**MARC047** Manage a propulsion unit using appropriate engine systems and support services/

**MARB046** Plan and supervise routine maintenance on a vessel up to 80m

# MARC047

Manage a propulsion unit using appropriate engine systems and support services

# Prepare for service and maintenance work

- Every vessel as part of the SMS system must have a planned maintenance system which engineers, masters and crew must follow.
- Every vessel must have operating procedures in the SMS which engineers, masters and crew must follow.
- After every trip you need to assess the maintenance and servicing that is required before the vessel goes back to sea
- If at sea for extended periods you need to access the planned maintenance to assess what will need servicing before the vessel returns to port.
- You will need to ensure you have the required parts and materials on board, plus spares in order to meet your obligations for maintaining the ship under the NSCV and OH&S

# Preparing for operation and sea

- Before starting any machinery consult the SMS for the correct procedures
- Collect the prestart check sheets and complete them as you conduct the prestart checks.
- Any faults found must be fixed before proceeding to sea or a risk assessment done to assess the impact on operations.
- Confirm and ensure all equipment is operational before casting off the lines

## Prepare for service and maintenance work

- You must make and record regular inspections of operating machinery, this will also identify other items that may require maintenance other than what is planned.
- Before starting any servicing or maintenance work, consult the manufacturers hand books and technical manuals for the correct procedures and specifications.
- Failure to consult the manuals could breach OH&S

## Prepare for service and maintenance work

- The ships SMS system must have a technical manual for the ship, this should contain all manufacturers manuals for the ships equipment. Including servicing and maintenance instructions for ALL EQUIPMENT
- If you do not have these manuals you need to obtain them from the manufacturer or GOOGLE is a good friend especially for older equipment
- Don’t sail with out the manuals.

## Prepare for service and maintenance work

- Maintenance needs to be planned with all crew on board, including shore based staff if they are required to carry out any work.
- Before starting any servicing work ISOLATE the equipment to be worked on, affix DO NOT USE LABELS, remove keys, and make sure crew know of work being carried out
- Good communications are the key to a safe work place for all.

## Prepare for service and maintenance work

- All ways select the appropriate tools for the job, do not use tools that are damaged or worn.
- Make sure you use the appropriate PPE
- Make sure you have all the correct  parts and materials on hand.
- Make sure the area is cleared away and free from clutter that could cause you to fall, stumble, trip or slip.

## Prepare for service and maintenance work

- Carry out all identified service work to specification and be observant for abnormal wear or deterioration.
- Do regular oil sample analysis for early warning of problems that can not be seen.
- Always replace worn components with manufacturer approved parts and adjust to manufacturers specifications or you will not be meeting your OH&S requirements.
- After work is completed always do an operational check before returning it to operational service

## Prepare for service and maintenance work

- Clear away and clean up work area and dispose of all materials in accordance with company policies and procedures and laws
- Document all materials disposed of in oil or garbage disposal logs
- Complete maintenance paper work, fill out engineers log, service reports, sign of defect reports if you have fixed a registered defect
- Clean and pack away tools and order replacement parts for those used to maintain spares levels.
- Every vessel must carry sufficient tools to carry out diagnosis, service and repairs at sea, tools need to be in good condition and checked to insure they are all there.

# Marine Diesel Engine Theory MARC011

***Basic Engine Terminology***

## Internal combustion engines = I.C. Engines:

Conversion of chemical energy (Fuel Energy) to mechanical energy within the engine itself

Types: S.I. or C.I. Engines

*** S.I. Engines Spark Ignition**

**Petrol & LPG**

**Combustion occurs with the ignition of a fuel/air mixture by a spark**

**C.I. Engines: Compression Ignition Diesel – Crude**

** Combustion occurs with the injection of atomised fuel into highly compressed (heated) air

## *Engine Terminology 2*

**Stroke** Distance travelled by the piston from top dead centre (TDC) to bottom dead centre (BDC)

**Cycle** All the events that occur from one firing point in a cylinder to the next in that cylinder

Engine types

- 4 Stroke Cycle
  - Induction
  - Compression
  - Power
  - Exhaust
- 2 Stroke Cycle
  - Power – Exhaust – Induction
  - induction – Compression – Ignition

***4 Stroke Cycle*** - S.I. Petrol C.I. Diesel

1 Rev Of Crank

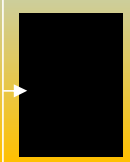
1st Stroke ↓ Induction of a fuel air mixture

Induction of AIR only

2nd Stroke ↑ Compression of fuel/air mixture to high temp. & pressure

Compression of AIR to very high temps. & pressures

Ignition by a spark Injection of atomised fuel



1 Rev Of Crank

3rd Stroke ↓ Power

Power

4th Stroke ↑ Exhausting of Waste Gases

Exhausting of Waste Gases

# *2 Stroke Cycle* S.I and CI.

1 Rev Of Crank

1st Stroke

Power – Exhaust opens – Start of transfer of fuel/air mix from crankcase to cylinder

Power – Exhaust opens – Scavenging Commences

2nd Stroke

Transfer ceases – Exhaust shuts – Compression of Fuel/Air Mixture

Scavenging Ceases – Exhaust shuts – Compression of AIR

Ignition by a spark

Injection of atomised fuel

## *Engine Terminology*

| | |
|---|---|
| Compression Ratio | ** Ratio of the volume contained in the cylinder with piston at BDC compared to volume in cylinder with piston at TDC ** |
| Calorific Value | ** Amount of heat energy contained in the fuel ** |
| Thermal Efficiency | ** The measure of engine ability to convert the heat energy in the fuel to useful mechanical energy ** |
| Scavenging | ** The removal (Washing Out) of exhaust gases with fresh incoming air |
| Turbulence | ** The movement created in the air in the cylinder to promote better mixing of fuel with air in order to obtain more complete combustion ** |

## Engine Terminology 4

Volumetric Efficiency: the measure of the engine ability to replace the contents in the cylinder with a fresh incoming charge.

The open combustion chamber (Direct injection): Usually marine type engines where atomised fuel is injected directly into the cylinder

Precombustion chambers (Indirect Injection): This system uses a small auxiliary chamber situated in the cylinder head & connected directly to the main chamber by a small passage. Atomised fuel is injected into this auxiliary chamber.

Indirect injection is usually found on lighter lower compression ratio engines. (a starting aid, glow plug, is required for cold starts)

## *Engine Terminology*

Valve Overlap: The period in the engine's cycle when both Inlet & exhaust valves are open at the same instance.

Valves on the rock: the period when exhaust valve is closing
& inlet valve is opening (valves seen to be rocking)

Dwell period: the time delay between the end of valve opening & start of closing (peak and width of cam lobe)

Cam Lift: the amount of eccentricity of the cam.
(amount of opening of valve)

Power Overlap: the period in the engines operation when more than one cylinder is on power.

Inertia: Resistance offered by a body to a change in its state of rest or uniform motion

Force: the action that changes or tends to change the state of rest or uniform motion of a body
Unit of force is a NEWTON (N)

Work: work is done when the application of a force moves an object over a distance N x m = Nm
Unit of work is the JOULE (J)

Power: This is the rate of doing work
Unit of Power is the WATT (W)

Torque: torque is the turning effect about a point. In an engine this will include the force acting on the piston through the connecting rod & the effective turning action on the crankshaft.
Unit of torque is the NEWTON METRE (Nm)

# *Comparison chart C.I. to S.I. Engines*

| Feature | High Speed Diesel | Petrol |
|---|---|---|
| Fuel Admission | **Fuel injection into combustion chamber** | **Carburettor or Fuel injection to intake port** |
| Compression Ratio | **From 14:1 to 24:1** | **From 7:1 to 10:1** |
| Ignition | **Compression heat** | **Electric Spark** |
| Torque | **Varies little with speed** | **Varies a lot with speed** |
| Brake thermal effic. | **35 – 40%** | **25 – 30%** |
| Exhaust gases | **Non-poisonous** | **Poisonous** |
| Engine construction | **Robust** | **Lighter than diesel** |
| Max. crankshaft r.p.m | **2500 to 5000 rpm** | **4000 to 6000 rpm** |
| Compression pressure | **Actual 3100- 3800kPa** | **Actual 750-1400kPa** |
| Compression Temps. | **Actual 425 - $550^0$C** | **Actual up to $230^0$C** |
| Fuel Used | **Diesel/Distillate** | **Petrol/LPG** |

# Engine protection devices

## Low oil pressure alarm

The oil pressure alarm consists of a pressure switch fitted to the pressure side of the lubricating oil system, usually into an oil gallery. The oil pressure acts on a diaphragm and spring which open the contacts in a micro switch. When the spring pressure is greater than the oil pressure, the contacts will close and sound the audible alarm. If an alarm switch is fitted, switch it on. When the engine is started, the oil pressure switch opens as the oil pressure reaches approximately 69 kPa (10 psi) and the alarm will cease to sound. Likewise, if the oil pressure drops below the setting of 69 kPa (10 psi), the oil pressure switch will close the circuit and sound the audible alarm.

The alarm will continue to sound until the engine is stopped or if an alarm switch is fitted, it is switched off.

# Engine protection devices

## •High temperature fresh water alarm

•The high temperature fresh water alarm consists of a thermo switch. It has a bi-metal probe that activates contacts in a micro switch. It is installed in the side of the thermostat housing.

•When the engine is started and running at normal operating temperature, the contacts in the switch will be open. Should the engine coolant exceed say 96°

205° F) the water temperature switch will close the electrical circuit and sound the audible alarm.

•The alarm will continue to sound until the temperature drops below the above mentioned setting.

# Engine protection devices

**Murphy Gauges**

A large number of engines are also fitted with Murphy Gauges engine. This additional sensor monitors the level of coolant in the header tank of the cooling. It will also sound the alarm on a large loss of coolant. A big and sudden loss in coolant may reduce the coolant level to below the probe in the thermostat housing. As the water is not now circulating over this probe, it will not detect the rise in temperature of the coolant.  An additional sensor may also be fitted into the exhaust pipe to detect the rise in temperature due to overheating.

