

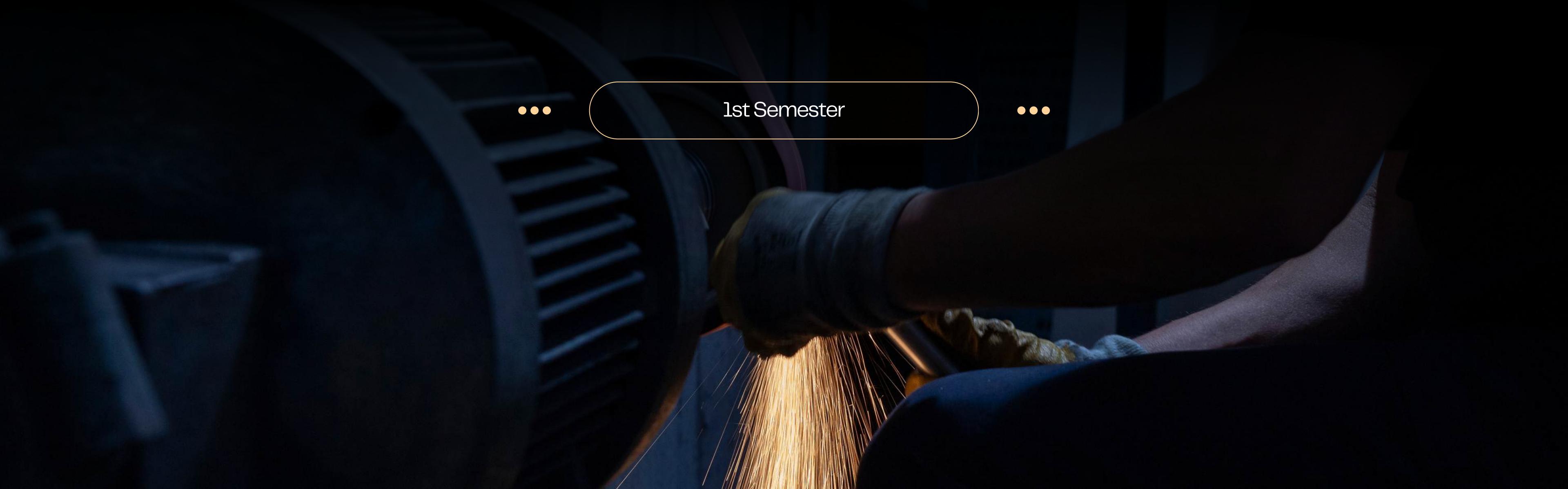
# AUXMACH1B

## STUDENT PORTFOLIO

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1st Semester

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# AUXMACH1B OVERVIEW



## STUDENT PORTFOLIO

The student portfolio should comprehensively cover the Pumps and Valves which are essential for fluid management across various ship systems; the Air Compressor which supplies high-pressure air for starting the main engine and powering controls; Heat Exchangers crucial for maintaining safe operating temperatures by cooling machinery fluids; and the Fresh Water Generator for producing potable and technical water from seawater. Furthermore, it must detail the operation of Deck Machineries, including the E/R Crane, used for handling cargo and machinery; the procedural and regulatory aspects of Ballasting Operations to maintain stability and trim; the function of the Oily Water Separator (OWS) for environmental compliance in bilge water discharge; and the principles of Automatic Controls that ensure safe, efficient, and monitored operation of shipboard systems.





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# PUMPS AND VALVES



## PUMPS

A mechanical device that uses energy to move fluids (liquids or gases) by creating a pressure difference. Pumps work through mechanical action, often by using a suction or compression process to raise, transport, or compress fluids from one place to another.

## VALVES

A mechanical device that regulates, directs, or controls the flow of a fluid (like liquid, gas, or steam) by opening, closing, or partially obstructing a passageway. These devices are essential in many applications, from simple home plumbing to complex industrial processes, and can be operated manually or automatically.

## OPERATION:



### Compression:

Air is drawn in and compressed in stages, usually two or three. Each stage significantly increases the air pressure and, critically, its temperature.



### Intercooling and Aftercooling:

To manage this high heat, the air is passed through intercoolers after each compression stage. The final stage is followed by an aftercooler.



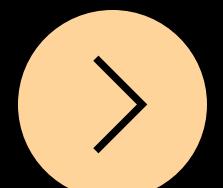
### Storage:

The compressed, cooled, and dried air is then stored in large, high-pressure air reservoirs or receivers.



# AIR COMPRESSOR

A COMPRESSOR is a thermal machine used for repeated compression of gases. The air compressor is used to compress the atmospheric air.



## Applications:



### Starting Air (High Pressure):

Typically stored at 25–30 bar. This is the most crucial application, used to turn the main engine over and ignite the fuel for start-up.



### Service Air (Medium Pressure):

Reduced to around 7–10 bar. Used for general shipboard needs, such as operating pneumatic power tools, cleaning filters, filling tires, and supplying air to the ship's whistle.



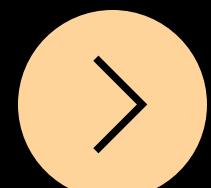
### Control Air (Dry, Regulated Pressure):

Highly filtered and dried, often regulated to 5–7 bar. This "instrument air" is vital for operating sophisticated pneumatic automatic control systems.



# AIR COMPRESSOR

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## Maintenance:



### Draining Moisture:

Drain water from all air reservoirs and coolers regularly (daily or per watch). Removing this condensate prevents corrosion inside the tanks and prevents water carryover into the air systems.



### Checking Oil Levels:

Maintain the correct lubricating oil level in the compressor's crankcase, as per manufacturer specifications. Use the correct grade of oil to ensure efficient lubrication and cooling of moving parts.



### Inspecting Safety Devices:

Regularly test the safety relief valves on both the compressor stages and the air receivers. These valves protect the system from over-pressurization. Also, check the unloader mechanism which allows the motor to start without pressure load.

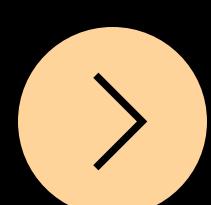
# AIR COMPRESSOR

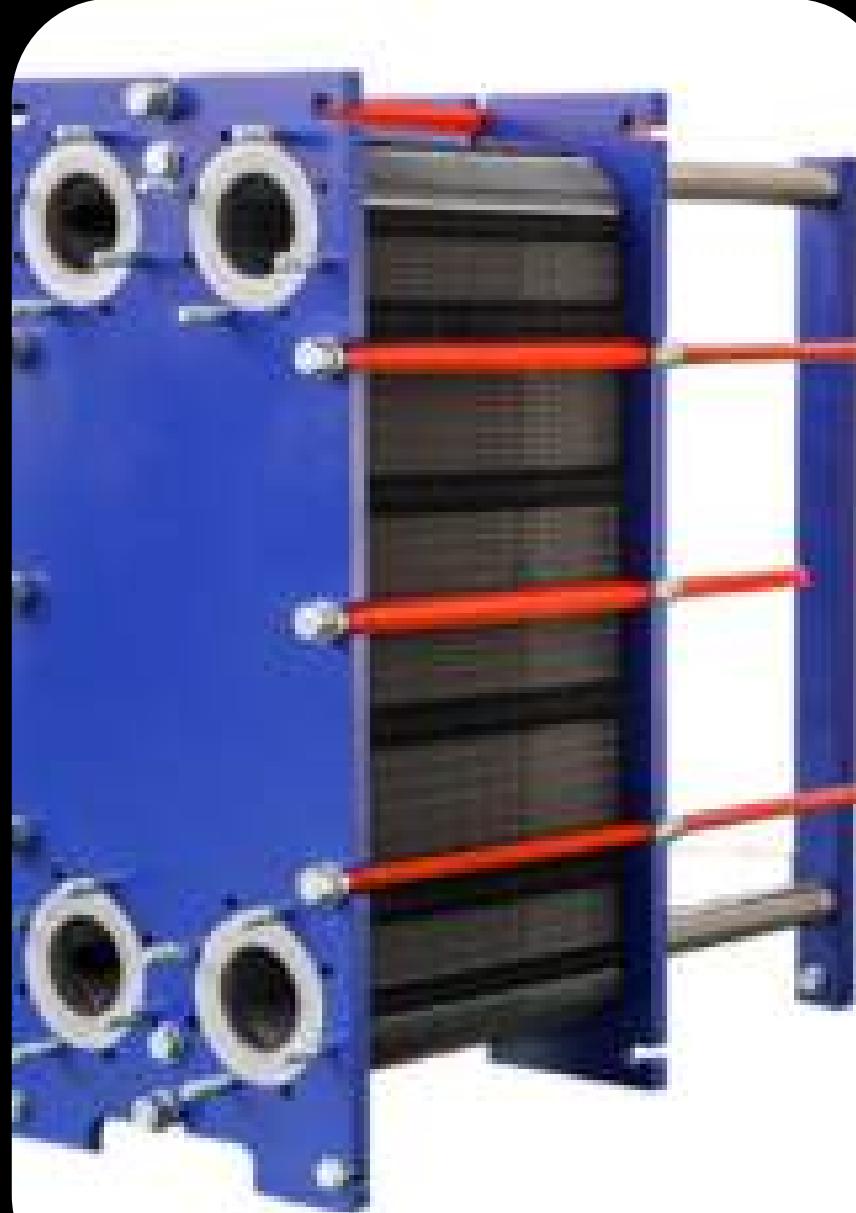
A COMPRESSOR is a thermal machine used for repeated compression of gases. The air compressor is used to compress the atmospheric air.



