity) match the order and meet vessel requirements.
- **Analyze Fuel Certificate:** Verify the fuel meets international standards for quality and compatibility with the vessel's engine.
- **Inspect Bunkering Manifolds and Hoses:** Visually check for leaks, damage, or wear and tear on bunkering hoses and connections.

2. **During Bunkering:**

- **Double-Check Tank Capacity and Ullage:** Confirm sufficient tank capacity to accommodate the planned bunker quantity to prevent overfilling.
- **Establish Clear Communication:** Maintain clear communication between vessel crew and bunkering personnel regarding agreed flow rates, hose connections, and emergency shutdown procedures.
- **Monitor Bunkering Operation:** Assign dedicated personnel to continuously monitor the bunkering process, observing flow rates, tank levels, and any signs of leaks or spills.

(b) Tests to Ensure Uncontaminated Fuel:

1. **Visual Inspection:** Check for any discoloration, cloudiness, or presence of a "diesel bug" layer at the fuel-oil interface during bunkering, which might indicate microbial contamination.
2. **Spot Test:** A simple test using a commercially available kit can provide an initial indication of water content in the fuel. However, this might not be as precise as laboratory testing.
3. **Laboratory Analysis:** Sending fuel samples to a laboratory for detailed analysis provides a more accurate picture of fuel quality. This can include tests for water content, sediment levels, sulfur content, and presence of microbial growth.
4. **Flash Point Test:** This test determines the minimum temperature at which the fuel vapors ignite, ensuring the fuel meets safety specifications and has not been contaminated with lighter, more volatile hydrocarbons.

By implementing these precautions and tests, the risk of receiving contaminated fuel and potential problems during bunkering can be significantly reduced. It's important to follow established bunkering procedures, maintain clear communication, and prioritize safety throughout the operation.

nov 2020

Nov 2020

4. With reference to marine diesel oil:

(a) define EACH of the following terms, stating the unit used in EACH:

(i) density; (2)

(ii) viscosity; (2)

(iii) flash point. (2)

(b) excluding the THREE terms listed in part (a), state FOUR items of information contained on a Bunker delivery note. (4)

Marine Diesel Oil (MDO) Properties and Bunker Delivery Note (BDN) Information:

(a) MDO Property Definitions and Units:

(i) **Density:** This refers to the mass of MDO per unit volume at a specific temperature. It is typically expressed in kilograms per cubic meter (kg/m³) or pounds per gallon (lbs/gal).

(ii) **Viscosity:** This property describes the MDO's resistance to flow at a specific temperature. It is measured in kinematic viscosity units, typically centiStokes (cSt). Lower cSt values indicate lower viscosity and easier flow.

(iii) **Flash Point:** The flash point is the minimum temperature at which the fuel vapors will ignite in the presence of a spark or flame. It is measured in degrees Celsius (°C) or degrees Fahrenheit (°F).

(b) Additional Information on a Bunker Delivery Note (BDN):

While density, viscosity, and flash point are crucial, a Bunker Delivery Note (BDN) contains various other items of information:

1. **Fuel Grade:** This specifies the type of MDO being delivered, such as DMA (Marine Gas Oil) or MDO 0.5% (referring to maximum sulfur content).
2. **Quantity:** The total amount of MDO delivered in metric tons (MT) or long tons (LT).
3. **Supplier Information:** Details of the company supplying the fuel, including their name, address, and contact information.
4. **Vessel Information:** Name and registration details of the vessel receiving the fuel.
5. **Date and Time of Delivery:** Records the specific date and time when the bunkering operation took place.

These are just some of the key details found on a BDN. Depending on specific regulations and requirements, additional information like sulfur content analysis results, API gravity (a measure of fuel density), and reference to relevant standards (e.g., ISO 8217) might also be included.

aug 2023

AUG 2023

4. With reference to bunkering of marine diesel oil:

(a) state THREE possible consequences of water contamination of the fuel; (3)

(b) state THREE sources of contamination of fuel by water on board a vessel; (3)

(c) describe TWO separate tests which would indicate the presence of water in the fuel. (4)

Bunkering and Water Contamination of Marine Diesel Oil (MDO):

(a) Consequences of Water Contamination:

Water contamination in MDO can have several detrimental consequences:

1. **Microbial Growth:** The presence of water creates a breeding ground for microbes (bacteria and fungi) that can grow in the fuel. These microbes can:
    - Break down fuel components, reducing its energy content and combustion efficiency, leading to increased fuel consumption and reduced engine power output.
    - Produce biofilms and slimes that can clog fuel filters, restricting fuel flow and potentially leading to engine shutdown.
    - Generate corrosive byproducts that can damage fuel tanks, pipes, and engine components.
2. **Corrosion:** Water itself can contribute to corrosion within the fuel system, especially in the presence of dissolved salts or contaminants. This can lead to leaks, equipment damage, and potential safety hazards.
3. **Fuel System Icing:** In cold weather conditions, water in the fuel can freeze and form ice crystals. These ice crystals can block fuel filters and pipelines, disrupting fuel flow and potentially causing engine failure.

