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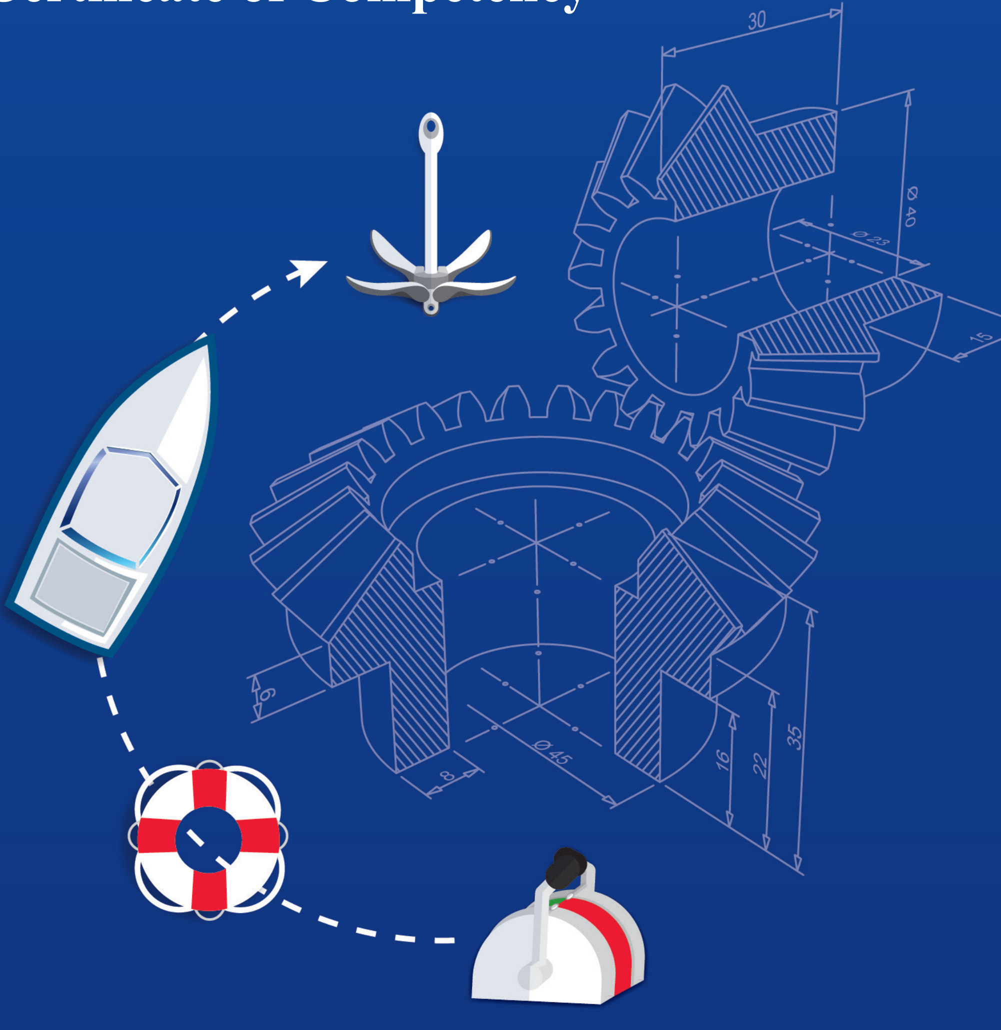
Marine Department

Examination Guidebook on Pleasure Vessel Operator Grade 2 Certificate of Competency



Examination Guidebook on Pleasure Vessel Operator Grade 2 Certificate of Competency

Disclaimer

The Pleasure Vessel Operator Grade 2 Certificate Examination Guidebook facilitates public understanding on the examination requirements and the deck and engineering knowledge required for the professional qualification. The information contained in this guidebook is compiled by the Marine Department for general information only. Whilst the Marine Department endeavours to ensure the accuracy of this general information, no statement, representation, warranty or guarantee, express or implied, is given as to its accuracy or appropriateness for use in any particular circumstances. The Marine Department is not responsible for any loss or damage whatsoever arising out of or in connection with any information.

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Chapter 1 —
Eligibility Criteria for Pleasure Vessel Operator Grade 2 Certificate

1. A Pleasure Vessel Operator Grade 2 Certificate entitles the holder to take charge of a pleasure vessel that is of not more than 15 m in length overall operating in Hong Kong waters.

2. A local certificate of competency becomes valid when it is granted to the holder. It expires when the holder attains the age of 65, or when it is cancelled or suspended under the Merchant Shipping (Local Vessels) Ordinance. The holder or a certificate may apply for extension of the certificate and the application shall be made within 6 months before the expiry of the certificate. If the holder is of age 71 or above, he/she shall renew the certificate within 3 months before the expiry of the certificate. If the Director is satisfied that the applicant is fit to hold the certificate for the extended term, the Director shall approve the application. Application made after expiry of the certificate will not be accepted.

3. To be eligible for the issue of a Pleasure Vessel Operator Grade 2 Certificate, an applicant must:

   a. be at least 18 years of age when applying for an examination;

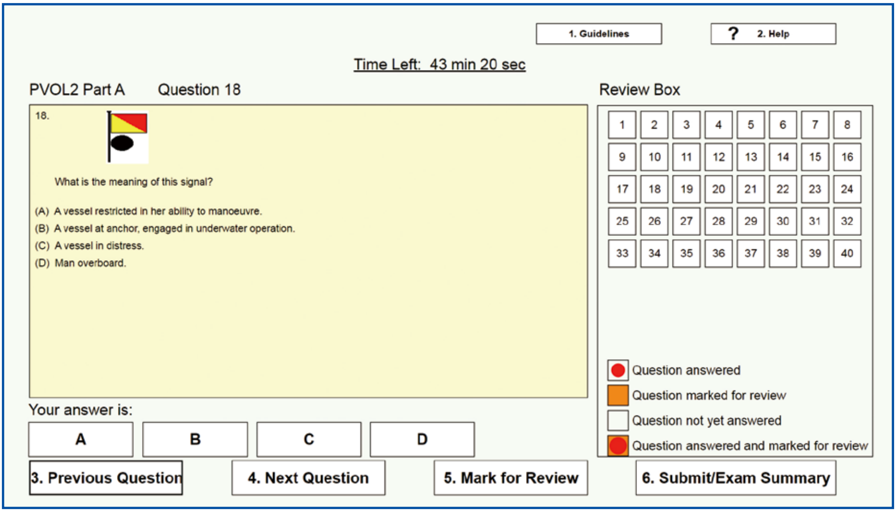
   b. reach the eyesight standard prescribed in Examination Rules (see Appendix 1); and

   c. have passed Marine Department Pleasure Vessel Operator Grade 2 Part A and Part B examinations or have satisfactorily completed the Hong Kong Sailing Federation's Pleasure Vessel Operators Licence Grade 2 (PVOL 2) Course, which is approved under the Pleasure Vessel Competency Training and Assessment Scheme, and have passed the course assessment.

Chapter 2 —

Mode of Assessment for Pleasure Vessel Operator Grade 2 Certificate Examination

The Pleasure Vessel Operator Grade 2 Examination consists of two parts: Part A – navigation, seamanship and safety; and Part B – engineering knowledge. The examination in each part consists of 40 multiple choice questions and time allowed for each examination is 45 minutes. The passing mark is 60% (i.e. at least 24 questions should be correct). Examination will be conducted with an interactive computer system.



For issuance of a Pleasure Vessel Operator Grade 2 Certificate, the candidate must pass Part A and Part B examination. A partial pass of Part A or Part B may retain for a period of two years.

Chapter 3 —

Syllabus for Pleasure Vessel Operator Grade 2 Examination

Part A : Navigation, Seamanship and Safety

(1) Handling characteristics and limitations of small craft

(a) Manoeuvring characteristics, response to rudder, transverse thrust and stopping distances.

(b) Appreciation of manoeuvring difficulties of larger vessels and sailing craft.

(c) Berthing and unberthing at piers and buoys.

(d) Manoeuvring in confined spaces.

(e) Handling small craft in rough seas and heavy swell under power.

(f) Handling small craft in fog/restricted visibility under power.

(2) Anchoring

(a) Coming to and leaving an anchorage.

(b) Identifying a suitable position in which to anchor - depth of water, type of bottom and adequate swinging room.

(c) Precautions when at anchor.

(d) Action in event of fouled anchor.

(e) Action in event of dragging anchor.

(f) Anchoring in emergencies.

(3) Start up and close down safety checks

(a) Pre-departure
- (i) weather forecast.
- (ii) check compartments to ensure all are dry.
- (iii) check lifejackets, lifebuoys, fire-fighting appliances, distress signals are all correctly stowed and ready for immediate use.
- (iv) check compass, steering, anchor, mooring ropes, radio if fitted, navigation lights, sound signalling apparatus, and bilge pump.

(b) Post arrival
- (i) ensure vessel securely moored.
- (ii) check compartments to ensure all are dry.

(iii) ensure equipment securely stowed away as necessary.
(iv) check LPG supply duly shut and disconnected at cylinder.
(v) check batteries fully charged.

(4) Chart work, position fixing, ETA etc.

(a) Knowledge of symbols used on navigation charts relating to depth of water, buoys, lights, pipelines, submarine cables, wrecks, rocks and tidal streams.

(b) Use of clearing marks and transits.

(c) Position fixing using cross bearings.

(d) Ability to determine the course to steer between two points.

(e) Ability to measure a distance between two points and calculate ETA making allowance for effect of a tidal stream.

(f) A knowledge of the factors affecting the accuracy of a magnetic compass and how to approximate the error.

(g) Plan a short sea passage by day or by night.

(h) Ability to plot and report a position by latitude and longitude; also by bearing and distance.

(5) Tides

Use of Hong Kong tide tables, tidal stream atlas and tidal information from charts of Hong Kong waters. Neap and Spring tides.

(6) Navigation of small power driven craft in restricted visibility

(7) Local knowledge

(a) Victoria Harbour limits.

(b) Location of fairways, prohibited anchorages, restricted and prohibited entry areas.

(c) Speed limits within Hong Kong waters and navigation in typhoon shelters.

(d) Traffic separation schemes, both IMO adopted and locally recommended. Application of Rule 10 of Colregs.

(e) Ferry routes and ferry piers - precautions when navigating in vicinity thereof.

(f) Safe recreation areas.

(g) Lights exhibited by high speed craft in Hong Kong waters.

(h) Lights which may be exhibited by sailing junks in Hong Kong waters.

(i) Penalties for polluting and throwing garbage into Hong Kong waters.

(j) Buoyage system in use in Hong Kong waters (Cardinal, lateral, isolated danger, safe water and special marks - shapes and colour of buoys, lights and topmarks).

(k) How to request assistance from the relevant authorities in Hong Kong in case of emergency.

(8) International Regulations for Preventing Collisions at Sea (Colregs)

(a) Knowledge of International Regulations for Preventing Collisions at Sea including the proper use of Radar, the meaning and importance of proper lookout and safe speed.

(b) Knowledge of the lights, shapes and sound signals for vessels up to 15 m in length.

(c) Recognition of the lights and shapes carried by:
- (i) Power driven vessels of any length.
- (ii) Sailing vessels of any length.
- (iii) Vessels towing or pushing.
- (iv) Vessels not under command or restricted in their ability to manoeuvre (including dredging, salvage, underwater operations; also constrained by their draught).
- (v) Fishing vessels.
- (vi) Pilot vessels.
- (vii) Anchored vessels.

(d) Sound signals in restricted visibility.

(e) Manoeuvring and warning signals.

(f) Signals of distress.

(9) Safety equipment to be carried on board

(a) Knowledge of statutory requirement to carry lifesaving and fire-fighting equipment on pleasure craft.

(b) Knowledge of the correct use of lifesaving equipment carried on pleasure craft.
- (i) Lifejackets.
- (ii) Lifebuoys.
- (iii) Buoyant items such as plastic seats.

(c) Knowledge of the maintenance procedures for lifesaving equipment on pleasure craft.

(d) Distress signals and their use.
   (i) Red Flares (hand held or parachute).
   (ii) Orange Smoke signal.

(10) Use of VHF

(a) Radiotelephone procedures ─ reception and transmission.

(b) VHF channels in use in Hong Kong waters.

(c) Distress transmitting procedure.

(11) Marine Department services

(a) Vessel Traffic Centre (VTC) ─ Radio navigation warnings.

(b) Marine Rescue Co-ordination Centre (MRCC).

(c) Notices to Mariners.

(d) Marine Department Notices.

(12) Storm signals and weather

(a) An understanding of the significance of Typhoon Signals and the Strong Monsoon Signal together with associated sea and swell conditions.

(b) The effect of fetch on wave height.

(c) Knowledge of the available sources of weather information and warnings. Types of report available.

(d) Correct interpretation of weather information received.

(e) Knowledge of local weather patterns.

(f) Understanding of the Beaufort Wind Scale.

(13) Handling of emergency situations

(a) Action to be taken in event of collision, grounding, springing a leak, or fire on board.

(b) Action to be taken in event of loss of rudder, lost or fouled propeller or loss of anchor.

(c) Handling a partially disabled vessel and action to be taken if completely disabled.

(d) Beaching.

(e) Rendering assistance to other vessels in distress. Taking a disabled vessel in tow.

(f) Appreciation of the obligations of the operator to persons and crew.

(g) Disposition of persons and crew to ensure satisfactory stability and trim.

(h) Man overboard. Immediate response; action to recover person from the water; signals.

(14) Accident reports

(a) Statutory duty to report an accident on board.

(b) What constitutes a reportable accident.

Part B : Engineering Knowledge

(15) Engines ─ Construction and functions of internal combustion engines, pre-start inspection, starting and stopping sequences

(a) Construction and functions of various components of engines (petrol and diesel).

(b) A knowledge of the pre-start inspection/check of the following items:
- (i) Unrestricted movement of engine, shafting and propeller.
- (ii) Integrity of engine and propeller mounting (outboard).
- (iii) Fuel oil system and quantity of fuel for intended voyage.
- (iv) Quantity of lubricating oils:
  - A. crankcase and gearbox (inboard)
  - B. gearcase (outboard) .
- (v) Proportion of fuel and lubricating oil (outboard).
- (vi) Cooling system and quantity of coolant.
- (vii) Functional test of engine/gearbox control system.
- (viii) Functional test of steering gear/mechanism.

(c) Starting procedures.

(d) Effect of repeated/prolonged starting.

(e) An understanding of the need for warming up and cooling down and the procedures to follow.

(f) Stopping procedures.

(g) Procedures for securing the machinery spaces

(16) Duties while underway

(a) Monitoring of engine performance by
- (i) RPM.
- (ii) coolant temperature/flow.
- (iii) lubricating oil pressure.
- (iv) lubricating oil temperature.

(v) exhaust temperature.

(vi) exhaust condition.

(vii) engine noise/vibration.

(b) Monitoring of stern gland condition and bilge level in machinery space.

(c) Machinery space ventilation.

(17) Batteries and electrical equipment

(a) Batteries

(i) verify charging condition of batteries.

(ii) replenishing electrolyte in batteries.

(iii) the importance of ventilation of battery lockers.

(iv) charging current and indication.

(b) brief outline of simple switchboard and its instrumentation.

(c) the function, types and rating of fuses, their routine checks and actions in event of blown fuse.

(d) the hazards of and actions in event of electric shock.

(18) Trouble shooting and remedies at sea

(a) difficulties in starting engine.

(b) engine stop when underway.

(c) engine speed fluctuation.

(d) excessive engine vibration.

(e) excessive turbo charger vibration.

(f) abnormal smoke from exhaust.

(g) high lubricating oil temperature.

(h) high coolant temperature (inboard) and/or low/no coolant flow (outboard).

(i) high exhaust temperature.

(j) difficulties in engaging/disengaging gear.

(k) engine fails to stop.

(l) deteriorating bilge pumping efficiency.

(19) Maintenance

(a) Appreciation of maintenance schedules recommended by shipbuilder and engine manufacturer.

(b) A knowledge of the importance of:
  (i) cleaning/replacement of air, fuel and lube oil filters and sea suction strainers.
  (ii) replacement of lubricating oils.
  (iii) cleaning/inspection of cooling and exhaust system.
  (iv) checking of belt drives.

(20) Safe operation of deck equipment

(21) Fire-fighting and fire prevention

(a) fire hazard of petrol and diesel fuel.

(b) types of fire and appropriate fire-fighting medium.

(c) types of portable fire extinguishers, their operation and maintenance.

(d) practical fire-fighting techniques.

(e) LPG installation and associated hazards.

(f) safe fuel storage and isolation of fuel supply in case of fire.

(g) actions to be taken in event of fuel leak.

(h) precautions when taking fuel on board.

Chapter 4 —
Reference

(Part A) Navigation, Seamanship and Safety

(1) Handling characteristics and limitations of small craft

(a) Vessels operating with a single right handed propeller will generate a transverse thrust when going astern and this thrust is particularly significant at the starting stage. The transverse thrust will undesirably push the vessel's stern to the port side. It is therefore easier to berth a vessel with its port side alongside than its starboard side.