# Engine protection devices

## Emergency stop device

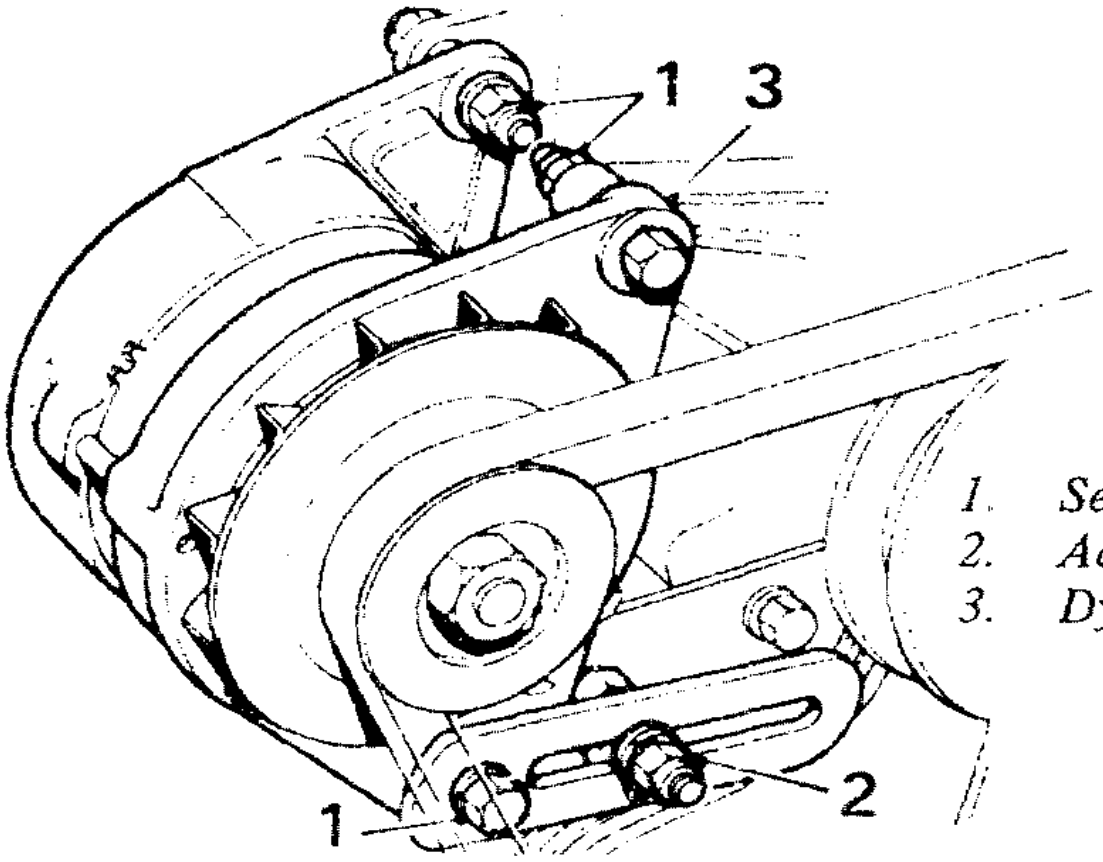
Numerous diesel engines are fitted with a manually operated emergency engine shut down device. This is mounted in the air inlet housing, to stop the engine if an abnormal condition should arise. If the engine continues to run after the engine throttle is placed in the “no fuel” position, or if combustible liquids or gases are accidentally introduced into the combustion chamber causing over speeding of the engine, the shut down device will prevent damage to the engine by cutting off the air supply and thus stopping the engine.

The shut down device consists of an air shut off valve (flap) mounted in the air inlet housing which is retained in the open position by a latch. A cable assembly is used to remotely trip the latch. The shut off valve must be manually reset on the latch for restarting the engine after the malfunction has been rectified.

## SERVICING ENGINES AND AUXILIARIES

- Follow manufacturers instructions
- Do oil samples for analysis
- Change oil and filters
- Change clean air filters
- Change fuel filters
- Grease and lube linkages and check for wear
- Check valve clearances
- Check timing, pumps and valves
- Check drive belt condition and tension
- Check secureness of mountings and fixings
- Check coolant inhibitor strength
- Check operation of engine alarms
- Check for oil and coolant leaks
- Check battery cable terminals are clean and tight
- Check water intake filters clean and exercise and lubricate valve stems

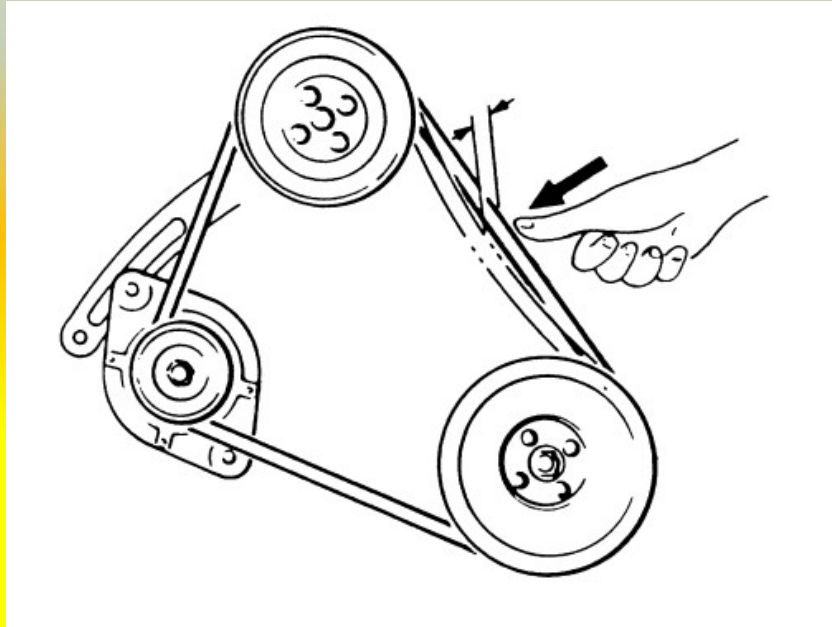
# Adjust Drive Belts




1. *Securing bolts*
2. *Adjusting link nut*
3. *Dynamo/alternator*

**Fan belt adjustment**

# Adjust Drive Belts



# Transmission Systems Maintenance

- Check oil levels and check for leaks, change oil and filters as per planned maintenance system
- Grease swivel pins, out drives and outboards
- Adjust stern gland packing tension
- Check operation before every trip
- Out drives require specialist tools to service and are prone to water in the gear box just like an outboard, they have lots of maintenance issues
- Jet drives, stern drives and all stern gear require regular inspection of anodes especially on any aluminium parts

# Transmission Systems Maintenance

- Check security of propeller nut and locking devices
- Check for wear in stern bearings
- Check for wear in rudder bearings and stock
- Check water flow through stern bearings as waterways block up with marine growth

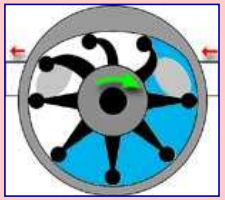
# BILGE PUMPING

| PROBLEM | SOLUTION |
|---|---|
| Not pumping | Bilge compartment not selected |
| Not pumping | Bilge suction blocked |
| Not pumping | Bilge pump not operating |
| Not pumping | Broken pipe/hole in suction line |

# BILGE PUMPING PROBLEMS

**Mechanical Pump Failure**

- Check power switch is on (electric pump)
- Check clutch engagement (mechanical drive)
- Check mechanical drive coupling connection
- Check condition of pump impeller

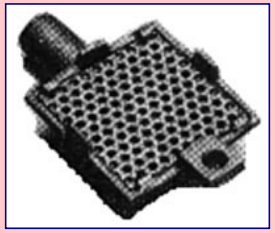


**Air Leaks**

- Check suction side of pump piping for corrosion holes
- Leaking gland on pump drive shaft
- Leaking gland on valve/s
- Empty compartment/s selected

**Blocked Bilges**

- Check strum box (strainer)



# BILGE PUMPING PROBLEMS

**Dangers of High Bilge Levels**

- **Free surface effect on stability**
- **Fire hazard due to oil in bilges**
- **Dangerous/explosive gasses from bilges**
- **Slippery/dangerous surfaces to work on**
- **Corrosion**
- **Oil/Water splashing on machinery**
- **Effect on trim, heel and draft of ship**
- **Lack of cleanliness**
- **No/poor visibility to lower spaces covered by bilge water/oil**

# BILGE PUMPING MAINTENANCE

- Exercise all valves and lubricate shafts monthly
- Check strum boxes clear and bilges free of debris
- Start and run pumps, put flexible bucket under suction to prove system works
- Check non return valves working and system does not back flood
- Check condition of any anodes in system
- Clean and paint rusty pipes
- Check for excessive corrosion and possible holes

# Fire protection  equipment and devices

**Fire detection systems require regular checking by crew to ensure that they are in operational order check back up battery condition, test call points, smoke and heat sensors and alarms every month.**

**Check condition of water tight bulkheads and sealing devices, automatic door closers, ventilation fan emergency shut offs these are also static fire protection devises**

**Record checks and fix all faults before sailing**

# Fire fighting equipment

Every piece of fire fighting equipment shall have a regular maintenance schedule and inspection regime on top of the statutory inspections by a licenced qualified person every 6 months.

Engineers and crew should be inspecting and testing each piece of equipment every month at least and recording the results.

