SEAFARERS TRAINING CENTER INC

RATING FORMING PART OF A WATCH IN A MANNED ENGINE-ROOM OR DESIGNATED TO PERFORM DUTIES IN A PERIODICALLY UNMANNED ENGINE-ROOM

IN ACCORDANCE TO INTERNATIONAL CONVENTION ON STANDARDS OF TRAINING, CERTIFICATION AND WATCHKEEPING FOR SEAFARERS (STCW), 1978, AS AMENDED

SCOPE

This course aims to meet the mandatory requirements for knowledge, understanding and proficiency in table A-III/4 of the STCW Code for the function Marine Engineering.

OBJECTIVE

This syllabus covers the requirements of chapter III of the STCW Convention and A-III/4 of The STCW Code. This functional element provides the detailed knowledge to support the training outcomes related to Marine Engineering at the Support Level.

This Section provides the background knowledge and practical work to:

a. Contribute to safe engineering watch
b. Communicate with the officer of the watch , and
c. Use internal communication systems

ENTRY STANDARDS

The course is principally intended for candidates for certification as ratings forming part of watch in a manned engine-room or designated to perform duties in periodically unmanned engine room.

In preparing this course it has been assumed that entrants will have successfully completed a minimum period of full-time education of about 9 to 10 years up to secondary level.

COURSE CERTIFICATE

On successful completion of the course and assessment, document may be issued certifying that the holder has successfully completed a course of training that meets or exceeds the level of knowledge and competence specified in table A-III/4 of the STCW Code, for the function Marine Engineering at the Support level.

COURSE INTAKE LIMITATIONS

Training to acquire engineering skills in workshops will be planned and implement for a certain period of time. Staffing levels and how the timetable and utilization of premises can be arranged, other subjects may be studied in class sized of not more than 24 in order for the instructor to give adequate attention to individual trainees.

STAFF REQUIREMENTS

Instructor shall be qualified in the task for which training is being conducted and have appropriate training in instructional techniques and training methods

TEACHING FACILITIES EQUIPMENT

Suitable classrooms equipped with the relevant facilities the delivery of training through lecture, group exercises and discussion should be provided. Where the use of audiovisual material such as simulation, PowerPoint presentations, videos or slides is intended, it should be ensured that the appropriate multi-media equipment is made available

BIBLIOGRAPHY

- AuxiliaryMarineMachinery.pdf
- The enhancement of operational safety of engine room machinery th.pdf
- Evacuation routes prom machinery spaces – quantity, construction and layout.pdf
- International convention on standards of training, certification and watchkeeping for seafarers (STCW), 1978, as amended
- IMO Model Course 7.09 Rating forming part of a watch in a manned engine-room or designated to perform duties in a periodically unmanned engine-room

COURSE OUTLINE

Competence	Knowledge, understanding and proficiency	Training Hours	Lecture	Practical Hours
	Introduction to the course	**2.0**	1.0	1.0
1.1 a. Carry out a watch routine appropriate to the duties of rating forming part of an engine - room watch 1.1 b. Understand orders and be understood in matters relevant to wachkeeping duties	1.1.1 Minimum standard Maritime English at the Elementary Level (reference to IMO model course 3.17) to be able to understand orders and communicate with the officer of the watch in matters relevant to watchkeeping duties	**As per IMO model course 3.17**		
	1.1.2 Terms used in machinery spaces and names of machinery and equipment	**22.0**	4.0	18.0
	1.1.3 Engine-room watchkeeping procedures	**8.0**	2.0	6.0
	1.1.4 Safe working practices as related to engine-room operations	**8.0**	2.0	6.0
	1.1.5 Basic environmental protection procedures	**8.0**	4.0	4.0
	1.16 Use of appropriate internal communication system	**4.0**		4.0
	1.1.7 Engine – room alarm systems and ability to distinguish between the various alarms, with special references to fire -extinguishing gas alarm	**4.0**		4.0
1.2 Keep a boiler watch maintain the correct water levels and steam pressure	1.2.1 Keep a safe boiler watch a. Check boiler fuel combustion for normal b. ascertain the correct water level c. check steam pressures	**16.0**	4.0	12.0
1.3 Operate Emergency equipment and apply emergency procedures	1.3.1 Knowledge of emergency duties a. shipboard Oil Pollution Emergency Plan (SOPEP) b. procedures to follow in the event of oil spill	**8.0**	2.0	6.0
	1.3.2 Escape routes from machinery spaces	**8.0**		8.0

	1.3.3 Familiarity with the location and use of firefighting equipment in the machinery spaces	**4.0**		4.0
	End of course assessment	**2.0**	2.0	
	End of course briefing	**0.15 min**	0.15 min	
	Feedback	**0.20 min**	0.20 min	
	Evaluation:			
	a. Practical	**0.40 min**	0.40 min	
	b. Theoretical	**0.45 min**	0.45 min	
	Total Training hours	**96.0**	23.0	73.0

COURSE TIMETABLE

Period (2 hours)	Day 1	Day 2	Day 3	Day 4	Day 5
1ST	Introduction to the course	1.1.2 Terms used in machinery spaces and equipment	1.1.2 Terms used in machinery spaces and equipment	1.1.3 Engine - room watchkeeping procedures	1.1.4 Safe working practice as related to engine-room operations
BREAK					
2nd	1.1.2 Terms used in machinery spaces and equipment	1.1.2 Terms used in machinery spaces and equipment	1.1.2 Terms used in machinery spaces and equipment	1.1.3 Engine - room watchkeeping procedures	1.1.4 Safe working practice as related to engine-room operations
Meal Break					
3rd	1.1.2 Terms used in machinery spaces and equipment	1.1.2 Terms used in machinery spaces and equipment	1.1.2 Terms used in machinery spaces and equipment	1.1.3 Engine - room watchkeeping procedures	1.1.4 Safe working practice as related to engine-room operations
Break					
4th	1.1.2 Terms used in machinery spaces and equipment	1.1.2 Terms used in machinery spaces and equipment	1.1.2 Terms used in machinery spaces and equipment	1.1.3 Engine - room watchkeeping procedures	1.1.4 Safe working practice as related to engine-room operations

Period (2 hours)	Day 6	Day 7	Day 8	Day 9	Day 10
1ST	1.15 Basic environmental protection procedures	1.1.6 Use of appropriate internal communication	1.2.1 Keep a safe boiler watch a) Check boiler fuel combustion	1.2.1 Keep a safe boiler watch b) ascertain the correct water level	1.3.1 Knowledge of emergency duties

			for normal operation		
BREAK					
2nd	1.15 Basic environmental protection procedures	1.1.6 Use of appropriate internal communication	1.2.1 Keep a safe boiler watch a) Check boiler fuel combustion for normal operation	1.2.1 Keep a safe boiler watch b) ascertain the correct water level	1.3.1 Knowledge of emergency duties
Meal Break					
3rd	1.15 Basic environmental protection procedures	1.1.7 Engine - room alarm systems and ability to distinguish between the various alarms, with special reference to fire-extinguishing gas alarms	1.2.1 Keep a safe boiler watch a) Check boiler fuel combustion for normal operation	1.2.1 Keep a safe boiler watch c) check steam pressures	1.3.1 Knowledge of emergency duties
Break					
4th	1.15 Basic environmental protection procedures	1.1.7 Engine - room alarm systems and ability to distinguish between the various alarms, with special reference to fire-extinguishing gas alarms	1.2.1 Keep a safe boiler watch b) ascertain the correct water level	1.2.1 Keep a safe boiler watch c) check steam pressures	1.3.1 Knowledge of emergency duties

Period (2 hour)	Day 11	Day 12
1st	1.3.2 Escape routes from machinery spaces	1.3.3 Familiarity with the location and use of firefighting equipment in the machinery spaces
Break		
2nd	1.3.2 Escape routes from machinery spaces	1.3.3 Familiarity with the location and use of firefighting equipment in the machinery spaces
Meal Break		
3rd	1.3.2 Escape routes from machinery spaces	End of course assessment
Meal		
4th	1.3.2 Escape routes from machinery spaces	End of curse briefing feedback and evaluation

1. MARINE ENGINEERING AT THE SUPPORT LEVEL

About a century ago no one would have heard about a marine engineer, but today it is a profession which is as established as any other famous ones. Over the last 100 years, engineering as a field of study has developed and diversified far beyond what could have been imagined prior to this period. Not only this, it has also branched out into various specialized fields that have achieved great progress. Most of these new fields are aligned to any of the basic engineering branches like mechanical, electrical, civil, electronics, computers etc. and have something or the other incorporated from them. One such branch is called marine engineering.

Marine engineering is the branch of study that deals with the design, development, production and maintenance of the equipment's used at sea and on board sea vessels like boats, ships etc. As a matter of fact, it is quite a vast field and it also has many sister like naval architecture and nautical science.

A marine engineer is a professional who is responsible for the operation, maintenance and repair of all major mechanical and engineered equipment's on board a ship. There are many mechanical systems that help in the operations of any vessel like the propulsion mechanics, electricity and power generation system, lubrication, fuel systems, water distillation, lighting and air conditioning system etc. These are all included in the technical responsibilities of a marine engineer.

As stipulated in Rule III / 4 of the STCW Convention, all that is necessary to face the cameras in the machines or in the sea designated to perform the tasks in a machine room without a permanent connection, on board a sea-going vessel whose propulsion machine has a power equal to or greater than 750 kW, except for sailors who are receiving training and those whose tasks do not require specialization, have the proper qualifications to perform such tasks.

Once the course is finished, the student will be able to:

- Carry out a normal guard appropriate to the duties of a sailor who is part of the watch in the engine room.
- Understand the orders and be understood in everything that relates to the tasks related to the guard.
- Perform the boiler guard: maintain the steam pressures and the correct water levels.
- Operate emergency equipment and apply emergency procedures.

1.1. Watchkeeping routine and schedule

The engine seaman on ships perform their duties in rotation shifts, each with a fixed and equal number of hours. This work shift, also known as "guard", must be carried out efficiently to ensure the safety of life and the ship at sea.

The engine seaman can master the maintenance procedure in several ways; however, additional care must be taken while the guard is handed over to the officer who relieves it to ensure that the vessel continues to operate safely and normally.

Orders in the watchkeeping duties:

- Special instructions related to any ship operation, control system or maintenance work.
- Permanent orders of the Chief Engineer or the company
- Level of important tanks such as bilges, ballast tanks, sewage tanks, reserve tanks, slop tanks, fuel tanks, or any other tank that requires attention.

- Condition and condition of fire fighting equipment and systems, in case a specific section or fire alarm has been isolated
- Special mode of operation in case of emergency situation, breakdowns, special loads, ice, or shallow water, etc.
- In the event that some type of maintenance work is performed in the engine room by another machinery officer and crew member, information should be provided on the place where it will be worked, details of the machinery in maintenance and the person authorized and authorized crew. You must be informed of any potential danger due to ongoing maintenance work.
- In the event that a device that is failing or functioning incorrectly is produced, it must be informed about it.
- All controls already made when the ship leaves the port should be recorded. In case a check is pending, it must be transmitted to the official

- All checks carried out when the ship enters the port must be registered and informed in case one is missing.
- The condition and important information about the operation mode of the main motor, boiler and auxiliary motors must be informed
- In case of a team that needs to be manually monitored, details of it must be provided, together with the status of the monitoring and control equipment
- Any form of adverse condition of the boat must be informed
- Information should be provided on the status and modes of all important auxiliary machines, such as purifiers, fresh water generator, oily water separator, pumps, wastewater treatment plant, etc.

- If some important machinery does not receive attention during the watch, the relevant officer should be notified and take care of it.
- The condition and operating modes of the automatic controls of the boiler and other equipment related to the operation of the steam boiler must be provided
- The engineer officer must ensure that all important parameters relating to main and auxiliary machines are properly recorded in the log book of the engine room.

It is noteworthy that if the Machinist who delivers the guard feels that the relevant machinist is not in a position to carry out surveillance tasks efficiently, the former should not surrender the guard and inform the Chief Engineer.

Before Going Unmanned machinery space (UMS):

- Before going UMS, the Duty Engineer must ensure that all day service tanks for fuel, cylinder oil and header tanks for cooling water, lubricating oil, etc are full. An inspection of all active and operational machinery and systems in all the machinery spaces, particularly for fuel and lubricating oil leakage, is to be carried out. That the main engine is on bridge Control
- Check that all bilges and seawalls are empty.
- Test Oil Mist Detector alarm on M.E , test bilge wells High Levels Alarms , test Boiler High/Low/Cut out alarms where applicable
- Check that bilge pump is in auto position.
- Check that Emergency DG is in stand-by position.
- Check that Stand-by DG is on auto-start.
- Check that steering gear motors are in stand-by position.
- Check that all stand-by pumps are on auto-start.
- Check that OWS overboard valve is secured (OWS stopped when E/R unmanned and if not automatic discharge).
- Check that all fire loops are activated.
- Check whether all watertight and weather doors/openings are closed.
- Check that the Purifier Room and Steering Gear door is closed.
- Check cabin / public room’s alarms prior to the engine room being unmanned.
- Inform bridge and confirm UMS before leaving E/R
- Check that all flammable liquids are in sealed canisters.
- Check that all oil spills etc have been cleaned up.
- Check that all waste, rags and other cleaning materials are stowed away.

- Check that all Engine Room gear, spare parts etc are properly secured.
- Check that all alarms are active.
- Check that all fire detection sensors are active.
- Check that all fire doors are closed.
- Test the “Deadman” alarm and Engineer’s Call Alarms, ensuring they are sounding in public rooms, Bridge, Cargo Offices and appropriate cabins.

Entering / Leaving the Engine Room during Unmanned Period the Duty Engineer Officer must report to the Bridge when he is entering and leaving the Machinery Spaces. Whenever the duty engineer is required to enter the machinery spaces during UMS periods, including attendance for evening rounds and to respond to alarms, the “Deadman” alarm system is to be operated, where fitted. On vessels without a “Deadman” alarm system, the duty engineer must contact the bridge every 15 minutes to verify his safety. In the case of an alarm, the Duty Engineer Officer must verify the cause of the alarm, and take necessary measures to rectify the cause. If necessary he is to call another Engineer Officer. In the case of fire, flooding, serious machinery or electrical generation malfunction or similar threat to safety, the Duty Engineer Officer must call the Bridge and the Chief Engineer. Two full log entries of the engine room machinery parameters are to be made during the 8 hr. manned period, and one log entry for the unmanned period. The Chief Engineer is to issue standing instructions specific to the vessel detailing the operation of the machinery during the unmanned period. Means are to be adopted to ensure that entry into unmanned machinery spaces outside normal working hours is restricted to the Duty Engineer and any other persons as authorized by the Chief Engineer. Access doors are to carry appropriately worded "Entry Prohibited" signs indicating the times during which the special restrictions are applicable.