To stop a vessel from moving forward, we may use the vessel's propulsion engines and operate them on astern. The vessel will however continue to move forward for a further distance before it completely stops in water. The stopping distance would depend on various environmental factors like the wind and the current, and more significantly the type of vessel and the power of the main propulsion engines.

According to the International Regulations for Preventing Collisions at Sea, "Every vessel shall at all times proceed at a safe speed so that it can take proper and effective action to avoid collision and be stopped within a distance appropriate to the prevailing circumstances and conditions." Every master of vessel should therefore thoroughly understand his/her vessel's manoeuvring characteristics and stopping distances in order to be able to control the vessel properly when dealing with emergency situations.

(b) The appreciation of the manoeuvring constraints likely to be suffered by large vessels and sailing craft is important. Vessel with a relatively deep draft may find it difficult to change course or take avoiding action due to the constraints of their deep draft in relation to the available depth or width of waterways they can safely navigate only in. Sailing craft must rely on the presence of wind for movements and controls, without which little effective avoiding action can be taken by the craft. When an ordinary power driven vessel approaches a deep draft or a sailing vessel, it should give way in order to avoid collision.

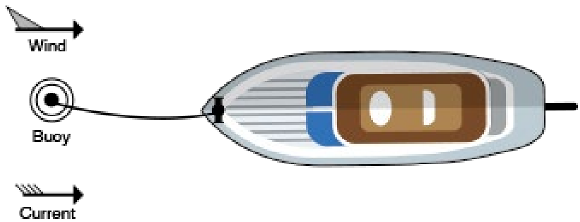
(c) When berthing a vessel, the commonly adopted practice is to have its bow heading into the wind and current since the head wind and current would assist the control of the bodily movement of the vessel. As the vessel reaches its assigned berthing position, it is desirable to make fast a head line to the pier first. This will help prevent the vessel from colliding with other vessels at the stern in case of sudden loss of power.

For unberthing, as vessels are easily vulnerable to the wind and current while at slow movement, in order to avoid the stern from contacting the pier, attention must be paid that the vessel be maintained at a safe distance from the pier, taking into account the prevailing weather.

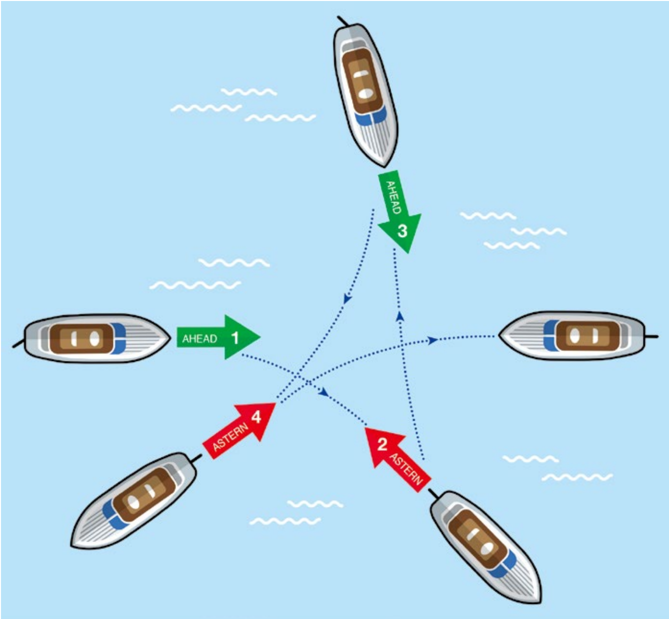
Before the vessel leaves the pier, the master must ensure that a safe distance is kept from the vessels next to own vessel. Unless it is certain that the vessel can safely depart from the pier, it is always desirable to keep at least one headline and one stern line to the pier for any unexpected situation.

After the mooring lines are disconnected, they must be retrieved on board as soon as possible to prevent the danger of fouling the propeller.

Securing to a buoy: Steer the vessel to the buoy at slow speed with wind and current ahead. Adjust the direction of the bow so as to align in the same heading with other nearby the moored vessels. Crew should be deployed at forward station to indicate the position of and the distance from the mooring buoy. Adjust the distance by using the appropriate engine movement to the desired position and make fast the mooring line on the bitts at the bow.



(d) Manoeuvring in confined spaces: If it is required that the vessels be turned 180° in narrow waters, making a right turn would be desirable due to the transverse thrust created by the propeller.



Position 1: Put the engine on full ahead with the rudder hard to starboard. When the vessel is moving forward, stop the engine and return the rudder to midship position. Then put the engine on full astern.

Position 2: When the vessel is moving backwards, stop the engine. Then put the engine on full ahead with the rudder hard to starboard again. The vessel will begin to turn to starboard.

Position 3 and Position 4: Repeat the steps of Position 1 and Position 2 again, until the vessel has completed a turn by 180°. Meanwhile, get the anchor ready for emergency uses.

(e) Handling small craft in rough seas and heavy swell under power

i. Slow down the vessel immediately. Adjust the ship's head of the vessel and head into the direction of waves at an angle of 20° to 30°;

ii. Crew members and passengers are to put on lifejackets immediately;

iii. Assemble the passengers to remain at a position near to the centre of the vessel. Loitering of passengers during rough seas should not be allowed;

iv. Close all the windows and doors to enhance watertight integrity;

v. Lash up all loose objects to prevent them from moving, so as not to create any undesired shift of the center of gravity to the vessel;

vi. Keeps all drain holes on deck clear of fouls;

vii. Pump out excess bilge water;

viii. Set the telephone and VHF radiotelephone on standby mode. Keep contact with shore radio station, and report to them the current location of the vessel;

ix. Seek appropriate nearby location for shelter as soon as possible.

(2) Anchoring

Preparation and actions for anchoring:

1. Choose a suitable anchorage by consulting appropriate navigation chart. Suitable anchorage should refer to waters with sufficient water depth, suitable seabed with good holding power (mud, sand, etc.) and mild gradient, and be free of any underwater obstruction such as shipwrecks, cables, pipelines, etc.;
2. A suitable anchorage should not be affected by strong winds or strong currents;
3. Vessels should not anchor too close to each other, and allow enough swinging room between vessels;
4. Depending on the weather and vicinity of nearby anchored vessels, where possible, the length of the anchor chain paid out should be at least four times the water depth or more, the longer length of chain would give better holding power;
5. Crew members operating the windlass at the bow must wear life jackets;
6. Adjust ship's heading against tide and wind and proceed at slow speed towards the anchorage;
7. Exhibit anchor light signal immediately after anchoring. Hoist a black ball on the foremast in the daytime, and a round white light in the night time;
8. Make use of conspicuous shore objects to determine the anchored position on the chart;
9. Arrange anchor watch to ensure the anchor is not dragging and a safe distance is kept between nearby anchored vessels;
10. Keep listening watch on appropriate VHF communication channels. Pay attention to the safety notices issued by the Marine Department and the weather reports from the Observatory;
11. Small vessels must avoid anchoring by stern. As the vessel's main engine, fuel and heavier equipment are mostly installed at the stern, its freeboard at the aft is already smaller than that at the bow. If anchoring by stern, water may wash the stern during the passage of a storm and could reduce the vessel stability.

Action in event of dragging anchor:

If own ship is heading in a different direction from other vessels at anchor nearby, check the position of the vessel immediately. If the anchor is dragging, the following actions must be taken:

1. If there's enough room available, pay out more anchor chain immediately to increase the holding power;
2. If the anchor is not holding the seabed, start the engine immediately and manoeuver the vessel as required. Heave up the anchor and find another safe anchorage.
3. If the engine could not be started, drop the spare anchor to stop the vessel from drifting, but beware for possible entangling of the two anchor chains.

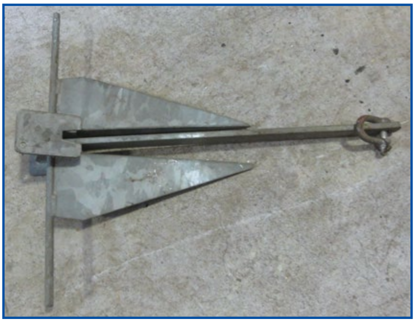
Action in event of fouled anchor:

When the anchor is found being fouled with underwater obstacles, tighten up the anchor chain first. Manoeuver the vessel around the location of the anchor so that the anchor might be loosen from the obstacles. Make continuous attempts to heave back the anchor chain from different directions. If all failed, consider to abandon the anchor.

When abandoning the anchor, we should disconnect the chain. Before disconnecting, prepare a rope with a length greater than the depth of water and tie it to the section of chain intended to be detached from the main chain. Connect the other end of the rope to a buoy, which will be left in the water for location and recovery of the anchor at a later time. Note down the position and report to the Marine Department. Vessel owner should make arrangement for the recovery of the abandoned anchor as soon as possible.

Anchoring in emergencies

While navigating in busy waterways, the vessel's anchor should always be put in readiness for emergency uses including emergency stop of the vessel if required. Similarly, vessels proceeding in dense fog or poor visibility may consider to leave temporarily the congested traffic lane, and anchor at a safe place to wait for the visibility to improve.



Danforth Anchor

Folding Grapnel

(3) Start up and close down safety checks

(a) Pre-departure

1. Make reference to the weather forecast;
2. Check compartments to ensure all are dry;
3. Check lifejackets, lifebuoys, fire-fighting appliances, distress signals, first-aid box and batteries to ensure all are correctly stowed and ready for immediate use;
4. Check compass, steering, anchor, mooring ropes, radio (if fitted), navigation lights, sound signaling apparatus and bilge pump;
5. Draw sailing routes on the nautical charts to ensure navigation of the voyage is undertaken within safe water areas;
6. Acquire the most updated notices from the website of Marine Department and listen to the hourly safety notices broadcast on VHF Channel 20 to ensure that there are no marine constructions or obstructions which would affect the safe navigation near the planned routes;
7. Tighten all loosened objects on the vessel;
8. Ensure sufficient fuel oil and drinking water on the vessel;
9. Tell friends/relatives on-shore about the information on the concerned voyage, such as number of passengers, stopovers along the route, and ETA at destination etc.;
10. Inspect and conduct tests on the machinery.

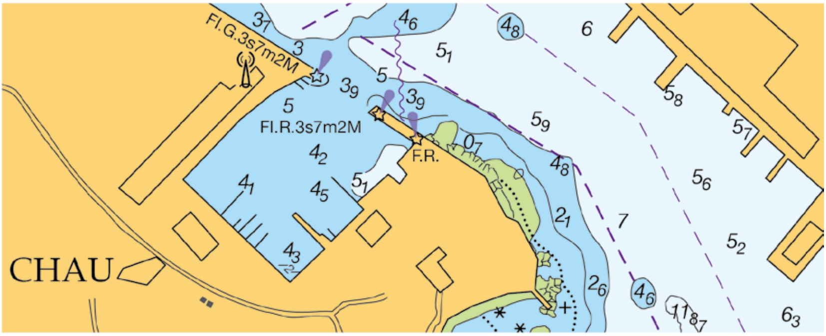
(b) Post arrival

1. Ensure the vessel is securely moored;
2. Inform friends/relatives on-shore of the safe arrival of the vessel at the destination;
3. Check compartments to ensure all are dry;
4. Ensure equipment is securely stowed away as necessary;
5. Check if the LPG supply is shut and disconnected at the cylinder;
6. Check if the batteries are fully charged.

(4) Chart work, position fixing, ETA etc.

(a) Knowledge of symbols used on navigation charts relating to depth of water, buoys, lights, pipelines, submarine cables, wrecks, rocks and tidal streams

Depth — The extract of a navigation chart below uses 0.1 m as progressive unit for depths between 0.1 m to 20.9 m; 0.5 m for depths between 21 m to 31 m; and 1 m for depths of more than 31 m. Numbers appearing in the blue area of the chart show the depth of water. Dark blue areas indicate shallow water zones, with a (5 m) contour dividing them from the deeper zones in light blue colour.



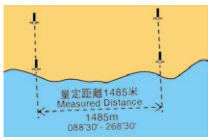
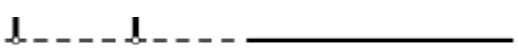
Characters and Abbreviation of Buoys and Light

F	Fixed	Fl(2+1)	Composite group-flashing	VQ(3)	Group very quick
FFl	Fixed and flashing	LFl	Long-flashing	IVQ	Interrupted very quick
Oc	Single-occulting	Q	Continuous quick	MO(A)	Morse • — flashing
Iso	Isophase	Q(3)	Group quick	Al.WR	Alternating
Fl	Single-flashing	IQ	Interrupted quick	Al.Fl.BuY	Alternating flashes of blue and yellow light
Fl(2)	Group-flashing	VQ	Continuous very quick	UQ	Continuous ultra quick

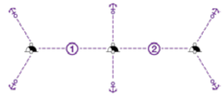
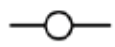
Colours of Lights for Buoys and Light Illustration

W	White	Fl(2)10s	Group flashing repeating a group of two flashes and eclipses every 10 seconds.
R	Red	Al Fl BuY 3s	Alternating flashing with blue and yellow light every 3 seconds.
G	Green	LFl.10s	One long flash every 10 seconds.
Bu	Blue	Fl.G.3s9m5M	Single-flashing with green light and eclipses every 3 seconds. Elevation of focal plane above HWM: 9 metres. Light range is 5 nautical miles.
Y	Yellow	Fl(2)20s68m24M	Group flashing repeating a group of two flashes and eclipses every 20 seconds. Elevation of focal plane above HWM: 68 metres. Light range is 24 nautical miles.
Or	Orange	F.R.7m3M	Fixed red light. Elevation of focal plane above HWM: 7 metres. Light range is 3 nautical miles.

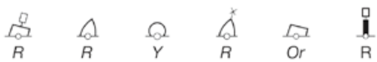
Beacons

	Beacon towers, with and without topmarks and colours		Beacons marking measured distance with quoted bearings
	Leading beacons		Beacon marking cable landing point

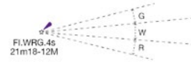
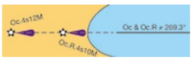
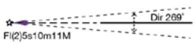
Shapes of Buoys

	Conical buoy		Mooring buoy
	Can buoy		Lighted mooring buoy
	Spherical buoy		Trot, mooring buoys with ground tackles and berth numbers
	Pillar buoy		
	Spar buoy	小船浮泡 Small Craft Moorings	Numerous moorings
	Barrel buoy		
			Position of buoy or beacon
			Special purpose buoys (buoy marking cable, spoil ground, outfall, wave recorder or current meter, recreation zone and entry prohibited area)
			Emergency wreck marking buoys

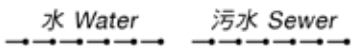
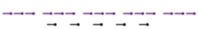
Colours of Buoys and Beacons

	Single colour: green (G) and black (B) (symbols filled black)
	Single colour other than green and black: red (R), yellow (Y), orange (Or)
	Multiple colours in horizontal bands, the colour sequence is from top to bottom
	Multiple colours in vertical or diagonal stripes, darker colour is given first

Lights

	Major light		Direction light with narrow fairway sector flanked by light sectors of different characters
	lighted beacon		Sector light on standard charts
	Leading lights		All-round light with obscured sector
	Direction light with narrow sector and course to be followed, flanked by darkness or unintensified light		Aero light

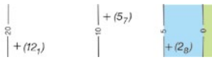
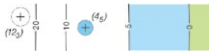
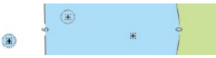
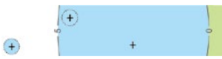
Submarine Cables and Pipes

	Supply pipeline : oil		Submarine cable
	Supply pipeline : gas		Submarine cable area
	Supply pipeline : water		Submarine power cable
	Discharge pipe: water or sewer		Submarine power cable area
	Disused pipeline/pipe		Disused submarine cable

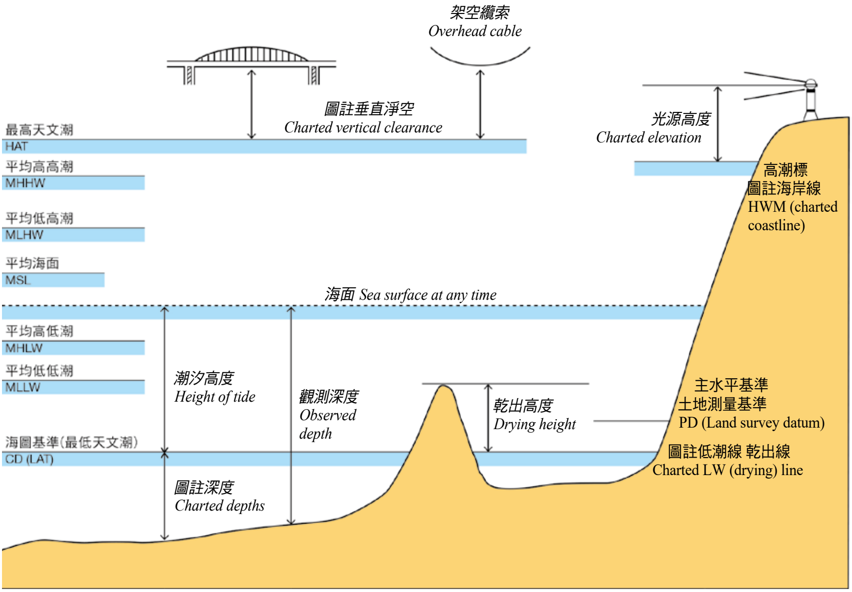
Wrecks

	Wreck, hull never covers, on large-scale charts		Wreck, least depth known by sounding only
	Wreck, covers and uncovers, on large-scale charts		Wreck, least depth known, swept by wire drag or diver
	Submerged wreck, depth known, on large-scale charts		Wreck, least depth unknown, considered to be potentially dangerous to some surface vessels
	Submerged wreck, depth unknown, on large-scale charts		Wreck, least depth unknown, but considered to be covered by more than 20 m of water
	Wreck showing any portion of hull or superstructure at level of chart datum		Wreck, least depth unknown, but considered to have a safe clearance to the depth shown
	Wreck of which the mast(s) only are visible at Chart Datum		Remains of a wreck or other foul area, non-dangerous to navigation but to be avoided by vessels anchoring, trawling etc.