Drills shall also be carried out every 2 months at least to ensure the crew know how to efficiently operate the equipment on board and recognise faulty equipment

# Fire fighting equipment

## Monthly Checks on board

Check both main and auxiliary pumps work efficiently
Check water intake filters are not blocked
Check all valves work, including fuel shut off valves
Check hose connectors are not seized and are working
Check fire extinguishers are charged, powder is free
Check all equipment storage brackets are sound
Check all equipment is within inspection dates
Fire plans are in place and readable
Check BA and EEBD cylinder pressures

# Fire and Lifesaving appliances

## Fire and life saving  consumables

**Batteries in Radios, EPIRBS, SARTS, torches, life raft lights, life jacket lights, Dan buoy lights, fire panel back up batteries.**
**Supplies in first aid kits on the vessel and in the life raft and boat life raft and Life boat emergency rations and water.**
**MOB smoke signals.**
**Flares in the life raft, life boat and the main vessel.**
**Powder and chemicals in the fire extinguishers.**
**Air in the BA and EEBD normally changed each year at service.**
**Hydrostatic releases on the life rafts.**
**Chemical pipe repair bandages and epoxy repair putty have expiry dates.**
**Any more you can think of ??**

# Fire and Lifesaving appliances

**Legislation,**

**Marine orders part 28 deals with life saving and fire equipment testing and maintenance.**
**Navigation act 2012 and domestic law of 2012**
**NSCV and the USL code also cover these items**
**TOMSA, TOMSR and OH&S**
**Class society rules.**
**A Certificate for safety equipment is required each year by an approved surveyor to ensure that it all meets statutory requirements.**

# Survey Requirements

- At each yearly survey inspection the surveyor will test the operation of all bilge and fire pumps. Fire hoses, bilge and fire systems for operation. Main and auxiliary machinery. Operation of transmission, operation of steering system and emergency steering.
- Every 2 years the surveyor will inspect all underwater transmission parts and rudders.
- Every 4 years the propeller shafts will have to be removed for inspection
- Every 8 years the rudder shafts will have to be removed for inspection

# **MARC047** Manage a propulsion unit using appropriate engine systems and support services

**ECA Maritime College**

Master <35m (NC)

We will be looking at;

- ✓ Common terms used
- ✓ Series and parallel circuits
- ✓ Methods of protection
- ✓ Extra Low Voltage (ELV) System
- ✓ Stray currents
- ✓ Battery charging alternators
- ✓ Charging system failures

# Common Terms

## Voltage (v)

Volts is the unit of electromotive force (EMF) and potential difference (PD) or, the pressure or available force or potential to cause a current to flow through a conductor. Unit = Volts (V) Symbol = E

## Current (A)

The amount of electrons flowing through a conductor
Unit = Ampere (A) Symbol = I

## Resistance (OHM)

All conductors resist the flow of electric current (except super conductors) converting a portion of the electrical energy into heat
Unit = OHM (R ) Symbol = R

## Power (Watts)

The amount of work done in one second with a potential difference of one volt and a constant current of one ampere.
Unit Watts (W) or Joules Symbol = P

# Common terms

Power = Volts x Amps
Power = Amps squared x resistance $P = I^2 \times R$
Power = Volts squared divided by resistance $P=E^2 / R$
Therefore
Volts times amps = watts i.e. 12 volts X 2 amps = 24 watts
Or at 24 volts x 1 amp = 24 watts
Hence to pressure has increased and the current decreased for the same amount of work done or light given
Volts divided by Amps = resistance IE 12 volts divided by 2 amps = 6 OHMs

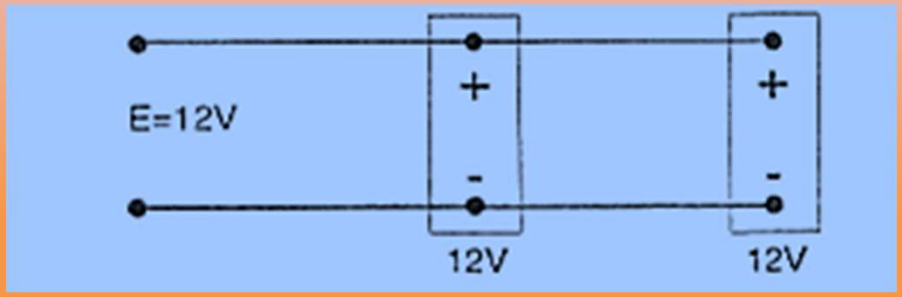
# Amp Hours

The amount of energy stored in a battery, IE 100 amp hrs battery = 100 amps for 1 hour or 1 amp for 100 hours in theory.
In practice you will only get a little over half as when the battery starts to discharge the voltage will start to drop and hence the amperage drawn will rise and the battery will drain faster

# Series and parallel circuits

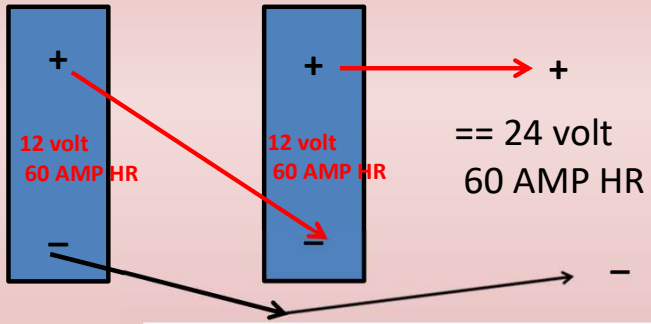
A l2 volt lead acid battery would have 6 x 2 volt cells connected in series


Two 12 volt batteries connected in parallel  equals 12 volts but double the amperage capacity

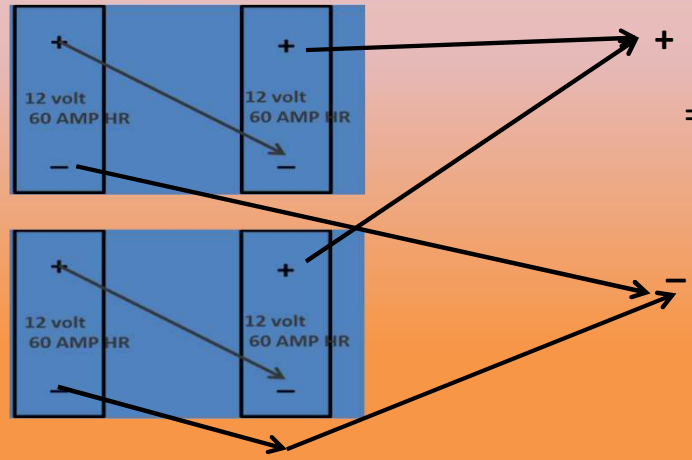


# Series and parallel circuits

## Batteries connected in series




## Batteries connected series Parallel



## Series and parallel circuits

In the case of two batteries in parallel, they still have the same voltage, but there is an increase in the capacity ( AMP HR) it doubles. That is, if the batteries were each rated at 60A.H., in parallel they would increase the capacity to 120 A.H.

When you connect batteries up in Series then if you were connecting up two batteries then the voltage would double but the capacity would be that of only one battery IE 2 two 12 volt 60 AMP HR batteries connected series would give 24 volts @ 60 AMP HR

Eg. When you jump start your motor car. you connect the two batteries in parallel.

# Methods of protection

To protect circuits (and users) from electrical accidents, the first priority is, **The system must be a 2 wire insulated return**. This means that no part of the circuit is connected to any ground or equipment. The system is completely isolated including engine sensors, starter motors and alternators. **This is called wired above ground,** Not like in automotive where the negative is grounded to the chassis of the vehicle and is called negative earth

There should be a main 2 pole isolator and fuses or circuit breaker adjacent to the battery bank. This would be an enclosed type so that no sparks or arcs could risk battery explosion.

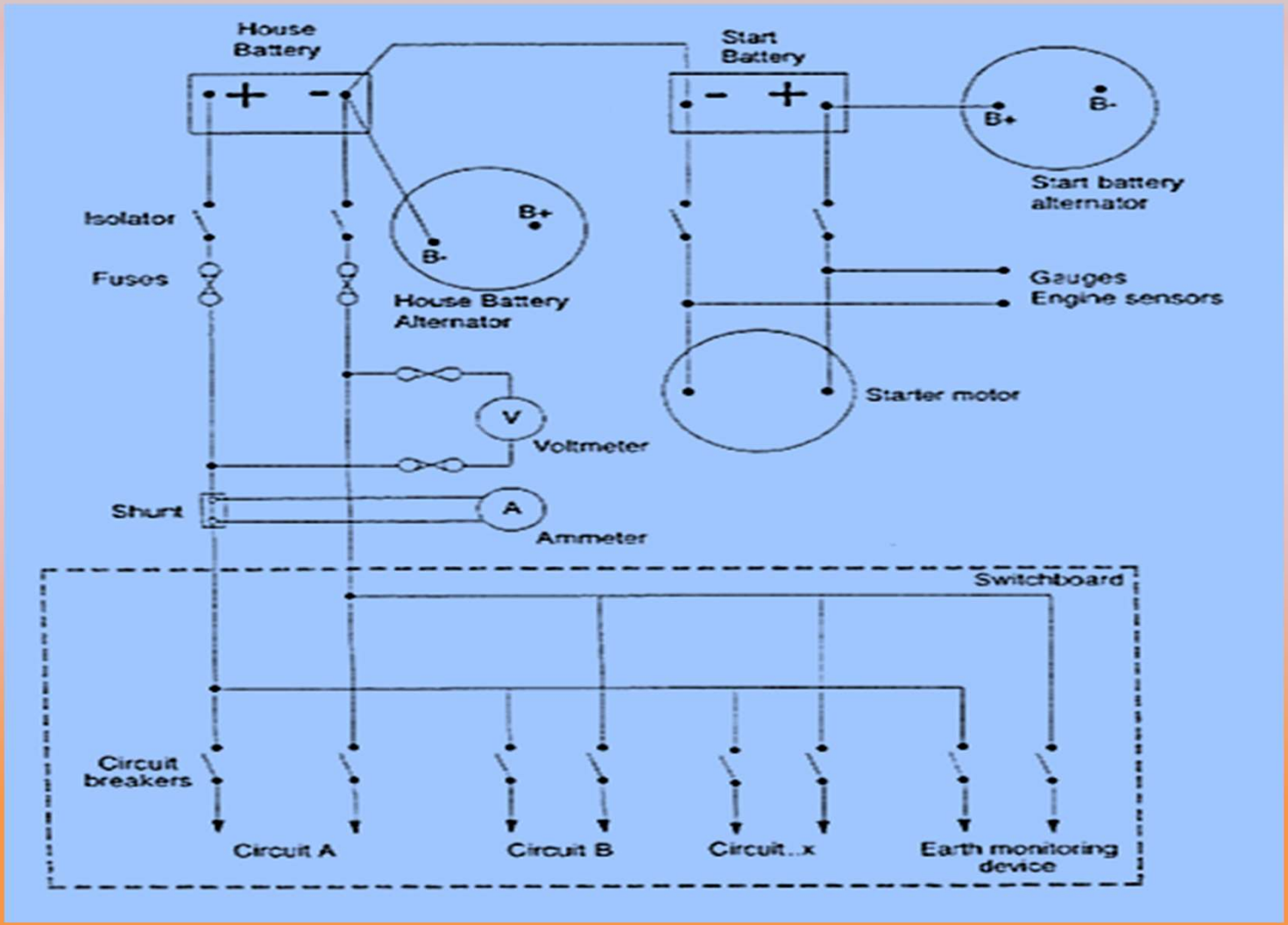
The Batteries must not be turned off whilst the engine is running or damage to the charging circuit can result

# Methods of protection

**A Volt meter** may be installed so that the battery charging voltage and charge condition of the batteries can be monitored.