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# HEAT EXCHANGER

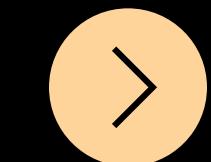
A HEAT EXCHANGER is a component that allows the transfer of heat from one fluid (liquid or gas) to another fluid.

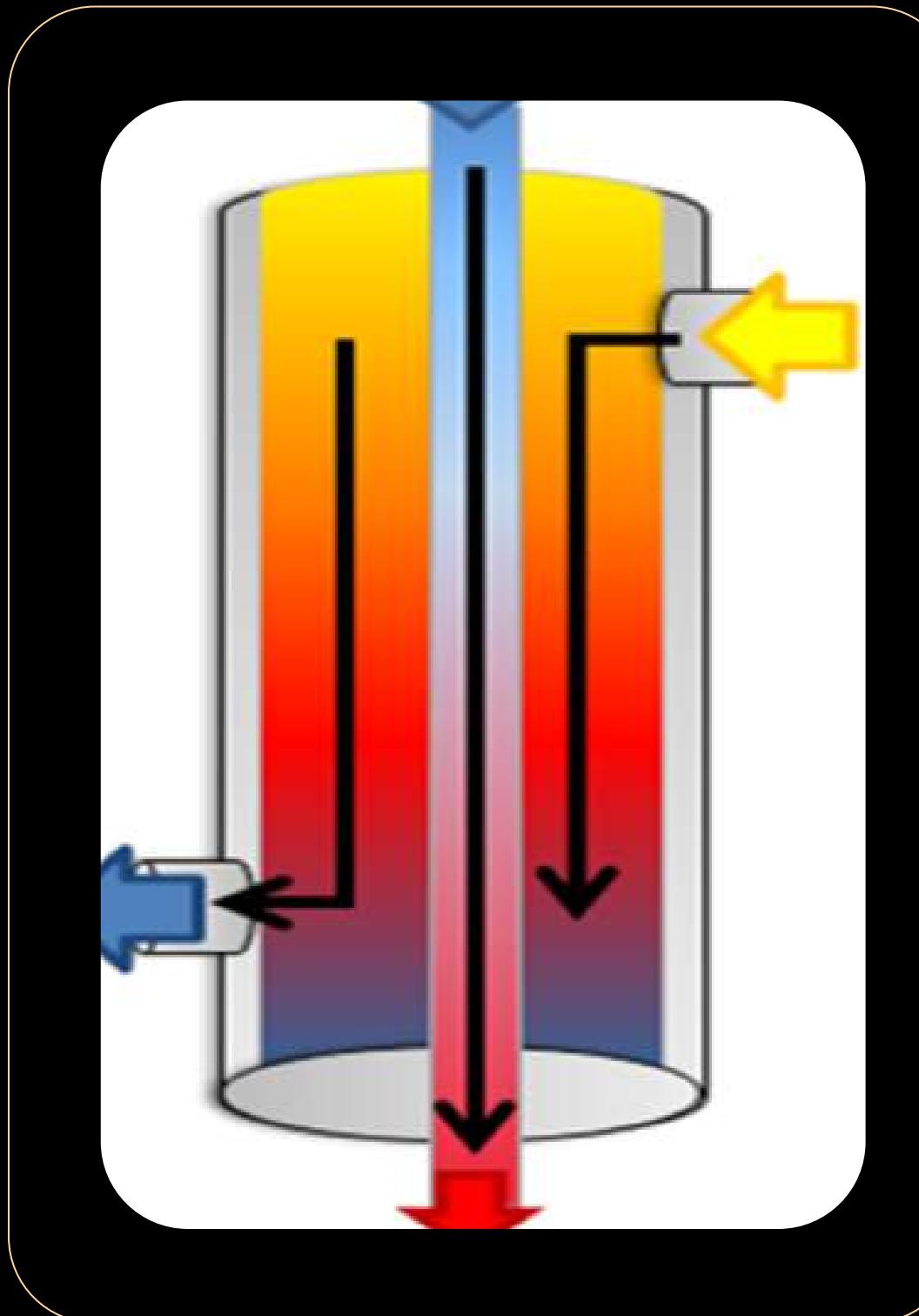
## SHELL AND TUBE TYPE

Characterized by a bundle of tubes housed within a shell. One fluid flows through the tubes, while the other flows around the tubes within the shell. They are robust and suitable for high-pressure applications.

## PLATE TYPE

Consists of a series of metal plates with gaskets that create alternating channels for the two fluids. They offer high thermal efficiency and are easier to disassemble for cleaning (required due to fouling—the buildup of deposits that reduces efficiency).





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# HEAT EXCHANGER

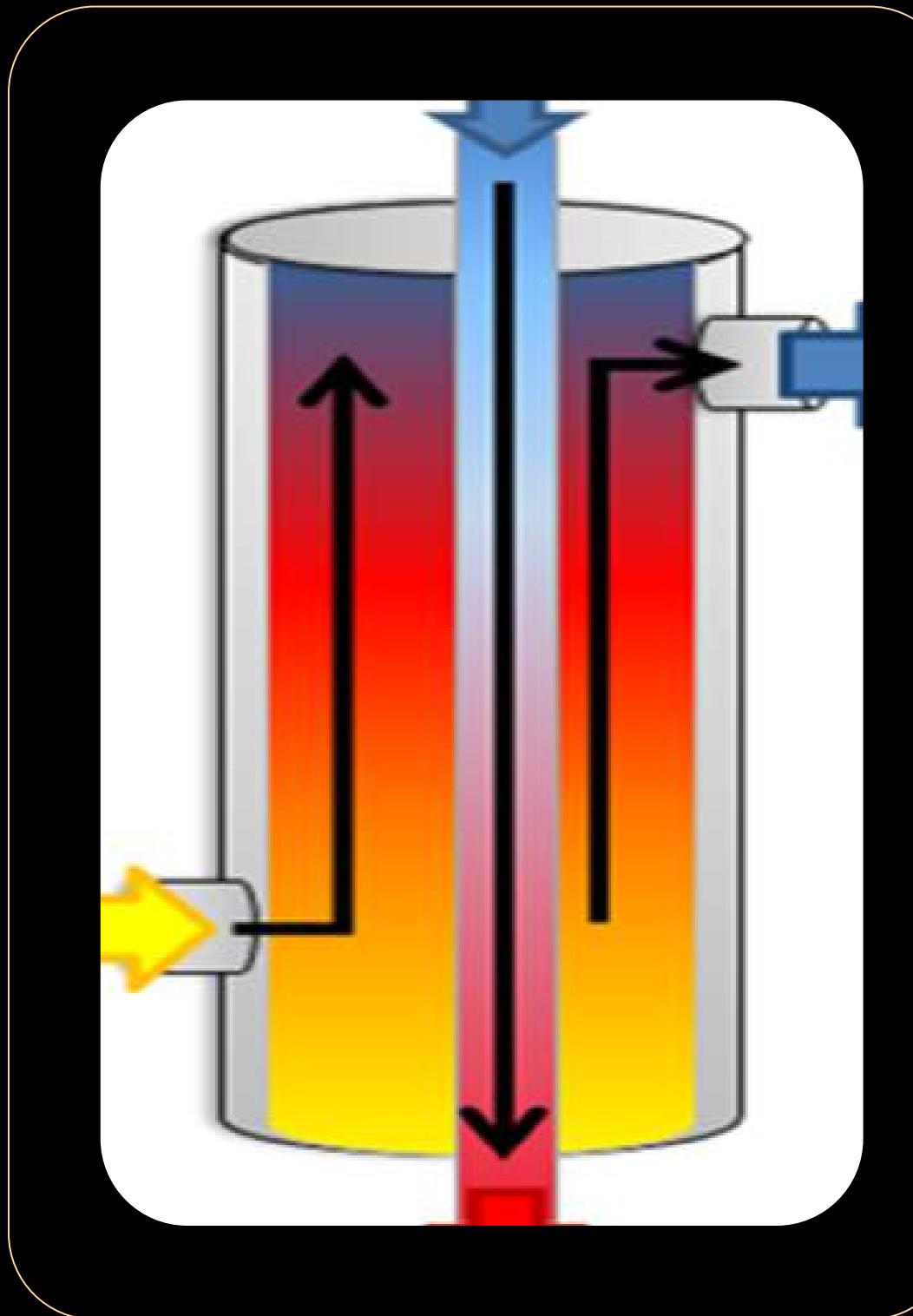
A HEAT EXCHANGER is a component that allows the transfer of heat from one fluid (liquid or gas) to another fluid.