1.1.1. Minimum standard Maritime English at the Elementary Level (reference to IMO model course 3.17) to be able to understand orders and communicate with the officer of the watch in matters relevant to watchkeeping duties

Maritime English training can be divided into 4 main levels:

1. Basic Marine Vocabulary (BMV) that covers the introduction to shipping English.
2. Standard Marine Communication Phrases (SMCP) used by officers and crew dealing with navigation, safety communications, cargo operations and everything used for work of the deck department and engine department
3. English used by engineers and crew dealing with the main and auxiliary engines, the electric, the electronics, operations and maintenance and everything used for work of the engineering department (on board communications).
4. Maritime English used by administrative officers and those concerned with the commercial business of the merchant marine, Maritime Law procedures, insurance

Basic Marine Vocabulary (BMV)

This is an introductory stage that requires cadet officers/navigators to learn and be skillful in recognizing the basic operations of the vessel, ship terminologies, ship functions and safety procedures. Among the topics covered in this stage are:

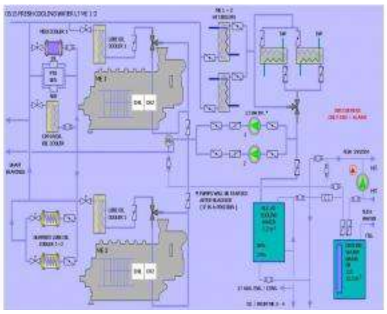
a. Parts of ship
b. Types of ship
c. Names and functions of equipment on board of merchant ship

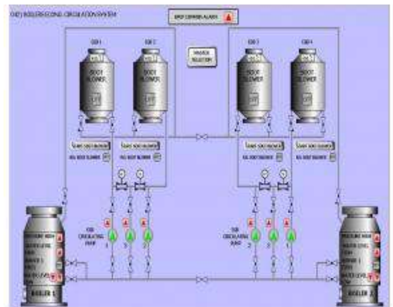
d. Routine operations on board such as bunkering, alongside, maintenance, loading and unloading of cargo, watch-keeping, mustering and etc.
e. Ship movement and directions
f. Basic ship communication in English
g. Ship organization
h. Duties and responsibilities on board

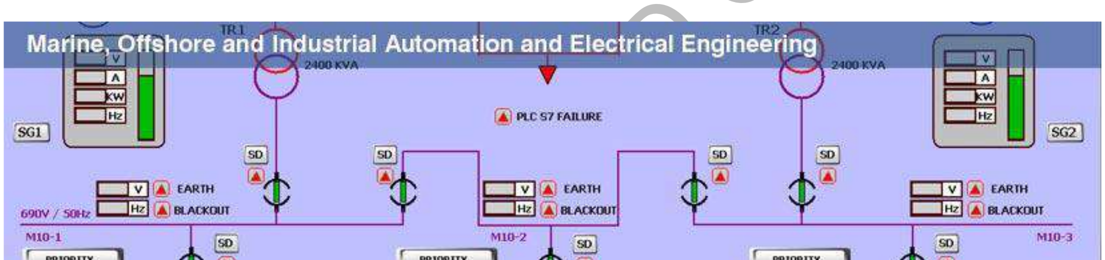
Suffice to mention here that the specialty of this stage lies on the emphasis of the trainers to review previously taught English language skills/lessons so that a common platform will be formulated for 'basic English proficiency'. In other words, at this stage, the trainer will ensure that cadet officers are capable of performing fundamental English skills such as listening to main ideas and specific details (listening), provide appropriate responses and explanation to questions (speaking) question and sentence construction (oral and written), tenses and subject-verb agreement (grammar) and paragraphing (essay composition).

1.1.2. Terms used in machinery spaces and names of machinery and equipment

- Auxiliary Marine Machinery: is designed to ensure the proper functioning of a ship's main engines, piping systems, and equipment. Auxiliary marine machinery includes pumps, compressors, and blowers for circulating fuel and the fresh water and seawater used in cooling systems, for supplying air to the starting system of the main engine, for cooling refrigerated holds, and for air-conditioning various parts of the ship and for refrigeration machinery. Auxiliary marine machinery also includes separators for removing water and other contaminants from fuel and oil, steering machinery, capstans, windlasses, winches for anchoring, mooring, and cargo loading, and cranes. Other items include heat exchangers used to condense vapors and to heat and cool working fluids, such as water, oil, and air, filters for the seawater and fuel supplies, and separators for bilge water.







Marine auxiliary machinery - various installations on board

Ships are large, complex vehicles which must be self-sustaining in their environment for long periods with a high degree of reliability. A ship is the product of two main areas of skill, those of the naval architect and the marine engineer. The naval architect is concerned with the hull, its construction, form, habitability and ability to endure its environment. The marine engineer is responsible for the various systems which propel and operate the ship. More specifically, this means the machinery required for propulsion, steering, anchoring and ship securing, cargo handling, air conditioning, power generation and its distribution. Some overlap in responsibilities occurs between naval architects and marine engineers in areas such as propeller design, the reduction of noise and vibration in the ship's structure, and engineering services provided to considerable areas of the ship. A ship might reasonably be divided into three distinct areas: the cargo-carrying holds or tanks, the accommodation and the machinery space. Depending upon the type each ship will assume varying proportions and functions. An oil tanker, for instance, will have the cargo-carrying region divided into tanks by two longitudinal bulkheads and several transverse bulkheads. There will be considerable quantities of cargo piping both above and below decks.

The general cargo ship will have various cargo holds which are usually the full width of the vessel and formed by transverse bulkheads along the ship's length. Cargo handling equipment will be arranged on deck and there will be large hatch openings closed with steel hatch covers. The accommodation areas in each of these ship types will be sufficient to meet the requirements for the ship's crew, provide a navigating bridge area and a communications center. The machinery space size will be decided by the particular machinery installed and the auxiliary equipment necessary. A passenger ship, however, would have a large accommodation area, since this might be considered the 'cargo space'. Machinery space requirements will probably be larger because of air conditioning equipment, stabilizers and other passenger related equipment.

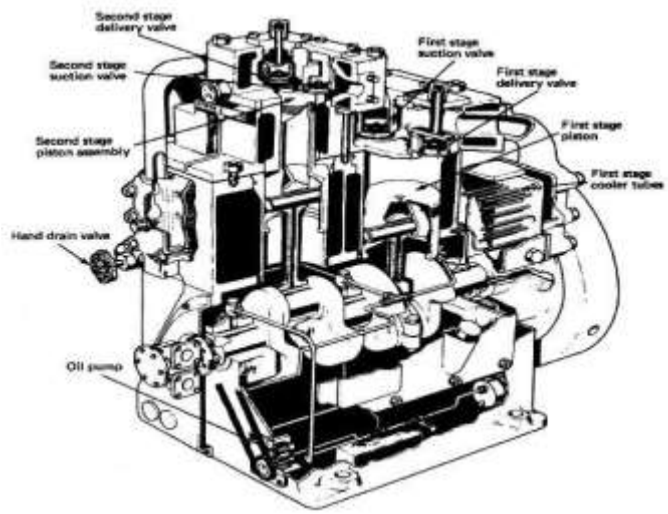
- Machinery arrangement

Three principal types of machinery installation are to be found at sea today. Their individual merits change with technological advances and improvements and economic factors such as the change in oil prices. It is intended therefore only to describe the layouts from an engineering point of view. The three layouts involve the use of direct-coupled slow-speed diesel engines, medium-speed diesels with a gearbox, and the steam turbine with a gearbox drive to the propeller. A propeller, in order to operate efficiently, must rotate at a relatively low speed. Thus, regardless of the rotational speed of the prime mover, the propeller shaft must rotate at about 80 to 100 rev/min. The slow-speed diesel engine rotates at this low speed and the crankshaft is thus directly coupled to the propeller shafting. The medium-speed diesel engine operates in the range 250—750 rev/min and cannot therefore be direction coupled to the propeller shaft. A gearbox is used to provide a low-speed drive for the propeller shaft. The steam turbine rotates at a very high speed, in the order of 6000 rev/min. Again, a gearbox must be used to provide a low-speed drive for the propeller shaft,

- Air compressor arrangement - working principles and operational guideline

Compressed air has many uses on board ship, ranging from diesel engine starting to the cleaning of machinery during maintenance. The air pressures of 25 bar or more are usually provided in multi-stage machines. Here the air is compressed in the first stage, cooled and compressed to a higher pressure in the next stage, and so on. The two-stage crank machine is probably the most common. Air is drawn in on the suction stroke through the first-stage suction valve via the silencer/filter. The suction valve closes on the piston upstroke and the air is compressed. The compressed air, having reached its first-stage pressure, passes through the delivery valve to the first-stage cooler. The second-stage suction and compression now take place in a similar manner, achieving a much higher pressure in the smaller, second-stage cylinder.

After passing through the second-stage delivery valve, the air is again cooled and delivered to the storage system. The machine has a rigid crankcase which provides support for the three crankshaft bearings. The cylinder block is located above and replaceable liners are fitted in the cylinder block. The running gear consists of pistons, connecting rods and the one-piece, two-throw crankshaft.



Two stage air compressor

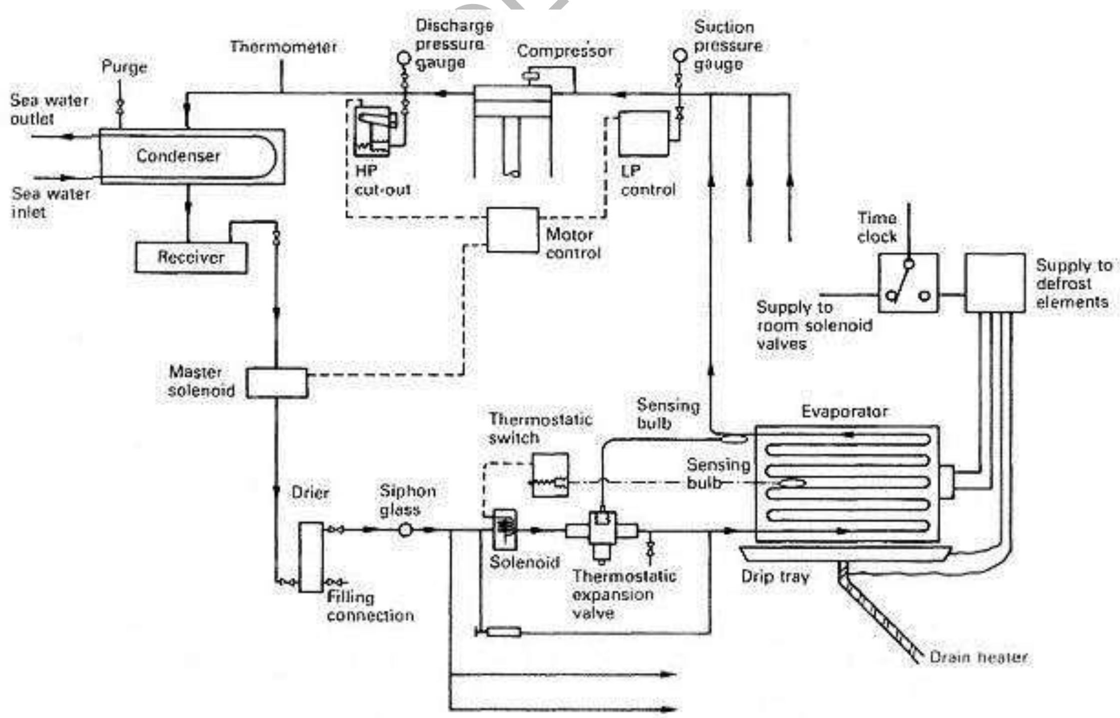
The first-stage cylinder head is located on the cylinder block and the second-stage cylinder head is mounted on the first: each of the heads carries its suction and delivery valves. A chain-driven rotary-gear pump provides lubricating oil to the main bearings and through internally drilled passages in the crankshaft to both connecting rod bearings. Cooling water is supplied either from an integral pump or the machinery space system. The water passes into the cylinder block which contains both stage coolers and then into the first and second stage cylinder heads. A water jacket safety valve prevents a build-up of pressure should a cooler tube burst and compressed air escape. Relief valves are fitted to the first and second-stage air outlets and are designed to lift at 10% excess pressure. A fusible plug is fitted after the second-stage cooler to limit delivered air temperature and thus protect the compressed-air reservoirs and pipework. Cooler drain valves are fitted to compressors. When these are open the machine is 'unloaded' and does not produce compressed air. A compressor when started must always be in the unloaded condition. This reduces the starting torque for the machine and clears out any accumulated moisture in the system. This moisture can affect lubrication and may produce oil/water emulsions which line the air pipelines and could lead to fires or explosions.

To stop the compressor, the first and second-stage cooler drain valves should be opened and the machine run unloaded for two to three minutes. This unloaded running will clear the coolers of condensate. The compressor can now be stopped and the drains should be left open. The cooling water should be isolated if the machine is to be stopped for a long period. Automatic compressor operation is quite usual and involves certain additional equipment. An unloader must be fitted to ensure the machine starts unloaded, and once running at speed will load' and begin to produce compressed air. Various methods of unloading can be used but marine designs favour either depressors which hold the suction valve plates on their seats or a bypass which discharges to suction. Automatic drains must also be fitted to ensure the removal of moisture from the stage coolers. A non-return valve is usually fitted as close as possible to the discharge valve on a compressor to prevent return air flow: it is an essential fitting where unloaders are used.

- Refrigeration system for cargo ships

Refrigeration process for cargo spaces and store rooms Refrigeration is a process in which the temperature of a space or its contents is reduced to below that of their surroundings. Refrigeration of cargo spaces and storerooms employs a system of components to remove heat from the space being cooled. This heat is transferred to another body at a lower temperature. The cooling of air for air conditioning entails a similar process. Refrigerated cargo vessels usually require a system which provides for various spaces to be cooled to different temperatures. The arrangements adopted can be considered in three parts: the central primary refrigerating plant, the brine circulating system, and the air circulating system for cooling the cargo in the hold.

An automatic direct expansion refrigeration system is shown in Figure below. The refrigerant flow through the chiller splits into four circuits, each with its own expansion valve. The four circuits are used to control the amount of evaporator surface, depending on the degree of condenser loading at the time, thus giving greater system flexibility. The large oil separator is a feature of screw compressor plants and the circuit for oil return is shown in the illustration. Each primary refrigerant circuit has its own evaporator within the brine chiller which results in totally independent gas systems. There will probably be three such systems on a cargo or container ship installation. Since they are totally independent each system can be set to control the outlet brine at different temperatures. Each brine temperature is identified by a colour and will have its own circulating pump. The cold brine is supplied to the cargo space air cooler and the flow of this brine is controlled by the temperature of the air leaving the cooler. The cooler in the cargo space is arranged for air circulation over it and then through the cargo before returning. An arrangement of fans and ducting direct the air to the cooler and below the cargo. The cargo is stacked on gratings which allow the passage of cooled air up through the cargo.



For small refrigerated cargo spaces or provision rooms a direct expansion primary refrigerant system may be used. The twin circuit arrangement for each cooler (evaporator) provides flexibility and duplication in the event of one system failing. The back pressure valve maintains a minimum constant pressure or temperature in the evaporator when working a space in high-temperature conditions to prevent under-cooling of the cargo. If one space is operating at a low-temperature condition at the same time the back pressure valve would be bypassed. The liquid cooler illustrated in the diagram is necessary where an abnormal high static head has to be overcome between the machinery and the coolers. In this vessel the liquid is sub-cooled to prevent it flashing off before reaching the thermostat expansion valve

Vessels designed for specific refrigerated container trades have built-in ducting systems. These can be in two forms: a horizontal finger duct system in which up to 48 containers are fed from one cooler situated in the wings of the ship or, alternatively, a vertical duct system in which each stack of containers has its own duct and cooler. This type of system is employed for standard containers having two port holes in the wall opposite the loading doors. Air is delivered into the bottom opening and, after passing through a plenum, rises through a floor grating over the cargo and returns via another section of the plenum to the top port. The connection between the duct arid containers is made by couplings which are pneumatically controlled.