Rocks

	Rock (islet) which does not cover, height above high water mark		Dangerous underwater rock of known depth, inside the corresponding depth area
	Rock which covers and uncovers, height above chart datum		Dangerous underwater rock of known depth, outside the corresponding depth area
	Rock awash at the level of chart datum	*35* *R*	Non-dangerous rock, depth known
	Dangerous underwater rock of uncertain depth		Breakers
	Danger line		Depth swept by wire drag or diver investigation

Tidal Levels and Charted Data



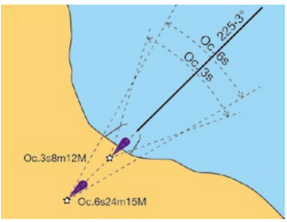
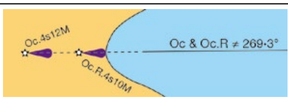
CD	Chart Datum (Datum for Sounding Reduction)	MHHW	Mean Higher High Water
LAT	Lowest Astronomical Tide	MHLW	Mean Higher Low Water
HAT	Highest Astronomical Tide	MLHW	Mean Lower High Water
MSL	Mean Sea Level	Sp	Spring tide
PD	Principal Datum (Land Survey Datum)	Np	Neap tide
MLLW	Mean Lower Low Water	HWM	High Water Mark

Navigation Chart Plotting Symbols

	Course to Steer: Course through water		The expected position (dead reckoning) after sailing a certain course for a certain distance.
	Course Made Good: Course over the ground		Estimated position after allowing for set and drift.
	Set and Drift		The definite and confirmed position.
	Position line: it is obtained through celestial navigation or by means other than terrestrial bearing	3kn	Flood tide stream (with mean spring rate)
	Overfalls, tide rips, races	3kn	Ebb tide stream (with mean spring rate)

(b) Use of clearing marks and transit bearings

Navigation Line — Observe the transit bearing of two objects or light beacons ashore in a straight line. The two objects should best not be too far apart from each other. At night the vessel may deem its course to steer as correct if the ship's head forms a straight line with the two light beacons ashore. Please refer to the paragraph (g) of this chapter for the practical usage of safe navigation line.

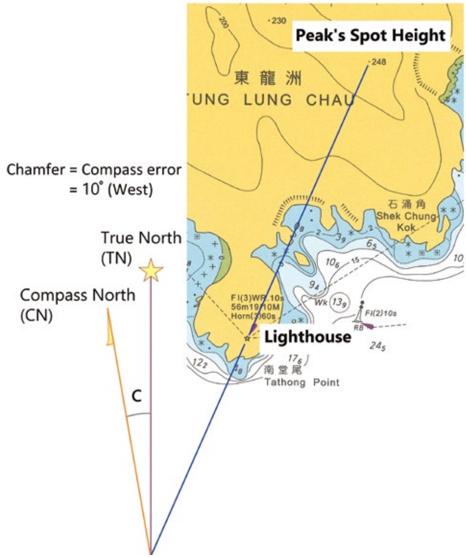
	Leading lights with leading line (firm line is fairway) and arcs of visibility
	Leading lights ≠: two objects in line
	Leading lights on small-scale charts

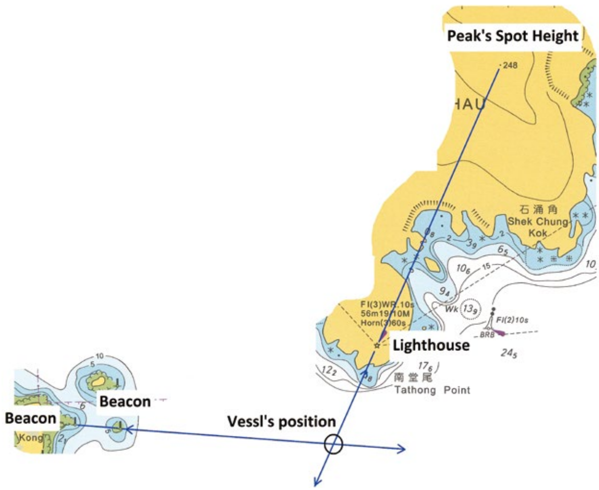
Range — When sailing along the coast, it would be an advantage if we can locate two objects objects ashore in a straight line. By comparing their bearing obtained over the compass and their true transit bearing from the chart, the compass error can be obtained without having to calculate it through the variation and deviation.

e.g.: The true bearing of the Peak's spot height and the lighthouse = 040˚

The compass bearing of the Peak's spot height and the lighthouse = 050˚

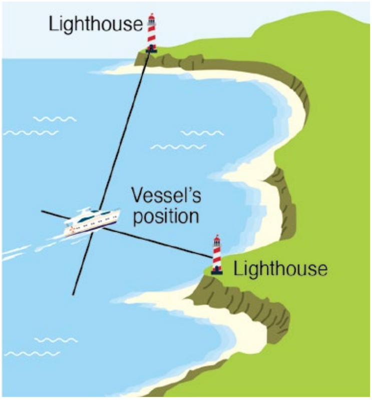
Compass error = 10˚ (West)





(c) Position fixing using cross bearings

Take the compass bearings of two to three objects and convert them into true bearings after allowing for variation and deviation. Plot the true bearings on the chart. The intersection point of the bearing lines would be the ship's position.



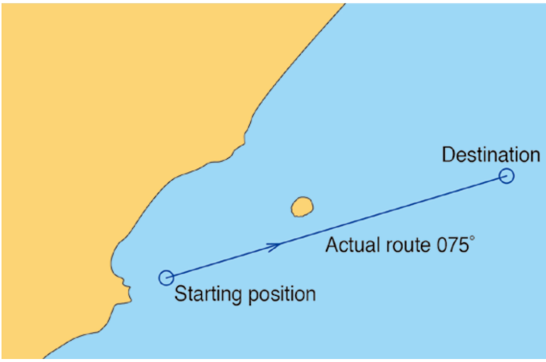
(d) Determine the course to steer between two points

In chart work studies, distance, time and speed (in Knot) are the three variables or factors for calculating the vessel's movement. If any two variables are known, the third one can be calculated by the simple formula below.

e.g.: Distance = Time x Speed;

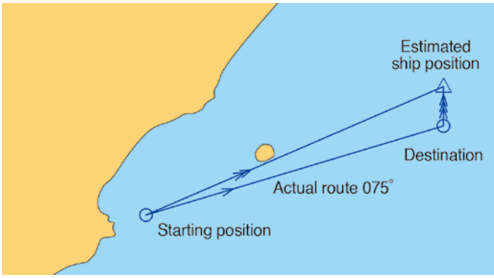
Time = Distance / Speed;
Speed = Distance / Time, etc.

Mark the vessel's starting position and destination on the chart. Connect them with a straight line. This line is called the true course to steer. By applying the compass error, the compass course can be found.



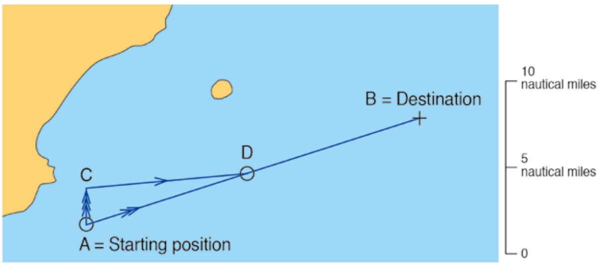
(e) Measure the distance between two points and calculate ETA having due allowance for the effect of the current

While drawing the course between two points on the chart, the master should take into consideration the effect of a current, which may cause the vessel to deviate from its original intended route.



As the above figure shows, the vessel has been affected by an unnoticeable north flowing current. Although the ship's head is on 075°, the actual track of the vessel is pushed north to a resultant track →»——. If the vessel unknowingly continues its movement along this track, it may get very close to, or even stranded on the shoal.

If the magnitude and direction of the current is known, a course to steer to counteract the current should be determined as part of the passage planning before sailing. The method of determining this course to steer is as below:



The distance between A and B is 20 nautical miles. The speed of the ship is 10 knots. It is estimated that the ship is affected by a north flowing current with a speed of 2 knots. If, the ship departs at 08:30 a.m., find:

(1) the course to steer and the speed of a vessel counteracting the current;

(2) the estimated time of arrival.

Draw a line to link up A and B on the chart. This will represent the actual course over ground that the vessel should move forward along. This track of 075° is also called the course made good of the vessel, and its distance is 20 miles;

AC = the distance known as “Drift of the current” covered by the current in a period of one hour at 2 knots. Use a pencil compass to subtend a length equal to 10 nautical miles (= vessel’s speed) on the chart. With this, place the needle of the pencil compass at point C and draw an arc across the line AB and call the crossing point D.

CD = the course to steer that counteracts the current = 086°; AD = Because of the effect of the current, the actual speed of vessel over ground = 10.3 knots.

Steaming time = Distance/actual speed = 20/10.3 = 1.94 hour

ETA at destination = Departure time + steaming time = 0830 + 1.94 = 1026 hrs.

If the vessel is not affected by any current at all, steaming time = distance/speed = 20/10 = 2 hours

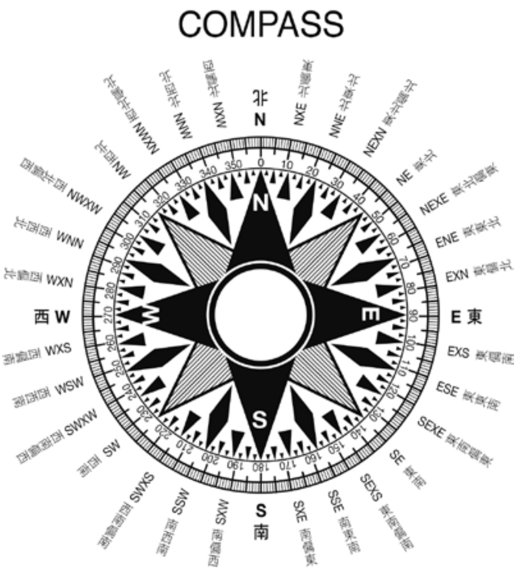
ETA at destination = Departure time + steaming time = 0830 + 0200 = 1030 hrs.

(f) Knowledge of the factors affecting the accuracy of a magnetic compass and how to determine the error

Variation and deviation are the major factors affecting the accuracy of a magnetic compass.

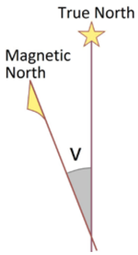
The surface of a Compass Card

A circle consists of 360° or 32 points. Each point is 11¼°. Each point has a cardinal name as listed below:



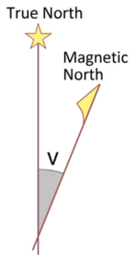
Variation

Each vessel must be equipped with one magnetic compass to indicate the vessel's courses at sea. The magnetic compass points to the magnetic north or magnetic south, which is not the geographic true north. As the magnetic meridian linking up the magnetic north and south poles does not superimpose with the true meridian, these two meridians will cross at a certain location to form an angle known the angle of "Variation" at the location.



(a) V angle West variation

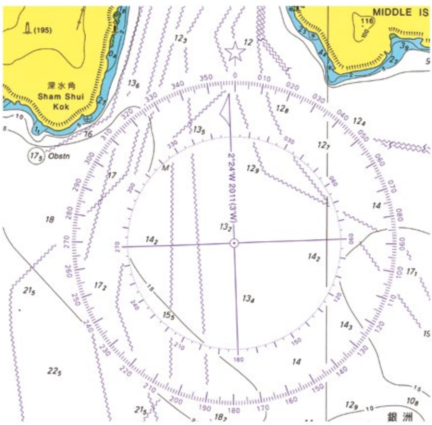
When magnetic north is on the left of true north, it is known as west variation



(b) V angle East variation

When magnetic north is on the right of true north, it is known as east variation

The value of variation varies from place to place, and changes over time due to the changes of the magnetic field on the Earth. Navigators can use the annual change of variation on the compass rose to calculate the updated variation. The method is as follows:



It is known from the compass rose that:

In 2011, the variation of the area near the centre of the compass rose was 2° 24' W, with an annual change of 3' W. The magnetic North is represented by the arrow.

The amount of changes of variation between 2011 and 2016

= (2016 - 2011) x 3' W = 15' W

The variation in 2016 = The variation in 2011 + 5 years of change in variation*

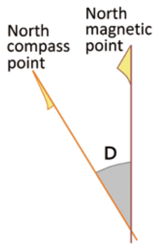
= 2° 24' W + 15' W

= 2° 39' W

* (The difference between, instead of the sum of, the two figures should be taken if the annual change of variation direction is different from that of the variation.)

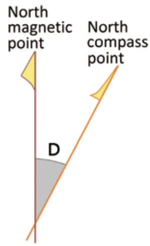
Deviation

When the magnetic compass of a vessel points a direction away from the geographical North or South poles of the Earth, the angle of inaccuracy is known as "Deviation". This is resulted from the magnetism caused by the vessel's structure, cargo or equipment on board. The amount of deviation varies according to the ship's head. The deviation for individual ship's head can be obtained from the vessel's Deviation Card.



Angle D = West deviation

When North compass point is
on the left of Magnetic point,
the deviation is called West deviation



Angle D = East deviation

When North compass point is
on the right of Magnetic point,
the deviation is called East deviation

DEVIATION CARD No. 1	
Ship's Head by Compass	**Deviation**
000	NIL
020	3E
040	6E
060	8E
080	9E
100	6½ E
120	7E
140	4E
160	1E
180	2W
200	4W
220	6½ W
240	8W
260	9W
280	8½ W
300	7W
320	5W
340	2½ W
360	NIL

Compass deviation = Variation plus/minus deviation (plus when directions are the same; minus when directions are different)

T = True North

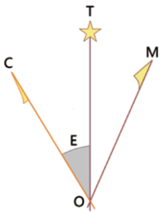
Angle TOM = angle of variation

M = Magnetic North

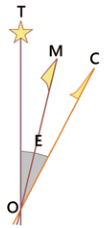
Angle MOC = angle of deviation

C = Compass North

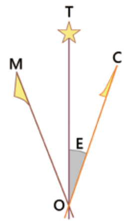
Angle TOC = angle of compass error



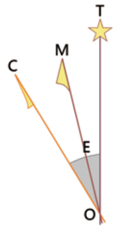
(fig. A)



(fig. B)



(fig. C)



(fig. D)

variation 5° East	variation 5° East	variation 7° West	variation 4° West
deviation 12° West	deviation 5° East	deviation 13° East	deviation 7° West
compass error **7° West**	compass error **10° East**	compass error **6° East**	compass error **11° West**

Another method to obtain the compass error is to compare the compass bearing taken over the compass with the true transit bearing of two objects measured out on the chart.

e.g. (1):

True transit bearing of two lighthouses	= 047°
Compass transit bearing of two lighthouses	= 050°
Compass error	= 3° (W)

e.g. (2):

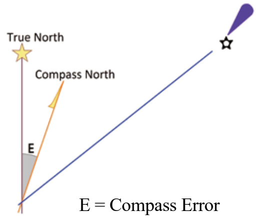
True bearing of two lighthouses Compass	= 050°
bearing of two lighthouses Compass error	= 047°
	= 3° (E)

When using the compass to observe a target on the shore to determine the position of the ship, the obtained bearing is the compass bearing, which must be converted to the true bearing before it can be plotted on the chart. On the contrary, after a true course to steer has been determined and plotted on the chart, the master must convert this true course to steer back to a compass course in order that the vessel will have a direction to steer by the compass.

The method of converting the compass bearing to the true bearing:

e.g. A ship has a compass heading of 060°. It measures a compass bearing of 040° of a lighthouse. Find the true bearing of the lighthouse.

Compass bearing	040°	
Deviation	8°E	(derived from the deviation card in accordance with a ship's head of 060°(C))
Magnetic bearing	048°	
Variation	2°W	(from the compass rose on the chart)
True bearing	046°	



Deviation	8°E	Compass bearing	040°
Variation	2°W	Compass Error	6°E
Compass Error	6°E	True bearing	046°

To convert true course into compass course:

e.g. The true course of a ship on the chart is 040°, what is its compass course?