## TYPES OF HEAT EXCHANGER FLOW

### 1. Parallel flow

Parallel Flow is the least efficient arrangement where the hot and cold fluids flow in the same direction from the same entry point. This configuration leads to the largest temperature difference at the inlet, but the two fluid temperatures quickly approach each other, limiting the maximum heat transfer. Crucially, the cold fluid's outlet temperature can never exceed the hot fluid's outlet temperature.





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# HEAT EXCHANGER

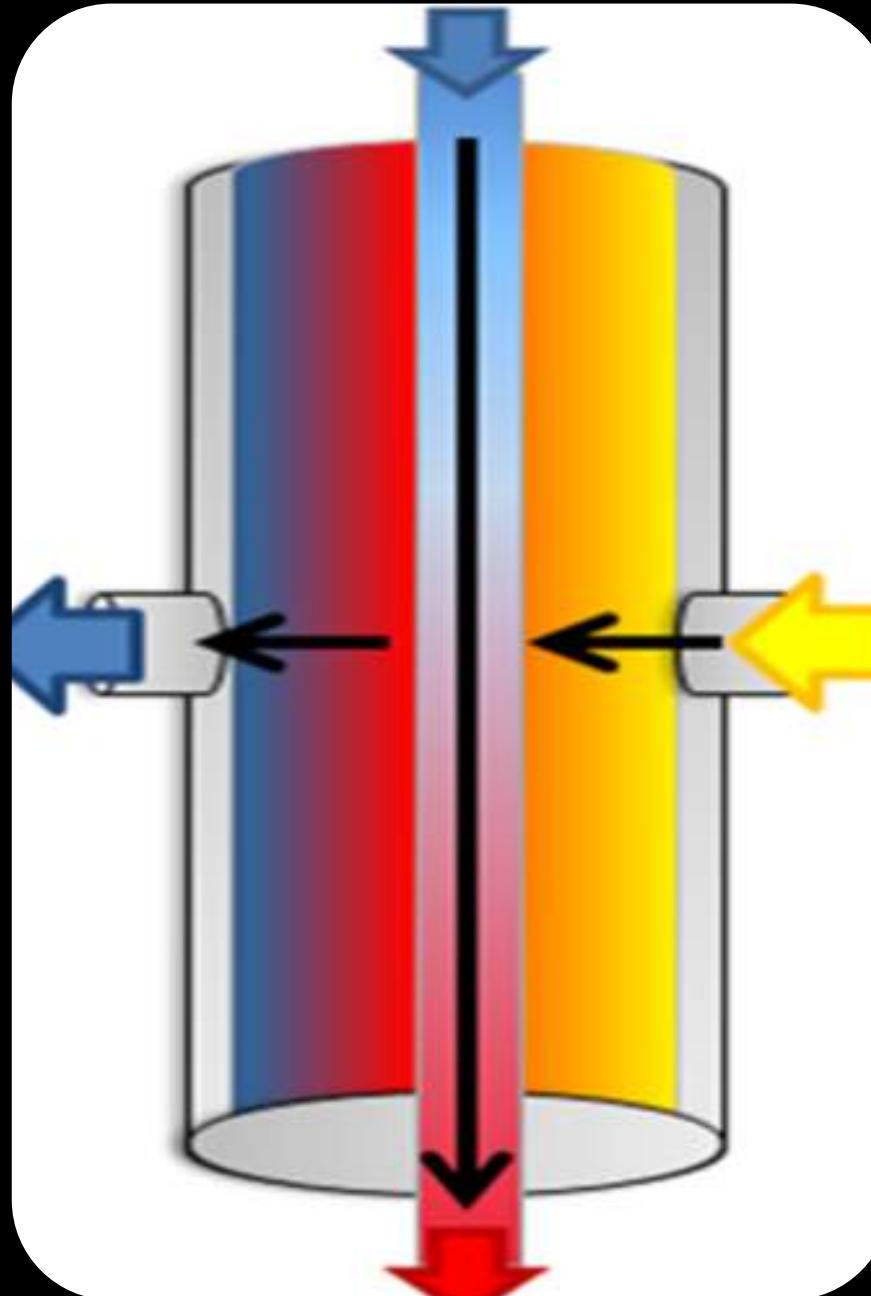
A HEAT EXCHANGER is a component that allows the transfer of heat from one fluid (liquid or gas) to another fluid.

## TYPES OF HEAT EXCHANGER FLOW

### 2. Counter flow

Counter Flow is the most efficient arrangement, with fluids flowing in opposite directions (entering at opposite ends). This setup maintains a more uniform temperature difference along the exchanger's entire length, resulting in maximum heat transfer. Its key advantage is that the cold fluid's outlet temperature can be higher than the hot fluid's outlet temperature.





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# HEAT EXCHANGER

A HEAT EXCHANGER is a component that allows the transfer of heat from one fluid (liquid or gas) to another fluid.

## TYPES OF HEAT EXCHANGER FLOW

### 3. Cross flow

Cross Flow is an intermediate arrangement where the fluids flow perpendicularly to each other. It is commonly used in applications where one fluid is gaseous or unconfined, such as in shipboard air coolers. The efficiency of a cross-flow design falls between that of parallel and counter flow, offering a practical balance between thermal performance and compact construction.





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# HEAT EXCHANGER

A HEAT EXCHANGER is a component that allows the transfer of heat from one fluid (liquid or gas) to another fluid.

## APPLICATIONS:

- **Main Engine Jacket Water Cooler:** Uses seawater to cool the engine's primary freshwater cooling circuit
- **Lubricating Oil Cooler:** Maintains the oil temperature below the breakdown point.
- **Charge Air Cooler (Air Cooler):** Cools the compressed air before it enters the engine cylinders to increase its density, improving combustion efficiency.



**OPERATION:**

The feed water to be distilled is taken from the sea cooling water outlet of the condenser. It enters the evaporator where it evaporates at about 40 to 50° as it passes between the plates heated by the heating medium.

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# FRESHWATER ➤ GENERATOR

A crucial piece of equipment that provides potable (drinking) and technical (service) water by distilling seawater, ensuring the ship's self-sufficiency on long voyages.

**PROCESS:**

- 1 Heat Source: Seawater flowing through the FWG is heated by a hot source, typically the Main Engine Jacket Cooling Water (usually around 80 degrees Celsius)
2. Vacuum Creation: An Ejector Pump (or vacuum pump) continuously removes air and non-condensable gases from the Evaporator Shell, maintaining a deep vacuum.
3. Flash Evaporation: Because the pressure inside the shell is so low, the pre-heated seawater "flashes" or boils instantly at the low temperature provided by the jacket water. This separates the pure water vapor from the brine (concentrated saltwater).

# FRESHWATER GENERATOR

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**PROCESS:**

4. Condensation: The pure, low-pressure steam moves to the Condenser, where it flows over tubes cooled by a cold fluid (usually cold seawater). The steam condenses into fresh water.

5. Discharge: The resulting fresh water (distillate) is pumped out for storage. The concentrated brine is continuously discharged back overboard.

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# FRESHWATER ➤ GENERATOR

A crucial piece of equipment that provides potable (drinking) and technical (service) water by distilling seawater, ensuring the ship's self-sufficiency on long voyages.

# ENGINE ROOM CRANE



## OVER HEAD CRANE PARTS

The Engine Room Crane is fitted in the engine room as per the Main Engine Specification so that the crane can lift all the individual parts of the engine during routine maintenance.



### Bridge (or Girder)

- The horizontal beam that spans across the engine room.
- Supports the hoist and trolley.
- Can be either fixed or movable depending on the crane type.

### Trolley

- Mounted on the bridge and moves horizontally along it.
- Carries the hoisting mechanism.
- Allows precise positioning of the load across the span of the bridge.