- Coolers

Coolers at sea Coolers at sea fall into two groups, shell and tube type coolers and the plate type. Both are considered below. Shell and tube type coolers in the shell and tube design a tube bundle or stack is fitted into a shell. The end plates are sealed at either end of the shell and provision is made at one end for expansion. The tubes are sealed into the tube plate at either end and provide a passageway for the cooling liquid. Headers or water boxes surround the tube plates and enclose the shell. They are arranged for either a single pass or, for a double pass of cooling liquid. The tube bundle has baffles fitted which serve to direct the liquid to be cooled up and down over the tubes as it passes along the cooler. The joint arrangements at the tube plate ends are different. At the fixed end, gaskets are fitted between either side of the tube plate and the shell and end cover. At the other end, the tube plate is free to move with seals fitted either side of a safety expansion ring. Should either liquid leak past the seal it will pass out of the cooler and be visible. There will be no intermixing or contamination.

- Plate type heat exchangers
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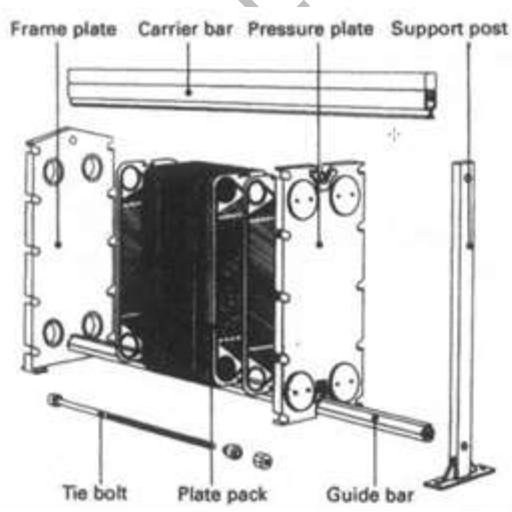
The plate-type heat exchanger is made up of a number of pressed plates surrounded by seals and held together in a frame. The inlet and outlet branches for each liquid are attached to one end plate. The arrangement of seals between the plates provides passageways between adjacent plates for the cooling liquid and the hot liquid. The plates have various designs of corrugations to aid



heat transfer and provide support for the large, flat surface. A double seal arrangement is provided at each branch point with a drain hole to detect leakage and prevent intermixing or contamination.

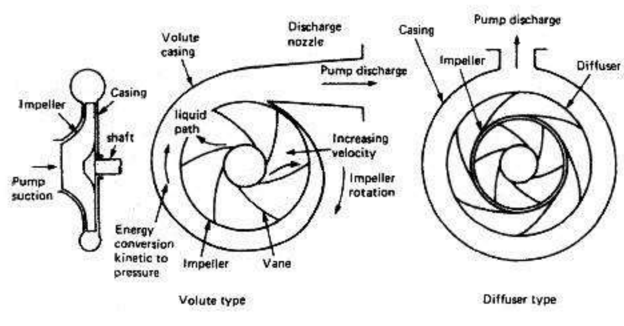
- Centrifugal pumps

Centrifugal pump principles and working procedure

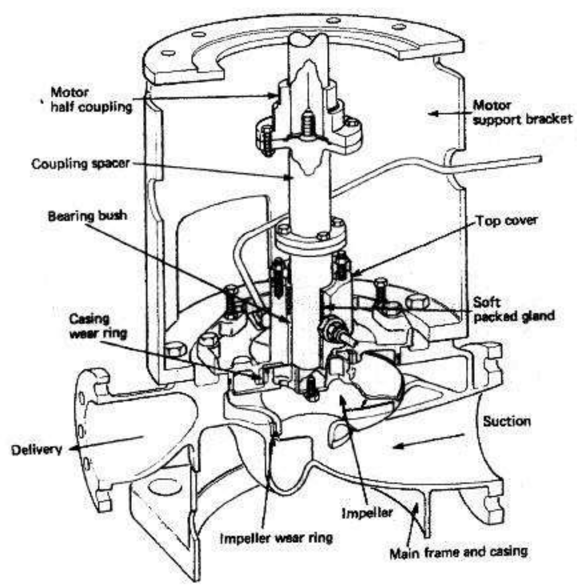
A pump is a machine used to raise liquids from a low point to a high point. In a centrifugal pump liquid enters the center or eye of the impeller and flows radially out between the vanes, its velocity being increased by the impeller rotation. A diffuser or volute is then used to convert most of the kinetic energy in the liquid into pressure. The arrangement of a centrifugal pump is shown diagrammatically in figure below A vertical, single stage, single entry, centrifugal pump for general marine duties is shown in Figure here. The main frame and casing, together with a motor support bracket, house the pumping element assembly. The pumping element is made up of a top cover, a pump shaft, an impeller, a bearing bush and a sealing arrangement around the shaft.

The sealing arrangement may be a packed gland or a mechanical seal and the bearing lubrication system will vary according to the type of seal. Replaceable wear rings are fitted to the impeller and the casing.

Centrifugal pumping operation



The motor support bracket has two large apertures to provide access to the pumping element, and a coupling spacer is fitted between the motor and pump shaft to enable the removal of the pumping element without disturbing the motor.



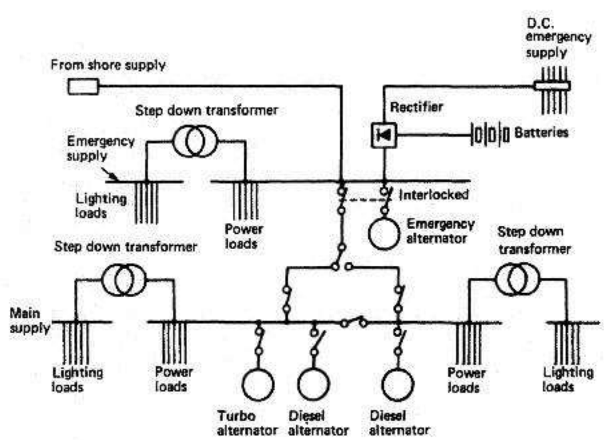
Single entry centrifugal pump

A diffuser is fitted to high-pressure centrifugal pumps. This is a ring fixed to the casing, around the impeller, in which there are passages formed by vanes. The passages widen out in the direction of liquid flow and act to convert the kinetic energy of the liquid into pressure energy. Hydraulic balance arrangements are also usual. Some of the high-pressure discharge liquid is directed against a drum or piston arrangement to balance the discharge liquid pressure on the impeller and thus maintain it in an equilibrium position.

- Emergency power supply for ships machinery operation

Use of emergency generator In the event of a main generating system failure an emergency supply of electricity is required for essential services. This can be supplied by batteries, but most merchant ships have an emergency generator. The unit is diesel driven and located outside of the machinery space. The emergency generator must be rated to provide power for the driving motors of the emergency bilge pump, fire pumps, steering gear, watertight doors and possibly fire fighting equipment. Emergency lighting for occupied areas, navigation lights, communications systems and alarm systems must also be supplied. Where electrical control devices are used in the operation of main machinery, these too may require a supply from the emergency generator.

A switchboard in the emergency generator room supplies these various loads. It is not usual for an emergency generator to require paralleling, so no equipment is provided for this purpose. Automatic startup of the emergency generator at a low voltage value is usual on modern installations.



Distribution system

Emergency Generator Operation to ensure reliable operation in the event of an emergency, the emergency generator/alternator set, if fitted, is to be run up (on load if possible) weekly. Prior to this test, oil, water and fuel levels must be checked. Where possible, the prime mover is to be started by a simulated power failure. These tests and their results are to be recorded in the Engine Room Log Book. Tests should include: - Starting by alternative means such as back up batteries, hydraulic or hand starters - recorded at least bi-weekly.

Interlocks, if fitted, such as to cooling flaps should be checked at this time.

Where a load test requires the emergency switchboard to be blacked out, this should be carried out at least once every 3 months. This will involve blackout of the ESB by manually disconnecting it from the MSB and observing the auto start and paralleling sequence. "Black-out Tests" must be subject to a risk assessment and critical operations checklist to ensure all electronic equipment connected to the ESB is properly shut down prior to the blackout, and that any other risks have been assessed. The test should be carried out alongside or at anchor.

Once running, the generator load should be increased to the maximum practical load for at least 15 minutes and all electrical load, relevant temperature and pressure readings records. All maintenance carried out on emergency generator sets is to be in accordance with the manufacturer's instructions. Suitable frost precautions must be taken with water cooled engines. On air-cooled engines the air path is to be maintained unrestricted with venting arrangements clear of obstruction and free to operate. Any faults or defects in the emergency generator/alternator, its prime mover and associated equipment, must be rectified and immediately reported to the appropriate management office. Where the above requirement cannot be complied with the shore advice must be consulted and a suitable alternative procedure developed.

- Auxiliary Engines (Diesel Alternator)

The engines used to drive the generators/alternators are the vessels primary source of power. This must always be taken into account in establishing priorities with regard to the operation, maintenance, and ordering of spares. It is essential that the manufacturer's instructions are closely followed with regard to maintenance and overhaul of critical components such as connecting rods, bottom end bolts, shell bearings, pistons. All maintenance, overhauls and repairs must be fully and accurately recorded. Any accidental over speed, overheating, blackout or major failure must be notified to the relevant Management office. During "Standby" for maneuvering periods, a minimum of two generators/alternators are to be on load.

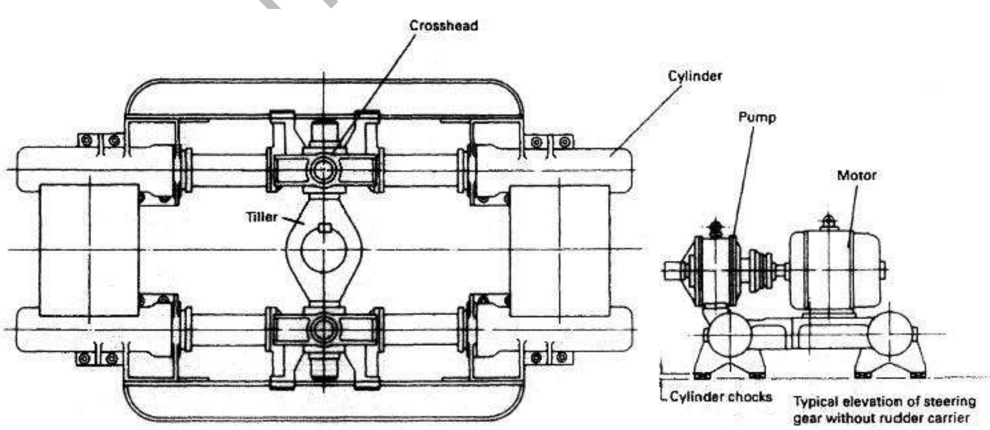
The instructions given for main machinery are also applicable to auxiliary engines, generally the routine inspections must be carried out at much more frequent periods. The crankcase inspection is most important and must be carried out after a machine is shut down following a long run. Maintenance completed on the diesel generators is to be recorded on the "Maintenance Report Diesel Generators". The lubricating oil in the engine system must be treated with the same care as the oil in the main engine system but with auxiliary engines there is usually more risk of fuel contamination and special care must be given in this respect. Oil cleaning arrangement such as filters or similar equipment must be kept in use the whole time the engine is working. If for any reason this equipment is not kept in use while an engine is running a note must be made in the log book that the equipment was not used and the reason given for not using it. The auxiliary diesel engine alarms and shutdowns are to be tested at monthly intervals and the relevant details noted in the Work Book. An entry should be made in the Machinery Log Book whenever such tests have been carried out.

Consulted regarding the deck requirements in port. The reduction in the number of auxiliary engines will not only result in fuel saving but primarily a reduction in auxiliary maintenance and will allow better engine performance. It must be stressed that in emergency situations, the possibility of a blackout must not delay the decision to shut down dangerous machinery. When the vessel is in confined waters the above should not apply as enough auxiliary engines should be run to provide an ample supply of power to cope with any such emergency. When not being maintained, all non-running engines should be kept in STAND BY condition to allow quick starting in cases of emergency. Regular checks should be made by an Engineer Officer to ensure that the cylinders of these engines are clear of water or fuel. Diesel engines should be barred over once a day. Serious damage may be caused by water leaking from defective turbo-blower casings into the cylinders via the exhaust manifolds. Water accumulation may also occur from leaking cylinder heads or cylinder liners. Fuel may also accumulate from leaking fuel combustion equipment. Drain cocks in exhaust and inlet manifolds are to remain open when machines are at rest and should be regularly tested and proved clear of blockages, especially prior to stopping machines. Every month, each main diesel generator is to be load tested and figures recorded. The load test is to be carried out at the maximum sustainable load, the limits being taken from the parameters in the maker's manual. This load is to be maintained for one hour before readings are taken.

During the load test, the engine should be brought up to 100% load for a few seconds, or long enough to prove that it can sustain this power/frequency during starting of machinery or in an short term emergency. If the continuous load achieved is less than 90% of the rated load of the engine, or the 100% test is not possible then an explanation must be sent to the superintendent with the reason for the low load achieved, and clearly stating which the limiting parameter is and with a plan to correct the situation. Either mechanical indicators, peak pressure gauges or ideally, electronic indicators should be used to record cylinder conditions. It is essential that power balance between cylinders is maintained by proper analysis of cylinder conditions and that maintenance and adjustments are carried out to maintain operating conditions as close as possible to the design figures. Results should be compared to the previous set of results and to the test bed (shop trial) results in order to determine if adjustments or maintenance are required. During the load test, attention should be paid to the electrical power factor (i.e reactive load) balance achieved by all of the generators on load as this gives a good indication of the condition of the AVR's. A monthly report on the "Auxiliary Machinery" should be completed and returned to the Managing Office.

- Steering gear

Ships steering gear information every ocean going cargo ship need to be provided with a main steering gear and an auxiliary steering gear unless the main steering gear comprises two or more identical power units. The main steering gear is to be capable of putting the rudder over from 35° on one side to 35° on the other side with the ship at its deepest draft and running ahead at maximum service speed, and under the same conditions from 35° on either side to 30° on the other side in not more than 28 seconds. It is to be power operated where necessary to meet the above conditions and where the stock diameter exceeds 120mm. The auxiliary steering gear is to be capable of putting the rudder over 15° on one side to 15° on the other side in not more than 60 seconds with the ship at its deepest draft and running ahead at half the maximum service speed or 7 knots whichever is greater. Power operated auxiliary steering gear is required if necessary to meet the forgoing requirement or where the rudder stock diameter exceeds 230 mm.



Typical 4 ram steering gear arrangement for cargo ships

Steering gear control for power operated main and auxiliary steering gears is from the bridge and steering gear compartment, the auxiliary steering gear control being independent of the main steering gear control (but not duplication of the wheel or steering lever). Steering gear on ocean-going ships is generally of the electro-hydraulic type. Where the rudder stock is greater than 230 mm an alternative power supply is to be provided automatically from the ship's emergency power supply or from an independent source of power located in the steering gear compartment. The steering gear provides a movement of the rudder in response to a signal from the bridge. The total system may be considered made up of three parts, control equipment, a power unit and a transmission to the rudder stock. The control equipment conveys a signal of desired rudder angle from the bridge and activates the power unit and transmission system until the desired angle is reached. The power unit provides the force, when required and with immediate effect, to move the rudder to the desired angle. The transmission system, the steering gear, is the means by which the movement of the rudder is accomplished.