True course	040°	
Variation	2°W	(from the compass rose on the chart)
Magnetic course	042°	
Deviation	5.5°E	(derived from the deviation card with a magnetic course of 042° (M))

Compass Course 036.5°

To find the deviation, we must first refer the compass course to the deviation card, and work out the value of deviation for the particular compass ship's head by interpolation between the two given compass ship's heads.

Compass Course	Deviation	Magnetic Course
020°	3°E	023°
040°	6°E	046°
	5.5°E =	042°

To assist conversion of compass and true courses, we may use "**CADET**" to remind us of the method to convert true course/bearing to compass course/bearing, and vice versa.

C = Compass **AD** = Add **E** = East **T** = True (Compass ADd East to get True)

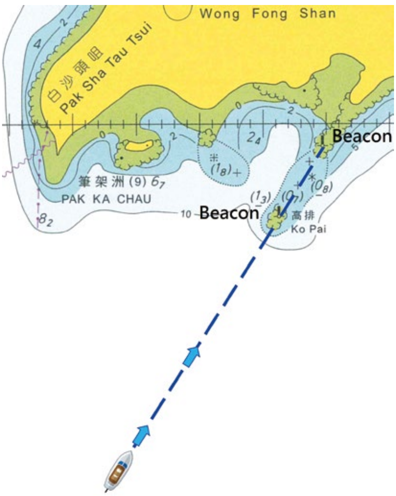
Meaning: When the name or the title of the compass error is east, add it to the compass course/bearing to determine the true course/bearing. On the contrary, the "CADET" rule can also be used to find the compass directions from the true ones, and the orientations of all the compass error, variation and deviation.

(g) Plan a short sea voyage by day or by night

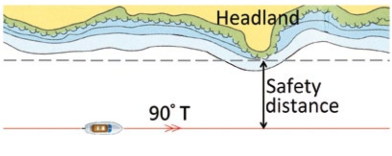
Regardless the length of the voyage, the ship master must carry out the safety checks described in paragraph 3(a) of this Chapter before sailing. During the voyage, he must check the vessel's position regularly to ensure the vessel is navigating on the planned route. He must ensure there is enough manpower in keeping lookout. He must make proper uses of navigational equipment such as radar and sounding machine. His vessel must stay well away from any obstructions such as shallow shoal, rock and vessel/wreck which may affect the safe navigation of the vessel. The master must be proficient with the local environment. When the vessel encounters bad weather, he must be able to tell where to seek refuge. When navigating at night, he should plan a route to make better uses of lighthouses and light buoy along the intended route to help checking the vessel's position. However, he should be cautious that the vessel's position obtained by observing a buoy could only be used as a reference, since the buoy might be drifted away from the charted position without notice. The following two methods could help ensure the vessel to remain on the intended route and keep a safe distance away from dangers:

1. While proceeding along a route with nearby dangers, if situation allows, the master may monitor the ship's head constantly so that it lie in line with a leading light or a transit bearing to ensure that the vessel is staying on route.

2. While proceeding along a coast with nearby dangers, make proper uses of radar and in particular by setting the variable range rings so that it can be used as guard ring on the radar screen to give early warning to the vessel for keeping off the dangers.



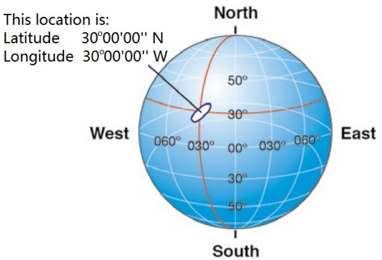
(Method 1)



(Method 2)

(h) Plot and report a position by latitude and longitude; also by bearing and distance

There are two ways to describe a location on Earth. The most common one is to plot the location on the nautical chart and define it by latitude and longitude. The 2nd method is to describe by the bearing and distance of a conspicuous object ashore as appearing to the vessel (e.g. a lighthouse and the spot height of a mountain). This method is used commonly when the object and the vessel are within a short distance from each other.



1 degree (1°) has 60 minutes (60'); 1 minute (1') has 60 seconds (60")

1 minute = 1 nautical mile

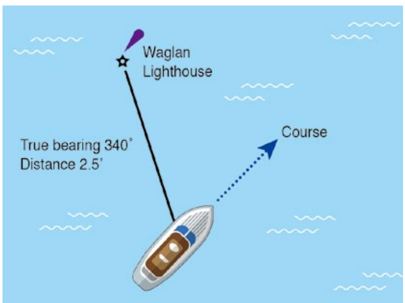
1 nautical mile = 6,080 ft = 1,853 m = 10 cables 1 knot = 1 nautical mile per hour

The combination of latitude and longitude forms a coordinate system which can be used to indicate any location on earth. The former Greenwich Observatory in England was situated on the 0° meridian of longitude called the Prime Meridian. The longitudes measured eastwards from the Prime Meridian up to 180° are called the East longitudes, and those westwards the West longitudes. The 180°E and 180°W Longitudes overlap with each other, and form a common line called the International Date Line. The Equator of the earth lies in the 0° parallel of latitude bisecting the earth into the Northern and the Southern hemisphere. The latitudes measured northwards from the Equator to the North Pole are called the North latitudes and those southwards to the South Pole the south latitudes. The Vernier scales of the latitude and the longitude are printed on the left and right edges and on the top and bottom edges of the chart respectively. Other than telling the latitude coordinate of a location, the Vernier scale of latitude in particular serves another very important function which is for measuring distances on the chart in the scale that 1 minute of latitude on the chart is equal to 1 nautical mile. However, the longitude cannot be used for measuring distances.

Bearing and distance

Report the location of vessel based on the true bearing and the distance off.

For example: the location of this vessel is true bearing of Waglan Lighthouse is 340° with a distance of 2.5 nautical miles.



(5) Tides — Use of Hong Kong tide tables, tidal stream atlas and tidal information from charts of Hong Kong waters. Neap and Spring tides

Neap tides and Spring tides

The Hong Kong Observatory publishes a booklet called Tide tables for Hong Kong annually. In the tide tables, the times, and the heights of the high and low tides each day at eleven selected locations are shown. Tidal information for Hong Kong in tabular and graphic form is also available at the Hong Kong Observatory's website http://www.hko.gov.hk/m/rt.htm (as updated) and at the Hydrographic Office, Marine Department's website http://tide1.hydro.gov.hk/hotide/en/index.php (as updated). Detailed descriptions on the relationship between the depth of water and the heights of objects shown on the chart, and the heights of tides given in the Tide Tables are set out in Section 4(a) of this Chapter. Listed below are some specific names and definitions on tides:

Neap tides — Tides with small tidal ranges occurring when the moon is at its first or last quarter.

Spring tides — Tides with great tidal ranges occurring when the moon is new or full.

High tide — The maximum height reached in a flooding tide.

Low tide — The minimum height reached in a ebbing tide.

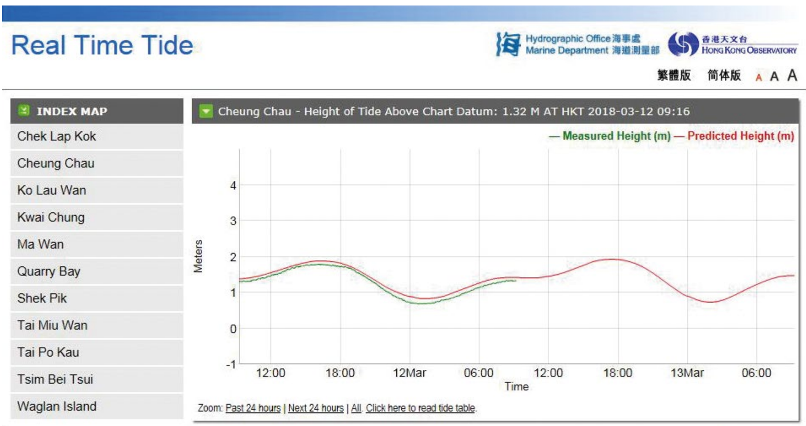
Tidal range — The difference in height between a high tide and the succeeding or preceding low tide

Semi-diurnal tide — A tidal pattern in which there are two high tides and two low tides in a day.

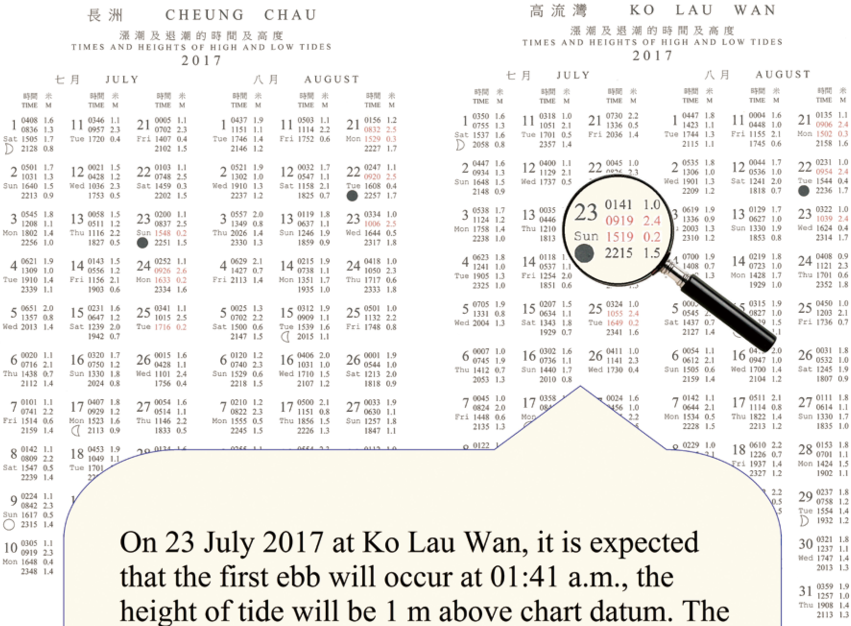
Chart Datum — The level to which soundings or heights of tide are referenced.

The Hong Kong Tidal Stream Prediction System provides 11 days tidal stream magnitude and direction prediction results in the waters of Hong Kong which includes the results of 8 days in advance of and 2 days before the current date. Website: http://current.hydro.gov.hk/en/map.html (as updated)

Real Time Tide

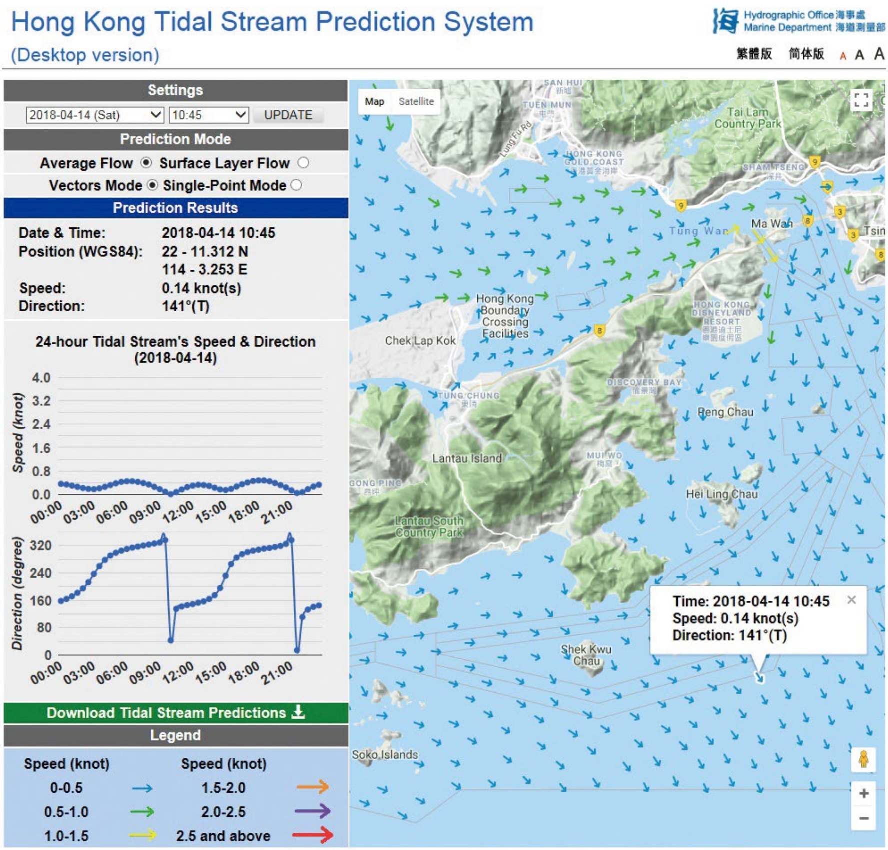


Tide Tables



On 23 July 2017 at Ko Lau Wan, it is expected that the first ebb will occur at 01:41 a.m., the height of tide will be 1 m above chart datum. The subsequent high tide will occur at 09:19 a.m., the height of tide will be 2.4 m above chart datum. The second ebb will occur at 3:19 p.m., the height of tide will be 0.2 m above chart datum. The last high tide on that date will occur at 10:15 p.m., the height of tide will be 1.5 m above chart datum.

Hong Kong Tidal Stream Prediction System



(6) Navigation of small power driven craft in restricted visibility

a. During navigation, masters, coxswains and persons-in-charge of vessels shall strictly comply with the ”International Regulations for Preventing Collisions at Sea, 1972”;

b. Every vessel shall at all times proceed at a safe speed and should not exceed the speed limits (if applicable). In or near an area of restricted visibility, whether by day or night, the sound signals prescribed in "International Regulations for Preventing Collisions at Sea, 1972" shall be followed;

c. When navigating by radar in limited visibility, it is important to always comply with Rule 5 (Look-out), Rule 6 (Safe Speed), Rule 7 (Risk of Collision), Rule 8 (Action to avoid collision) and Rule 19 (Conduct of Vessel in Restricted Visibility) of the "International Regulations for Preventing Collisions at Sea";

d. If surrounding traffic information obtained by radar cannot suffice for a full assessment of the situation, the master shall take into account such situation for assessing speed to be used.

e. When the visibility in Hong Kong waters is less than two nautical miles, the Vessel Traffic Centre (call sign “MARDEP”) will broadcast visibility reports on VHF channels 02, 12, 14, 63 and 67 hourly until the visibility improves.

f. Report to the Vessel Traffic Centre immediately of any marine accident, either through VHF channel 02, 12, 14, 63 or 67 or telephone at 2233 7801 / 2233 7802.

(7) Local knowledge

(a) Victoria Harbour boundaries

On the east — A straight line drawn from the westernmost extremity of Siu Chau Wan Point to the westernmost extremity of Ah Kung Ngam Point (sometimes known as Kung Am);

On the west — A straight line drawn from the westernmost point of Island of Hong Kong to the westernmost point of Green Island, thence a straight line drawn from the westernmost point of Green Island to the south-easternmost point of Tsing Yi, thence along the eastern and northern coast lines of Tsing Yi to the westernmost extremity of Tsing Yi and thence a straight line drawn true north therefrom to the mainland.

(b) Location of fairways, prohibited anchorages, restricted and prohibited entry areas

Location of fairways:

Within the Victoria Harbour — Eastern Fairway; Hung Hom Fairway; Central Fairway; Yau Ma Tei Fairway; Northern Fairway; North Green Island Fairway; Southern Fairway.

Outside the Victoria Harbour — Western Fairway; Ma Wan Fairway; Kap Shui Mun Fairway; Ha Pang Fairway; Castle Peak Fairway; Urmston Road Fairway.

Prohibited anchorages:

1. all cable areas, cable reserve areas and underwater tunnels;
2. in the direct approaches to the Lei Yue Mun Pass or Sulphur Channel;
3. in a position which obstructs the approaches or entrances to any principal fairway, typhoon shelter or pier;
4. in a position which gives a foul berth to any other vessel made fast to a mooring, pier or dock premises;
5. except with the permission of the Director, within 500 metres of any place or vessel designated as a Government Explosives Depot;
6. at any place at which anchoring or lying is prohibited by notice posted;
7. Hong Kong Disneyland International Theme Park Area.