**An Amp meter** may be installed to show the current draw on the circuit and the amount being drawn from the battery, this enable discharge rate to be monitored

# typical extra low voltage system:



# Stray currents

When operating electric motors for pumps and other equipment, a magnetic field is produced around and about the motor. This field creates an electrolytic reaction with the sea water, which causes corrosion of the metal hull.

It is for this reason that sacrificial anodes are located on the parts of the vessel most likely to be affected by this reaction. These anodes are made of materials such as zinc, which corrode before the metal hull or other parts. The anodes must be replaced regularly. Any faults which may produce stray current must be rectified as soon as possible.

Stray currents are leakage currents which occur when a conductor has an earth fault.

These faults are usually caused by moisture in junction boxes or other components, and from damaged cable insulation. They are often too small to trip circuit breakers or other protection devices.

Stray currents create electrolytic corrosion which will increase corrosion rates on hulls and sacrificial anodes and will degrade the galvanic protection system.

Because of the effects of stray currents, it is necessary to regularly check the earth monitoring system as it is imperative that the earth faults be rectified as soon as practical.

There are other complicated methods of detecting stray currents. Use a specialist contractor to confirm any suspicions.

# Battery charging alternators

Battery charging alternators are basically a 3 phase A.C. alternator which produces one DC output.

Most alternators have a charging voltage of 14V which is sufficient for lead acid batteries but insufficient for alkaline batteries which require 15.5V 16V.

The charging rate is controlled by the regulator which monitors the output voltage of the alternator and varies the field voltage in responses to load variations.

Batteries will absorb a large current until the battery charge level is approximately 50%. When this is achieved the regulator within the alternator starts to limit the voltage.

The charge current will level off as the battery voltage level rises.

# Battery safety.

Batteries store large amounts of energy and present risks aboard a vessels. When charge and discharging Hydrogen gas is produced which is flammable and can cause explosions.

Hydrogen is a very light gas so it will not accumulate in bilges but will rise up to the deck head (celling) hence DO NOT MOUNT BATTERIES BELOW STARTER MOTORS

Any metal object falling across the positive and negative terminals will short out the battery and the metal object will get very hot very fast with the potential to cause a fire or explosion

Wet cell batteries contain acid which is highly corrosive

**Batteries must be stored in a acid proof box and secured to the ship as to prevent movement in any direction. The box also must have a lid to stop anything coming into contact with the terminals**

# Battery safety.

All wiring on a vessel must be protected by double pole switches that means that the switch breaks the positive and the neutral wires at the same time.
This also helps in the elimination of stray currents that can accelerate electrolysis.

When leaving a vessel it is good policy to isolate all engine starting batteries and turn off all but essential monitoring services.

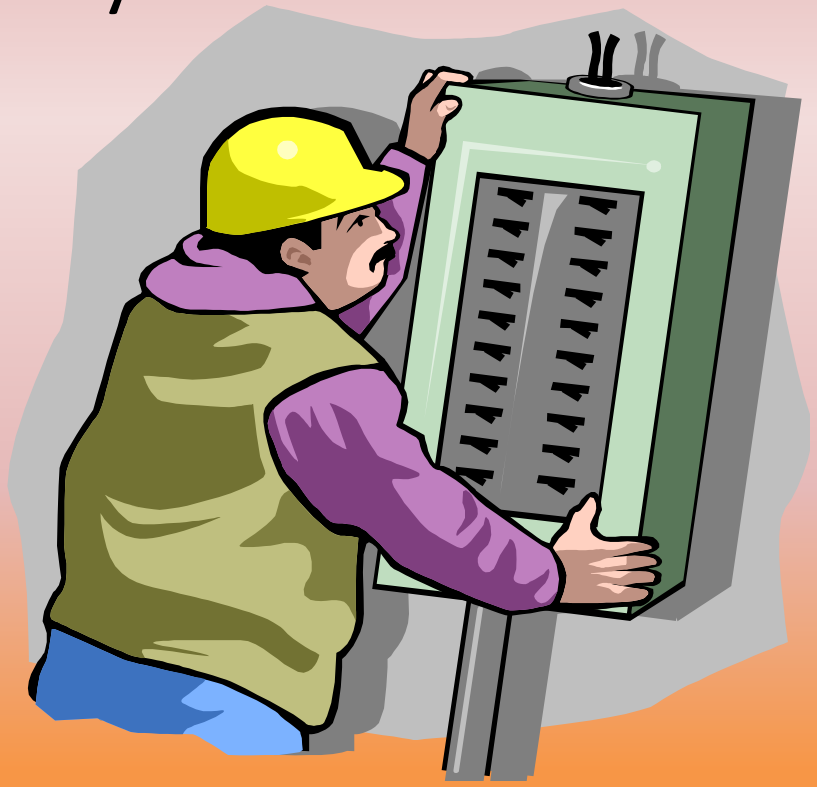
# Survey Requirements

ELV systems of less than 1000 Watts do not require a certificate of design nor do they require a electricians inspection certificate unless requested by a surveyor or an MSQ inspector as per the NSCV.
Systems of more than a 1000 watts excluding the starter motor require a certificate of inspection
( electrical contractors statement) every 2 years.

ELV electrics can be worked on and repaired by any competent person as long as the work is completed to industry standards and practices.

All electrical systems must have wiring diagrams showing the components, the wire sizes and ratings of fuses and circuit breakers in the ships drawings and operation manual

# Low voltage Electrical Safety Onboard your vessel 220v – 415



# Electricity – How it Works

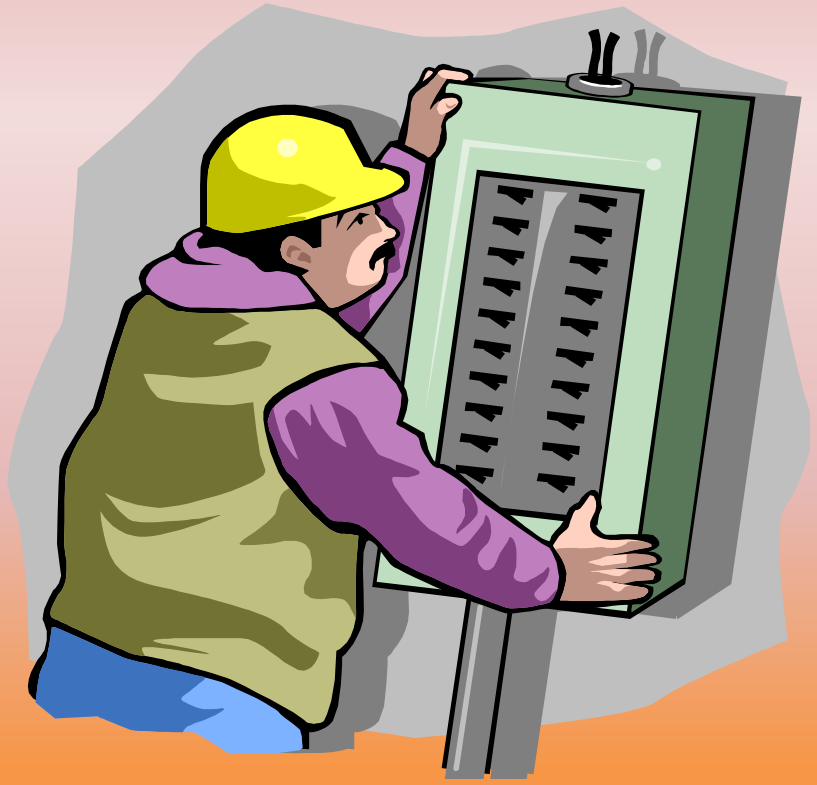
- Electricity is the flow of electrons
- (electrical energy) from one place to another
- Requires a source of power: Shore power or an on board generating set on the vessel
- A flow of electrons (current) travels through a conductor ( a insulated wire)
- Travels in a closed circuit

# Marine Generating sets

Marine generating sets are normally diesel engine driven and the engines cooled by either heat exchanges or keel cooling

The engine is direct coupled to the alternator and the engine RPM control the hertz of the output current

# Electrical Safety Onboard your vessel



# Marine Generating sets

- Some vessels may have more than one gen set and where large amounts of current are required the sets may be linked by synchronisation or wired so that different loads can be put onto either generating set.
- Always read the ships operation manual In the SMS to see how to operate the generators properly

# SHORE POWER

- Connect lead to shore side socket and vessel input socket
- Switch on shore power and check all phases live and on earth or neutral fault lamp lit
- Check phase correct rotation and polarity and voltage on input lines
- Unload ship power demand before switching from genset to shore power
- Switch from genset to shore power confirm correct rotation of 3 phase equipment (engine room fans good check)
- Load up shore power by switching on services as required again and shut down the genset

# SHORE POWER

- Start up genset and run up
- Unload ship power demand before switching from shore power to genset or the set may stall if a large load is just dumped on the circuit
- Switch from shore power to genset and once the set is on line and stable start switching back on the required circuits load up the set slowly
- Turn off shore power at shore supply and disconnect lead and roll up and put away in dry place.
- Replace splash/water proof covers on sockets

# Electrical Terms

- **Current** - electrical movement (measured in amps)
- **Voltage** - The pressure in the electrical circuit
- **Circuit -** complete path of the current. Includes electricity source, a conductor, and the output device or load (such as a lamp, tool, or heater)
- **Resistance** - restriction to electrical flow
- **Conductors** - Insulated metals, Usually copper with little resistance to electricity that allow electricity to flow
- **Grounding** - a conductive connection to the earth which acts as a protective measure

# Electrical Terms

- **Insulators** - substances with high resistance to electricity like glass, porcelain, plastic, and dry wood that prevent electricity from getting to unwanted areas
- **Switches** - Turn the flow of electrons on and off
- **Amp meter -** measures the current flowing
- **Volt meter -**measures the Voltage ( pressure, Potential)
- **Hertz meter -**Measures the cycles of the electrons IE 50 hertz = 50 cycles per second

# Electrical Injuries

There are four main types of electrical injuries:

- Direct:
  - Electrocution or death due to electrical shock
  - Electrical shock
  - Burns
- Indirect - Falls

# Electricity - The Dangers

- About 5 workers are electrocuted every week
- Causes 12% of young worker workplace deaths
- Takes very little electricity to cause harm
- Significant risk of causing fires

# Electrical Shock

An electrical shock is received when electrical current passes through the body.