Steering gears can be arranged with hydraulic control equipment known as a 'telemeter', or with electrical control equipment. The power unit may in turn be hydraulic or electrically operated. Each of these units will be considered in turn, with the hydraulic unit pump being considered first. A pump is required in the hydraulic system which can immediately pump fluid in order to provide a hydraulic force that will move the rudder. Instant response does not allow time for the pump to be switched on and therefore a constantly running pump is required which pumps fluid only when required. A variable delivery pump provides this facility. Generally, work should not be done on steering gear when a ship is under way. If it is necessary to work on steering gear when the vessel is at sea, the ship should be stopped and suitable steps taken to immobilize the rudder by closing the valves on the hydraulic cylinders or by other appropriate and effective means.

- Engine room safety

Safety precautions Merchant Shipping regulations require every dangerous part of a ship's machinery to be securely guarded unless it is so positioned or constructed that it is as safe as if it were securely guarded or is otherwise safeguarded. All steam pipes, exhaust pipes and fittings which by their location and temperature present a hazard, should be adequately lagged or otherwise shielded. The insulation of hot surfaces should be properly maintained, particularly in the vicinity of oil systems. Personnel required to work in machinery spaces which have high noise levels should wear suitable hearing protectors. Where a high noise level in a machinery space, or the wearing of ear protectors, may mask an audible alarm, a visual alarm of suitable intensity should be provided, where practicable, to attract attention and indicate that an audible alarm is sounding. This should preferably take the form of a light or lights with rotating reflectors. Guidance may be found in the IMO Code on Alarms and Indicators.

The source of any oil leakage should be located and repaired as soon as practicable. Waste oil should not be allowed to accumulate in the bilges or on tank tops. Any leakage of fuel, lubricating and hydraulic oil should be disposed of in accordance with Oil Pollution Regulations at the earliest opportunity. Tank tops and bilges should, wherever practicable, be painted a light colour and kept clean and well-illuminated in the vicinity of pressure oil pipes so that leaks may be readily located. Great caution is required when filling any settling or other oil tank to prevent it overflowing, especially in an engine room where exhaust pipes or other hot surfaces are directly below. Manholes or other openings in the tanks should always be secured so that should a tank be overfilled the oil is directed to a safe place through the overflow arrangements. Particular care should be taken when filling tanks which have their sounding pipes in the machinery spaces to ensure that weighted cocks are closed. In no case should a weighted cock on a fuel or lubricated oil tank sounding pipe or on a fuel, lubricating or hydraulic oil tank gauge be secured in the open position.

Engine room bilges should at all times be kept clear of rubbish and other substances so that mud-boxes are not blocked and the bilges may be readily and easily pumped. Remote controls fitted for stopping machinery or pumps or for operating oil-tank quick-closing valves in the event of fire, should be tested regularly to ensure that they are functioning satisfactorily. This also applies to the controls on fuel storage daily service tanks (other than double bottoms) and lubricating oil tanks. Cleaning solvents should always be used in accordance with manufacturers' instructions and in an area that is well ventilated. Care should be taken to ensure that spare gear is properly stowed and items of machinery under overhaul safely secured so that they do not break loose and cause injury or damage even in the heaviest weather.

Tanks

There are lots of fluids that need storage space on a ship, and hence there are different kinds of tanks meant for such storage. Given below is a list of tanks that you would normally find on the bottom platform of a ship

- Fuel oil drain tank
- Sludge drain tank
- Lube oil drain tank
- Lube oil renovating tank
- Scavenger drain tank
- Stuffing oil drain tank.
- Piston cooling water tank.
- Bilge holding tank.
- Bilge holding tank

Bilge Wells

We have studied about bilges and the bilge pump in detail at this site. Basically all leakage oil and sludges along with engine room wash water get collected in the spaces known as bilge wells

There are normally 5 bilge wells inside the engine room as follow

Aft bilge well

Port side bilge well

Starboard bilge well

Central bilge well

Cargo bilge well

Auxiliary Machinery

Auxiliary machinery does not directly help in ship propulsion but is very important to carry out related tasks without which it would be literally impossible to run a ship smoothly. Here are some of the auxiliary machineries found on the bottom platform of a vessel

Lube oil purifier

Diesel oil purifier

Oil water seperator

Cofferdam and Drain Tanks

1.1.3. Engine-room watchkeeping procedures

Engineers on ships perform their duties in rotational shifts, each having fixed and equal number of hours. This work shift, also known as a watch, needs to be carried out in an efficient manner to ensure the safety of life and property at sea. The normal watch keeping schedule and responsible watch keeping engineers in a fully manned engine room:

0800-1200——4/E, 2000-2400—-4/E
1200-1600——3/E, 2400-0400—-3/E
1600-2000——2/E, 0400-0800—-2/E

A watch keeping engineer should take extra care while handing over the watch to the incoming watch keeping engineer to make sure that the ship runs safely and smoothly.

It is necessary that the right information is passed to the incoming engineer by the engineer on watch so that he can concentrate on his watch and perform more demanding and important jobs.

Handing over of the watch should be carried out according to the instructions provided by the chief engineer's standing orders and company's instructional manual. It should be done very sincerely and honestly so that the watch keeping becomes smoother and continuation of any kind of work is not affected on the ship.

The following things need to be informed to the reliving officer:

- Special orders related to any ship operation from bridge or the company
- Standing orders from the chief engineer
- Special mode of navigational operation of ship in case of emergency situation, damage, icy, or shallow water etc
- In case there is any kind of maintenance work being carried out in the engine room by other engineers and crew members then their work location, details of machinery under maintenance, and information of authorized person and crew members should be provided.
- Any potential hazard because of the ongoing maintenance work should also be informed.
- In case there is any equipment failure, details of the same should be informed
- All the checks already made when the ship leaves the port should be noted. In case any check is pending, it should be conveyed to the incoming watch keeping engineer
- All the checks that are made when the ship enters the port should be noted and informed in case any is missing.
- Condition and important information regarding mode of operation of main engine, boiler, and auxiliary engines should be informed
- Level of important tanks such as bilges, ballast tank, sewage tank, reserve tank, slop tank, fuel tank, or any other tank which requires attention
- Condition and state of fire extinguishing equipment and systems, in case any specific section or fire alarm has been isolated

- In case an equipment needs to be monitored manually, details of the same should be provided, along with the condition of monitoring and control equipment
- Any form of adverse ship condition needs to be informed
- Information on the condition and modes of all the important auxiliary machinery such as purifiers, fresh water generator, oily water separator, pumps, sewage treatment plant, should be provided
- Stand by machinery are at Standby mode and emergency equipment's are at ready mode.
- If any machinery runs in manual mode for special precaution need to be informed (for example F.O. Transfer pump or boiler feed pump etc)
- In case any important machinery failed to receive attention during the watch, the reliving officer should be reported and asked to take care of the same
- The condition and modes of automatic boiler controls and details of other equipment related to the operation of the steam boiler should be provided
- The engineer officer should ensure that all the important parameters regarding main and auxiliary machines are suitably recorded in the engine room log book.
- Main and Auxiliary machineries, boiler, A/C, refrigeration, steering, electrical motors, alternators etc. in good order or any changes from normal, abnormality to be informed.
- Status of communication with bridge to be informed.
- Environmental protection in good order e.g. smoke etc is in acceptable level and ppm & alarm of OWS if it is running
- M/E rpm/ ship speed status
- Log Book updated in time, all parameters logged down, meter readings recorded as appropriate
- For and UMS ship alarm record book and equipment check lists to be verified
- If you are satisfied that the incoming watch keeping engineer is in fit/good condition; not drunk etc. and mentally and physically prepare to take over the watch then hand over the watch to him by signing company form.

- if in doubt, inform and consult with the chief engineer officer.

- Taking over a watch

For taking over a watch get ready with proper PPE at least 20 minutes before the watch. Then if not restricted area go outside the accommodation to see the M/E and Aux Engines exhaust gas colour from the funnel.

Then after coming back to the control room, check the control panel for any abnormal alarms or parameters.

- Accepting Watch

If all above check points are covered satisfactorily, watch is taken over smoothly. If in doubt – may inform and consult with chief engineer

Compilation of machinery space log book & understanding significance of readings taken

In general while taking over/handing over a watch, considering a smooth running operation, all parameters – pressure, temperature, level, flow meter reading etc. are normal and logged down in the log book accordingly. Should there be any abnormality following significant difference will appear:

Change in temperature and pressure will indicate deviation/abnormality, considering same ambient condition

Different level condition indicates loss, leakage, overflow etc.

A distillate plant flow meter small (red new) reading may indicate performance fall off.

FO/DO flow meter increased reading may indicate loss of above, leakage etc.

In brief any change in log book parameters will help to make out difference between condition monitoring and easily detects some fault with relevant machineries and indicate their performance.

- Duties of a watchkeeping engineer during an engine room watch:

During the engine room watch, the following machineries to be monitor regularly:

- ME or propulsion systems functioning and all units' exhaust temp, piston cooling lub oil outlet temp, JCW outlet temp, Lub inlet pressure & temp, Air Cooler temp, fuel temp & pressure to be maintained.
- Aux Engine system functioning and all units' exhaust temp, piston cooling lub oil outlet temp, JCW outlet temp, Lub inlet pressure & temp, Air Cooler temp, fuel temp & pressure to be maintained.
- Steering system functioning and tank oil level to be maintained. System to be greased or lubricate.
- Boiler pressure and water level maintaining.
- Accommodation A/C and provision refrigeration plants to be checked and provision rooms temp to be maintained.
- EGE/EGB soot to be blown.
- Bilge level to be checked and if necessary, bilge to be transferred in Bilge holding tank.
- Sludge tanks level to be checked and if required, sludge to be transferred in BSO tank.
- Purifier fuel temperature, pressure and de-sludging in time.
- Air Compressor runs in auto and air bottles pressure maintaining
- Drain fuel oil settling and service tanks and maintain proper level and temperature.
- Air Bottles to be drained and pressures to be maintained.

- If the incinerator runs, waste oil service tank level and temperature and incinerator furnace temperature to be monitored.
- Sewage treatment plants to be check for proper functioning
- Environmental protection in good order e.g. smoke etc is in acceptable level.
- M/E rpm to be maintained according to C/E instructions.
- Safety related items e.g. fire alarms and fire extinguishing system to be checked for proper functioning.
- Additionally check for any bad smell, abnormal sound, and look for any abnormality, leakage, level etc.
- In fact a good watch keeping helps keep aware of any changes and decision can be made out accordingly.
- Bridge/chief engineers any instruction should be completed with
- Any pending repairs, bilge, ballast operations to be supervised carefully.
- During any congested water navigation, bad weather, appropriate decision should be taken. For any kind of problems with main/auxiliary machines, bridge/chief engineer officer to be informed as appropriate, meanwhile preventive/corrective action to be taken.
- Safety precautions to be observed during a watch and immediate actions in the event of a fire or accident by informing bridge and chief engineer.

- What precautions to be observed during a watch?

- Regular rounds to observe for bad smell, abnormal sound/noise,leakage,level etc.
- Main, auxiliary machinery, steering gear etc. pressure temperature, level maintained normal, main engine RPM, vessel speed normal
- Boiler, pressure, level, A/C, refrigeration, pumps etc in order
- Exhaust/smoke checked clear, bilge level, normal, fire duties, active
- No undue bilge level, ballast, transfer operation taking place.

- Take corrective actions to change in parameters and inform chief engineer/bridge when appropriate.

- What immediate action you are going to take in the event of a fire or accident?

- Ans: The Abbreviation of Fire:

F – Find	or	Find
I – Inform		Isolate
R – Restrict		Report
E – Extinguish		Extinguish

Hence on viewing a fire isolate the source of combustion and inform the bridge and Chief Engineer, raise fire alarm, so that others will remain aware of the situation, will muster & come to help.

Meanwhile try to extinguish the fire with appropriate means.

Should there be any accident inside E/R, inform bridge, Chief Engineer and raise emergency alarm so that other crew members will muster and come to help/rescue as appropriate. Meanwhile take corrective actions as deemed necessary.

All members of the engine room crew shall be familiar with their assigned duties. In addition, every member shall at least have knowledge of:

- the use of appropriate internal communication systems
- the escape routes from machinery spaces
- the location and use of all types of fire-fighting equipment
- the engine room alarms
- the damage control gear in the machinery spaces, together with their use and the various safety precautions to be observed.

All members:

- shall ensure that all communication is carried out in closed loop
- shall always comply with the chief engineer's standing and special orders
- shall ensure that the bridge and other team members are informed and updated on occurrences during the watch that are of significance regarding safety of the vessel
- shall always comply with the vessel's Safety Management System (SMS)
- shall only use SMS approved checklists
- shall before arrival or departure be part of a pre-arrival and pre-departure meeting. During the meeting the operation is discussed and tasks/duties are assigned
- shall update the PMS when required or inform EOOW when a job is completed
- shall have required knowledge about the PMS requirements and how the system operates.

1.1.4. Safe working practices as related to engine-room operations

'Safety First' is made as a sign that is quite visible almost in all engine rooms. But what does this mean and is it really enforced? The International Maritime Organization (IMO) has long been promoting safety of life and property at sea along with environmental protection. Today, we now have a new safety management code (ISM Code) instructing the industry that the most important matter to be addressed, both ashore and afloat, is that safety must come first (Anderson, 2003). Moreover, this Code requires operators to embrace safety as an integral part of their policy and working practices but gives no descriptive rules to say how this must be done.

Safety is defined as the control of accidental loss. Accidents will occur because a problem that was not adequately defined; a problem whose consequences were not fully perceived, or simply a problem that was not considered to exist (Kuhlman, 1977). However, within the engine room the immediate cause of an accident may appear to be equipment related or human-related. Nevertheless, need for a pro-active, holistic approach to safety must be considered. The pro-active approach is the identification of potential dangers of accidents which requires the involvement of all on board (Rajendra Prasad, 1999). This may significantly change the way ships are run and operated thus safety awareness is the very first step to this approach.

How can safety awareness be carried out in the engine room? These methods have been used on board ships and were found to be good and effective (Lavery, 1990)

- **Films:** The showing of safety films is good so as to keep the crew abreast with safety matters.
- **Posters:** This can be an effective method of bringing particular dangers to the attention of engine room members.
- **Informal talks:** The idea of having a safety meeting once a month to build up crew morale is effective.
- **Warning and Working Signs**: This serves as a notice to the other crew members.
- **Maintenance of Safety Equipment**: It is advisable to keep a record of the dates and work done on any machinery.

- **Permit to Work system:** For dangerous work or hot work a permit must be issued which is also effective.

The whole aim of this safety awareness is to create a safety culture which will reduce accidents, damage, personal injury and lost-time incidents in competitive, commercial ship operations.

- Developing a Safety Culture

Safety culture is more than merely avoiding accidents or even reducing the number of accidents, although these are likely to be the most apparent measures of success. The quality and effectiveness of training will play a significant part in determining the attitude and performance and the professionalism that the seafarer will subsequently demonstrate in his, or her, work. The attitude adopted will, in turn, be shaped to a large degree by the "culture" of the company (Hanza-Pazara & Arsenie, 2007). The product of an individual, group values, attitudes, perception, competencies to, style and proficiency of an organization's safety management are the words used to describe Safety Culture.