Prohibition of entry into restricted areas:

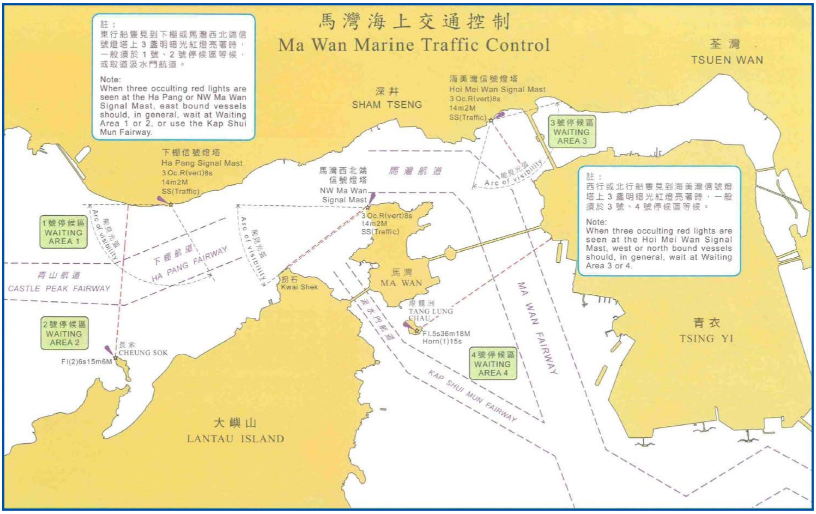
1. any area within 100 metres from the low water mark on Green Island;
2. the Ngong Shuen Chau Barracks area specified in Shipping and Port Control Regulations;

3. any area within 100 metres from the low water mark on Waglan Island;

4. Shing Mun River Channel.

Except with the permission of the Director or with reasonable excuse, if the Merchant Shipping (Local Vessels) (General) Regulation 14 (i.e. prohibition of entry into restricted areas) is contravened, the master of the vessel and the masters of the tugs or other vessels towing the vessel commit an offence and each of them is liable to a fine at level 3 ($10,000) and to imprisonment for 6 months. [548F/20(1)] #

Role of the Ma Wan Marine Traffic Control Station and Means of Signal Lights



Ma Wan Marine Traffic Control

The general requirement

In order that ocean-going vessels and small vessels can safely pass through Ma Wan waters, the co-operation of small vessels, including local vessels and river trading vessels is essential. In general, such small vessels must meet the following requirements when they are proceeding in the waters of Ma Wan:

- To comply with the "International Regulations for Preventing Collisions at Sea" and the local rules as enforced in Hong Kong;
- To keep to the starboard side of the Ma Wan Fairway, otherwise as far away from the fairway as possible;

Note: [548F/20(1)] refers to Section 20, paragraph 1 of Chapter 548F of the Laws of Hong Kong.

- To cross Ma Wan Fairway at right angles;
- Never to obstruct the passage of large vessels;
- Never to anchor or fish in the Ma Wan Fairway; and
- To listen to the VHF channel 14 and follow the instructions as may be given by the Vessel Traffic Center.

Prohibition of entry into Kap Shui Mun Special Area

If for any reason the traffic of small craft can not proceed in Ma Wan area, the traffic through Kap Shui Mun would be increased. As Kap Shui Mun is mainly for southeast bound vessels only, ship masters must stay vigilant at all times when using this fairway.

The Kap Shui Mun waters between the northeast tip Lantau Island and Ma Wan Island is designated as Kap Shui Mun Special Area. Unless with the permission of the Director of Marine, no vessel exceeding 10 metres in length shall enter the Special Area via Tang Lung Chau Island for a northwest bound passage, instead they shall only use Ma Wan Fairway en route northwards. Those with a practical operational need to transit through the Special Area on a regular basis, they may do so only after obtaining a special permission from the Director of Marine. Contravention of this regulation would result in a fine at level 3 ($10,000) and to imprisonment for 6 months. [548F/20(1)]

Prohibition of entry into Bridges Area

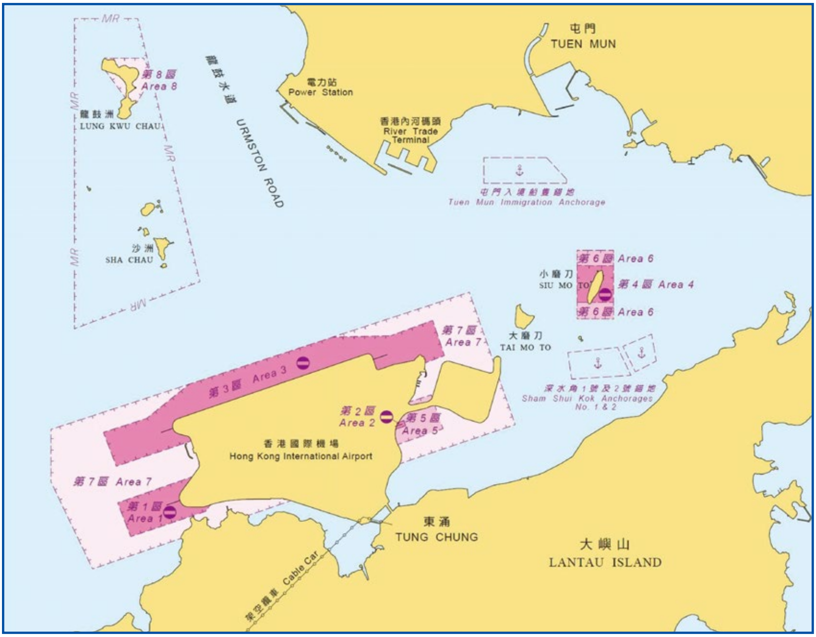
Except with the permission of the Director, no vessel with a height exceeding the following specified shall enter or pass through the areas below:

1. Tsing Yi Bridge Area (Vertical clearance 17 m).
2. Ap Lei Chau Bridge Area (Vertical clearance 14 m).
3. Tsing Tsuen Bridge Area (Vertical clearance 17 m).
4. Cheung Tsing Bridge Area (Vertical clearance 17 m).
5. Kwai Tsing Bridge Area (Vertical clearance 17 m).
6. Tsing Ma Bridge Area (Vertical clearance 54.6 m)*.
7. Kap Shui Mun Bridge Area (Vertical clearance 41 m).
8. Tsing Lai Bridge Area [MTR] (Vertical clearance 17 m).
9. Tung Chung Bridges Area [Two bridges] (Vertical clearance 8 m).
10. Stonecutters Bridge Area (Vertical clearance 68.5 m).

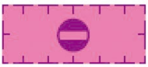
If a local vessel collides with any bridge within any of the Areas referred to, the owner of the vessel, his agent and the coxswain of the vessel commit an offence and each of them is liable on conviction to a fine at level 5 ($50,000) and to imprisonment for 6 months. [548F/20(3)]

*Remarks: The height restriction at the Tsing Ma Bridge (TMB) Area is relaxed to 57 metres (above sea level) during the period of Specified Hours. Vessels with height exceeding 57.0 meters above sea level which wish to enter or pass through the TMB Area during low tide period within the Specified Hours should seek prior permission from the Vessel Traffic Centre.

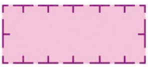
Restricted Areas of Hong Kong International Airport



Airport Approach Restricted Areas [548F/12]



Except with the permission of the Director of Marine, no vessel shall enter or pass through the Airport Approach Area No. 1, 2, 3 or 4.

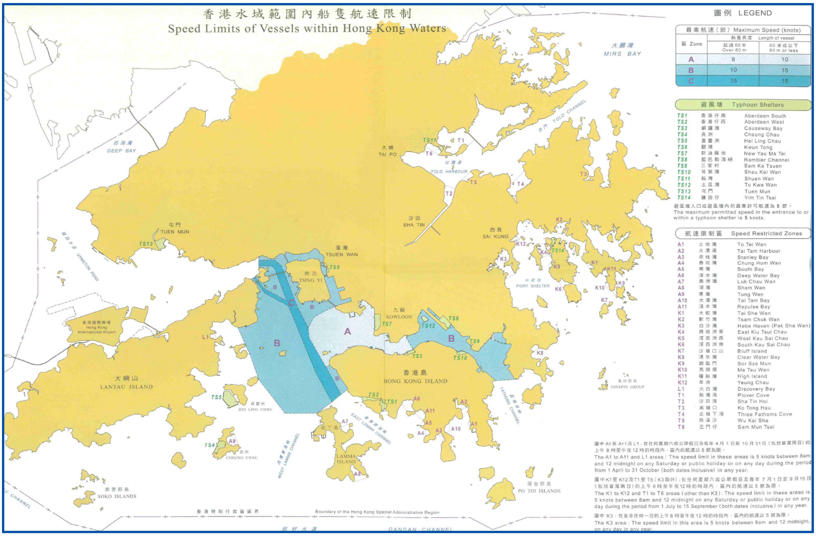


Except with the permission of the Director of Marine, no vessel which has a height exceeding 15 metres above sea level shall enter or pass through the Airport Approach Area No. 5 or 6.

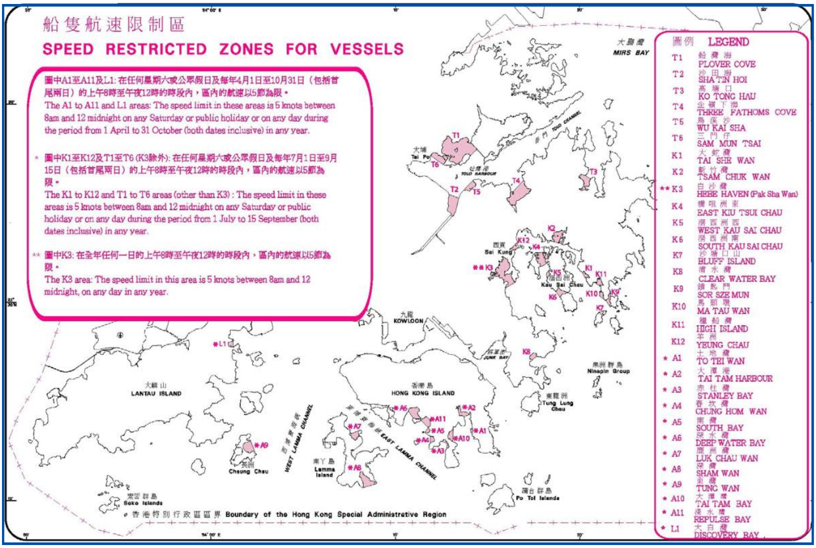
Except with the permission of the Director of Marine, no vessel which has a height exceeding 30 metres above sea level shall enter or pass through the Airport Approach Area No. 7 or 8.

Offenders are liable to a fine at level 3 ($10,000) and to imprisonment for 6 months. [548F/20(1)]

(c) Speed limits within Hong Kong waters and navigation in typhoon shelters



Speed Limit Zones in Victoria Harbour and Adjacent Waters



Speed Limit Zones in other parts of Hong Kong Waters

For speeding at Zone A, Zone B and Zone C: [548F/9(1)]; [313A/19(2)]

The coxswain of the vessel commits an offence and is liable to a fine at level 3 ($10,000) and to imprisonment for 6 months.

The maximum speed permitted in the entrance to or within a typhoon shelter is five knots.

For speeding at Typhoon Shelters: [548F/9(4)]; [313A/19(4)]

The coxswain of the vessel commits an offence and is liable to a fine at level 2 ($5,000).

For speeding at Speed Restricted Zones: [548F/9(3)]; [313A/19(3)]

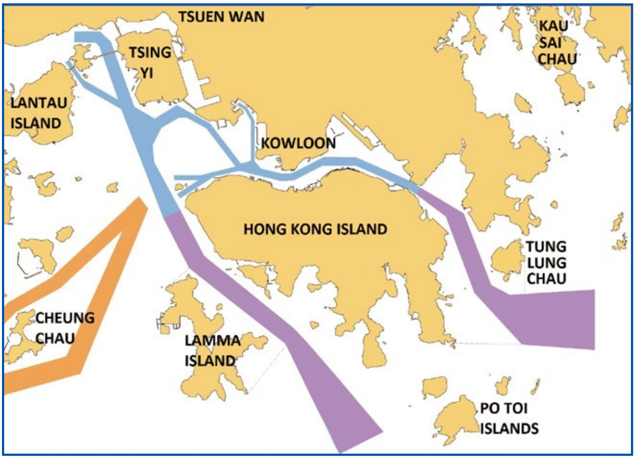
The coxswain of the vessel commits an offence and is liable to a fine at level 3 ($10,000).

The speed limit inside a marine park or marine reserve is 10 knots [476A/10]

No person shall moor or anchor a vessel in a marine park or marine reserve except under and in accordance with a permit or at mooring buoys or mooring sites provided by the Country and Marine Parks Authority [476A/11]

Any person who contravenes the Regulation commits an offence and is liable on conviction to a fine at level 4 ($25,000) and to imprisonment for 1 year. [476A/21(1)]

(d) Traffic separation schemes, both IMO adopted and locally recommended. Application of Rule 10 of Colregs



Traffic separation schemes adopted by IMO:-

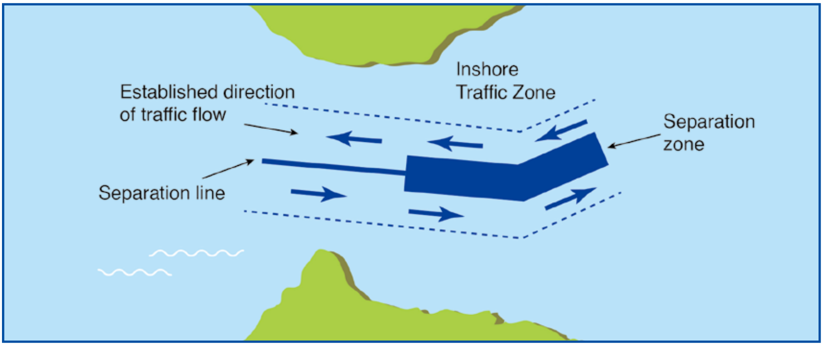
(a) Tathong Channel (b) East Lamma Channel

Traffic Separation Schemes locally recommended:-
Between south of Kau Yi Chau and Fan Lau (including routes via north and south of Cheung Chau)

Principal Fairways
Eastern Fairway, Hung Hom Fairway, Central Fairway, Yau Ma Tei Fairway, Northern Fairway, North Green Island Fairway, Southern Fairway, Western Fairway, Ma Wan Fairway, Kap Shui Mun Fairway, Ha Pang Fairway, Castle Peak Fairway, and Urmston Road Fairway.

When using the Traffic Separation Schemes, small vessels shall pay attention to the following:

1. Vessels of less than 20 meters in length, sailing vessels and fishing vessels shall use coastal zones;
2. Vessels engaged in fishing shall not obstruct the passage of any vessel using the Traffic Separation Schemes;
3. Sailing vessels or vessels of less than 20 meters in length shall not impede the safe passage of power driven vessels using the Traffic Separation Schemes;
4. Vessels using the Traffic Separation Schemes shall travel along the general direction of traffic flow of the fairway; try to avoid traffic separation line or separation zones; enter or leave a fairway at the end of the fairway, or enter or leave at a small angle from the sideways of the fairway.
5. Vessels shall avoid crossing the fairway. If crossing is necessary, it shall do so at right angle to the general direction of traffic flow;
6. Vessels shall avoid anchoring in a Traffic Separation Scheme or near its termination.



(e) Ferry routes and ferry piers - precautions when navigating in vicinity thereof

Vessels navigating in the waters of Hong Kong should keep a proper lookout at all times and proceed at a safe speed. Special care should be taken when navigating near ferry piers and public piers, and shall pass at a distance of at least 100 meters away from the pier.

Berthing at Government piers

Rules on Use of Government Piers (also applicable to all public landing steps designated by the Marine Department)

A local vessel shall not lie alongside a Government pier for any purpose other than to enable passengers of the vessel to embark or disembark (with their baggage, if any) and for any time longer than is reasonably necessary for the embarkation or disembarkation.[313A/46(1)]; [548F/28(1)]

Except with the permission of the Director, a local vessel exceeding 35 m in length overall shall not go alongside a Government pier. [313A/46(2)]; [548F/28(2)]

(Offenders may be fined $2,000)

Government piers

Seawall

Berthing measures

When berthing at Government piers, make sure the length of the vessel should not exceed 35 meters. If a Marine Department patrol launch or the police launch is on scene regulating the marine traffic, follow the instructions as may be given by them. During berthing, move slowly to the berth and observe safe distance from other nearby vessels. When departing, move slowly away from berth for a distance of at least 100 meters before accelerating. To wait for passengers, you must wait at 100 meters away from the pier.

(f) Safety of recreation activities in water

The Marine Department designates a number of speed restricted zones at most recreational areas for all vessels in order to ensure the safety of the waterborne activity participators. On Saturdays, public holidays or from 1 July to 15 September each day between 8:00 a.m. and 12:00 midnight, the speed in these zones is limited to 5 knots. This restriction also prevents the vessel from towing water skiers in the zones. Please refer to paragraph 7(c) of this Chapter for speed limits of vessels in various zones. Vessels shall slowdown in speed restricted areas or in waters with people participating in water activities.

Below is an excerpt from the safety code issued by the Marine Department:

Snorkeling

Vessel operators should note the following:

- Check the time of high and low tides before snorkeling. Do not snorkel when the tides are flooding or ebbing rapidly.
- Take heed of the weather conditions. Do not snorkel when the wind is strong and the sea is rough.
- Do not snorkel in waters with busy traffic, strong currents or poor visibility, or in fishing areas. Post a lookout to keep in view of the situation when snorkeling is in progress, or place clearly recognizable buoys or code signals (such as International Code Signal "A") on the water surface to alert vessel operators to stay away from that snorkeling spot.
- Have distress signaling equipment and audible signaling devices in readiness for uses.

In addition, vessel operators should always stay alert of people engaged in water activities when operating pleasure vessels in or near recreational areas. They should proceed at a safe speed in these waters and keep special lookout for people engaged in water sports (including snorkeling or diving). If any diving buoy or sign are observed, the master or operator of the vessel should steer away slowly from them so as not to cause any danger.