### Hoist

- The lifting mechanism that raises and lowers the load.
- Can be electric, hydraulic, or manual.
- Includes a motor, drum, wire rope or chain, and hook.

### Hook or Lifting Attachment

- The part that physically connects to the load.
- May include shackles, slings, or specialized lifting tools depending on the machinery being handled.

### Control System

- Used to operate the crane (lifting, lowering, moving).
- Can be a pendant control, remote control, or cabin control.
- Includes safety features like emergency stop, limit switches, and overload protection.

### Runway Rails

- Tracks on which the bridge travels (if the crane is a traveling type).
- Mounted on the engine room ceiling or structure.

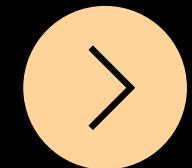
### End Carriages

- Located at both ends of the bridge.
- Contain wheels that allow the bridge to move along the runway rails.

### Power Supply System

- Provides electrical or hydraulic power to the crane.
- Includes cables, festoon systems, or conductor bars.

# ENGINE ROOM CRANE



## ... OVER HEAD CRANE MOVEMENT AND SAFETY ...

The Engine Room Crane is fitted in the engine room as per the Main Engine Specification so that the crane can lift all the individual parts of the engine during routine maintenance.

- UP and DOWN (hook)
- LONGITUDINAL (Forward and Aft)
- TRAVERSE (Port and Starboard)

1. The most important safety feature of the crane is the electromagnetic fail-safe brakes which do not allow the crane to fall with the load even when there is a failure of power. For this:

- Normally centrifugal brakes are used which are fitted inside the rotating drum.
- The brake pads are always in an applied state and pushed by magnetic springs when not in operation or when there is a power failure.
- As the crane is operated or the power is supplied, the spring gets pulled inward or compressed due to the electromagnetic effect of the current. This allows the crane to be operated normally.

2. Emergency stop is provided in the remote so that the operator can stop the crane at any time.

3. The motor is fitted with a distance limit switch in both transverse and longitudinal directions so that the travel of the trolley and hence the crane should not overshoot the rack's end.

4. Mechanical stoppers are provided for both directions in case the electrical distance limit trips fail.

5. The up and down travel of the hook is also attached with an automatic stopper to avoid overloading of the motor.

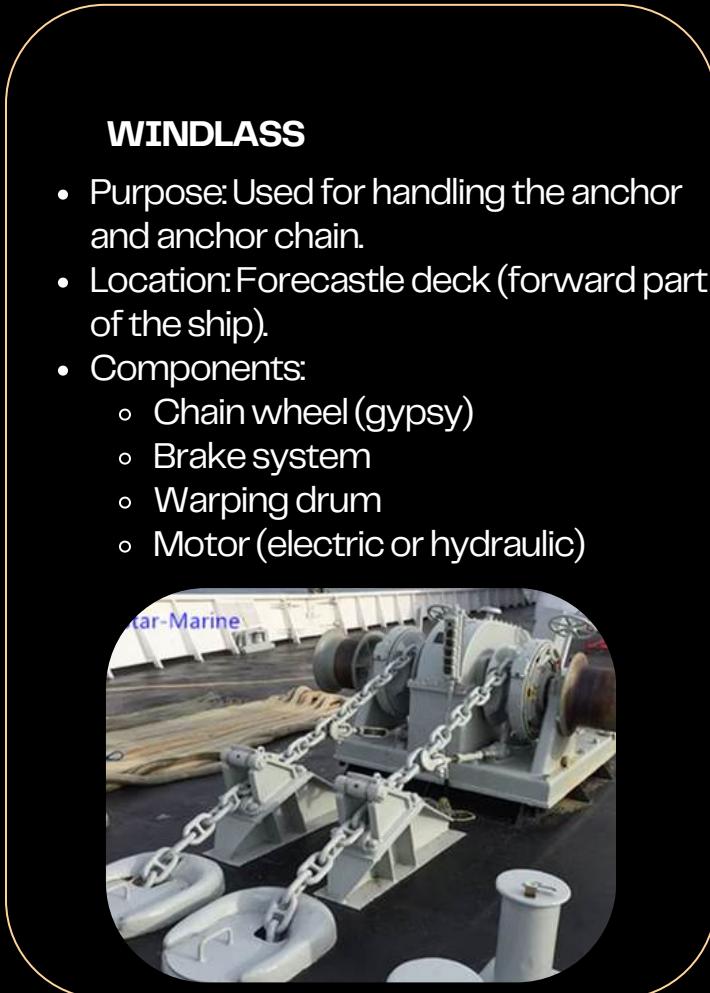
6. The motor is fitted with a thermal protection trip. When the motor windings get overheated, the trip will activate saving the motor winding from burning.

7. Load limit switch is also fitted which will trip the motor if the load to be lifted is above the crane capacity.

8. It's the responsibility of senior officers to operate the crane and to make sure all the personnel involved in any lifting operation are at a safe distance during the operation of the crane.

9. Additional tools like i-bolts, shackle, wire sling, belts etc. used for lifting must be checked before use.

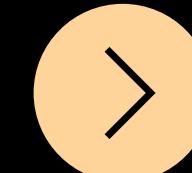
10. It should be noted that no one walks or stand below the crane when it is in loaded condition.

**WINDLASS**

- Purpose: Used for handling the anchor and anchor chain.
- Location: Forecastle deck (forward part of the ship).
- Components:
  - Chain wheel (gypsy)
  - Brake system
  - Warping drum
  - Motor (electric or hydraulic)