You will get an electrical shock if a part of your body completes an electrical circuit by…

- Touching a live wire and an electrical ground, or
- Touching a live wire and another wire at a different voltage.

# Dangers of Electrical Shock

- **Currents above 10 mA* can paralyze or "freeze" muscles.**
- **Currents more than 75 mA can cause a rapid, ineffective heartbeat -- death will occur in a few minutes unless a defibrillator is used**
- **75 mA is not much current – a small power drill uses 30 times as much**

**Defibrillator in use**

* mA = milliampere = 1/1,000 of an ampere

# Electrical Hazards and How to Control Them

Electrical accidents are caused by a combination of three factors:

- Unsafe equipment and/or installation,
- Workplaces made unsafe by the environment, and
- Unsafe work practices.

# Control – Isolate Electrical Parts

- **Isolate all electrics before attempting any work**
- **Use guards or barriers**
- **Replace covers**
- **When finished**

Guard live terminals of electric at 50 volts or more against accidental contact

# Electrical Protective Devices

- **Thermal overloads, fuses, and circuit breakers Automatically open a circuit if it is overload**
- **Thermal overloads open as the heat of current warms bimetallic contact, automatically resets as it cools, or manual reset in motor contactor**
- **Circuit breakers are overcurrent devices. They trip open when the current gets to much stopping the flow, unlike fuses which melt circuit breakers can be reset**
- **Fuses are overcurrent devices. When too much current is drawn :**
  - **Fuses melt stopping the flow**

# TAG and TEST

**Tag and test covers all appliances that plug into a 240 volt socket outlet:**

- **All cord sets**
- **Receptacles not part of a building or structure**
- **Equipment connected by plug and cord**

**Program requirements include:**

- **Testing and tagging by licensed person**
- **Construction industry every 3 months**
- **Most vessels 6 monthly**

# Power tool Safety – Use a RCD protected power box for all power tools and cables every time

- **Protects you from shock**
- **Detects difference in current between the live and neutral wires**
- **If fault is detected, RCD shuts off electricity in fraction of a second**
- **Use RCD'S on all 240-volt, single-phase power tools.**

# Hazard – Defective Cords & Wires

- **Plastic or rubber covering is missing**

- **Damaged extension cords & tools**

# Hazard – Damaged Cords

- **Cords can be damaged by:**
  - **Aging**
  - **Overloading**
  - **Door or hatch edges**
  - **Poor fastenings**
  - **Abrasion from adjacent materials**
  - **Activity in the area**
- **Improper use can cause shocks, burns or fire**

# Hazard – Overloaded Circuits

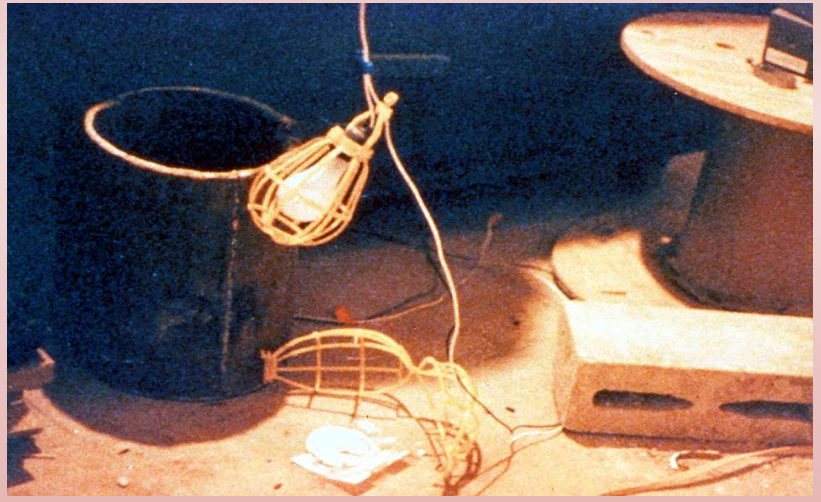
**Hazards may result from:**

- **Too many devices plugged into a circuit, causing heated wires and possibly a fire**
- **Damaged tools overheating**
- **Lack of overcurrent protection**
- **Wire insulation melting, which may cause arcing and a fire in the area where the overload exists, even inside a wall**

# Tool Safety Tips

- Use gloves and appropriate footwear
- Check tool and power cord before use
- Don’t use a untested tool
- Store in dry place when not using
- Don’t use in wet/damp conditions
- Keep working areas well lit
- Ensure not a tripping hazard
- Don’t carry a tool by the cord
- Don’t yank the cord to disconnect it
- Keep cords away from heat, oil, & sharp edges
- Disconnect when not in use and when changing accessories such as blades & bits
- Remove damaged tools from use and Tag Out of service

# Temporary Lights



Protect from contact and damage, and don't suspend by cords unless designed to do so.

Use ELV if possible ( 12/24 Volt)

# Clues that Electrical Hazards Exist

- **Tripped circuit breakers or blown fuses**
- **Warm tools, wires, cords, connections, or junction boxes**
- **RCD shuts off a circuit**
- **Worn or frayed insulation around wire or connection**
- **Smoke or fumes**

# Lockout and Tagging of Circuits

- Apply locks to power source after de-energizing
- Tag deactivated controls
- Tag de-energized equipment and circuits at all points where they can be energized
- Tags must identify equipment or circuits being worked on and faults if applicable

# Avoid Wet Conditions

- **Aboard vessels salt water drying out or entering electrical equipment can cause shorts as electricity will run on the salt crystals .**
- **Damaged insulation, equipment, or tools can expose you to live electrical parts.**
- **Wet clothing, high humidity, and perspiration increase your chances of being electrocuted.**

# Training

Train employees in electric equipment safe work practices, including:

- De energize electric equipment before inspecting or repairing, always make safe!!
- Only use cords, cables, and electric tools that are in good repair and tested
- Lockout / Tag out recognition and procedure
- Repairs and modifications by licensed persons only to appropriate standards of Practice

# Summary – Hazards & Protections

**Hazards**

- Inadequate wiring
- Exposed electrical parts
- Wires with bad insulation
- Ungrounded electrical systems and tools
- Overloaded circuits
- Damaged power tools and equipment
- Using the wrong PPE and tools
- All hazards are made worse in wet conditions

**Protective Measures**

- Use RCD'S
- Use fuses and circuit breakers
- Guard live parts
- Lockout and Tagout
- Proper use of flexible cords
- Close electric panels
- Training

# Survey Requirements

- All L/V M/V electrical systems require an electrical contractors statement of compliance every 2 years
- All EL/V systems over 1000Watts also require a EL/V contractors statement of compliance every 2 years
- All systems require approved design and accompanying drawings.

# Summary

Electrical equipment must be:

- Listed and labeled
- Free from hazards
- Tag And Tested
- Used in the proper manner

If you use electrical tools you must be:

- Protected from electrical shock
- Use necessary safety equipment

# **MARB046** Plan and Supervise routine maintenance on a vessel up to 80m

# Topics Covered in MARB046

- Planned Maintenance
- Maintenance of vessels structure
- Maintenance of deck and hull fittings
- Statutory Surveys
- Docking and Slipping
- Review

# Planned Maintenance

# Planned Maintenance

- The master is responsible for the seaworthiness of the vessel and must ensure that all national and international requirements regarding safety and pollution prevention are being complied with. Effective planning is required to ensure that the vessel, its machinery systems and its services are functioning correctly and being properly maintained, including dry-docking to maintain hull smoothness.

Planned maintenance is primarily concerned with reducing breakdowns and the associated costs. There are two kinds of planned maintenance.

1. *Preventative maintenance* - is aimed at preventing failures or discovering a failure at an early stage.

2. *Corrective maintenance* - is aimed at repairing failures that were expected, but were not prevented because they were not critical for safety or economy.

# Advantages of planned maintenance

- Fewer breakdowns and repairs
- Equipment operates efficiently at all times
- Fewer hazards to the crew when working with well maintained equipment
- Vessel complies with survey requirements at all times
- No areas of the vessel or items of equipment are overlooked or neglected

# Elements of a planned maintenance program

- You can develop a basic maintenance program for your vessel by taking the following steps:

1. **Determine what items need to be maintained**
2. **Determine the type of maintenance tasks required for each item**
3. **Determine the frequency of carrying out particular maintenance jobs**
4. **Prepare a maintenance schedule**
5. **Develop operational and recording procedures.**

# You will need to consider the following issues in the planning process:

1. Is an item worth maintaining? What would be the real cost of failure to maintain that item?
2. Equipment manufacturers instructions
3. Statutory survey requirements
4. Classification Society requirements
5. Maximum length of survey cycle
6. Magnitude of maintenance task

7. Maintenance/inspection that can only be carried out when the vessel is out of water
8. Resources required
9. Recording
10. Length of voyages, routes and trades the vessel is involved in
11. Spare parts replacement.

- The plan must be adaptable to various weather conditions and must be flexible enough to accommodate changes in the vessel's trade.
- It is convenient to draw up a maintenance schedule by breaking down the plan into various 'time phases'. Two suggested categories are:

1. Short-term maintenance
2. Long-term maintenance.

- Short-term maintenance may include weekly, fortnightly or monthly inspections and greasing routines. Long-term maintenance will involve major overhauls and surveys. Remember too that some operational maintenance tasks will only be carried out as and when necessary.
- The actual operation and documentation of the plan will vary from vessel to vessel. Many vessels use a card index system or computer program for this purpose. Usually a job sheet is prepared for each job. The job sheet contains a description of the work and a list of relevant spare parts and references to drawings and instruction manuals. On completion of the job, relevant details are then entered in the job sheet.

# Maintenance of Vessel Structure

# Maintenance of vessel structure

- The maintenance of vessel structures is primarily concerned with prevention and control of corrosion.  To be able to select appropriate materials, and use the correct procedures for maintenance, you should first of all be aware of the causes of corrosion.

# Corrosion

- Corrosion is the alteration and decomposition of metals or alloys by direct chemical attack or by persistent electrochemical reactions. Corrosion can be classified as:

1. *Chemical corrosion*
2. *Electrochemical corrosion*

# Chemical corrosion

- This is the attack of metals by solutions of acids or alkalines, which will chemically combine with the metal to form entirely new products. The material can be considered as being dissolved in the solution. Such attack is usually caused by spillage of liquids such as battery acids, galley refuse, or in toilet areas.