Tor Christian Mathiesen in 1994 defined safety culture as "describing a situation where owners are engaged in a continuous process to improve safety and see this as their management philosophy and operational mode to reduce losses" and he added that "this implies focus on the entire management chain, from the board room to the ship." As a supporter of the safety culture he emphasized that "to control safety is the answer to regain credibility for the shipping industry" (Velga, 2001).

Safety Culture is not only a way of complying with organizational rules but rather a way of life, individual inner motivation and an acceptance to do the right thing. Therefore, to develop this culture onboard certain parameters must be put in place. These parameters are in the form of five different components; Informed, Reporting, Just, Flexible and Learning Cultures (Reason, 1997).

Informed Culture involves creating a safety information system that collects analyses and disseminates information from accidents and near-misses as well as regular pro-active check on the system's vital signs. Reporting culture depends on the atmosphere whereby the people are willing or prepared to report their errors and near misses without fear of being punished. Just Culture involves an atmosphere of trust in which people are encouraged even rewarded, for providing essential safety-related information. Flexible Culture means the shifting from that conventional hierarchical mode into a professional structure of somewhat being more friendly. Learning culture which involves the willingness to draw the right conclusions from its safety information and implement major reforms when the needs are indicated (Mejia, 2008). In establishing safety culture within the engine room, the crew must start with realistic expectations, be patient but persistent in their implementation, target the human element in the safety equation and above all be intolerant of substandard practices Finally, the objective of developing a safety culture is that it should aim at inspiring the seafarers towards firm and effective self-regulation and to encourage their personal ownership of establishing best practice (Iarossi, 1999). With this in mind it will be quite understandable that the approaches in handling machinery onboard should/must be scrutinized.

Engine room safety and environmental procedures

Safety precautions: The engine room is a place where accidents and pollution incidents can easily occur if safe working practices and pollution prevention measures are not strictly followed. The Chief Engineer is responsible for ensuring that the importance of accident/incident prevention is fully understood by all engineering staff including the potential risks involved.

Safety standards

All Engine Room Staff must be suitably dressed and must wear coveralls, safety shoes, gloves, goggles and helmets as per the VMS PPE matrix.

Engine Room and machinery spaces must be kept clean, tidy and as free as possible from oil/fuel stains or sources, all of which must be identified and eliminated.

To prevent fires, any possible source of uncontrollable heat must be protected and any fuel leakage must be cleaned up and the source identified and eliminated.

No oil leak collecting tins, trays or other temporary means of collection are allowed. Save-alls around tanks and machinery must always be kept clean and drainage trays clean.

Dirty rags, cotton waste etc must be removed and all such waste must be collected and disposed of according to the instructions set out in the Safety and Environmental Procedures.

Particular attention must be paid by all Engineer Officers to valves, flanges, thermometer pockets, pressure gauges and other elements which may work loose, on fuel and lube oil pressurized pipes, resulting in the spray of combustible liquid onto hot surfaces. Particular attention to this potential hazard is required in unmanned engine rooms where they can remain undetected for long periods.

High pressure fuel pipe shielding must be intact and properly secured. The heating of water / oil mixtures such as oil or sludge tanks must be deemed as a critical operation. It should be kept in mind that the ambient temperature may require the sludge / oil water mix to be heated and the expansion volume of the liquid may cause an overflow of the tanks that have been filled close to their maximum capacity. A maximum filling level for such tanks must be identified that leaves a safety margin for this expansion. This level should be recorded on the checklist.

Workshops must be maintained in a clean and tidy condition with all tools kept in good working order. The area used for welding and brazing must be clearly defined and provided with the necessary means to prevent accidents and fires.

Oxygen and acetylene bottles must be stored outside the engine room and accommodation areas. They must not be stored together but kept apart and securely lashed. Lockers containing gas bottles must be properly identified.

Chemicals must be used in accordance with the maker's instructions including any guidelines regarding the use of protective clothing. Information on medical care to be followed in case of accidents is to be posted in appropriate places. Product data sheets are to be kept with the chemicals along with the appropriate protective clothing. An officer is to be designated in charge of chemical management.

Particular care must be taken when fixing and lashing stores, bottles, drums and spares in order to avoid personal injuries and damages.

The precautions a duty engineer should take while working in the vicinity of the funnel are:
To inform engine room duty personnel to ensure steps are taken to reduce the emission of steam, harmful gases and fumes as much as possible.
The Chief Engineer must ensure that all checks and precautions to avoid electrical shocks are taken by the Electrical Engineer Officer. Naked, disconnected/worn wires or open electrical equipment are not allowed onboard. All electrical equipment must be protected and any potentially dangerous situations immediately reported to the Chief Engineer and rectified by the Engineer Officer.

The Electrical Engineer Officer must inspect accommodation areas including cabins at regular intervals to ensure that no potentially hazardous problems can result from the use of unauthorised equipment and/or alterations to the electrical wiring.

All lifting equipment must be regularly tested according to the applicable rules and / or the maker's recommendations, under the supervision of the Chief Engineer who must maintain a record of the same which is to include certification. Blocks, slings and similar equipment must be maintained in a good condition and stored separately. Safe working loads must be clearly indicated in a permanent manner. Critical measuring instrumentation must be calibrated according to rules and maker's instructions.

In addition to the above, it must be noted that:
A clean and oil free engine room contributes greatly to overall safety; No unauthorized personnel may operate equipment or machinery; Visitors are only allowed in the engine room without permission of the Chief Engineer. All visitors must be accompanied.

As a final point, the Chief Engineer is to employ all available means in order to create a safety conscious and environmentally friendly atmosphere throughout the engine department. Such means include the holding of meetings, the viewing of training videos and the reading of Company manuals. All officers and ratings are to be encouraged to contribute to enhanced safety, and improved pollution prevention measures.

The table below provides guidance on the type of PPE to be used for different operations.

WORKING AREA/ACTIVITY	SAFETY HELMETS	SAFETY BOOTS/ SHOES	COVERALLS/ BOILER SUITS	APPROPRIATE GLOVES	BUOYANCY AIDS	FALL PREVENTION SYSTEM ()	APPROPRIATE EYE PROTECTION	VISOR / HOOD	EAR DEFENDERS	RESPIRATORY PROTECTION	CHEMICAL SUITS/APRON	EEBD	PERSONAL GAS METER
Portable Power Tools Including Grinders	Required	Required	Required	Required	Unlikely	Unlikely	Required	Required	Consider	Consider	Unlikely	Unlikely	Unlikely
Working Aloft	Required	Required	Required	Required	Unlikely	Required	Required	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely
Anchoring	Required	Required	Required	Required	Unlikely	Unlikely	Required	Unlikely	Consider	Unlikely	Unlikely	Unlikely	Unlikely
Cargo Operations	Required	Required	Required	Required	Unlikely	Consider	Required	Consider	Unlikely	Consider	Consider	Unlikely	Consider
Handling Chemicals	Required	Required	Required	Required	Unlikely	Unlikely	Required	Required	Unlikely	Consider	Required	Unlikely	Unlikely
General Cleaning Outside Accommodation	Required	Required	Required	Required	Unlikely	Unlikely	Required	Consider	Unlikely	Consider	Unlikely	Unlikely	Unlikely
Crane/Lifting Operations	Required	Required	Required	Required	Unlikely	Unlikely	Required	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely
Deck (Bad Weather)	Required	Required	Required	Required	Required	Consider	Consider	Unlikely	Consider	Unlikely	Unlikely	Unlikely	Unlikely
Deck (Normal Conditions)	Required	Required	Required	Consider	Unlikely	Unlikely	Required	Consider	Consider	Consider	Unlikely	Unlikely	Consider
De-Scaling	Required	Required	Required	Required	Unlikely	Unlikely	Required	Unlikely	Required	Consider	Unlikely	Unlikely	Unlikely
Dry-Dock (Walking)	Required	Required	Required	Required	Unlikely	Unlikely	Required	Unlikely	Consider	Unlikely	Unlikely	Unlikely	Unlikely
Electrical Equipment	Required	Required	Required	Consider	Unlikely	Unlikely	Required	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely
Enclosed Space	Required	Required	Required	Required	Unlikely	Consider	Required	Unlikely	Consider	Unlikely	Unlikely	Consider	Required
FRC Deployment	Required	Required	Required	Required	Required	Consider	Required	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely
FRC Passengers	Required	Unlikely	Unlikely	Required	Required	Consider	Consider	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely
High Pressure Hydro Blaster	Required	Required	Required	Required	Unlikely	Unlikely	Required	Required	Required	Consider	Unlikely	Unlikely	Unlikely
Hydraulic Equipment	Required	Required	Required	Consider	Unlikely	Unlikely	Required	Required	Consider	Unlikely	Unlikely	Unlikely	Unlikely
Launch Transfer	Required	Required	Required	Required	Required	Consider	Required	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely
Lifeboats (Launching)	Required	Required	Required	Required	Required	Consider	Required	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely
Lifeboats On Davits	Required	Required	Required	Required	Consider	Unlikely	Required	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely
Machinery Space	Required	Required	Required	Consider	Unlikely	Unlikely	Required	Consider	Required	Consider	Unlikely	Unlikely	Unlikely
Mooring Operations	Required	Required	Required	Required	Unlikely	Unlikely	Required	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely
Over side/Close To Unguarded Shipside	Required	Required	Required	Required	Required	Required	Required	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely
Painting/Greasing	Required	Required	Required	Required	Unlikely	Unlikely	Required	Consider	Unlikely	Consider	Unlikely	Unlikely	Unlikely
Fixed Power Tools	Required	Required	Required	Consider	Unlikely	Unlikely	Required	Consider	Consider	Consider	Unlikely	Unlikely	Unlikely
Pressure Vessels And Pipelines	Required	Required	Required	Required	Unlikely	Unlikely	Required	Consider	Consider	Consider	Unlikely	Unlikely	Unlikely
Working with Steam	Required	Required	Required	Required	Unlikely	Consider	Required	Required	Consider	Unlikely	Unlikely	Unlikely	Unlikely
Welding/Gas Cutting	Required	Required	Required	Required	Unlikely	Unlikely	Consider	Required	Unlikely	Consider	Unlikely	Unlikely	Unlikely
Wire Handling	Required	Required	Required	Required	Unlikely	Unlikely	Required	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely

REQUIRED CONSIDER UNLIKELY

1.1.5. Basic environmental protection procedures

The design of a ship should aim at reducing the likelihood of human error, in that the machineries should not be complicated in handling so as to accommodate human error. If errors are not self-evident, their occurrence should be clearly signalled to the crew. Maritime safety therefore involves the integration of three elements. Man (Seafarer), Machine and Environment into one system. Each element influences the other to varying degrees and the elements are often depend on each other. A hazard in one element can start a chain reaction leading to an accident in which all three elements are involved. Many of the hazards that occurare brought about by difficulties at the interface between these three elements.

- **Environmental protection system - Procedures for operational control on board ships**

Procedures for operational control on board ships include:

1. Reduction of Marine Pollution on board
2. Prevention of leaks and spills of oil and chemical products on board ships
3. Provision on board for education and on-the-job training
4. Bans on exchange of Ballast Water in regulated coastal areas and the practice of exchange of ballast water at high seas
5. Research on restrictions at various ports;
6. Research and study of facilities and equipment to handle ballast water
7. Reduction of Wastes on board
8. Reduction of the quantity of waste generated on board ships
9. Compliance of GARBAGE management plan;
10. Research into and study of the introduction of, waste disposal facilities and equipment
11. Reduction of Consumption of Natural Resources

12. Prevention of Air Pollution

13. Reduction of the consumption of fuel oil and lubricating oil (a cutback in the emissions of CO_2, NO_x and SO_x)

14. Provision on board ships of education to raise awareness and on-the-job training,

15. Research into and study of the introduction of, laborsaving and efficient shipboard facilities and equipment

16. Reduction of the generation of Dioxin

17. Proper use of incinerators

18. Proper control of plastics;

19. Proper control of ozone depleting substances

20. Social Contribution & Provision of Weather Data Collection on board

21. Instruction to conduct weather observations on board ships

22. Otherwise, participation in marine weather observation and technical cooperation

- ***Planning of Education and Training -Case Study – Oil Record Books***

A case study from the P&I Club Gard which highlighted ships Chief Engineer was unable to account for all sludge disposal also involving the incinerator. It was eventually proven after some weeks that there had been no illegal discharge, however the Officers had put themselves at risk through inaccurate entries in the ORB and 'suspect' statements to the USCG.

Please note in particular.

1. The Act to Prevent Pollution from Ships (APPS) is the US version of MARPOL.

2. It is both a civil and a criminal violation under APPS and domestic US law to intentionally falsify an Oil Record Book.

3. If the entries are intended to hide discharges of oily waste water, for example, by bypassing the oily water separator, the penalties can be very severe.

4. Even although there was no illegal discharge, the Chief Engineer was fined for lying to the USCG officer and for making false entries in the Oil Record Book. He was also detained in the USA for a number of weeks while the investigation was ongoing.

The USA remains the highest risk, however many other Port State Control regimes examine records of environmental discharges very carefully. It is therefore critical that Oil Record Books, Garbage Disposal Records, Ballast Management plans and the US Vessel General Permit Log are accurately maintained and agree with records maintained in Sounding Books and other associated Logbooks.

Please review compliance onboard your vessel and discuss this at the next management and safety meetings. Any concerns are to be brought to the immediate intention of your management ashore.

Education and training for the master and chief engineer of each ship which would include:

a. Roles and responsibilities in the EMS

b. Compliance with the requirements of the manual environmental management system

c. Encouragement to raise awareness of environmental issues amongst the crew as well as to report any non-conformity or environmental concerns to the office. Such training is a part of Pre-boarding training in office.

d. Evaluation and review of education and training

- **Ways to prevent pollution by ships - communication procedures**

Procedures for communication shall include:

a. Information, requests, complaints etc., from interested parties including cargo owners, port facilities, and residents close to port

b. Information on new environmental aspects

c. Occurrence of environmental accidents including those by other companies

d. Information on the establishment or amendment of any legal regulations

e. Requirements of public agencies

Vessels, too, should communicate any of above issues without delay to the shore authority, if they are privy to such knowledge.

Internal and external information shall be recorded in the Record of Communication and Handling of Environmental Information

1.1.6. Use of appropriate internal communication system

A ship is successfully run by two different departments – Engine and Deck that work day and night to ensure that the ship delivers its cargo on time. Duties of officers and crew in each of these departments is of great importance and the ship cannot sail if a problem is faced by either of them.

Moreover, everyone from the maritime industry know the fact that there is always a cold war between the engine and deck officers on every ship. It is often seen that officers and crew from each of the departments would try to prove that the ship cannot run without them; though everyone deep down knows that in order to allow the ship to sail efficiently none of the departments can do without each other and it’s all about teamwork on board.

One of the most common and important operations wherein the deck and engine departments come together is the ship’s maneuvering. However, in order to ensure utmost safety of the ship, it is important that officers and crew members from each department shun their ego and maintain healthy communication not only during emergency situations but throughout all important ship operations.

Mentioned below are some of the most important situations on board wherein the engine and deck officers must communicate properly and inform each other about the situation.