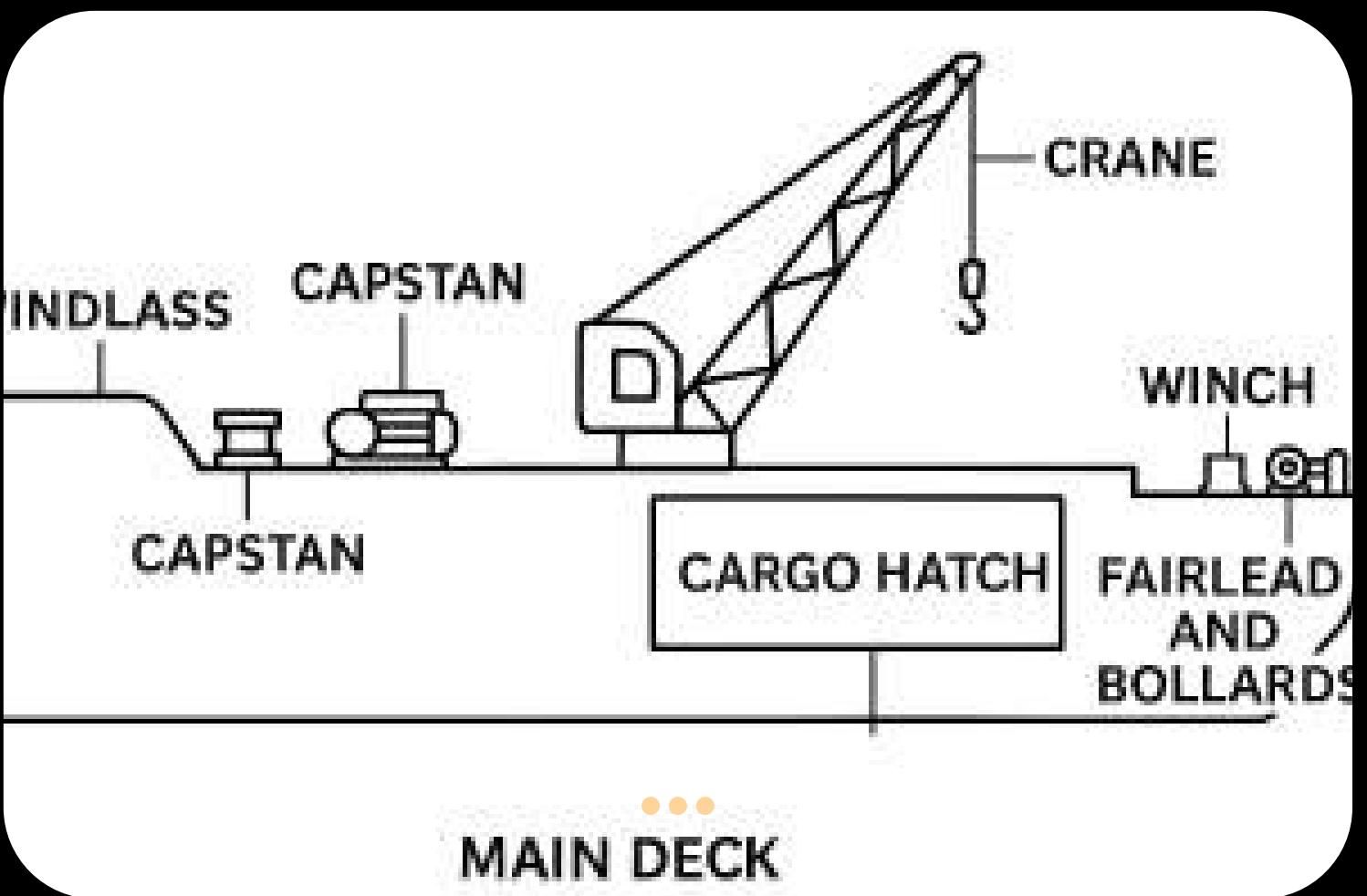
**CAPSTAN**

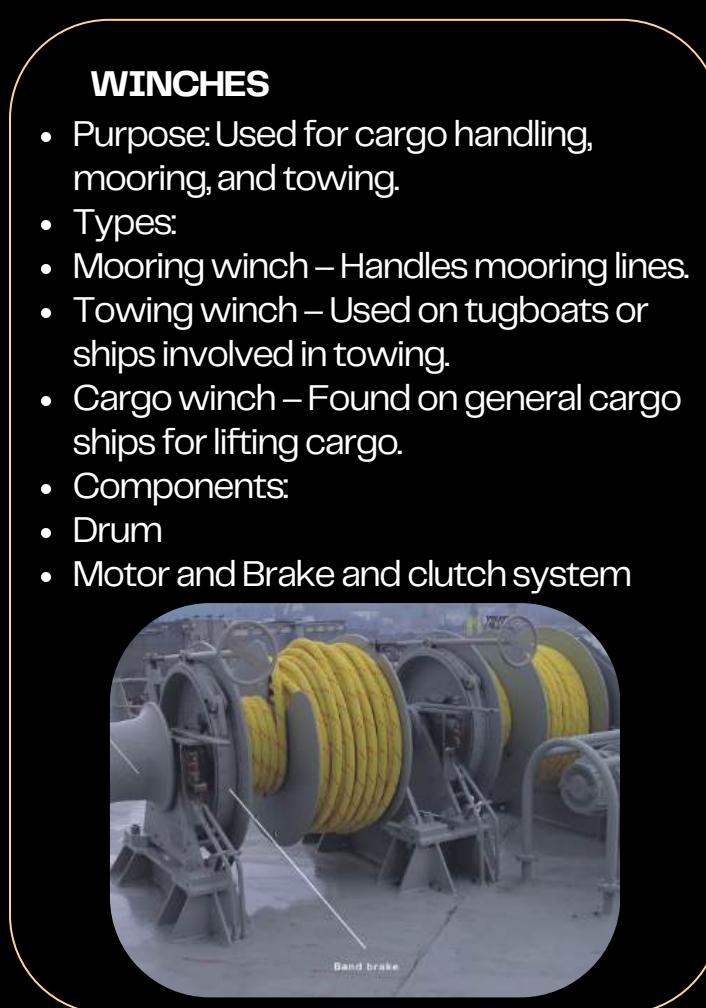
- Purpose: Used for mooring operations and handling ropes or cables.
- Location: Usually found on the aft deck.
- Features:
  - Vertical axis drum
  - Can be manually or power-operated



# DECK MACHINERIES

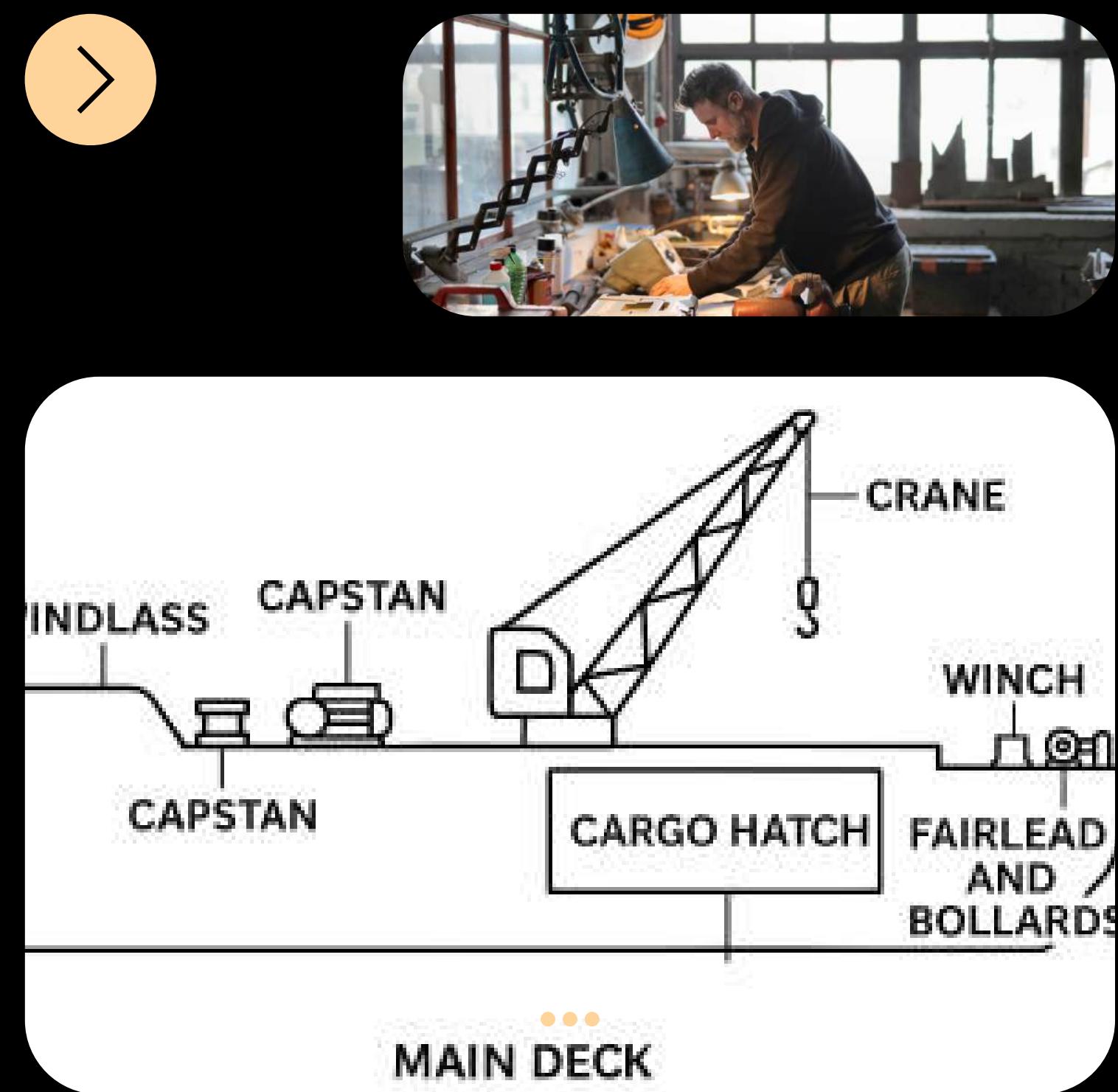
Deck machinery on board ships plays a crucial role in cargo handling, anchoring, mooring, and other essential operations. These machines are typically located on the main deck and are powered either hydraulically, electrically, or pneumatically.