# Electrochemical corrosion

- This is the most common type of corrosion.  It is caused by very small electrical currents flowing between one metallic area to another. These electrical currents cause the material which is being corroded to change to a completely different substance; for example, steel changes to rust.  Whether the corrosion takes place below the waterline, or above the waterline, the presence of both oxygen and an electrolyte (i.e. a conducting solution) play an important part. Saltwater is a liquid which encourages corrosion because it is an excellent conductor of electricity.
- Corrosion is indicated by the presence of rust or wastage of a metal.

# Corrosion prone areas

*Parts of a vessel that are especially liable to corrosion include:*

- Ballast tanks
- Bilges
- Hull plating between light and load waterline
- In the vicinity of scuppers and overboard discharges
- Areas where water can accumulate (e.g. stringers used for stiffening)
- Stern, in the vicinity of propeller
- Storerooms
- Below, wood deck sheathing
- Areas not easily accessible for maintenance

# Corrosion control

There are two ways of preventing corrosion.

1. By providing a piece of material which will corrode in preference to the vessel. Such a substance is usually found attached to the hull near the propeller or attached inside a tank, in the form of a sacrificial anode. When two metals in contact with each other result in one of the metals corroding, the metal which is preserved is called more "Noble" than the metal that corrodes. In such cases aluminium will corrode in preference to steel; steel will corrode in preference to brass; brass will corrode in preference to stainless steel. Different metals should not be used in close contact unless there is good insulation between them; for example, it is bad practice to connect a steel valve to an aluminium hull, without insulation. The aluminium may corrode around the steel. Lead, in contact with aluminium will cause rapid wasting of the aluminium. For this reason, lead based paints must never be used on aluminium hulls. Lead incidentally, is more noble than steel, but the problem is not nearly as noticeable.

- 2. By coating the surface with a substance such as paint, this will prevent the electrolyte from coming into contact with the metal.

- We shall now look at the use of paints in more detail.

# Paints

- A single coat of paint cannot usually fulfill the requirements of protection and decoration; therefore it is necessary to apply more than one coat. This is why each surface needs it's own paint application system.

| | |
|---|---|
| **Painted woodwork** | • **wood primer**<br>• **undercoat**<br>• **finish coat (top coat)** |
| **Varnished woodwork** | • **3 coats of clear varnish** |

| | |
|---|---|
| **Aluminium** | • etch primer<br>• **undercoat**<br>• **finish coat (top coat)** |
| **Steel** | • **anti-corrosive primer**<br>• **undercoat**<br>• **finish coat (top coat)** |

The performance of any painting scheme is strongly influenced by the preparation of the surface, the paint and the manner in which the paint is applied.

# Surface preparation

**In general, surfaces can be prepared for painting by:**

- Cleaning and, where necessary, degreasing the surface
- Removal of corrosion (rust) and/or defective paint coats by abrasive blast cleaning, mechanical or hand cleaning
- Using rust converters/inhibiters
- Roughening of the old paint where needed
- Removal of dust
- Drying the surface.

- Freshly prepared bare-steel surfaces rust very quickly at nearly all times of the year. The interval between surface preparation and painting should therefore be kept to a minimum (particularly when there is danger of condensation).

**The drying of paint can be retarded by:**

- Low temperatures
- High humidity
- Presence of salt or other pollutants in the air.

All painting should be done under warm, dry, dust free, and unpolluted conditions. Paints should be strictly applied as per the paint manufacturer's instructions.

- Paints can be loosely classified as Conventional Paints and High Performance Paints.

| | |
|---|---|
| **Conventional paints** | ***Are usually recognised by the following:***<br>• **oil based**<br>• **single pack**<br>• **use mineral turps as a cleaning/thinning agent**<br>• **may be applied by brush, roller (lambs wool), spray-gun**<br>• **dry through evaporation of solvent.** |

| | |
|---|---|
| High performance paints | *Are usually recognised by the following:*<br>• chemical based<br>• 2 parts - a Base (large tin) and a Hardener (small tin)<br>• have a 'Pot Life'<br>• use special thinners as cleaning/thinning agent<br>• may be applied by brush, roller (mohair), spray-gun<br>• dry by chemical reaction between both parts. |

# Caution

- High performance paints generate highly **toxic**, highly **flammable** fumes, as well as heat due to chemical reaction.
- Safety goggles, rubber gloves and an appropriate respirator should be used when mixing and applying. Adequate ventilation should be available when painting in enclosed spaces.

# Maintenance of deck and hull fittings

# Maintenance of deck and hull fittings

- Deck and hull fittings include those items that are not an integral part of the vessel's structure. Examples include cargo-handling gear, anchoring and mooring equipment, gangways, hatch covers, ventilators, air pipes, boat davits etc. As in the case of vessel structures, these fittings must also be kept free from corrosion and painted if necessary. Most of the hull and deck fittings will have one or more moving parts. Therefore the major focus of any routine maintenance is towards keeping the parts moving and working efficiently by proper and regular lubrication. Proper use, and regular inspections of a fitting are an equally important part of maintenance. We will now look at the routine maintenance of some of these items in more detail.

# Cargo Handling Gear

- In Australia, the Marine Orders govern the use and maintenance of vessels cargo handling gear.  Cargo gear is worked hard, especially in bulk trades if there is no shore gear. It is, therefore, of vital importance to see that all moving parts are kept thoroughly lubricated so that they don't seize up in service.  A regular, comprehensive greasing routine is the only answer.
- Periodic inspections and examinations will enable any faults to be quickly spotted and rectified, and should be carried out:
- Before starting to use the gear
- At regular intervals while the gear is in use, and
- As per the vessel's maintenance program and survey requirements.

# Inspecting cargo handling gear

**Always carry out an inspection of cargo handling gear prior to use. Check (if applicable) that:**

- All wires are in good condition, wound properly on the drums, well lubricated and correctly secured
- All shackles are in the right way, the pins fully home and seized
- All blocks/pulleys, drop and restraining chains are properly secured
- The gear is marked with its safe working load
- Winch gear change levers are in the correct position and secured
- Securing points (eye pads and cleats) are in good order.
- By carrying out these checks you will prevent the need for emergency repairs and go a long way towards preventing accidents. Keep a record of all renewals and repairs done on the gear.

# Mooring and anchoring equipment

- Windlasses, capstans, mooring winches, roller fairleads, anchor chains and mooring lines (rope and wire) all have to be in good working order. A comprehensive lubrication and maintenance program should be in place to care for this equipment. It is not sufficient just to pump grease into the machines; they should be carefully examined at the same time. Windlass and winch brakes should be operated to see that they are working correctly; fairleads spun so they don't freeze. Periodically the gear should be stripped down and cleaned off - old grease and paint removed, bearings examined, grease nipples and cups cleaned out and the unit relubricated.

# Gangways

- A vessel's gangway is the principal means of access to the vessel and must always be in good condition.  The hoisting tackle must be regularly examined and maintained in good working order.  This means wires properly lubricated, shackle pins fully home and moored, winches thoroughly greased. The stanchions should be kept straight. The gangway net must not be frayed or broken.

# Hatch Covers

- Paintwork aside, the primary object in the successful maintenance of hatch covers is to keep them weathertight. To this end, careful attention must be paid to the heavy rubber sealing strips on the underside of the hatches. These must be kept firmly bonded in place with no gaps between the segments. The packing channels should be kept clear of rust, and the packing itself free of grease and paint. When the hatch is closed for sea, (battened down) check for a good seal. If there is a gap, you must open the hatch and find out why it hasn't sealed tight. Keep the track ways and compression bars clean - if this is not the problem, replace the offending packing segment.

# Watertight doors

- Examine closely the packing and rims and keep free from rust and scale. Keep packing clean of paint. All clips should be free, and hinges well oiled so the opening can be closed rapidly and efficiently.

# Ventilators

- Ventilators of all types should be worked at frequent intervals. Check flaps and seals to ensure proper closure.

# Air Pipes

- Should be examined.  Spark arresters, for fuel tank air pipes, must be kept whole and clean.  Heavy weather closures for unprotected air pipes should be regularly examined and kept in good order.

# Survival craft davits

- Lubricate davits and wires regularly.  A good idea is to grease the davit as it is being worked, thus ensuring the lubricant is properly dispersed.  The same technique holds for all greasing, where practicable grease the gear while it is working. Davit falls should be end-for ended and replaced as per statutory requirements.

# Statutory Surveys

# Statutory surveys

- In general for vessels of 35 metres in length and over, the survey schedule is as follows:

# Annual surveys

- Equipment
- Running trial of each main engine and associated gear box
- Operation test of all valves in the fire main system
- Operational test of all sea injection and overboard discharge valves and cocks
- Operational test of main and emergency means of steering
- Running trial of all machinery essential to the safe operation of the vessel
- Inspection of all pipe arrangements

- General inspection of machinery installation and electrical installation
- All safety and relief valves associated with the safe operation of the vessel to be set at the required working pressure
- Pressure vessels used for the generation of steam at a pressure not exceeding 345 kPa, or for heating water to a temperature exceeding 99°C together with their associated mountings.
- Inspection of the liquefied petroleum gas installation
- Inspection of cargo handling, fishing and trawling gear

- Inspection of escapes from engine room and accommodation spaces
- Inspection of personnel protection arrangements in machinery spaces
- Inspection of casings, superstructures, skylights, hatchways, companionways, bulwarks and guard rails, ventilators and air pipes, together with all closing devices
- A boiler and its mountings where the boiler has been in service for more than eight years.
- An evaporator and its mountings which has been in service for more than eight years, and in which the operating pressure is above atmospheric.

# Two yearly surveys

- Hull externally and internally except in way of tanks forming part of the structure
- Sea cocks and valves, bilge injection valves and overboard discharge valves
- Inspection of propellers, rudders and under water fittings
- Operational test of bilge pumps, bilge valves and bilge alarms
- Pressure vessel and associate mountings of an air pressure/salt water system having a working pressure of more than 275 kPa
- A boiler and its mountings where the boiler has been in service for less than eight years
- An evaporator and its mountings, which has been in service for less than eight years, and in which the operating pressure is above atmospheric.