1. Engine Room Machinery Abnormality: A machinery in the ship's engine room is bound to face problem when at sea. In case of breakdown of any machinery, the duty engineer must inform the bridge officer immediately without any delay. If problem occurs in the main engine, power generator or any associated machinery which can affect the voyage of the ship, the engineer must take all necessary steps and inform the bridge at the earliest.

2. Fire on ship: With implementation of advanced safety and automation systems, detection of fire on board ships has become quite efficient. In case of fire on the ship, the indication of affected location is displayed either on the bridge or in the fire station. In such condition, it is important that deck officer call the engine room to inform about the specific location of fire even after the fire alarm has been sounded. The same rule also applies to the engine officer, who must inform the bridge on how big is the fire and its condition after ringing the fire alarm. However, only informing is not important, it is necessary that all required steps are taken by the ship's crew to stop the fire and inform other department regarding the same.

3. Fog, Traffic or Other Manned Situation: Today, most of the ships have UMS engine room and the engine is controlled from the bridge. If any situation arises wherein the engine is to be slowed down and manned, the bridge officer must inform the duty engineer well in advance. These situation may include: Fog or weather warnings, Canal Crossing, High Traffic Areas, Under-Bridge Crossing etc.

4. Heavy Smoke/ Spark from the Funnel: If the ship's funnel is discharging abnormal black/ white smoke or there are sparks rising from the funnel, the deck officer on the bridge must inform the same to the engine room immediately as it may lead to uptake fire if ignored.

5. Internal Oil Transfer Operation: Any engine room internal oil transfer procedure must be pre-informed to the bridge officer as the transfer of oil from one tank to another may affect the current list/ trim of the ship. Also, an informed deck officer will keep a good overboard watch and revert back to the engine room immediately in case of oil leakage or spill.

6. Pumping Operation: Ballast pumps are high capacity pumps which are used to correct the list, trim or draught of the ship. They are also used in ports for cargo loading/ discharging. In order to save fuel, normally one generator is run at higher load when the ship is at port. Hence deck officer must inform the engine department before starting any pumps including ballast and fire pump as there might be a requirement to start one more generators to accommodate the power requirement.

7. Deck Machinery Operation: Before starting any deck machinery including bow thrusters and winches, the deck officer must inform the engine department so that engineers can check and ensure that the machinery is ready to start and the generator has enough

accommodating power available. Also, in case of bow thruster (BT), hydraulic pumps and fans are to be started sequentially before the main operation, which the ship engineer will perform if informed well in advance.

1.1.7. Engine – room alarm systems and ability to distinguish between the various alarms, with special references to fire -extinguishing gas alarm

An emergency does not come with an alarm but an alarm can definitely help us to tackle an emergency or to avoid an emergency situation efficiently and in the right way. Alarm systems are installed all over the ship's systems and machinery to notify the crew on board about the dangerous situation that can arise on the ship.

Alarm on board ships are audible as well as visual to ensure that a person can at least listen to the audible alarm when working in a area where seeing a visual alarm is not possible and vice versa

It is a normal practice in the international maritime industry to have alarm signal for a particular warning similar in all the ships, no matter in which seas they are sailing or to which company they belongs to. This commonness clearly helps the seafarer to know and understand the type of warning or emergency well and help to tackle the situation faster.

The main alarms that are installed in the ship to give audio-visual warnings are as follows:

1) General Alarm: The general alarm on the ship is recognized by 7 short ringing of bell followed by a long ring or 7 short blasts on the ship's horn followed by one long blast. The general alarm is sounded to make aware the crew on board that an emergency has occurred.

2) Fire Alarm: A fire alarm is sounded as continuous ringing of ship's electrical bell or continuous sounding of ship's horn.

3) Man Overboard Alarm: When a man falls overboard, the ship internal alarm bell sounds 3 long rings and ship whistle will blow 3 long blasts to notify the crew on board and the other ships in nearby vicinity.

4) Navigational Alarm: In the navigation bridge, most of the navigational equipments and navigation lights are fitted with failure alarm. If any of these malfunctions, an alarm will be sounded in an alarm panel displaying which system is malfunctioning.

5) Machinery space Alarm: The machinery in the engine room has various safety devices and alarms fitted for safe operation. If any one of these malfunctions, a common engine room alarm is operated and the problem can be seen in the engine control room control panel which will display the alarm.

6) Machinery Space CO2 Alarm: The machinery space is fitted with CO2 fixed with fire extinguishing system whose audible and visual alarm is entirely different from machinery space alarm and other alarm for easy reorganization.

7) Cargo Space CO2 Alarm: The cargo spaces of the ship are also fitted with fixed firefighting system which has a different alarm when operated.

8) Abandon Ship Alarm: When the emergency situation on board ship goes out of hands and ship is no longer safe for crew on board ship. The master of the ship can give a verbal Abandon ship order, but this alarm is never given in ship's bell or whistle. The general alarm is sounded and everybody comes to the emergency muster station where the master or his substitute (chief Officer) gives a verbal order to abandon ship.

9) Ship Security Alarm System: Most of the ocean going vessels are fitted with security alert alarm system, which is a silent alarm system sounded in a pirate attack emergency. This signal is connected with different coastal authorities all over the world via a global satellite system to inform about the piracy.

Different Alarm signals of the vessel are clearly described in the muster list along with the action to be carried out so that all the crew member can perform their duties within no time in actual emergency.

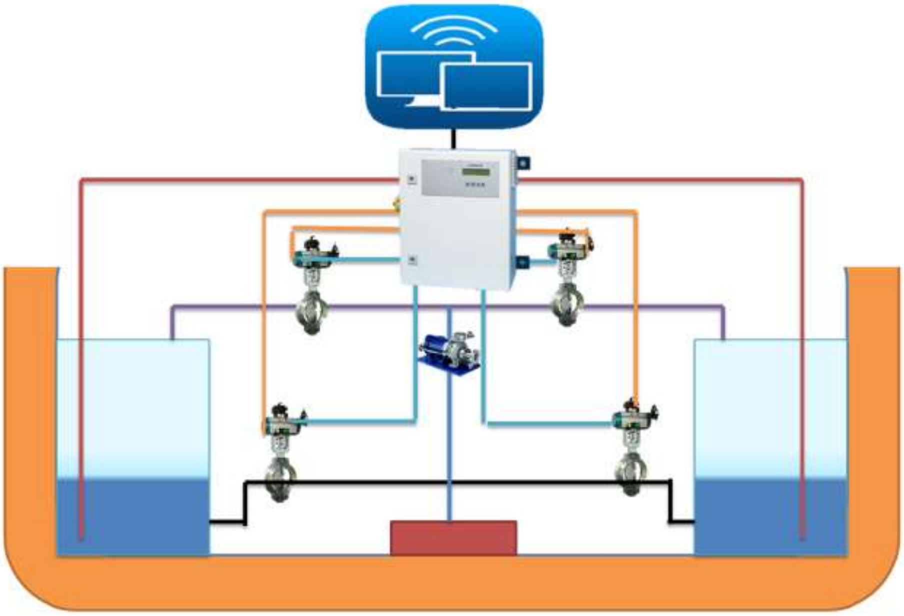
ENGINE ROOM ALARM MONITORING SYSTEMS

1. Servicing & Overhauling of All Leading Brands Engine Room Alarm Systems
2. Electronic Circuit Board Repairs
3. Testing & Calibration of Field Sensors
4. Cabling & Termination of Alarm Monitoring Systems
5. PLC, SCADA, DCS Based System Integration & Services

The modular design allows for flexible system configurations depending on the individual needs of the system, from simple systems to a very complex monitoring. The main part is modern PLC controller, whose main function is measuring data collection and processing in real time as well as visualizing all values through user-friendly interfaces.

In addition, all recorded data can be collected, archived, and ordered in the form of various reports. Such data is stored on your hard disk for several months, which is very helpful in detecting failure of any of the systems.

HMI systems (process visualization) play a very important role as it enables efficient and safe operation of the system which helps the operator to make optimal decisions and reduce the risk of human error. In designing the HMI we focus on logical operations, effective presentation of relevant information as well as userfriendly interface.



Anti Heeling System

Marine engine room alarm and monitoring system is one of the most important components of modern automatic engine room. Most of alarm and monitoring systems have only for real monitoring and alarm control, can't provide the function of simulation and training online; also have deficiencies in other functions and display modes, which can't meet the rapid development demand of the modern ship. A novel marine alarm and monitoring system combined with real-time monitoring and simulation, which can not only be used to monitoring and alarm, also can be used to training operators online and fault diagnosis. The system configures in two networks and modularization structure.

Gas detectors measure and indicate the concentration of certain gases in an air via different technologies. Typically employed to prevent toxic exposure and fire, gas detectors are often battery operated devices used for safety purposes. They are manufactured as portable or stationary (fixed) units and work by signifying high levels of gases through a series of audible or visible indicators, such as alarms, lights or a combination of signals. While many of the older, standard gas detector units were originally fabricated to detect one gas, modern multifunctional or multi-gas devices are capable of detecting several gases at once. Some detectors may be utilized as individual units to monitor small workspace areas, or units can be combined or linked together to create a protection system.

As detectors measure a specified gas concentration, the sensor response serves as the reference point or scale. When the sensors response surpasses a certain pre-set level, an alarm will activate to warn the user. There are various types of detectors available and the majority serves the same function: to monitor and warn of a dangerous gas level. However, when considering what type of detector to install, it is helpful to consider the different sensor technologies.

- **Gas Detector Technologies**

Gas detectors are categorized by the type of gas they detect: combustible or toxic. Within this broad categorization, they are further defined by the technology they use: catalytic and infrared sensors detect combustible gases and electrochemical and metal oxide semiconductor technologies generally detect toxic gases.

- **Measurement of Toxic Gases**

Electrochemical sensors or cells are most commonly used in the detection of toxic gases like carbon monoxide, chlorine and nitrogen oxides. They function via electrodes signals when a gas is detected. Generally, these types of detectors are highly sensitive and give off warning signals via electrical currents. Various manufacturers produce these detectors with a digital display.

Metal Oxide Semiconductors, or MOS, are also used for detecting toxic gases (commonly carbon monoxide) and work via a gas sensitive film that is composed of tin or tungsten oxides. The sensitive film reacts with gases, triggering the device when toxic levels are present. Generally, metal oxide sensors are considered efficient due their ability to operate in low-humidity ranges. In addition, they are able to detect a range of gases, including combustibles.

Measurement of Combustible Gases

Catalytic sensors represent a large number of gas detector devices that are manufactured today. This technology is used to detect combustible gases such as hydrocarbon, and works via catalytic oxidation. The sensors of this type of detector are typically constructed from a platinum treated wire coil. As a combustible gas comes into contact with the catalytic surface, it is oxidized and the wiring resistance is changed by heat that is released. A bridge circuit is typically used to indicate the resistance change.

Infrared sensors or IR detectors work via a system of transmitters and receivers to detect combustible gases, specifically hydrocarbon vapors. Typically, the transmitters are light sources and receivers are light detectors. If a gas is present in the optical path, it will interfere with the power of the light transmission between the transmitter and receiver. The altered state of light determines if and what type of gas is present.

- **Common Gas Detector Applications**

Although detectors are an essential application for home and commercial safety, they are also employed in numerous industrial industries. Gas detectors are used in welding shops to detect combustibles and toxics and in nuclear plants, to detect combustibles. They are also commonly used to detect hazardous vapors in wastewater treatment plants.

Gas detectors are very efficient in confined spaces where there is no continuous employee occupancy. Such spaces include tanks, pits, vessels and storage bins. Detectors may also be placed at a site to detect toxins prior to occupant entry.

Additional Gas Detector Information:

Although gas detectors are generally a reliable technology, with some models capable of lasting up to five years, their proper function is generally dependent on user maintenance, battery inspection and calibration. Calibration is a safety procedure executed to ensure that detectors are measuring the correct level of gas. In addition, the life-span of gas detectors also often depends on the amount of gas vapors to which they are exposed. Contaminated sensors may not register dangerous gas levels, which is why frequent calibration is essential.

1.2. Keep a boiler watch maintain the correct water levels and steam pressure

1.2.1. Keep a safe boiler watch

Marine boiler is one of the most easy-to-operate systems on board ships. Though most of the mariners will agree to this, they also know that it's a complex machinery which requires highest standards of safety precautions and correct operating procedures.

Accidents on board ships involving marine boiler has caused severe damage to the property and even claimed human lives in the past. Mariners know the dangers of high temperature steam and therefore do not take any chances when it comes to operation and maintenance of boilers.

According to an analysis, one of the main reasons behind accidents are improper operating procedures and overriding safety precautions while operating boilers. The main concern of any ship engineer is to operate all engine room machinery and systems to achieve maximum efficiency without hampering it's operating life and safety measure.

When it comes to marine boilers, the steam demand is the main criteria of operating a boiler at a given load. It is therefore important not to over-stress the boiler to achieve the desired output. Also it is necessary to ensure that the boiler is operated within all safety limits.

Below are some of the important Do's and Don'ts which a marine engineers must consider while operating a marine boiler in a safe and efficient manner:

Operating Procedure: Follow the correct operating procedure when lighting up the boiler from the cold condition. Ensure to pre and post purge every firing and also make sure that the air vent is kept open while initially firing and shutting down the boiler.

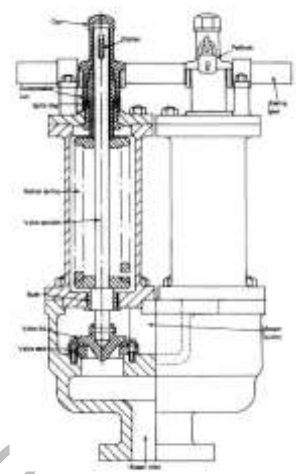
a. Check boiler fuel combustion for normal

Combustion is the burning of fuel in air in order to release heat energy. For complete and efficient combustion the correct quantities of fuel and air must be supplied to the furnace and ignited. About 14 times as much air as fuel is required for complete combustion.

The air and fuel must be intimately mixed and a small percentage of excess air is usually supplied to ensure that all the fuel is burnt. When the air supply is insufficient the fuel is not completely burnt and black exhaust gases will result.

The flow of air through a boiler furnace is known as 'draught'. Marine boilers are arranged for forced draught, i.e. fans which force the air through the furnace. Several arrangements of forced draught are possible. The usual forced draught arrangement is a large fan which supplies air along ducting to the furnace front.

The furnace front has an enclosed box arrangement, known as an 'air register', which can control the air supply.



The air ducting normally passes through the boiler exhaust where some air heating can take place. The induced draught arrangement has a fan in the exhaust uptake which draws the air through the furnace. The balanced draught arrangement has matched forced draught and induced draught fans which results in atmospheric pressure in the furnace.

- Soot Blowing Procedure

Main Boilers, Auxiliary Boilers & Exhaust Gas Economizers

Soot blowers fitted to Main and Auxiliary boilers, together with Exhaust Gas Economizers, are to be operated prior to arrival in Port and after Full Away On Passage. Under no circumstances are Soot Blowers to be operated during any cargo operations or when a vessel is alongside another vessel or on a berth. During the voyage, soot blowers are to be operated in accordance with manufacturer's instructions, care being taken during this operation to ensure funnel emissions are not discharged onto cargo areas.