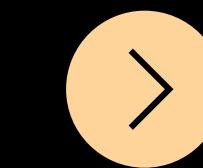
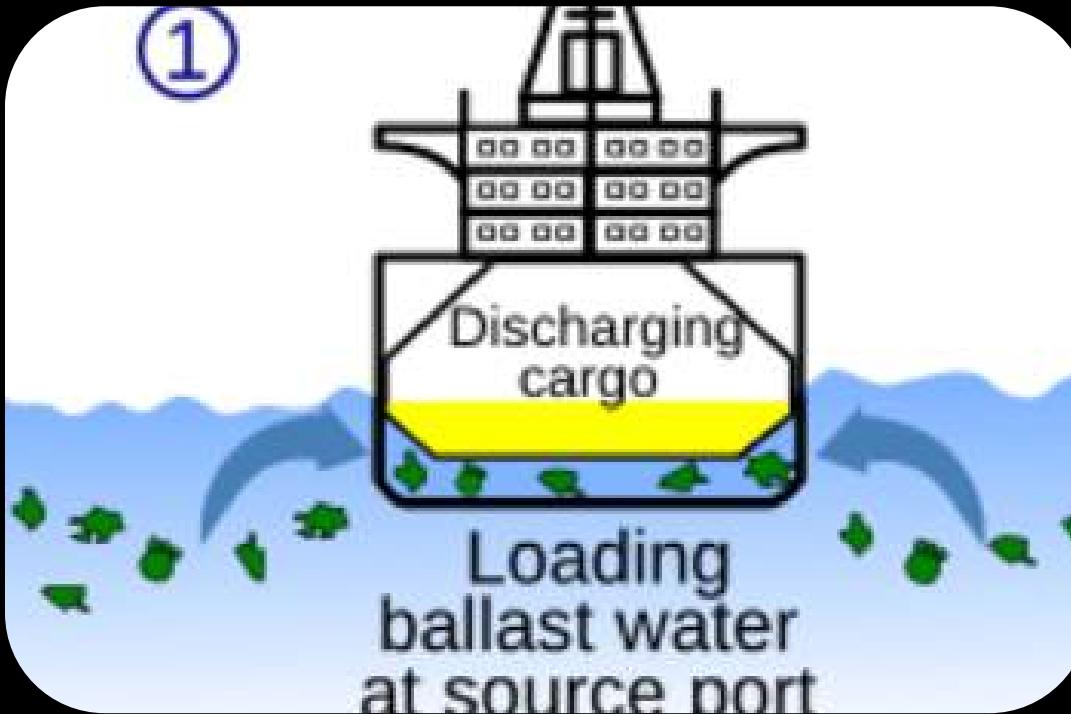




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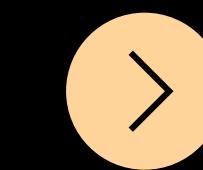
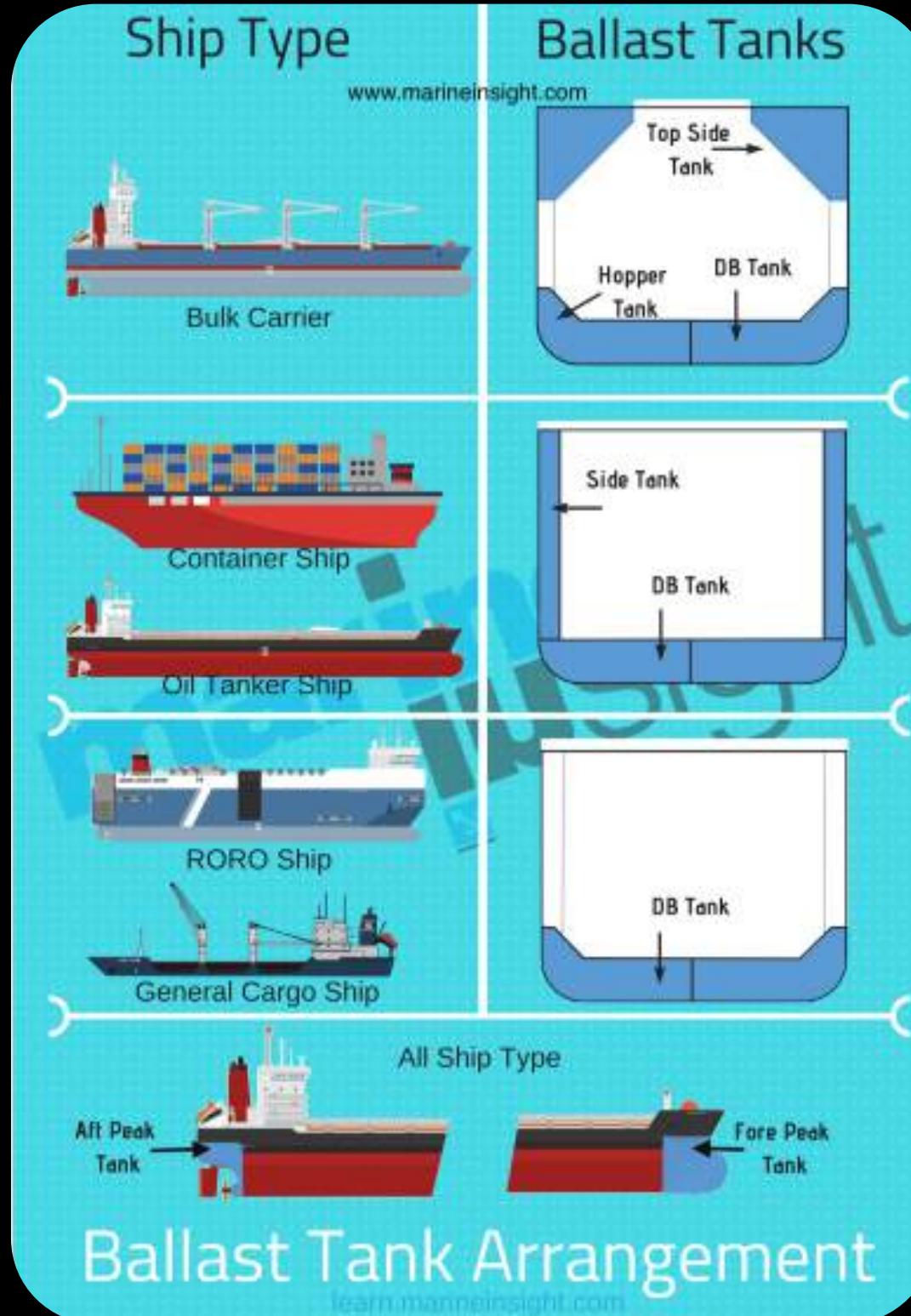
## Purpose of Ballast Operation

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- Stability: By adding or removing ballast water, ships can maintain proper stability, keeping them upright and preventing toppling.
- Trim and Draft Control: Ballast operations allow for adjusting the ship's waterline (draft) and the angle at which it sits in the water (trim) for optimal performance and safety during a voyage.
- Hull Stress Reduction: Ballasting helps to reduce the stress on the ship's hull by ensuring it is properly supported, especially in empty or partially loaded conditions.
- Improved Efficiency and Manoeuvrability: Adjusting the ship's weight distribution through ballasting can enhance its propulsion and make it easier to manoeuvre.
- Compensation for Weight Changes: As cargo, fuel, and water are consumed or loaded, ballast water is used to compensate for these changes, maintaining the ship's proper operating condition.
- Facilitating Cargo Operations: In port, ballasting can be used to adjust the trim and stability to improve the efficiency of loading and unloading cargo.

# BALLASTING OPERATION

Ballast or ballast water is sea water carried by a vessel in its ballast tanks to ensure its trim, stability and structural integrity. Ballast tanks are constructed in ships with piping system and high capacity ballast pumps to carry out the operation.



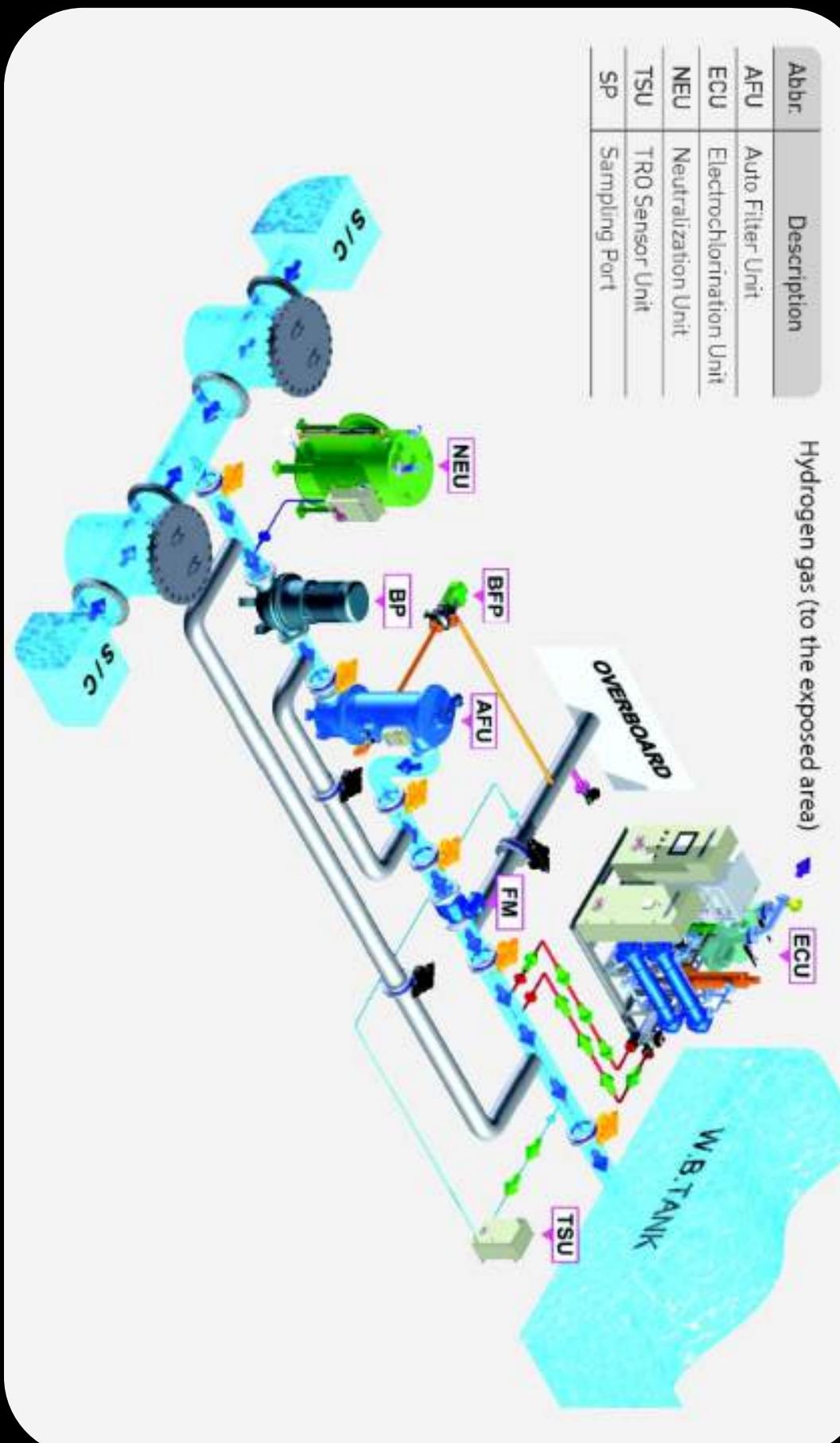
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## Different Forms of Ballasting and De-ballasting