# Four yearly surveys

- Sea cocks and valves, bilge injection valves and overboard discharge valves
- Bilge pumps
- Independent pumps used for pumping seawater, fresh water, fuel oil, condensate and boiler feed
- Air receivers and mountings, selected sections of air piping and explosion protection devices
- Main propulsion intermediate shafting
- Evaporators and mountings in which the operating pressure is at or below atmospheric pressure
- Anchors and cables and all links and joining shackles

- Windlass
- Condensers, lubricating oil coolers, jacket water coolers, drain coolers, distillers and air ejectors
- Boiler feed water heaters
- Oil fuel heaters
- Gear boxes to such extent necessary to ensure satisfactory condition
- Screw and tube shafts
- Internal combustion engines auxiliary generators other than emergency generators
- Turbo-generators

- Main engine, steam turbines
- Main engine, internal combustion engines
- Selected lengths of steel steam pipes having bolted joints and carrying steam at a temperature exceeding 455° C. Also hydraulic test of those lengths
- Steel pipes having welded joints carrying steam at a temperature exceeding 455° C. Also hydraulic test of those lengths
- Pressure vessel and associated mountings of an air pressure/fresh water system having a working pressure of more than 275 kPa

- After the twelfth year in service all solid drawn copper steam pipes having an internal diameter exceeding 75 mm are to be annealed and hydraulically tested.
- After the twelfth year in service selected lengths of steel steam pipes having an internal diameter exceeding 75 mm and carrying steam not exceeding 455° C are to be hydraulically tested.

# Five yearly surveys

- *Peak tanks internally*. Peak tanks are to be tested to a head sufficient to give the maximum pressure that can be experienced in service.
- *Deep tanks* (except those tanks used exclusively for oil fuel) internally. All deep tanks are to be tested to a head sufficient to give the maximum pressure that can be experienced in service. Deep tanks used exclusively for oil fuel need not be examined internally subject to satisfactory external survey and hydraulic test.

- *Double bottom tanks internally* (except those tanks used exclusively for oil fuel). All double bottom tanks are to be tested to a head sufficient to give the maximum pressure that can be experienced in service. Double bottom tanks used exclusively for oil fuel need not be examined internally subject to satisfactory external survey and hydraulic test
- *Ballast tanks and tanks forming part of the ship's main structure internally*. Ballast tanks and tanks forming part of the ship's structure are to be hydraulically tested to a head sufficient to give the maximum pressure that can be experienced in service.

# Six yearly surveys

- *Ballast tanks and tanks forming part of the ship's main structure internally.* Ballast tanks and tanks forming part of the ship's structure are to be hydraulically tested to a head sufficient to give the maximum pressure that can be experienced in service.

# Eight yearly surveys

- Independent pumps used for the supply of lubricating oil under pressure to hydraulically operated machinery
- Electrically operated or hydraulically operated steering gear
- All solid drawn copper steam pipes having an internal diameter exceeding 75 mm are to be annealed and hydraulically tested
- Selected lengths of steel steam pipes having an internal diameter exceeding 75 mm and carrying steam at a temperature not exceeding 455°C are to be hydraulically tested.

# Other survey periods

- Emergency generator i.e. generator used normally for emergency purposes shall be surveyed once in the first 12 years and there after once in every subsequent period of eight years
- One deep tank that is used exclusively for fuel oil to be surveyed internally every five years starting when the ship is 10 years old and all such deep tanks to be surveyed by the time the ship is 25 years old
- At least one double bottom tank that is used exclusively for fuel oil to be surveyed internally every five years starting when the ship is 10 years old and all such double bottom tanks to he surveyed by the time the ship is 25 years old

# Definitions

| | |
|---|---|
| **Authorised person or society** | • **A person appointed or recognised by the Authority, or a society or body and its servants appointed or recognised by the Authority, capable by reason of special qualifications of performing surveys and inspections** |

| | |
|---|---|
| Equipment | • In relation to a vessel, includes every thing or article belonging to or to be used in connection with, or necessary for the operation of the vessel and, includes life-saving appliances, fire-fighting appliances, miscellaneous equipment, radio equipment, lights and sound signals and medical stores |

| | |
|---|---|
| Inspection | • A visual inspection performed by an approved person |
| Machinery | • Means boilers, engines, pumps, electrical and ancillary equipment used |
| Survey | • A thorough examination performed by, or in the presence of a surveyor or an authorised person or society |

# Loadline survey requirements

- Where a vessel is assigned freeboards by an Authority under Loadline Rules, a Loadline Certificate is issued on completion of an initial survey. This certificate is usually valid for five years, however it is subject to an Annual Periodic Survey by a surveyor who endorses the certificate on the successful completion of the survey. During the Annual Periodic Survey the surveyor checks:
- The position of the load line marks
- If the structural strength has deteriorated
- The water tight integrity of the hull
- Whether any alterations have been made to the hull or superstructure

- The condition of the fittings and appliances for the protection of openings, guard rails, freeing ports and means of access to crew's quarters
- If the vessel has on board the following:
  - Stability Information Booklet
- Conditions of Assignment

# Loadline marks and conditions of assignment

**In general terms, the requirements are:**

- The vessel should be watertight below the freeboard deck and weathertight above the freeboard deck
- Openings to the hull and superstructure should be suitably protected
- Guardrails or bulwarks should be provided on all exposed parts of the freeboard and superstructure decks
- Guard rails, life lines, gangways or under deck passages should be provided for the protection of the crew in getting to and from quarters to the working areas
- Weather decks should be provided with adequate means for rapidly freeing and draining the decks of water.

# Preparations for an annual loadline survey

Where applicable:

- Check that all access openings at ends of enclosed structures are in good condition. All clips, clamps, and hinges should be free and well greased. All gaskets and watertight seals should be crack free. Ensure that the doors open from both sides
- Check all cargo hatches and access to holds for weather tightness, especially securing devices such as cleats and wedges
- Check the efficiency and securing of portable beams
- If portable wooden hatch covers are used, check that they are in good condition and that the steel binding bands are well secured

- If tarpaulins are used at least two should be provided for each hatch. The tarpaulins must be in good condition, waterproof, of ample strength, and of an approved material
- Hatches which are closed by portable covers and made weathertight by tarpaulins must have a steel locking bar across each section. Covers more than 1 .5m in length must be secured with two locking bars
- Inspect all machinery space openings on exposed decks. Check that any manholes and flush scuttles are capable of being made watertight
- Check that all ventilator openings are provided with efficient weathertight closing appliances and repair any defects
- All air pipes must be provided with permanently attached satisfactory means for closing the openings

- Inspect all cargo access openings below the freeboard deck and ensure that all of them are water-tight
- Ensure that the non-return valves on overboard discharges are operating in a satisfactory manner.  Side scuttles to spaces below the freeboard deck or to spaces within enclosed superstructure must have efficient internal watertight deadlights.  Inspect the deadlight seals
- Check that all freeing ports are in a satisfactory condition, e.g. shutters are not jammed, hinges are free, and that pins are of non-corroding material. Check that any securing appliances, if fitted, work correctly

- All guard rails and bulwarks should be in a satisfactory condition, e.g. all fractured rails should be re-welded
- If lifelines are required to be fitted in certain areas, rig the lines and overhaul as necessary
- De-rust and paint the deck line, load line mark, load lines, and the draught marks.

# Docking and slipping

# Docking and slipping

Often a vessel will need to be removed from the water in order to maintain the underwater hull and fittings. A vessel may be removed from the water by using any of the following methods and facilities:

- Graving Dock
- Floating Dock
- Synchrolift
- Patent Slip
- Careening
- Heaving Down
- Travel Lift

# The graving dock

- The graving dock is excavated from the land and closed to the sea by means of a large watertight door or gate known as the "Caisson Gate". The edge of the dock bottom beneath the gate is referred to as the sill. The dock bottom has a very rigid construction and is usually made of reinforced concrete. The dock bottom always has a slight slope towards the sill to aid drainage. The sides of the dock are usually terraced to enable side shoring. Along the centre line of the dock are blocks of concrete topped up with timber. They form the **keel blocks**. Two parallel rows of blocks on either side form the **bilge blocks** or **side blocks**. Depending on the size of the vessel and the shape of the underwater hull, the blocks are repositioned to suit the particular vessel.

- On the sides of the dock at ground level are rails on which winches travel along the length of the dock.  Wires from the winches are used, two on the forward beam and two on the after beam, to help position the vessel over the keel blocks when the vessel is brought in. Cranes are used for heavy lifting.  When the vessel is in position the lock gates are shut and pumping out commences. A diver may be employed to ensure that the vessel's keel is in line with the keel blocks.  As water is pumped out the diver keeps checking that the vessel is taking to the blocks as planned.  Sometimes blocks are shifted so that maintenance can be done on a sea chest valve, drain plug, and etc.

# The floating dock

- The basic structure of the floating dry dock is a very strong and rigid double walled "U". The bottom is constructed very similar to the bottom structure of ships. The sides of the dock are vertical wing tanks. Keel blocks and bilge blocks are laid on top of the double-bottomed structure. The whole dock forms a floating, watertight structure, which can be submerged by flooding the double bottom and wing tanks.
- The vessel to be dry-docked is simply floated into the dock and positioned above the keel and bilge blocks by use of mooring lines. Shores are fitted to provide support and as the dock tanks are pumped out the dock rises until the pontoon deck is dry.

# The cradle (patent slip)

- One of the most common methods of removing a small vessel from the water involves the use of the patented slipway. This is basically a sloping, reinforced concrete runway, which extends well below the low water mark. On the slip itself is built a set of railway tracks set well apart. Wheeled carriages run on these tracks and depending on the size of the vessel being dry-docked, carriages can be linked together to form a single unit. Cradles are fitted onto these carriages with keel blocks on the centre line atop the carriage. The entire assembly is made up to suit the vessel being dry-docked.

- The vessel is manoeuvred onto the cradle under its own power and is secured with "springs". As the vessel settles onto the cradle bed, wedges are inserted to keep the vessel upright. The entire assembly is slowly winched up the slipway. As the vessel takes to the keel blocks, securing beams are drawn tight and any shores, if required, are fitted. The vessel now secure in its cradle on the carriage is slowly winched out of the water.

A barge on the slip. The exterior of the vessel has been sandblasted back to bare metal in preparation for painting.

A research vessel on the slip.  The rail lines supporting the cradle can be clearly seen in the foreground..