Safety advice on specific water sports

Riding a small open cruiser

- Bring torches and enough fuel before setting sail.
- Avoid navigate at night or when the visibility is less than two nautical miles.
- Plan the route carefully and do not sail for waters too far off the coast or with rough sea.
- Install radar reflectors and lighting on board to allow other vessels to detect the presence of the cruiser and identify its location.
- Always keep alert and pay attention to the changes in currents, waves and weather.
- Wear a suitable lifejacket at all times when riding a vessel.
- The operator should follow the manufacturer's instructions when using the "kill cord" attached to the outboard engine or the helmsperson seat, for example, securely attach it to his/her body.
- Beware of the rolling of the vessel caused by the swells generated by passing vessels.
- Persons on board must maintain the balance of the vessel when riding it or loading items to avoid listing or capsizing of the vessel.

Boating activities

- Engage in boating activities in the daytime whenever possible.
- Do not have boating activities in busy waters and navigation channels or waters with strong currents.
- Keep clear of submerged rocks and obstacles.
- Avoid going alone but with companions and look after one another.
- Bring torches to allow other vessels to easily detect the presence of the boat and identify its location in the dusk.
- Wear a lifejacket or buoyancy aid suitable for boating activities at all times.
- Always keep alert and pay attention to the changes in weather and sea conditions.

Towing water sports

- Participants must wear suitable lifejackets or buoyancy aids.
- Participants must fully understand their own ability and physical condition and must not overeat or drink before taking part in these activities.
- Towing water sports should be conducted in open waters.
- When towing a towable buoyancy aid, the coxswain operating the speedboat must maintain a sharp lookout, keep a safe distance from other vessels and obstacles, and arrange an adult to watch out for the safety of the people on the buoyancy aid at all times.

Jet skis

- Both the operator and passenger of a jet ski should wear a suitable lifejacket at all times.
- The operator should follow the manufacturer's instructions to use the "kill cord" attached to the jet ski, for example, securely attach it to his/her body.
- Wear suitable safety equipment such as goggles and protective clothing.
- Do not operate a jet ski before sunrise or after sunset.
- When operating a jet ski in narrow waterways or busy waters, proceed with extra caution at a safe speed.
- Keep clear of other vessels or the shore to avoid colliding with swimmers or submerged rocks.
- Pay attention to the environment nearby and avoid creating big wash which may jeopardise the safety of small boats.
- Always observe the speed limit in the statutory speed restricted zones.
- Do not weave through swimmers to avoid causing danger to them.
- Do not operate a jet ski in inclement weather or on a rough sea.

Safety advice on specific water sports

Swimming during a cruise

- Do not get into the water until the vessel has come to a complete stop after anchoring and the engine is switched off.
- Take note of the conditions of the waters, such as swells, currents and tides, in the vicinity of the vessel before getting into the water.
- Swimmers should assess their swimming ability and physical condition before getting into the water.
- Incompetent swimmers should wear a lifejacket instead of relying on an inflatable buoyancy aid.
- Do not overeat or drink before swimming. Warm up before getting into the water.
- Do not swim when feeling seasick or unwell.
- Do not get into the water alone but in groups of two to three to look after one another.
- The coxswain should arrange an adult on board to monitor the conditions of the sea and swimmers so that assistance can be provided as and when necessary.
- Place safety equipment such as lifebuoys, lifejackets and lifelines at easily accessible locations for immediate use when needed.
- Pay close attention to changes in weather. Return to the vessel at the first sign of deteriorating weather conditions.
- Get into the water by the stern ladder of the vessel. Do not hastily jump into the water from the vessel to avoid injury as a result of hitting the hull, other protruding objects or underwater obstructions.
- Check whether any dangerous marine lives such as jellyfish are in the water before getting into it.

Water slides / inflatable water slides

- Vessel owners should properly maintain their water slides. Before a slide is used, the coxswain should inspect it to ensure it is safe for use.
- The coxswain should arrange an adult to maintain order at the slide.
- Users should take note of the sea condition in the vicinity before sliding down.
- Do not slide down until the user before you has left the end of the slide to avoid collision.
- Swim away from the end of the slide as soon as possible after getting into the water to avoid being hit or kicked by the user after you.

Water-skiing

- Water-skiers should wear suitable lifejackets or buoyancy aids at all times.
- A lookout must be on board when water-skiing is in progress.
- Operator of the speedboat towing the water-skier must always be on the lookout and keep a safe distance from other vessels and obstacles.
- Slow down and proceed with caution when passing through waters with swimmers.
- Do not water-ski in statutory speed restricted zones, waters crowded with swimmers or shallow areas.
- Do not water-ski in the direction of other vessels or swimming crowds.

Snorkeling

- Check the time of high and low tides before snorkelling. Do not snorkel when the tide is rising or falling rapidly.
- Take heed of the weather conditions. Do not snorkel when the wind is strong and the sea is rough.
- Do not snorkel at night.
- Do not snorkel in waters with busy traffic, strong currents or poor visibility, or in fishing areas. Arrange a lookout to stay on guard above the water when snorkelling is in progress, or place clearly recognisable buoys or code signals (such as International Code Signal "A") on the water surface to alert vessel operators to stay away from that area.
- Carry distress signalling equipment and audible signalling devices.
- Take heed of the surface conditions while ascending to the water surface. Watch out for any sound of vessel engine.

報告海上意外事故

Report marine accidents

如遇到海上意外，請致電 999 緊急求助熱線或向海事處海港巡邏組(電話: 2385 2791-2)報告，否則可能會被檢控。

In case of a marine accident, please call the 999 emergency services hotline or the Harbour Patrol Section, Marine Department (tel: 2385 2791-2). Those failing to report a marine accident may be prosecuted.

Controls over water-skiing activities

The coxswain of a local vessel being used for towing any person (whether or not he is riding on any planing device) shall be accompanied, on the vessel, by another person who is:

(a) not below 18 years of age; and

(b) assigned by the coxswain with the duty of informing the coxswain of any accident occurring to the person being towed.

If the regulation or a prohibition imposed is contravened, the coxswain of the vessel commits an offence and is liable on conviction to a fine at level 1 ($2,000). [548F/89(4)]

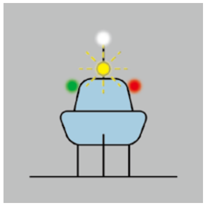

本地遊樂船隻
注意事項
Notes to Local Pleasure Vessels
遊樂船
Cruiser
遊樂船
Cruiser
開敞式遊樂船
Open Cruiser
開敞式遊樂船
(水上電單車)
Open Cruiser (Jet Ski)
如有查詢或舉報，請致電海事處海港巡邏組。
電話：2385 2791 / 2385 2792 (24小時)
For enquiries, or to make a report, please call
The Harbour Patrol Section, Marine Department
at tel: 2385 2791 / 2385 2792 (24 Hours).
香港特別行政區政府海事處
Marine Department, HKSARG
2017年4月
Apr2017
有關最新資訊，請瀏覽海事處網頁 Please visit the Marine Department's website for the latest information


本地遊樂船隻所受的限制
Restrictions on local pleasure vessels
本地遊樂船隻只能純為遊樂用途而使用。
Local pleasure vessels shall be used exclusively for pleasure purposes.
不可用作工作船
Not to be used as work boat
不可用作賓館
Not to be used as guesthouse
不可用作水上食肆
Not to be used as floating restaurant
不可非法改裝
No illegal alteration
不可拖曳船隻
Not to be used as towing vessel
不可用作海上的士
Not to be used as water taxi


本地船隻牌照事宜
Licensing of local vessels
所有裝設引擎的船隻，必須領有證明書及牌照。
All vessels fitted with an engine shall be certificated and licensed.
純為遊樂用途，沒有裝設引擎及海事處處長認為不能裝設引擎的船隻，無須申領證明書及牌照。
Vessels used exclusively for pleasure purpose, not fitted with an engine, and in the opinion of the Director of Marine that are incapable of being fitted with an engine, are not required to be certificated and licensed.
船隻均須在兩邊船舷或在船體最當眼位置，標示擁有權證明書號碼，顏色須成鮮明對比，如白底黑字。
The certificate of ownership number of the vessel shall be marked on each side of the hull of the vessel where it can best be seen in contrasting colours, such as number in black on white background.
123456

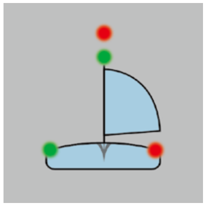

本地遊樂船隻的救生裝置及滅火器具
Life-saving appliances and fire-fighting apparatus of local leasure vessels
本地遊樂船隻配備的救生裝置及滅火器具須
All life-saving appliances and fire-fighting apparatus provided on board a local pleasure vessel shall be
定期檢查
Regularly Inspected
妥善維修
Properly Maintained
狀況良好
In Good Condition
符合法定數量
In Statutory Quantity
存放位置方便使用
Kept in Convenient Position
有關救生裝置及滅火器具的數量及特定規定，請參閱《商船(本地船隻)(安全及檢驗)規例》(第548G章)的附表3及4。
For the quantity and the specific requirements of life-saving appliances and fire-fighting apparatus, please refer to Schedules 3 and 4 of Merchant Shipping (Local Vessels) (Safety and Survey) Regulation (Cap. 548G).
FIRE
為安全著想，乘客乘坐本地遊樂船隻時應穿著救生衣。家長亦應為兒童穿著救生衣。
For safety reason, passengers aboard a local pleasure vessel should put on the life jackets. Parents should also help their children put on life jackets.
進行水上活動時須穿著救生衣。
Always wear a life jacket when taking part in water sport activities.

(g) Lights exhibited by high speed craft in Hong Kong waters



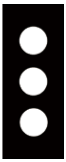
A high speed craft when operating shall exhibit a masthead light forward and a second masthead light abaft and higher than the forward one (depending on length of vessel); a high intensity all-round flashing yellow light; two sidelights; and a sternlight.

(h) Lights which may be exhibited by sailing junks in Hong Kong waters



Sailing junks when underway in the waters of Hong Kong shall exhibit the lights prescribed for sailing vessels underway in the Colregs; or
2 all-round white lights of such intensity as to be visible in clear atmosphere on a dark night at a distance of at least one nautical mile, one of which shall be placed at the fore masthead and the other at the stern at a height above the uppermost continuous deck of not less than 2 metres. [313A/39(1b)]

Hong Kong Port Signals

		Night	
H N N			Immigration examination
B			I am taking in or discharging or carrying dangerous goods.
		A blue flash light	Police launch flag

(i) Penalties for discharging oil and discharging garbage into Hong Kong waters

Causes of oil pollution

Oil pollution is usually caused by collision, stranding or sinking of ships, or fuel leakage, pipe burst, overflowing and pumping out of oils during bunkering operations.

Impact of pollution

Oil spills and garbage will pollute the sea water, coasts and beaches, causing harm to seabirds, marine organisms and the environment; and the large amount of dead fish in fish farms with serious losses to fishermen.

Prevention of oil pollution

Vessels should stay highly vigilant while navigating in order to avoid accidental oil pollution. When replenishing fuel, oil pollution prevention measures should be carried out, draining scuppers on the main deck should be plugged, and oil absorbent blanket, wood saw dust, plastic buckets and plastic shovels should be made available in case of spill. The crew of the ship should monitor the rate of loading of fuel oil and maintain effective communication with the loading station, and be able to stop the loading operation at any time.

Ways to treat garbage and waste oil on board

Garbage should be collected at one place and sent to the refuse disposal ashore. Oily water and waste oil should be stowed in containers and then sent to the oil treatment plant.

Penalty ordinance

Anyone who discharges oil or oil mixture into Hong Kong waters shall be liable to a fine of $200,000 [313/46(3)]; [548/47(3)].

Anyone who throws litter into Hong Kong waters may be liable on a fixed penalty of $1,500 [570/Schedule 1] or a fine of $10,000 and to imprisonment for six months [228/4D(1)].

Report on waste oil

If oil spills into the sea are found during the bunkering operation, the vessel involved must immediately report the incident to the Marine Department and a detailed written report shall be submitted thereafter.

Any sighting of waste oil at sea amidst the voyage should also be reported immediately to the Marine Department.

Prevention of garbage pollution from ships

Discharge of garbage from a ship into the Hong Kong waters is prohibited [413O/4(1)], with the exception of cleansing agents or additives contained in the washing water used in cleaning the vessel's cargo holds, decks or ship's sides that do not contain any substance classified as harmful to the marine environment. [413O/5(8)]

Ships with a length overall of 12 meters or more shall display a placard on board informing the crew and passengers of the waste discharge requirements. [413O/9(1)]

If the ship is certified to carry 15 or more persons, a waste management plan shall be provided on board. [413O/10(1)]

Any owner and master of a ship who fails to comply with the above requirements each commits an offence and is liable to a fine at level 6 ($100,000). [413O/19(1)]

Emission of dark smoke from local vessel

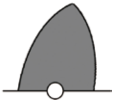
No local vessel in the waters of Hong Kong shall emit dark smoke continuously at any one time that lasts for a period of 3 minutes or more. If the regulation is contravened, the owner of the local vessel, his agent and the master of the vessel each commits an offence, and is liable to a fine at level 3 ($10,000) if the person has never committed the offence in relation to the vessel, a fine at level 4 ($25,000) if the person has previously committed the offence in relation to the vessel. [548/51]

(j) Buoyage system in use in Hong Kong waters

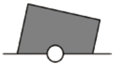
Buoyage System – Hong Kong

Hong Kong adopts International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA) Maritime Buoyage System (Region A). The IALA System applies to all fixed and floating marks except landfall lights, sector lights and major floating lights, leading lights and marks. The standard shapes of buoys consist of can, cone, sphere, pillar and spar. Secondary light buoys may have other particular shapes. In the cases of fixed beacons (lit or unlit), only the shape of their top mark is of navigational significance.

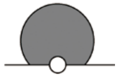
Shapes of Buoys



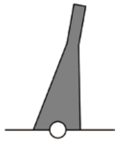
Conical buoy



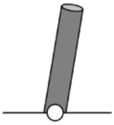
Can buoy



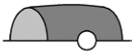
Spherical buoy



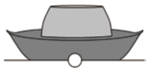
Pillar buoy



Spar buoy

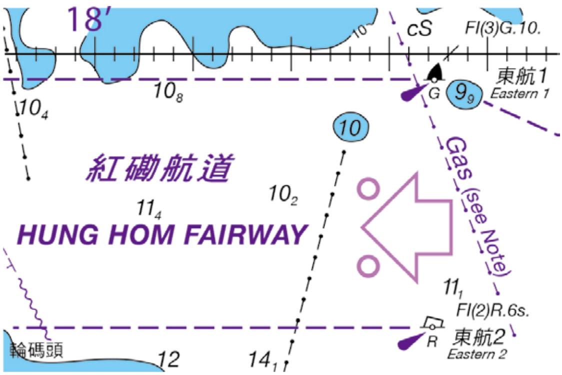


Barrel buoy

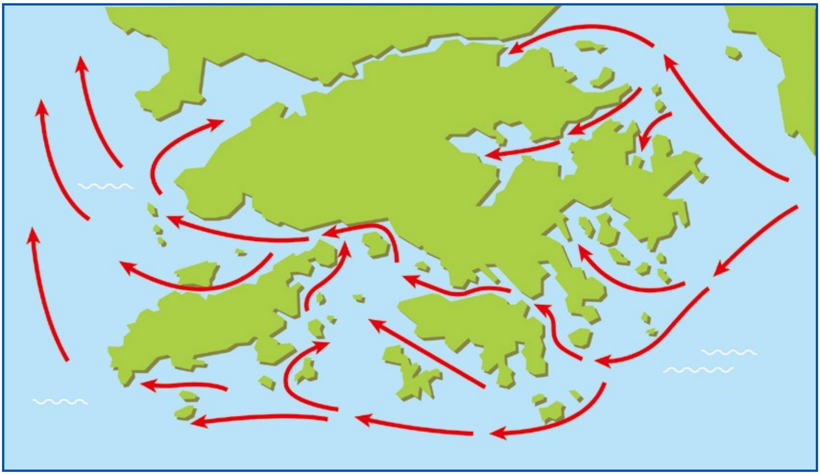


Secondary light buoy

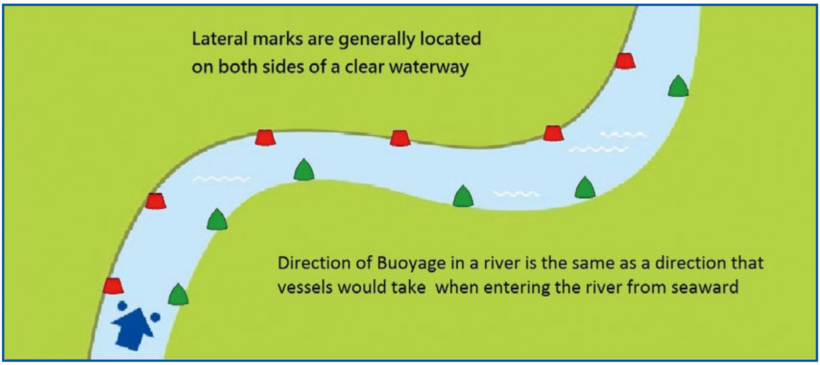
These symbols indicate the Direction of Buoyage in Hong Kong. It is determined by the direction of the flood tide. When the vessel is heading the same way as the direction of buoyage, the green light buoy must be passed on the starboard side of the vessel. When the vessel is navigating in a contrary direction, the red light buoy must be passed on its starboard side. For example, when the vessel enters the Hung Hom Fairway from the east, the red light buoy (Eastern 2) should be passed on the port side of the vessel and the green light buoy (Eastern 1) should be passed on its starboard side.