- Transferring water between tanks using gravity.
- Ballasting or De-ballasting tanks from the sea using gravity.
- Ballasting the tanks using the ballast pump/pumps.
- De-ballasting the tanks using the ballast pump/pumps.
- De-ballasting the tanks using the stripping ejectors.



# BALLASTING OPERATION

Ballast or ballast water is sea water carried by a vessel in its ballast tanks to ensure its trim, stability and structural integrity. Ballast tanks are constructed in ships with piping system and high capacity ballast pumps to carry out the operation.

## BALLASTING AND DEBALLASTING KEY METHODS

- the ballast tanks: These are separated from each other but linked to each other through pipes and valves.
- the piping system: This system connects the tanks, the ballast pumps and other peripherals. You can choose which tanks you want to pump water in or out by opening the right valves.
- the high-capacity ballast pumps: These are used to pump water in and out of the ballast water tanks during loading, off-loading and other situations described above.



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# OIL WATER SEPARATOR

An oily water separator is a device used on ships to separate oil from water before discharging it overboard. Its importance lies in environmental protection and regulatory compliance. Ships generate oily water from various sources such as machinery leaks, fuel spills, and cleaning operations. If this oily water is discharged directly into the sea, it can harm marine life and ecosystems.

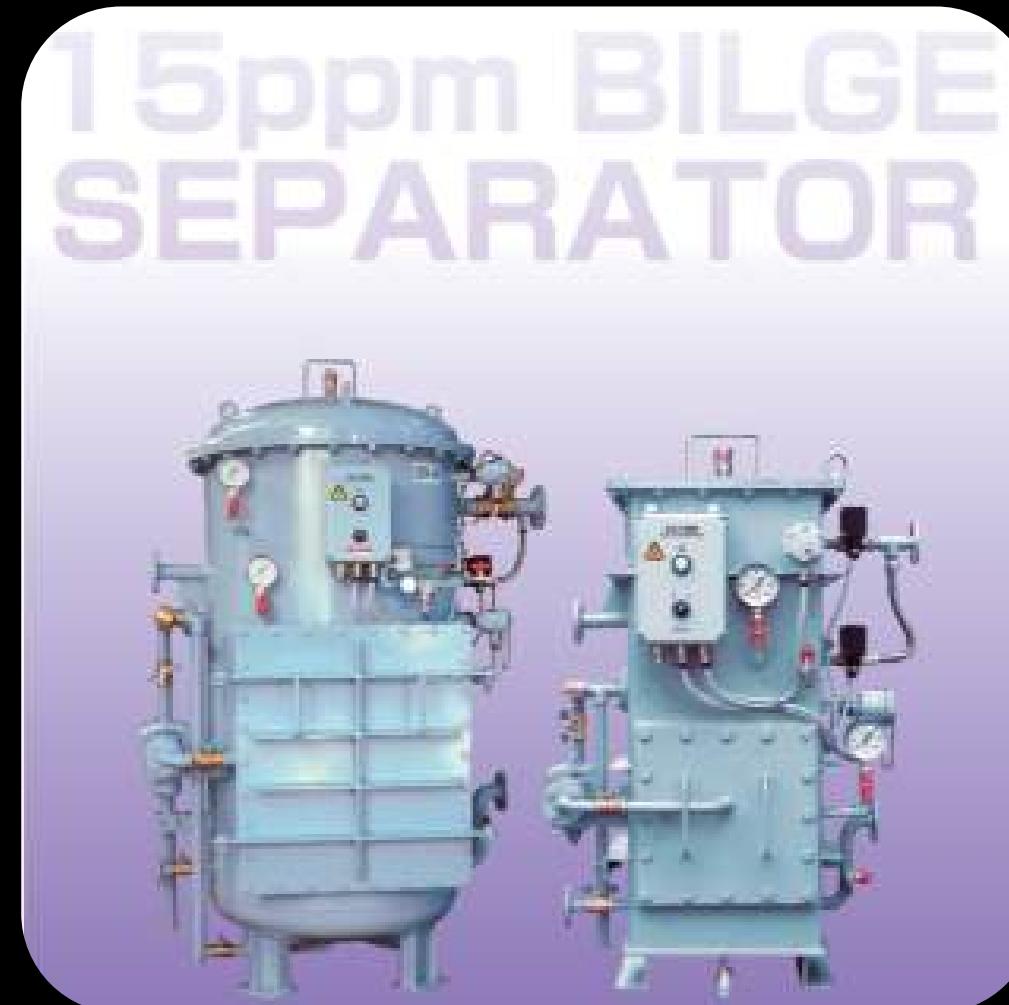
## REGULATORY REQUIREMENT

### MARPOL Annex I, Regulation 14

- Vessels required: Ships of 400 gross tonnage and above must be fitted with an OWS.
- Discharge limit: The oil content of the discharged mixture must not exceed 15 parts per million (ppm).
- Automatic functions: Ships of 10,000 gross tonnage and above must have additional alarms and an automatic stopping device that halts the discharge if the 15 ppm limit is exceeded.
- Discharge conditions: For ships of 400 gross tonnage and above, discharge is only permitted when the vessel is en route and not in a designated "Special Area".

### IMO Resolution MEPC.107(49)

- Applicability: These rules apply to ships constructed on or after January 1, 2005, or ships with new equipment installed on or after that date.
- Key components: It outlines the technical requirements for both the 15 ppm bilge separator and the 15 ppm bilge alarm.
- Testing and approval: Equipment must undergo specific type approval tests to ensure it can consistently produce an effluent with an oil content below 15 ppm, even when processing challenging emulsions.
- Tamper-proof design: The bilge alarm must be designed to be tamper-proof, including activating an alarm if fresh water is used for cleaning or zeroing.
- Sampling points: The guidelines require the installation of specific sampling points for inspection and for the bilge alarm. A sampling point for future inspections must be located in a vertical section of the effluent pipe.



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## REGULATORY REQUIREMENT

### MARPOL Annex I, Regulation 17 (Oil Record Book)

- Mandatory logs: Every vessel of 400 gross tonnage and above must maintain an Oil Record Book Part I (Machinery Space Operations).
- Required entries: All oil or sludge transfers and discharges must be logged accurately and immediately by the officer in charge.
- Inspections: The Oil Record Book is a primary document for inspections by Port State Control (PSC) authorities. Any falsification or inaccuracy can result in significant penalties.
- Retention period: The logbook must be kept on board for three years from the date of the last entry.

### Special Areas (MARPOL Annex I, Regulation 15)

- Zero discharge: In the Antarctic, any discharge of oil or oily mixture is completely prohibited.
- Specific restrictions: For other Special Areas, such as the Mediterranean or Baltic Sea, there are additional restrictions on bilge water discharge.