(b) Sources of Water Contamination Onboard:

While water ingress during bunkering is a concern, there are other sources of water contamination onboard a vessel:

1. **Tank Condensation:** Temperature fluctuations can cause condensation within fuel storage tanks. This is more prevalent in humid environments or during periods of significant temperature changes.
2. **Leaking Equipment:** Leaks in piping, seals, or heat exchangers can allow seawater to enter the fuel system, introducing water contamination.
3. **Poor Tank Venting:** Improper venting of fuel tanks can create a vacuum, drawing in moisture from the surrounding air, especially during bunkering operations.

(c) Tests for Water Contamination:

1. **Visual Inspection:** During bunkering or tank inspections, a visual check for cloudiness, discoloration, or the presence of a distinct water layer at the fuel-oil interface can indicate water contamination.
2. **Spot Test:** Commercially available test kits allow for a quick on-site check for water content in the fuel. However, these kits provide a basic indication and might not be as precise as laboratory analysis.

For a more reliable assessment, fuel samples should be sent to a laboratory for detailed analysis. Laboratory tests can determine the exact water content in the fuel and identify any other potential contaminants.

29 January 2021

4. With reference to the international agreement governing the discharge of oil from ships:

(a) state the name of the International Authority responsible for overseeing the legislation; (1)

(b) state the name of the appropriate regulation; (1)

(c) state what the abbreviation SOPEP stands for; (2)

(d) explain the purpose of a SOPEP; (2)

(e) list FOUR items of information a SOPEP should contain. (4)

International Agreement on Oil Pollution and SOPEPs:

(a) International Authority:

The International Maritime Organization (IMO) is the international authority responsible for overseeing the legislation governing the discharge of oil from ships.

(b) Appropriate Regulation:

The key regulation addressing oil pollution prevention from ships is:

- **MARPOL Annex I: Regulations for the Prevention of Pollution by Oil**.

(c) SOPEP Abbreviation:

SOPEP stands for **Shipboard Oil Pollution Emergency Plan**.

(d) Purpose of a SOPEP:

A SOPEP is a mandatory document for all seagoing vessels of a certain size. It outlines the procedures and actions to be taken in the event of an oil spill at sea. The SOPEP serves as a crucial guide for the ship's crew to respond effectively and minimize the environmental impact of the spill.

(e) Four Items in a SOPEP:

1. **Reporting Procedures:** The SOPEP details the reporting requirements for oil spills to relevant authorities, including the coastal state, flag state, and the IMO.

2. **Oil Spill Response Equipment:** The plan inventories all onboard equipment and resources available for oil spill response, such as containment booms, skimmers, and dispersants.

3. **Spill Response Actions:** Detailed procedures are outlined for various oil spill scenarios, including deployment of response equipment, containment strategies, and cleanup methods.

4. **Training and Drills:** The SOPEP specifies training requirements for crew members in oil spill response procedures and conducting regular drills to ensure crew familiarity with the plan and proper equipment

use.

By having a comprehensive and up-to-date SOPEP, ship crews are better prepared to handle oil spill emergencies effectively, reducing the risk of environmental damage and facilitating efficient response efforts.

may 2021

May 2021

4. (a) State the main pollutant produced when burning a hydrocarbon fuel. (1)

(b) Explain how the pollutant referred to in part (a) can be reduced. (2)

(c) State what is meant by an ECA. (1)

(d) State the current maximum % sulphur content in marine diesel oil in EACH of the following:

(i) worldwide; (1)

(ii) in a ECA. (1)

(e) Describe how SO_x is produced in the combustion process and the effects oxides of sulphur has on the environment. (4)

Marine Diesel Oil, Emissions, and Emission Control Areas (ECAs):

(a) Main Pollutant: The main pollutant produced when burning a hydrocarbon fuel like marine diesel oil is **Sulphur Oxides (SOx)**. These are primarily sulphur dioxide (SO2) with smaller amounts of sulphur trioxide (SO3).