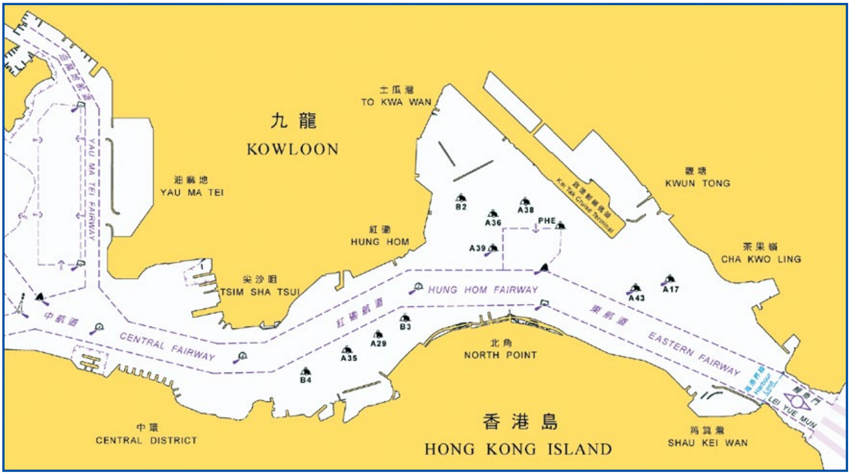
Lateral Marks



Directions of Flooding Tides in Hong Kong



Lateral Marks Distribution in a River



Eastern Part of Victoria Harbour

Port-hand Marks

Shape: Can, pillar or spar

Colour: Red

Topmark: Cylindrical topmarks (if any)

Light: Red

Light Characters: Any rhythm except Fl (2+1) R

Starboard-hand Marks

Shape: Conical, pillar or spar

Colour: Green

Topmark: Conical topmarks (if any)

Light: Green

Light Characters: Any rhythm except Fl (2+1) G

Special Marks

Not primarily to assist navigation but to indicate special features

Shape: Shape optional

Colour: Yellow

Topmark: Yellow “X” if installed

Light: Yellow

Light Characters: Single-flashing

Use: Special marks are used mainly to indicate a special area or feature whose nature can be found with reference to a chart or other nautical publication. They are not generally intended to mark channels or obstructions but to advise seafarers the existence of such special event or restriction, including:

1. Ocean data acquisition works;
2. Traffic separation zones where use of conventional channel marking may cause confusion;
3. Military exercise zones;
4. Underwater cable or pipeline areas;
5. Recreation zones;
6. Spoil grounds;
7. Entry prohibited areas;
8. Aquaculture.

The rhythms of light of special mark buoys should not be the same as the other buoys nearby that give out white light. It is because if the ship master sees the yellow light of a special mark buoy in drizzle or restricted visibility condition, he could easily mistake it the yellow light as white light. That is why the light characters of those buoys giving white light including cardinal marks, safe water marks and isolated danger marks will not be at the same rhythms as the special mark buoys.

Safe Water Marks

Such as mid-channel marks and landfall marks

Shape: Spherical, pillar or spar

Colour: Red and white vertical stripes

Topmark: Red sphere (if any)

Light: white

Light Characters: Isophase, occulting, one long flash every 10 seconds or Morse "A"

Isolated Danger Marks

Laid over dangers with navigable water around them

Shape: Pillar or spar

Colour: Black with red horizontal band(s)

Topmark: 2 black spheres in a vertical line

Light: White

Light Characters: Group flashing repeating a group of two flashes, Fl (2)

Emergency Wreck Marking Buoys

Shape: Pillar or spar

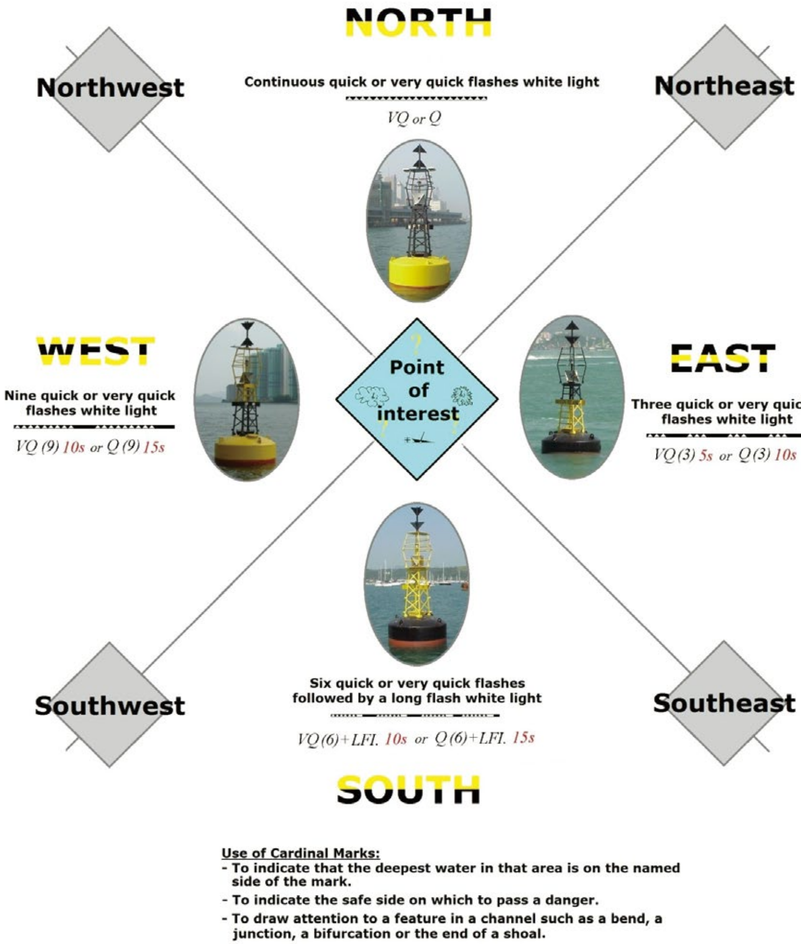
Colour: Blue/yellow vertical stripes equal in number and in dimensions for each colour

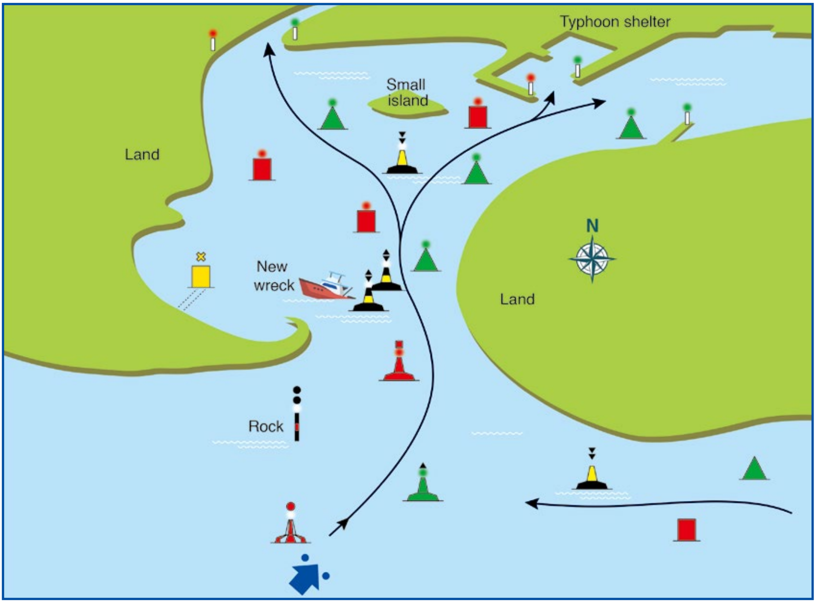
Topmark: Vertical/perpendicular yellow cross (if any)

LightCharacters: Yellow/blue alternating, one second of blue light and one second of yellow light with 0.5 second of darkness between, (Al Fl BuY 3s) in every cycle of 3 seconds

Cardinal Marks

Indicating navigable water situated on the side of the mark similarly named as the mark's own name.





International Association of Lighthouse Authorities (IALA) Maritime Buoyage System (Region A)

(k) How to request assistance from the relevant authorities in Hong Kong in case of emergency

Masters of all vessels in the waters of Hong Kong shall keep watch on the VHF radio frequency channel in the appropriate sector of waters as the vessel is situated, and report to the Marine Department through their respective VHF Radio channel in case of emergency.

The call sign of Marine Department is: "MARDEP" or "MARDEP HONGKONG"

Channel	VHF Sectors
02	Harbour East
12	Eastern Approaches
14	Harbour
63	Lantau South
67	Western Approaches
74	Kwai Chung Control Station

The waters of Hong Kong are divided into six VHF sectors

Distress signals should not be issued if the accident on board the vessel does not involve distress situations such as endangering of the safety of the ship or the life of the crew. Other emergency situations may be directed to the following departments for assistances:

Marine Department	Telephone number 2233
Vessel Traffic Centre	7801 or 2233 7802 2233
Maritime Rescue Co-ordination Centre	7999
Harbour Patrol Section (Command Centre)	2385 2791 or 2385 2792
Hong Kong Police Force	
Emergency telephone	999
Marine Regional Headquarter, HKPF	2803 6240

The contents of the verbal report should include:

(a) Name or Licence No. of the vessel, its particulars and the name of the master;

(b) Date, time and position of incident;

(c) Nature of incidents;

(d) Number of personnel on board, particulars of personnel injured/dead/missing in the incident;

(e) Damage to own vessel, and whether the vessel was seaworthy in all respects;

(f) State of weather and sea conditions;

(g) Any other information required by MD and HKPF.

(8) International Regulations for Preventing Collisions at Sea (Colregs)

(a) Knowledge of "International Regulations for Preventing Collisions at Sea" including the proper use of Radar, the meaning and importance of proper lookout and safe speed

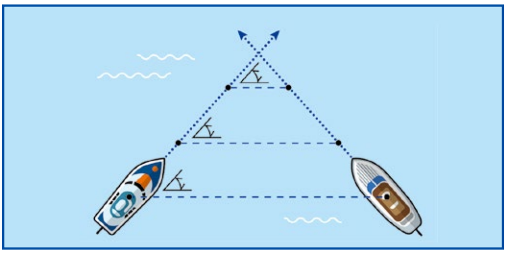
Conduct of vessels in any condition of visibility

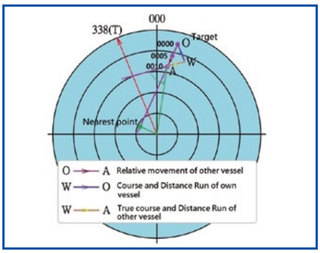
Look out — Every vessel shall at all times maintain a proper look-out by sight and hearing as well as by all available means appropriate in the prevailing circumstances and conditions so as to make a full appraisal of the situation and of the risk of collision.

Safe speed — Every vessel shall at all times proceed at a safe speed so that she can take proper and effective action to avoid collision and be stopped within a distance appropriate to the prevailing circumstances and conditions.

Risk of collision

- Every vessel shall use all available means appropriate to the prevailing circumstances and conditions to determine if risk of collision exists. If there is any doubt such risk shall be deemed to exist.
- Assumptions shall not be made on the basis of scanty information, especially scanty radar information.
  (i) Visually study the compass bearing of the other vessel several times in order to determine whether there is a risk of collision;
  (ii) The radar plotting for the other vessel must complete when using the radar to determine whether there is a risk of collision.





Action to avoid collision

- Any action to avoid collision shall be taken in accordance with the Colregs and shall, if the circumstances of the case admit, be positive, made in ample time and with due regard to the observance of good seamanship.
- Any alteration of course and/or speed to avoid collision shall, if the circumstances of the case admit, be large enough to be readily apparent to another vessel observing visually or by radar; a succession of small alterations of course and/or speed should be avoided.
- If there is sufficient sea-room, alteration of course alone may be the most effective action to avoid a close-quarters situation provided that it is made in good time, is substantial and does not result in another close-quarters situation.
- If necessary to avoid collision or allow more time to assess the situation, a vessel shall slacken her speed or take all way off by stopping or reversing her means of propulsion.

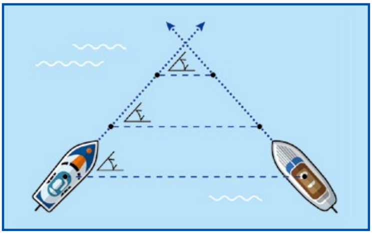
Narrow channels

- A vessel proceeding along the course of a narrow channel or fairway shall keep as near to the outer limit of the channel or fairway which lies on her starboard side as is safe and practicable.
- A vessel of less than 20 m in length or a sailing vessel shall not impede the passage of a vessel which can safely navigate only within a narrow channel or fairway. A vessel engaged in fishing shall not impede the passage of any other vessel navigating within a narrow channel or fairway.
- In a narrow channel or fairway when overtaking can take place only if the vessel to be overtaken has to take action to permit safe passing, the vessel intending to overtake shall indicate her intention by sounding the appropriate signal
- A vessel nearing a bend or an area of a channel or fairway where other vessels may be obscured by an intervening obstruction shall sound one prolonged blast.

Conduct of vessels in sight of one another

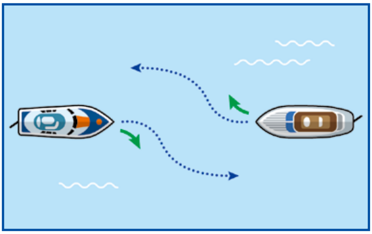
How to determine the existence of risk of collision

When two vessels are approaching each other, risk of collision shall be deemed to exist if there is no significant change in the compass bearing of the other vessel.

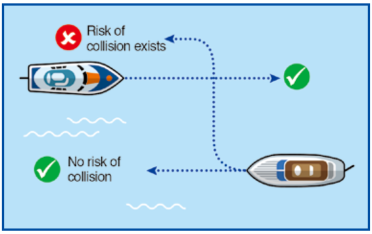


Head-on situation

When two power driven vessels are meeting on reciprocal or nearly reciprocal courses so as to involve risk of collision each shall alter her course to starboard.

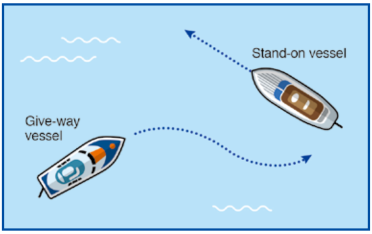


Avoid crossing ahead of the other vessel



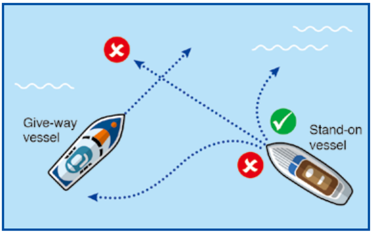
Crossing situation

When two power driven vessels are crossing so as to involve risk of collision, the vessel which has the other on her own starboard side shall keep out of the way.



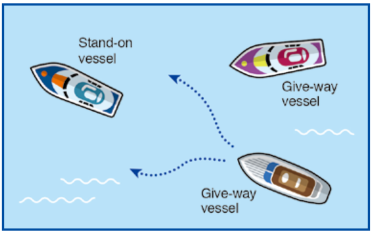
Action by stand-on vessel

Where one of two vessels is to keep out of the way the other shall keep her course and speed. The latter vessel may however take action to avoid collision by her manoeuvre alone, as soon as it becomes apparent to her that the vessel required to keep out of the way is not taking appropriate action. A power driven vessel which takes action in a crossing situation to avoid collision with another power driven vessel shall not alter course to port for a vessel on her own port side.



Overtaking

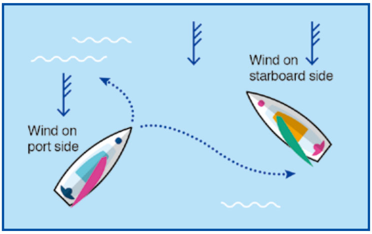
A vessel shall be deemed to be overtaking when coming up with another vessel from a direction more than 22.5° abaft her beam, that is, in such a position with reference to the vessel she is overtaking. Any vessel overtaking any other shall keep out of the way of the vessel being overtaken.



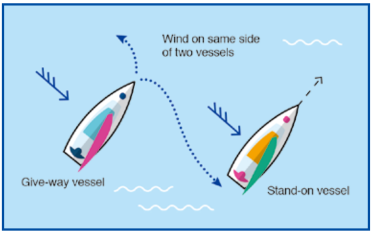
Sailing vessels

When two sailing vessels are approaching one another, so as to involve risk of collision, one of them shall keep out of the way of the other.