# The synchrolift

- Operates along the same lines as the floating dock in that the vessel is floated in over a submerged platform and is then lifted clear of the water by raising the platform. The synchrolift however, is a land-based platform, which is lowered into the water by a series of synchronised winches lining either side of the dock.

# Careening

- This method does not require a slipway or dry dock, so it is suitable for repairs in an isolated area or in an emergency. The only requirement is a tidal range greater then the vessel's draught.
- The vessel is driven to a flat, cleared section of the beach or river bank and positioned parallel to the shore or bank, to give even support along its length as the water level falls and rises. The bank should not be too steep, and must be clear of obstructions. The vessel must fall up hill if flooding on the incoming tide is to be avoided. It may be positioned between poles driven into the bed or simply weighted to fall up hill. Hawser lines may be tied to solid sections of the vessel, e.g. the foot of a mast, and secured to points onshore to help prevent the vessel from falling downhill. When the water level is low enough, shoring is installed on the downhill side to prevent rolling over.

# Heaving down

- In this method, a vessel is heeled over, while afloat, by means of tackles set up between its masts and another ship, or shore attachments.
- This method is not as successful as careening in exposing the hull, but since the vessel is afloat, there is little hull stress, and the dangers, through touching the bottom, or damage to the hull and the intakes, are minimal. It must be remembered that by heeling a vessel you increase its draft, and you should be sure that there is sufficient under-keel clearance for the job.

# The travel lift

- A narrow dock is excavated and then opened to the sea. The vessel to be lifted manoeuvres slowly into the dock and secured temporarily with mooring lines while a mobile straddle carrier is positioned above the vessel. Broad slings, which will eventually distribute the weight of the hull, are then put in place. The slings take up the weight. The moorings are released and the vessel is lifted clear of the water. The straddle crane, under its own power, carries the slung vessel to a suitable position in the shipyard where it is lowered on blocks and shored and the slings removed.
- The main advantage of this system is that many vessels can be docked at the same time and the slipping facility is not laid up for the duration of the vessel's stay.

- The above description of methods and facilities used for removing a vessel out of water should make it obvious that Careening, Heaving Down and Travel Lift are only suitable for small vessels.

A coral viewing vessel lifted clear of the water by a travel lift. This travel lift can handle vessels up to about 30 tonnes.

A slightly larger travel lift.  This one can handle vessels up to about 150 tonnes.

# General procedures for docking and slipping

| | |
|---|---|
| **Repair list** | **Prior to docking or slipping, a complete repair list of all work to be done while in dock should be made up. Several copies should be made so that all those directly involved in the work can monitor the progress being made and cross off the completed jobs.** |

| | |
|---|---|
| **Structural features** | **When docking or slipping your vessel, the entire weight of the vessel will be supported at a few localised points, instead of uniformly over the hull, as is the case when the vessel is afloat. External keel coolers, echo sounders, log and sonar transducers could be severely damaged if the bilge or keel supports came into contact with them. It is important that the dock master is supplied with up to date and accurate information regarding their location.** |

# Stability considerations

- If you are using a patent slip for docking your vessel, then stability is not a major problem provided that the vessel is snugly secured in the cradle and the side support beams are drawn up tight before it is pulled clear of the water. The same is true of the travel lift.

- If however, you are using a synchrolift, floating dock or graving dock, then you must be sure that your vessel has as much stability as possible. Tanks should preferably be empty so as to remove any free surface effect. The critical moment occurs just before the vessel settles on the keel blocks. Usually your vessel will be trimmed slightly by the stern. As the water level falls, the keel will touch the blocks at the stern first. This results in an up thrust on the stern, which increases as the water level falls. This has the effect of reducing your vessel's GM by causing an apparent rise in the centre of gravity. If it did not have sufficient initial stability, it could topple off the blocks, with disastrous consequences. It's happened before; make sure it never happens to you. Most shipbuilders will supply a recommended docking condition with the stability data for the ship.

- You should ensure that your stability condition is equal to, or better than the recommended condition.  All moveable weights should be secured, and all unnecessary weights on deck should be removed.

# General precautions in dry dock

- Echo sounder, log, and sonar transducers should be covered with grease and then masking tape to prevent them from being painted over
- Remove drain (docking) plugs from all tanks that need to be drained. Put them in a safe place and keep a written record of which plug goes where. Ensure that plugs are all replaced prior to flooding the dock or entry into the water
- Ensure that safe access is provided to and from the vessel
- Ensure that fire safety precautions are adhered to
- Ensure that all tanks, void spaces etc. are opened, vented and ready for inspection by surveyors at the appropriate time
- Ensure that all pollution control requirements are met. (Remember that sewage and garbage cause pollution too.)

# Caution

- In a dry dock the vessel may be unable to use its fire fighting system; Note the position of the fire hydrants ashore, and the site of the dock supplied fire extinguishers. Keep a close watch on any hot work being done and stop any unsafe practices.

# Undocking checks

**Ensure that:**

- All docking plugs have been replaced
- All intake gills/grates have been replaced
- All transducers are uncovered and wiped clean
- All tanks are boxed up (manhole/inspection covers are replaced)
- Anchors are secured and all loose gear is secured
- New paint is dry to manufacturer's specifications
- There is sufficient water depth to unslip
- There is no distribution of weights on board that would cause the vessel to take up an unwanted list or trim when it takes to the water
- Preferably the vessel should be in the same stability condition for undocking as it was at docking.

# MARB010 Review

# Please complete the following practical activities on a piece of paper and then check your answers against the feedback provided.

| | |
|---|---|
| Practical activity 1 | Prepare a list of survey items that require a vessel to be removed from the water. |
| Practical activity 2 | Explain the cause of corrosion in vessel structures. |
| Practical activity 3 | Describe two ways of preventing corrosion. |

| | |
|---|---|
| Practical activity 4 | Explain in general terms the routine maintenance of the following fittings:<br>1. watertight doors<br>2. hatch covers<br>3. cargo handling equipment<br>4. anchor windlass |
| Practical activity 5 | Describe how a vessel is docked when using<br>1. a slipway<br>2. a graving dock<br>and describe the precautions necessary when doing so. |

# Review answers

**Practical Activity 1**

- **Inspection of hull externally, sea cocks and valves, bilge injection valves and overboard discharge valves, propellers, rudders and underwater fittings, screw and tube shafts.**

# Review answers

**Practical Activity 2**

- **Corrosion is the alteration and decomposition of metals or alloys by direct chemical attack or by persistent electrochemical reactions. Corrosion can be classified as**
- **Chemical corrosion**
- **Electrochemical corrosion**
- **Chemical corrosion is the attack of metals by solutions of acids or alkalines, which will chemically combine, with the metal to form entirely new products. Electrochemical corrosion is caused by very small electrical currents flowing between one metallic area to another.**

# Review answers

**Practical Activity 3**

- **Corrosion can be prevented by providing a piece of material which will corrode in preference to the vessel (sacrificial anode) or by coating the surface with a substance such as an anti-corrosive paint.**

# Review Answers

**Practical Activity 4**

- Examine closely the packing and rims and keep free from rust and scale. Keep packing clean of paint. All clips should be free, and hinges well oiled so the opening can be closed rapidly and efficiently.

# Review Answers

**Practical Activity 4 cont**

- **Paintwork aside, the primary object in the successful maintenance of hatch covers is to keep them weathertight. To this end, careful attention must be paid to the heavy rubber sealing strips on the underside of the hatches. These must be kept firmly bonded in place with no gaps between the segments. The packing channels should be kept clear of rust, and the packing itself free of grease and paint. When the hatch is closed for sea, (battened down) check for a good seal. If there is a gap, you must open the hatch and find out why it hasn't sealed tight. Keep the track ways and compressor bars clean - if this is not the problem, replace the offending packing segment.**

# Review Answers

Practical Activity 4 cont

- In Australia, the Marine Orders govern the use and maintenance of vessels' cargo handling gear. Cargo gear is worked hard, especially in bulk trades if there is no shore gear. It is, therefore, of vital importance to see that all moving parts are kept thoroughly lubricated so that they don't seize up in service. A regular, comprehensive greasing routine is the only answer.
- Periodic inspections and examinations will enable any faults to be quickly spotted and rectified, and should be carried out:
  - Before starting to use the gear.
  - At regular intervals while the gear is in use.
  - As per the vessel's maintenance program and survey requirements.

# Review Answers

**Practical Activity 4 cont**

- **A comprehensive lubrication and maintenance program should be instituted to care for this equipment. It is not sufficient just to pump grease into the machines; they should be carefully examined at the same time. Brakes should be operated to see that they are working correctly; fairleads spun so they don't freeze. Periodically the gear should be stripped down and cleaned off - old grease and paint removed, bearings examined, grease nipples and cups cleaned out and the unit relubricated.**

# Review Answers

**Practical Activity 5**

- **Slipway**
- **One of the most common methods of removing a small vessel from the water involves the use of the patented slipway. This is basically a sloping, reinforced concrete runway, which extends well below the low water mark. On the slip itself is built a set of railway tracks set well apart. Wheeled carriages run on these tracks and depending on the size of the vessel being dry-docked, carriages can be linked together to form a single unit. Cradles are fitted onto these carriages with keel blocks on the centre line atop the carriage. The entire assembly is made up to suit the vessel being dry-docked.**

# Review Answers

**Practical Activity 5 cont**

- **The vessel is manoeuvred onto the cradle under its own power and is secured with "springs". As the vessel settles onto the cradle bed, wedges are inserted to keep the vessel upright. The entire assembly is slowly winched up the slipway. As the vessel takes to the keel blocks, securing beams are drawn tight and any shores, if required, are fitted. The vessel now secure in its cradle on the carriage is slowly winched out of the water.**

# Review Answers

- **Graving dock**
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# Review Answers

**Practical Activity 5 cont**

- **On the sides of the dock at ground level are rails on which winches travel along the length of the dock. Wires from the winches are used, two on the forward beam and two on the after beam, to help position the vessel over the keel blocks when the vessel is brought in. Cranes are used for heavy lifting. When the vessel is in position the lock gates are shut and pumping out commences. A diver may be employed to ensure that the vessel's keel is in line with the keel blocks. As water is pumped out the diver keeps checking that the vessel is taking to the blocks as planned. Sometimes blocks are shifted so that maintenance can be done on a sea chest valve, drain plug, and etc.**

# The End