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## CONSTRUCTION AND OPERATION

### SEPERATOR UNIT:

The first stage uses catch plates and gravity (oil is less dense) to separate coarse oil, which rises into an oil collecting chamber. A heater may be incorporated to aid flow and separation. The water leaving this unit has an oil content of about 100 ppm. Separated oil is released to the sludge tank via a control valve.

### OIL CONTENT MONITORING(OCM):

continuously monitors the oil content (ppm). If the level is too high, it triggers an alarm. The Control Unit then operates a 3-way solenoid valve to divert the oily water discharge from going overboard to instead being sent back to the OWS sludge tank.

### FILTER UNIT:

- This unit cleans the water further through three stages:
- Filter Stage: Removes impurities and particles.
- Coalescer Stage: Induces coalescence, where small oil droplets join to increase their size, allowing them to rise more easily.
- Collecting Chamber: Collects the larger, separated oil molecules. The output must be less than 15 ppm to meet legal discharge criteria.



## MAINTENANCE AND TROUBLESHOOTING

### MAINTENANCE:

Includes daily visual checks for leaks/corrosion, routine inspections (cleaning coalescers/filters), calibration and testing of sensors (especially the OCM), and oil skimmer maintenance. All activities must be logged in ship's records.

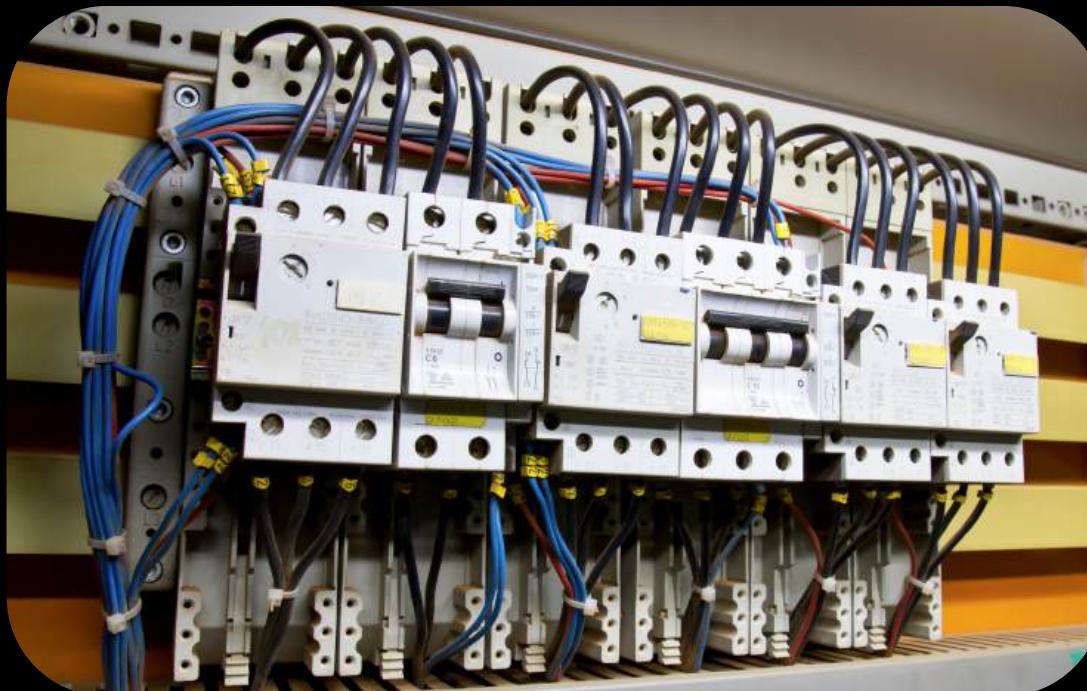
### TROUBLESHOOTING:

Common issues include excessive oil in the discharge (check filters/coalescers/settings), low separation efficiency (ensure operation within specs), and sensor malfunctions (check connections, fouling, and re-calibrate). Pump and system leaks must be addressed quickly.

# OIL WATER SEPARATOR

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# AUTOMATIC CONTROL



Deck cargo handling machinery, such as cranes, winches, and davits, are equipped with automatic safety controls to prevent accidents, equipment damage, and operational failures. These controls are crucial for safe and efficient maritime operations.

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## Tension Limits

- Purpose: Prevents excessive force in cables/ropes to avoid snapping or structural damage.
- Function: Sensors monitor tension; if exceeded, the system halts, reduces speed, or releases the line (e.g., on mooring winches).

## Weight Limits

- Purpose: Ensures the load does not exceed the equipment's Safe Working Load (SWL).
- Function: Load cells/strain gauges measure weight; if exceeded, the system automatically stops lifting and triggers an alarm (e.g., on cranes, davits).

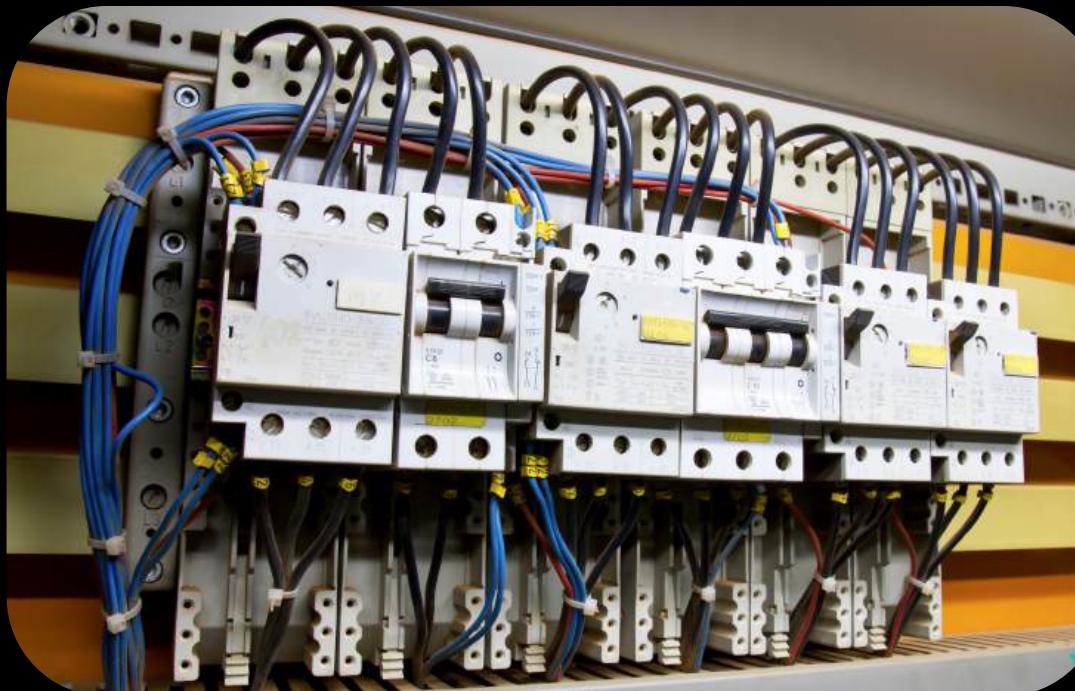
## Slewing Limits

- Purpose: Prevents the crane/boom from rotating beyond its safe operating angle.
- Function: Limit switches/encoders restrict movement to a programmed arc, stopping rotation if the limit is reached (to avoid collisions).

## Overpressure Limits

- Purpose: Protects hydraulic systems from pressure surges that could cause leaks or ruptures.
- Function: Pressure relief valves open to divert or bypass excess fluid back to the tank (e.g., in hydraulic winches).
- Temperature Limits
- Purpose: Prevents overheating of hydraulic oil, electric motors, or gearboxes.
- Function: Sensors monitor temperature; if exceeded, an alarm is triggered, and the system may shut down or reduce load.

# AUTOMATIC CONTROL



Deck cargo handling machinery, such as cranes, winches, and davits, are equipped with automatic safety controls to prevent accidents, equipment damage, and operational failures. These controls are crucial for safe and efficient maritime operations.



## Hydraulic Aggregate Systems Onboard

These are power systems where an electric motor drives a hydraulic pump to operate machinery:

- Electric/Hydraulic Windlass: Used for anchoring, featuring torque limiters and automatic brake engagement
- Electric/Hydraulic Mooring Winches: Features include automatic tension control, load monitoring, and emergency release systems.
- Boat Winches: Used for lifeboats/rescue boats, must comply with SOLAS regulations, including automatic braking and controlled speed.
- Hatch Cover Systems: Operated by hydraulics, incorporating overpressure valves and position sensors for safe closure.

# THANK

YOU

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Get In Touch



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MOL MAGSAYSAY MARITIME ACADEMY