Exhaust Gas Economizers

Water-washing or Exhaust Gas Economizers are to be conducted in port in accordance with the manufacturer's instructions. Liquid effluent collected from these processes is to be collected and retained in a Soot Wash Tank located onboard. After a period of settlement, the Ph of the liquid is to be chemically neutralized and decanted to the Bilge Tank, ensuring only clear liquid is decanted. This clear effluent decanted to the Bilge Tank is to be processed using the OWS observing standard operating procedures for this equipment, including appropriate entries to the Oil Record book. Details of all above operations are to be recorded in the Machinery Log Book.

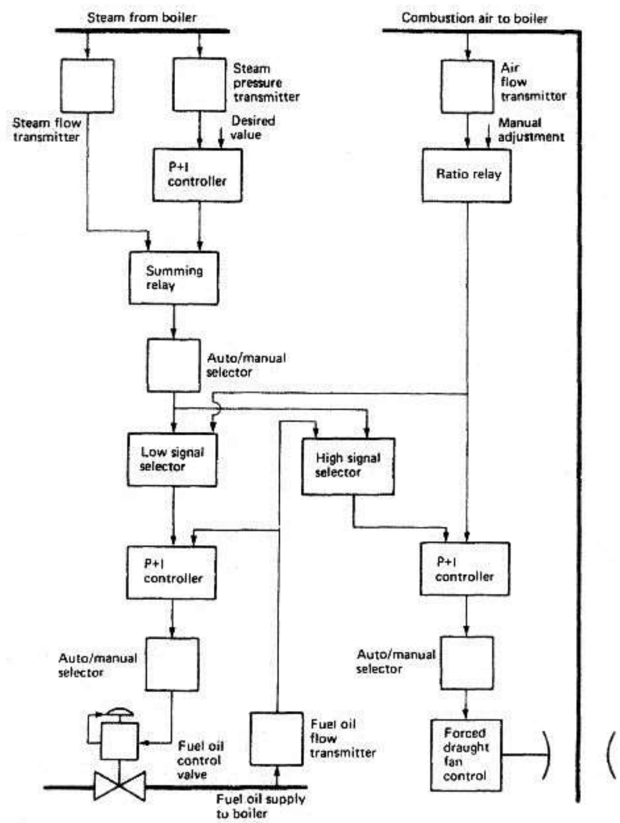
The essential requirement for a combustion control system is to correctly proportion the quantities of air and fuel being burnt. This will ensure complete combustion, a minimum of excess air and acceptable exhaust gases. The control system must therefore measure the flow rates of fuel oil and air in order to correctly regulate their proportions.

A combustion control system capable of accepting rapid load changes is shown in Figure. Two control elements are used, 'steam flow' and 'steam pressure'. The steam pressure signal is fed to a two-term controller and is compared with the desired value. Any deviation results in a signal to the summing relay.

The steam flow signal is also fed into the summing relay. The summing relay which may add or subtract the input signals provides an output which represents the fuel input requirements of the boiler. This output becomes a variable desired value signal to the two-term controllers in the fuel control and combustion air control loops.

Boiler combustion control

A high or low signal selector is present to ensure that when a load change occurs the combustion air flow is always in excess of the fuel requirements. This prevents poor combustion and black smokey exhaust gases. If the master signal is for an increase in steam flow, then when it is fed to the low signal selector it is blocked since it is the higher input value.



When the master signal is input to the high signal selector it passes through as the higher input. This master signal now acts as a variable desired value for the combustion air sub-loop and brings about an increased air flow. When the increased air flow is established its measured value is now the higher input to the low signal selector. The master signal will now pass through to bring about the increased fuel supply to the boiler via the fuel supply sub-loop. The air supply for an increase in load is therefore established before the increase in fuel supply occurs. The required air to fuel ratio is set in the ratio relay in the air flow signal lines.

Emergency fuel shut off valve: The two emergency valves fitted in a boiler fuel system are:

A quick closing valve on the settling tank which is operated from outside the engine room safety valves or cocks on each individual burner - this valve will operate in the event of high steam pressure, low water level, high water level, flame failure.

Emergency valves on burners have manual shut off for fuel, and automatic shut off in event of boiler fault.

The purpose of the recirculating valve fitted in a boiler fuel system is to enable the fuel oil to be brought up to the desired temperature quickly for combustion.

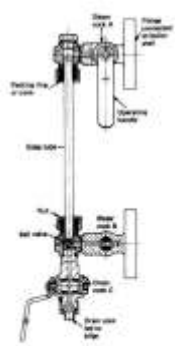
Note : The boiler fuel oil system can be changed to manual control by means of by-passing the automatic control valve and controlling the fuel oil supply pressure by means of a hand jacking valve on a spring-loaded relief valve governing the discharge pressure from the fuel oil service pumps

b. Ascertain the correct water level

Water level gauges working procedure

How to use water level gauges: The water level gauge provides a visible indication of the water level in a boiler in the region of the correct working level. If the water level were too high then water might pass out of the boiler and do serious damage to any equipment designed to accept steam. If the water level were too low then the heat transfer surfaces might become exposed to excessive temperatures and fail. Constant attention to the boiler water level is therefore essential. Due to the motion of the ship it is necessary to have a water level gauge at each end of the boiler to correctly observe the level.

Depending upon the boiler operating pressure, one of two basically different types of water level gauge will be fitted.
For boiler pressures up to a maximum of 17 bar a round glass tube type of water level gauge is used. The glass tube is connected to the boiler shell by cocks and pipes, as shown in Figure. Packing rings are positioned at the tube ends to give a tight seal and prevent leaks. A guard is usually placed around the tube to protect it from accidental damage and to avoid injury to any personnel in the vicinity if the tube shatters. The water level gauge is usually connected directly to the boiler. Isolating cocks are fitted in the steam and water passages, and a drain cock is also present. A ball valve is fitted below the tube to shut off the water should the tube break and water attempt to rush out.



Boiler Water level gauges

For boiler pressures above 17 bar a plate-glass-type water level gauge is used. The glass tube is replaced by an assembly made up of glass plates within a metal housing, as shown in Figure. The assembly is made up as a 'sandwich' of front and back metal plates with the glass plates and a centre metal plate between. Joints are placed between the glass and the metal plate and a mica sheet placed over the glass surface facing the water and steam. The mica sheet is an effective insulation to prevent the glass breaking at the very high temperature. When bolting up this assembly, care must be taken to ensure even all-round tightening of the bolts. Failure to do this will result in a leaking assembly and possibly shattered glass plates.

In addition to the direct-reading water level gauges, remote-reading level indicators are usually led to machinery control rooms. It is possible for the small water or steam passages to block with scale or dirt and the gauge will give an incorrect reading. To check that passages are dear a 'blowing through' procedure should be followed. Close the water cock B and open drain cock C.

The boiler pressure should produce a strong jet of steam from the drain. Cock A is now closed and Cock B opened. A jet of water should now pass through the drain. The absence of a flow through the drain will indicate that the passage to the open cock is blocked.

c. Check steam pressures

Steam heating boiler gauges: this article describes the pressure or sometimes combination & temperature gauges found on most steam heating systems. The steam oiler gauge gives helpful pressure readings that tell us if the boiler is operating normally.

The steam boiler pressure readings at a boiler can help diagnose problems abnormally high pressure levels that often mean problems with the steam heat distribution system or its piping. We give normal low-pressure steam heating boiler pressure numbers and we explain what variations from these data signify.

1.3. Operate Emergency equipment and apply emergency procedures

1.3.1. Knowledge of emergency duties

Drills on board ships play an important role in preparing the crew for emergency situations. The ship's engine room is a hazardous place where a variety of accidents can take place. Engine room crew members are therefore required to carry out all important drills and training procedures on regular basis to ensure safety of the ship and its crew

Mentioned below are ten important drills and training procedures for the ship's engine room.

1. Engine Room Fire Drills: Accidents as a result of fire are the most common in the ship's engine room. Fire drills, which must include fire fighters from both deck and engine sides, are to be carried out frequently to ensure that the ship's crew to well prepared for any such adverse condition. Fire drills must be performed at various levels and machinery of engine room i.e. Boiler, Generator, Purifier, Main Engine etc.

2. Engine Room Flooding Drill: A delayed action during engine room flooding can lead to loss of important machinery such as generators, main engine etc., leading to complete blackout of the ship. Engine room flooding response training and immediate repair actions must be taught to engine crew. The flooding training must include response actions to different emergency situations such as grounding, collision etc. which can lead to structural damage and flooding of water in the engine room.

3. Enclosed Space Drill: Engine room comprises of several tanks and confined spaces which are unsafe to enter without preparation and permission. Enclosed space training with risk assessment and dedicated checklists must be carried out for all ship's crew.

4. Scavenge Fire Drill: All engine room crew members must know engine scavenge firefighting procedure. The crew must know about the system that is to be employed for scavenge firefighting along with the precautions that are to be taken before implementing particular method to the engine. (For e.g. if steam is used to suppress the fire, the line should be drained before steam insertion as water in the line may lead to thermal cracks of engine parts).

5. Crankcase Explosion Drill: Crankcase explosion in the ship's engine can lead to fatal situations and heavy loss of ship's property. The crew should be prepared for taking the right action when the engine's oil mist detector gives an alarm.

6. Uptake Fire Drill: Engine crew to be well trained by frequent drills on how to fight boiler uptake fire. Crew should be trained n various stages of uptake fire and different procedures to fight these fires.

7. Oil Spill Drill: Oil carried on ship as a cargo or for use of ships machinery is handled by engine crew. It is important to know the correct oil transfer procedure.

8. Bunker Training: Bunkering is one of the most critical operations, which always involve risk of oil spill and fire. 24 hrs before every bunkering, all ship's crew must be called for meeting and complete bunkering operation should be discussed. Crew to be trained for safety signals, oil spill reporting procedure etc.

a. Shipboard Oil Pollution Emergency Plan (SOPEP)

If you are a maritime professional working on ships, SOPEP locker (room) is one of the important places which you would be asked to familiarize with in the first few days of joining a ship. Let's understand the importance of knowing SOPEP- Ship Oil Pollution Emergency Plan for a maritime professional.

When an oil spill occurs at sea, it tends to spread over the surface of the sea water, leaving a deadly impact on marine mammals, birds, the shoreline, and most importantly the ocean and the environment.

The cost to clean up an oil spill depends on the quantity and quality of oil discharged in the sea and is calculated on the basis of factors such as legal claims, money paid as penalties, loss of oil, repairs and cleanups, and the most important – loss of marine life and the effects on human health which cannot be measured against any amount.

As prevention is better than cure, in order to avoid the above mentioned monitory losses and primarily to avoid marine pollution and losses of marine species, a prevention plan is carried on board by almost all cruise and cargo vessels. This plan is known as SOPEP or ship oil pollution emergency plan.

As mentioned earlier, SOPEP stands for Ship oil pollution emergency plan and as per the MARPOL 73/78 requirement under Annex I, all ships with 400 GT and above must carry an oil prevention plan as per the norms and guidelines laid down by International Maritime Organization under MEPC (Marine Environmental Protection Committee) act.

The Gross tonnage requirement for an oil tanker, according to SOPEP, reduces to 150 GT as oil itself is a kind of cargo which doubles the risk of oil pollution.

Master of the ship is the overall in charge of the SOPEP, along with the chief officer as subordinate in charge for implementation of SOPEP on board. SOPEP also describes the plan for the master, officer and the crew of the ship regarding ways to tackle various oil spill scenarios that can occur on a ship. For oil tankers, action plan differs according to the cargo handling and cargo tanks containing huge quantities of oil.

The essential SOPEP requirements for a ship are:

1. The Ship Oil Pollution Emergency Plan must be written following the provisions of regulation 37 of Annex I of MARPOL

2. The approved plan guides the Master and officers on board the ship concerning the steps to be taken when an oil pollution incident has occurred or a ship is at risk of one.

3. It is a requirement under MEPC circular no. 256 that the SOPEP contains all the information and operational instructions related to the emergency procedure and SOPEP equipment provided in the SOPEP kit.

4. The plan must contain important telephone, telex numbers, names etc., of all the important contacts to be contacted in the event of an oil pollution

5. A recognized authority has approved the SOPEP, and there are no changes or revisions made without the prior approval of the Administration.

6. If there are any changes in the plan which is non-mandatory, it generally does not require approval from the administration. The owner and ship manager must update the appendices about the non-mandatory changes done in the plan

- **Contents of SOPEP**

SOPEP contains the following things:

The action plan contains the duty of each crew member at the time of the spill, including emergency muster and actions. SOPEP contains the general information about the ship and the owner of the ship etc.

- Steps and procedure to contain the discharge of oil into the sea using SOPEP equipment
- It contains the inventory of the SOPEP material provided for pollution prevention such as an oil absorbent pads, sawdust bags, booms etc.
- Onboard reporting procedure and requirement in case of an oil spill is described

- Authorities to contact and reporting requirements in case of an oil spill are listed in SOPEP. Authorities like port state control, oil clean up team etc are to be notified
- Authorities to contact and reporting requirements in case of an oil spill are listed in SOPEP. Authorities like port state control, oil clean up team etc. are to be notified.
- SOPEP includes drawing of various fuel lines, along with other oil lines on board vessel with the positioning of vents, save all trays etc.
- The general arrangement of the ship is also listed in SOPEP, which includes the location of all the oil tanks with capacity, content etc.
- The location of the SOPEP locker and contents of the locker with a list of inventory
- Guidance to keep the records of the pollution incident (for liability, compensation and insurance purpose)
- Material for Reference from essential organizations (guidelines issued by ICS, OCIMF, SIGTTO, INTERTANKO, etc.)
- Procedures for testing various plan described in the SOPEP
- Procedure to maintain the record as required by the authorities
- Details of when and how to review the plan
- The overview of general duties of ships' crew under SOPEP:

Example of responsibilities and duties of the crew:

MASTER: He/she is overall in charge of any incident related to the oil spill and should informing the authorities about it. He/she needs to ensure all crew members are complying with the plan and records are maintained for the incident

CHIEF ENGINEER: He/she will be the in charge of the bunkering operation and will instruct the subordinates to prepare SOPEP KIT prior to any oil related operation (Sludge transfer, lube oil bunkering, fuel oil bunkering etc.)

CHIEF ENGINEER: should keep the Master informed and updated on the situation, and the results from action taken to limit oil outflow.

CHIEF OFFICER: He/she will be the in charge of complete deck operation to prevent any oil spill or in the event of a spill, the Chief Officer must keep the master in the loop at all times and update the situation and action taken to stop or reduce an oil outflow.

DECK DUTY OFFICER: To Assist the chief officer in deck watch and Alert and inform Chief Officer/ Chief Engineer on any potential oil spill situation.

DUTY ENGINEER: To assist Chief Engineer for any oil transfer operation which includes preparation of SOPEP material and readiness of firefighting equipment.

DUTY RATING(S): To assist and alert the duty officer and engineer for detection of potential oil leakage and to immediately assist by all possible means to restrict and clean an ongoing spill. He/she should bring the additional SOPEP material to the location for preventing oil from reaching the ship's railing.

SOPEP does not only provide details for preventing and fighting an oil spill, but it also acts similar to any other regulation of SOLAS as it also has the details to save the ship and crew in the event of mishap such as fire, collision, listing etc. and other related incident related to oil.

b. Procedures to follow in the event of oil spill

Prevention of oil has as much to do with operational procedures as it does with modern technology and equipment. Following appropriate protocols, as well as maintenance procedures, ensures the safe operation of equipment, aiding in the goal to prevent spills from ever occurring.