(b) Reducing SOx Emissions: Several strategies can be employed to reduce SOx emissions:

- **Low-Sulphur Fuel:** Using marine diesel oil with a lower sulphur content significantly reduces SOx formation during combustion. International regulations and designated Emission Control Areas (ECAs) enforce stricter limits on sulphur content in fuels used by ships.
- **Exhaust Gas Cleaning Systems (EGCS):** Also known as "scrubbers," these systems remove SOx from the exhaust gases after combustion. They can be effective but require additional equipment and maintenance onboard.
- **Alternative Fuels:** Emerging technologies explore cleaner burning fuels like Liquefied Natural Gas (LNG) or biofuels, which can offer significant SOx reduction compared to traditional marine diesel oil.

(c) Emission Control Area (ECA): ECAs are designated areas around the world where stricter air pollution regulations apply to ships. This includes limitations on the sulphur content of fuels used within these zones.

(d) Maximum Sulphur Content:

(i) **Worldwide:** The current maximum sulphur content in marine diesel oil for use **globally** is **0.5%** by mass, as per MARPOL Annex VI regulations implemented by the IMO.

(ii) **ECA:** In **Emission Control Areas**, the maximum sulphur content is significantly stricter, currently set at **0.1%** by mass. This means ships operating within ECAs must use cleaner burning fuels with lower sulphur content to comply with regulations.

(e) SOx Production and Environmental Effects:

- **Combustion Process:** During the combustion of marine diesel oil, the sulphur present in the fuel reacts with oxygen to form SOx. The exact ratio of SO2 and SO3 depends on various factors like combustion temperature and air-fuel ratio.

- **Environmental Effects:** SOx emissions contribute to several environmental problems:

    - **Acid Rain:** SOx reacts with water vapor in the atmosphere to form sulphuric acid, a major component of acid rain. This acid rain can damage forests, acidify lakes and rivers, and harm plant and animal life.
    - **Respiratory Issues:** SO2 exposure can irritate the respiratory tract, causing coughing, wheezing, and breathing difficulties, especially for people with asthma or other respiratory conditions.

By implementing stricter regulations and promoting cleaner burning fuels, the impact of SOx emissions from maritime activities can be significantly reduced, leading to a cleaner and healthier environment.

may 2021

May 2021

5. With reference to bunkering of marine diesel oil:

(a) explain why the suppliers' tanks should be dipped prior to and after receiving fuel; (4)

(b) explain what is meant by a *letter of protest*, and when it must be issued; (4)

(c) state the person responsible for issuing the letter of protest. (2)

Bunkering of Marine Diesel Oil: Dipping Tanks, Letters of Protest, and Responsibilities

(a) Importance of Dipping Suppliers' Tanks:

Dipping the supplier's tanks before and after bunkering is a crucial practice for ensuring accurate fuel quantity measurement:

- **Pre-Bunkering Dip:** This establishes the initial volume of fuel present in the supplier's tank before transferring any fuel to the vessel. This initial reading serves as a baseline for calculating the delivered quantity.

- **Post-Bunkering Dip:** Once bunkering is complete, dipping the supplier's tank again provides the final volume remaining. By subtracting the final volume from the initial volume, the actual amount of fuel

transferred to the vessel can be determined.

Accurate quantity measurement is essential for several reasons:

- **Billing Verification:** It ensures the vessel is charged only for the fuel actually received, preventing overbilling by the supplier.
- **Fuel Inventory Management:** Accurate records of fuel received help maintain a precise inventory of onboard fuel, enabling better voyage planning and fuel management.
- **Dispute Resolution:** In case of discrepancies between the fuel quantity ordered and the quantity delivered, tank dipping records provide vital evidence for resolving disputes.

(b) Letter of Protest:

A letter of protest is a formal document issued by the ship's Master to the bunker supplier when discrepancies arise regarding the quantity or quality of fuel delivered.

It's a crucial step taken **when there's a significant difference** between the amount of fuel ordered/dipped and the amount delivered/billed, or when there's a suspected issue with the fuel quality.

(c) Issuing the Letter of Protest:

The responsibility for issuing a letter of protest falls on the **ship's Master**. As the person ultimately responsible for the vessel's safety and operations, the Master has the authority to document any concerns about the bunkering process.

The letter of protest should be issued promptly after bunkering is completed and discrepancies are identified. It should clearly state the nature of the issue, including the observed difference in quantity or the suspected quality problem. Preserving tank dipping records and collecting fuel samples (if applicable) for further analysis becomes crucial evidence to support the protest.