Extensive steps are in place to ensure that operators follow safe operating procedures. Specific Spill Prevention, Control and Countermeasure Plans (SPCC) outline an operator's prevention procedures and are required by the EPA. Best practices are shared across industry to highlight common general prevention measures and share case studies. Maintenance procedures require regular testing and inspection of both processes and equipment.

Ensuring process safety minimizes the risk of a spill and protects the health and safety of people and the environment. Operational and maintenance procedures are both encouraged and mandated across industry. Prevention, however, is not just the job of industry; consumers also play an important role in keeping oil and other fuels out of the environment by observing proper handling and disposal practices.

Procedure adopted during bunker spill will be as follows:

- Sound the emergency alarm.
- Initiate emergency shutdown, stop all transfer and bunkering operations, close all valves and inform the barge or terminal.
- Inform the master and initiate the emergency response procedures.
- Inform the port or local state authority.

Follow up Actions on oil spill during bunkering:

- Identify the source of spill or leak and initiate measures to stop or minimize the overflow.
- Drain or transfer the oil from affected area of the pipeline into empty tanks taking into account stress and stability of the vessel at all times.
- If there is a possibility of release of flammable vapors or its entry to the accommodation, engine room or cargo holds, ventilations to these areas must be shut off.
- Clean up operations must be started using the equipment available onboard.

- All spilled oil that is collected must be carefully stored onboard till it can safely be disposed off.
- No chemical or dispersant to be used if there is a possibility of them going into the water unless prior permission has been obtained from the port authority.
- Oil gone overboard should be contained so that it will not spread and oil dispersants to be used after getting permission from local authorities.

After the spill has been completely brought under control, oil spilled overboard and onboard ship has been removed and the cause of spill ascertained and corrective actions taken, the vessel can resume bunkering operation.

The chances of recurrences must be completely eliminated before starting bunkering.

Before resuming bunkering, permission from port or local authorities must be taken.

All incidents and corresponding actions to be recorded as it is required for further litigation purposes.

1.3.2. Escape routes from machinery spaces

Very important, if not the most, to the ship and its safety performance is the proper operation of equipment located in machinery spaces. Machine devices and their functions should also be continued in such circumstances, when the functions of the other devices have been violated, or where the vessel as the object is in a state of emergency.

On several occasions, the crew must comply with its obligations in machinery spaces to the last moments before leaving the vessel since the functioning of the machinery is dependent on the safety of the ship or the effective evacuation of the remaining passengers and crew from the ship.

In case of fires, the relatively frequent in machinery spaces, the crew should be able to safely leave the room. Complex spatial structure of space, complicated pathways and exits from each floor, and the inability to predict the location of potential sources of fire, force designers to place at least two exits from the main machinery space. Much less frequently this principle is implemented in the case of smaller compartments arranged inside the main engine room.

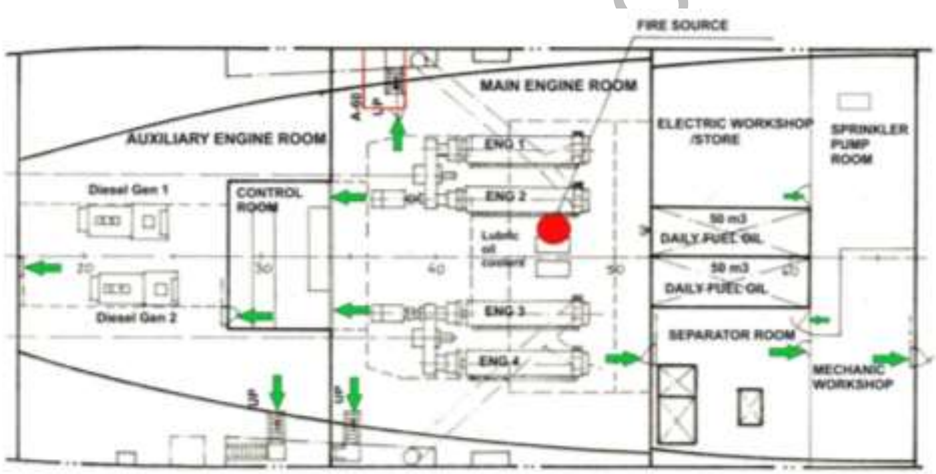
Escape routes from machinery spaces the following aims:

- Access for daily maintenance of equipment
- During routine placement of watch or review the status of devices;
- Transport of components and tools for the repair and refurbishing of the equipment;
- The movement of rescue teams and fire-fighters in the event of a fire, which should make it possible to navigate through the rescue team sand fire-fighters in protective clothing with breathing apparatus, the delivery of firefighting equipment, including at least water hoses with nozzles;
- Route of escape for the crew in the event of dumping of machinery room space;
- Road access for rescue workers with equipment to remove water, smoke, gas freeing after use of fire-extinguishing medium – after finishing the rescue action;
- Road for transport of accident victims, which should enable the movement of rescue workers with a piece of equipment, for example medical stretcher and breathing apparatus.

Fatal accidents are still at the time of the events, in particular fire in machinery spaces, which could be avoided, if there was a larger number of escape routes. It forms the basis for discussions on the regularity of solutions to the escape routes from machinery spaces on ships, including in the sphere of the provisions in force.

- **Requirements regarding the number and placement of escape routes.**

The basic requirements for escape routes on ships, which are also valid for the machinery spaces, are contained in regulation II-2/2.1.1.5 of SOLAS-1974: “provide adequate and readily accessible means of escape for passengers and crew " in the regulation of the Convention regarding the main objectives of the fire protection of vessels and functional requirements, which are contained in the chapter II-2 of SOLAS-1974. This is repeated in a similar manner in the functional requirements in regulation II-2/2.2.1.6: “protection of means of escape and access for firefighting”.



The arrangement of escape routes and exits in machinery spaces: main and auxiliary engine rooms, control room and work-shops on the ferry m/f "Mikolaj Kopernik" in relation to the place of the source of fire in the main engine room

Detailed requirements regarding the escape routes from machinery spaces are included in respect of passenger ships in regulation II-2/13.4.1, for cargo ships in regulation II-2/13.4.2 of SOLAS 1974. Requirements for passenger ships applies to all types of machinery spaces and differ depending on whether spaces are located, above or below the bulkhead deck.

For cargo ships, these requirements are more restrictive for machinery spaces of category A, which contain internal combustion machinery used for main propulsion, and other internal combustion engines which are not used for main propulsion, for example: engines, generators, aggregates – of the total power of not less than 375 kW or any boilers fired with liquid fuels, or other devices, such as, for example incinerators. These requirements for the escape routes from machinery spaces of category A for cargo ships are similar to the requirements for machinery spaces situated below the bulkhead deck on passenger ships and provide one of the following provisions of the possible evacuation:

1. Two sets of steel ladders, as widely separated away from each other as possible, leading to doors in the upper part of the machinery space, from where they should have access to the open deck. One of the ladder should be located within protected enclosure, satisfying requirements for class A-60 fire divisions, throughout the height from the lowest level of the machinery space to the level of exit to the safe area. The entrances to such enclosed space with ladder inside should lead by self-closing fire doors of the same class A-60, placed at every level of the entrance to the ladder enclosure. In addition, these are also the requirements of the minimum cross-section of such enclosure 800 mm x 800 mm, and the emergency lighting within the enclosed ladder space;

2. One steel ladder leading from the lowest level of the machinery space to the exit in the upperpart of the premises, offering access to the deck and additionally, in a place far from the entrance to such ladder, output by the steel doors with possibility to open and close from both sides, which leads a safe escape route from the lower part of the engine room to the open deck.

In practice, solution 1 will meet more frequently on ships powered by medium-speed engines, with gear box and two or more propellers, if there is no shaft tunnel. Solution 2 is typical of the engine room located aft on cargo ships, powered by the low-speed engine with one screw propeller. Escape route from the lowest part of the engine room leads, as a rule, by a narrow corridor along the shaft tunnel, or separated corridor along with, to the steering gear compartment, where the exit door directs to the corridor leading to open deck. On smaller ships by a steel ladder from steering gear compartment and hatch on the open deck.

One difficulty designers and Maritime Administration makes while Regulation II-2/13.4.1.3 and II-2/13.4.2.2 of SOLAS-1974 are applied, which concern, respectively, the exemption from the requirements of two escape routes from machinery spaces, respectively, on passenger ships and cargo ships.

1.3.3. Familiarity with the location and use of firefighting equipment in the machinery spaces

Without doubt, one of the main causes of accidents onboard ships is fire. This is because of the presence of high temperature, excess quantity of flammable oil and other combustible materials. A ship is approved to sail in international waters only if it is constructed as per Fire Safety System code and carries required Fire Fighting Appliances approved by the concerned authority.

A ship is fitted with various types of fire retardant and firefighting equipment's so as to fight any kind of fire and extinguish it as soon as possible before it turns into a major catastrophic situation.

An extended period of time onboard a ship without a fire incident can lead to complacency and a failure to prioritise fire prevention measures and simulated fire incident practices.

The risk of a fire can be substantially reduced by:

- Maintaining a clean and tidy engine room.

- Ensuring that machinery and emergency control equipment are installed and operating in accordance with SOLAS Regulations and IMO Guidelines and they are routinely serviced and maintained in good working order, and subject to routine testing.
- Ensuring that hot surfaces are shielded and clad in accordance with SOLAS requirements.
- Ensuring that emergency equipment such as oil tank quick closing valves, fire pumps, remote stop systems and fire fighting apparatus are generally armed and immediately ready for use.

DO:

- Ensure that oil leaks are attended to promptly by effecting permanent repairs.
- Ensure that where required by SOLAS II-2, oil pipes are sleeved and pipe joints are shielded, and that all oil pipework is adequately supported in correct fitting pipe clamps.
- Carry out routine temperature measurements of shielded or clad hot surfaces to ensure that even small parts are not exposed. This can be achieved by using an Infra-red temperature gun.
- Ensure that oil leak alarms on generators are in good operating order.
- Ensure that engine room stores are tidy and that packaging material is not close to light fittings.
- Ensure that engine room workshops are kept tidy, the floor area is clear of combustible materials and that cotton waste or rags are stored in a metal bin fitted with a lid or in metal cupboards.
- Ensure that drain lines in oil tank save-alls are clear and the save-alls are kept clean and free of solid materials such as cotton waste or rags.
- Ensure that oil tank gauge glass self-closing cocks are unrestricted and operating correctly.

- Ensure that oil tank quick closing valves are properly armed and that they are tested regularly.
- Ensure that fire detection equipment is properly maintained and operable.
- Ensure that automatic closing mechanisms on all fire doors within and at the boundaries of the engine room are working correctly.
- Ensure that ventilation closures are operable, are visually free of corrosion and provide a reasonable seal.
- Carry out routine inspections of electrical equipment to include (i) the insulation resistance of cables and equipment where appropriate (such as motor windings) and (ii) visual inspections of terminal connections and Infra-red temperature gun measurements.
- Ensure that portable fire fighting appliances are correctly positioned and serviced.
- Ensure that all hydrant outlets are accessible, and operable.
- Ensure that fixed fire fighting installations are properly maintained and armed.
- Carry out routine fire drills to address different simulated fire incidents in various parts of the engine room.
- Ensure that responsible persons are fully familiar with the correct operating sequences for the CO2 and foam fire fighting systems so that valuable time is not wasted.
- Ensure that oxygen, acetylene and propane cylinders are safely stowed in a ventilated compartment above deck and provided with correct regulators, flash back arrestors and shut-off valves. Ensure that cylinder valves are isolated when systems are not in use.
- Ensure that escape routes are clearly marked by using deck plate arrows and that exit doors are readily visible.

DO NOT

- Allow smoking in the engine room other than in the control room where suitable arrangements are provided for the disposal of waste smokers' material.
- Make temporary repairs to oil containing pipe work.
- Work on pressurised fuel systems.
- Secure open self-closing oil tank gauge glasses.
- Secure open by external means oil tank quick closing valves.
- Secure open fire doors within and at the boundaries of the engine room.
- Carry out hot-work in the engine room without a correctly completed, properly considered permit to work and until all necessary hot work precautions are in place.

- **Important firefighting equipment's and measures present on board**

Following are the Firefighting equipment's which used onboard ships are:

1. Fire Retardant Bulkhead: Different Class of bulkhead such Class-A, Class-B and Class-C are used on board ship for construction of bulkhead in areas like accommodation, machinery space, pump room etc. The main applications of such bulkhead are to contain or restrict the spread of fire in sensitive areas.

2. Fire doors: Fire doors are fitted in fire retardant bulkhead to provide access from the same. They are self-closing type doors with no hold back arrangement.

3. Fire Dampers: Dampers are provided in the ventilation system of cargo holds, engine room, accommodation etc. in order to block out excessive oxygen supply to the fire. For this, it is necessary that open and shut position clearly marked for fire dampers.

4. Fire Pumps: As per regulation, a ship must have main fire pump and an emergency power pump of approved type and capacity. The location of the emergency fire pump must be outside the space where main fire pump is located.

5. Fire Main Piping and Valves: The Fire Main piping which is connected to the main and emergency fire pump must be of approve type and capacity. Isolation and relief valves must be provided in the line to avoid over pressure of the same.

6. Fire Hose and Nozzles: Fire hoses with length of at least 10 meters are used in ships. Number and diameter of the hoses are determined by the classification society. Nozzle of diameters 12 m, 16 m and 19 m used on ship are of dual purpose types- Jet and spray mode.

7. Fire Hydrants: Fire hoses are connected to fire hydrants from which the water supply is controlled. They are made up of heat retardant material to get least affected from the subzero temperatures and also to ensure that hoses can be easily coupled with them.

8. Portable Fire Extinguishers: Portable fire extinguishers of CO2, Foam and Dry Chemical Powder are provided in accommodation, deck and machinery spaces carried along with number of spares as given by the regulation.

9. Fixed Fire extinguishing system: CO2, Foam and water are used in this type of system, which is installed at different locations on the ship and is remotely controlled from outside the space to be protected.

10. Inert Gas System: The inert gas system is provided in the oil tankers of 20000 dwt and above and those which are fitted with Crude oil washing. The IG system is to protect Cargo space from any fire hazards.

11. Fire Detectors and Alarms: Fire detection and alarm systems are installed in Cargo area, accommodation, deck areas, and machinery spaces along with alarm system to notify any outbreak of fire or smoke at the earliest.

12. Remote Shut and Stop System: The remote station shutdown is provided to all fuel lines from fuel oil and diesel oil tanks in the machinery space and which is done by quick closing valves. Remote stop system is also provided to stop the machineries like fuel pumps, purifier, ventilation fans, boiler etc. in the event of fire in the engine room or before discharging fixed firefighting system in the E/R.

13. EEBD: EEBD (Emergency Escape Breathing Device) is used to escape from a room on fire or filled with smoke. The location and spares of the same must be as per the requirements given in FSS code.

14. Fire Fighter's Outfit: Fire fighter's outfit is used to fight a fire on the ship made up of fire retardant material of approved type. For a cargo ship at least 2 outfits and for passenger ship at least 4 outfits must be present onboard.

15. International Shore Connection (ISC): ISC is used to connect shore water to the ship system to fight fire when the ship fire pump system is not operational and is on port, lay off or dry dock. The size and dimensions are standard for all the ship and at least one coupling with gasket must be present onboard.

16. Means of Escape: Escape routes and passages must be provided at different location of the ship along with ladders and supports leading to a safe location. The size and location are designed as per the regulation.