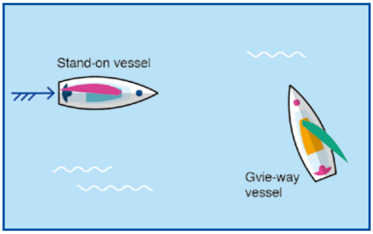
When each has the wind on a different side, the vessel which has the wind on the port side shall keep out of the way of the other.



When both have the wind on the same side, the vessel which is to windward shall keep out of the way of the vessel which is to leeward.



If a vessel with the wind on the port side sees a vessel to windward and cannot determine with certainty whether the other vessel has the wind on the port or on the starboard side, she shall keep out of the way of the other.

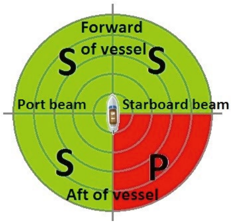


Conduct of vessels in restricted visibility

- Every vessel shall proceed at a safe speed at all times when navigating in or near an area of restricted visibility; additional look-outs should be posted; when making way through the water a prolonged blast should be sounded at intervals of not more than two minutes; navigational lights should be turned on during both day and night times; carefully listen to the sound signals issued by other vessels; prepare anchor for emergency stop; and pay attention to the information or alarms as may be received by navigational instruments such as radar, echo sounder and VHF. In situations with heavy traffic, vessels may even leave the fairway, and anchor in a suitable shallow water area, wait until the visibility improves before continuing their voyage.
- Vessels must also keep their main engine ready for immediate manoeuvring.
- When a vessel detects by radar alone the presence of another vessel with a risk of collision, and if its avoiding action consists an alteration of course, the following shall be avoided:
  - (i) an alteration of course to port side for a vessel forward of the beam, other than for a vessel being overtaken;
  - (ii) an alteration of course towards a vessel abeam or abaft the beam.

S = when the radar indicates the existence of vessel in these areas with a danger of collision, the ship should turn to starboard.

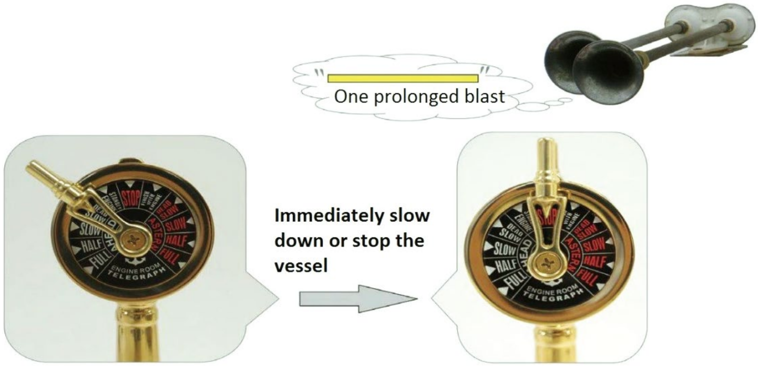
P = when the radar indicates the existence of vessel in this area with a danger of collision, the ship should turn to port.



Avoid alteration of course to port side for a vessel forward of the beam

Avoid alteration of course towards a vessel abeam or abaft the beam

- Except where it has been determined that a risk of collision does not exist, every vessel which hears apparently forward of her beam the fog signal of another vessel, or which cannot avoid a close-quarters situation with another vessel forward of her beam, shall reduce her speed to the minimum at which she can be kept on her course. She shall if necessary take all her way off and in any event navigate with extreme caution until danger of collision is over.



(b) Knowledge of the lights, shapes and sound signals for vessels up to 15 m in length

Definitions

(i) "Masthead light" means a white light placed over the fore-and-aft centreline of the vessel showing an unbroken light over an arc of the horizon of 225 degrees and so fixed as to show the light from right ahead to 22.5 degrees abaft the beam on either side of the vessel.

(ii) "Sidelights" means a green light on the starboard side and a red light on the port side each showing an unbroken light over an arc of the horizon of 112.5 degrees and so fixed as to show the light from right ahead to 22.5 degrees abaft the beam on its respective side. In a vessel of less than 20 m in length the sidelights may be combined in one lantern carried on the fore-and-aft centreline of the vessel.

(iii) "Sternlight" means a white light placed as nearly as practicable at the stern showing an unbroken light over an arc of the horizon of 135 degrees and so fixed as to show the light 67.5 degrees from right aft on each side of the vessel.

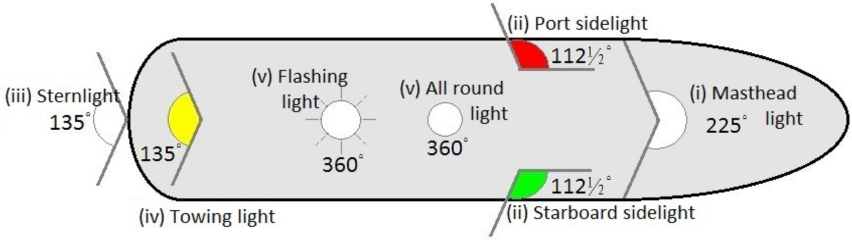
(iv) "Towing light" means a yellow light having the same characteristics as the "sternlight".

(v) "All-round light" means a light showing an unbroken light over an arc of the horizon of 360 degrees.

"Flashing light" means a light flashing at regular intervals at a frequency of 120 flashes or more per minute.

- The term "short blast" means a blast of about one second's duration.
- The term "prolonged blast" means a blast of from four to six seconds' duration.

Screens for sidelights — on vessels of less than 20 m in length the sidelights, if necessary to meet the "Horizontal Sectors" requirements, shall be fitted with inboard matt black screens. With a combined lantern, using a single vertical filament and a very narrow division between the green and red sections, external screens need not be fitted.



A power driven vessel of 12 m or more in length but less than 50 m in length				
• a masthead light • 2 sidelights (In a vessel of less than 20 m in length the sidelights may be combined in one lantern carried on the fore-and-aft centre line of the vessel.) • a sternlight		or	• a masthead light forward • a second masthead light abaft • 2 sidelights • a sternlight	
Sound signals in restricted visibility: • A power driven vessel making way through the water shall sound at intervals of not more than 2 minutes one prolonged blast. • A power driven vessel underway but stopped and making no way through the water shall sound at intervals of not more than 2 minutes two prolonged blasts in succession with an interval of about 2 seconds between them. At anchor: A vessel shall at intervals of not more than one minute ring the bell rapidly for about 5 seconds. (A vessel less than 20 m in length shall not be obliged to give the bell signals prescribed, she shall make some other efficient sound signal at intervals of not more than 2 minutes.)				

A power driven vessel of less than 12 m in length					A power driven vessel of less than 7 m in length whose maximum speed does not exceed 7 knots	
• a masthead light • 2 sidelights • a sternlight		or	• an all-round white light • 2 sidelights (the sidelights may be combined in one lantern which shall be carried on the fore-and-aft centre line of the vessel)		• exhibit an all-round white light and shall, if practicable, also exhibit sidelights	

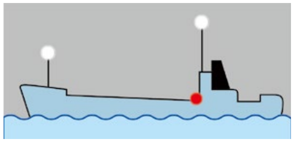
Sound signals in restricted visibility:

- A power driven vessel making way through the water shall sound at intervals of not more than 2 minutes one prolonged blast.
- A power-driven vessel underway but stopped and making no way through the water shall sound at intervals of not more than 2 minutes two prolonged blasts in succession with an interval of about 2 seconds between them. If she does not, she shall make some other efficient sound signal at intervals of not more than 2 minutes.

(c)(d) Recognition of various types of vessels by their lights, shapes and sound signals

<table>
<tr><th colspan="3">A power driven vessel of 50 m or more in length</th></tr>
<tr>
<td>

- a masthead light forward
- a second masthead light abaft
- 2 sidelights
- a sternlight

</td>
<td>
View from forward</td>
<td>
View from Port side</td>
</tr>
<tr>
<td colspan="3">

Sound signals in restricted visibility:

- A power driven vessel making way through the water shall sound at intervals of not more than 2 minutes one prolonged blast.
- A vessel underway but stopped and making no way through the water shall sound at intervals of not more than 2 minutes two prolonged blasts in succession with an interval of about 2 seconds between them.
- At anchor: A vessel of less than 100 m in length shall at intervals of not more than one minute ring the bell rapidly for about 5 seconds.

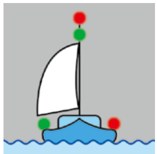
  A vessel of 100 m or more in length shall at intervals of not more than one minute ring the bell rapidly for about 5 seconds in the forepart of the vessel and immediately after the ringing of the bell the gong shall be sounded rapidly for about 5 seconds in the after part of the vessel.

  A vessel at anchor may in addition sound three blasts in succession, namely one short, one prolonged and one short blast, to give warning of her position and of the possibility of collision to an approaching vessel.

</td>
</tr>
</table>

<table>
<tr><th colspan="6">A sailing vessels in any length</th></tr>
<tr><td colspan="2">

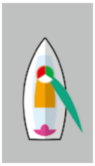
- two all-round lights in a vertical line, the upper being red and the lower green
- 2 sidelights
- a sternlight

</td><td colspan="2">
View from forward</td><td>or</td><td>
View from forward</td></tr>
<tr><td colspan="6">Sound signals in restricted visibility:

- A sailing vessel underway shall sound at intervals of not more than 2 minutes three blasts in succession, namely one prolonged followed by two short blasts.
- A sailing vessel at anchor shall give the same sound signals as a power driven vessel at anchor.

</td></tr>
<tr><th colspan="3">A sailing vessel of less than 20 m in length</th><th colspan="3">A sailing vessel of less than 7 m in length</th></tr>
<tr><td>

- 2 sidelights and a sternlight may be combined in one lantern carried at or near the top of the mast where it can best be seen.

</td><td></td><td></td><td colspan="2">If impracticable to exhibit the sidelights and sternlight, she shall have ready at hand an electric torch or lighted lantern showing a white light which shall be exhibited in sufficient time to prevent collision.</td><td></td></tr>
<tr><td colspan="6">Sound signals in restricted visibility:

- A sailing vessel underway shall sound at intervals of not more than 2 minutes three blasts in succession, namely one prolonged followed by two short blasts.
- A sailing vessel of less than 12 m in length shall not be obliged to give the bell signals prescribed. She shall make some other efficient sound signal at intervals of not more than 2 minutes.

</td></tr>
</table>

A sailing vessels in any length

A vessel proceeding under sail when also being propelled by machinery

Exhibit forward a conical shape, apex downwards

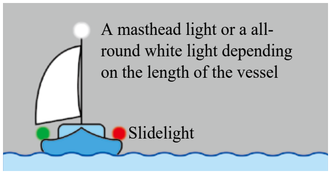


Exhibit lights same as a power driven vessel

Sound signals in restricted visibility:

- A sailing vessel making way through the water shall sound at intervals of not more than 2 minutes one prolonged blast.
- A sailing vessel underway but stopped and making no way through the water shall sound at intervals of not more than 2 minutes two prolonged blasts in succession with an interval of about 2 seconds between them; and a sailing vessel of less than 12 m in length shall make some other efficient sound signals at intervals of not more than 2 minutes.

Towing and pushing

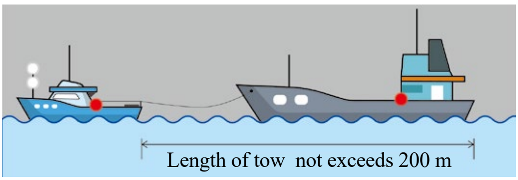
Length of tow not exceeds 200 m

Towing vessel (less than 50 m in length):

- 2 masthead lights in a vertical line
- 2 sidelights
- a towing light
- sternlight

Vessel being towed:

- 2 sidelights
- a sternlight



Viewed from forward

Viewed from astern

Sound signals in restricted visibility:

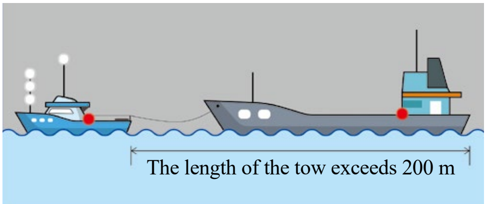
- Towing vessel — a vessel engaged in towing another vessel shall sound at intervals of not more than 2 minutes three blasts in succession, namely one prolonged followed by two short blasts.
- Vessel being towed — the last vessel of the tow, if manned, shall at intervals of not more than 2 minutes sound four blasts in succession, namely one prolonged followed by three short blasts. When practicable, this signal shall be made immediately after the signal made by the towing vessel.
- A towing vessel and vessel being towed at anchor shall give the same sound signals as a power driven vessel at anchor.

Towing and pushing

Length of tow exceeds 200 m

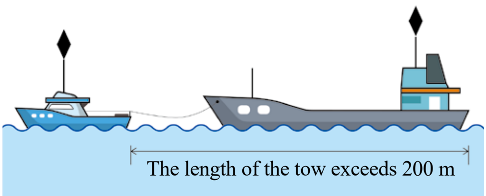
Towing vessel (50 m or more in length):

Night
- 3 masthead lights in a vertical line forward
- a second masthead light abaft
- 2 sidelights
- a towing light in a vertical line above the sternlight
- a sternlight



Vessel being towed
- 2 sidelights
- a sternlight

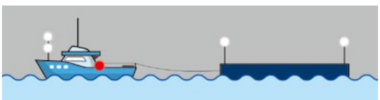
Day
- Towing vessel and vessel being towed shall exhibit, when the length of the tow exceeds 200 m, a diamond shape where it can best be seen.

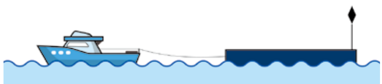


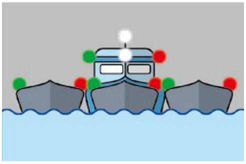
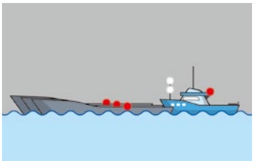
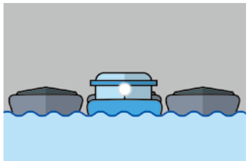
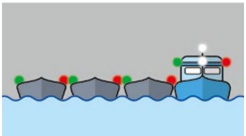
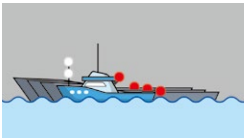
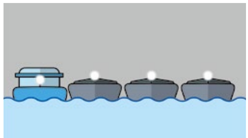
Sound signals in restricted visibility:

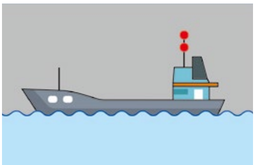
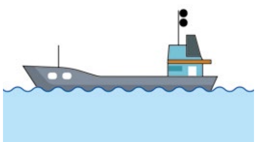
- Towing vessel — a vessel engaged in towing another vessel shall sound at intervals of not more than 2 minutes three blasts in succession, namely one prolonged followed by two short blasts.
- Vessel being towed — the last vessel of the tow, if manned, shall at intervals of not more than 2 minutes sound four blasts in succession, namely one prolonged followed by three short blasts. When practicable, this signal shall be made immediately after the signal made by the towing vessel.
- A towing vessel and vessel being towed at anchor shall give the same sound signals as a power driven vessel at anchor.

Length of tow less than 200 m and for an inconspicuous, a partly submerged vessel or object with a breadth less than 25 m, or for the combination of such vessels or objects being towed





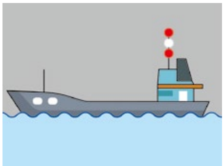
Towing and pushing		
Vessels engaged in pushing ahead operation		
		
Vessels engaged in towing alongside operation		
		

Vessels not under command or restricted in their ability to manoeuvre		
Vessels not under command		
Night • two all-round red lights in a vertical line where they can best be seen • when making way through the water, in addition to exhibit: • 2 sidelights; • a sternlight Day • two balls or similar shapes in a vertical line where they can best be seen Vessels of less than 12 m in length shall not be required to exhibit the lights and shapes prescribed.		
Sound signals in restricted visibility: • A vessel not under command underway shall sound at intervals of not more than 2 minutes three blasts in succession, namely one prolonged followed by two short blasts. • A vessel not under command at anchor shall give the same sound signals as a power driven vessel at anchor.		

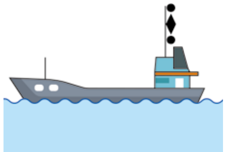
Vessels not under command or restricted in their ability to manoeuvre

A vessel restricted in her ability to manoeuvre

Night
- exhibit three all-round lights in a vertical line where they can best be seen. The highest and lowest of these lights shall be red and the middle light shall be white
- when making way through the water, in addition to the lights prescribed:
  - one or two masthead light(s) (depending on length of vessel)
  - 2 sidelights
  - a sternlight



Day
- three shapes in a vertical line where they can best be seen. The highest and lowest of these shapes shall be balls and the middle one a diamond.

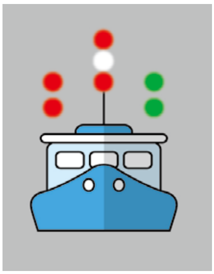


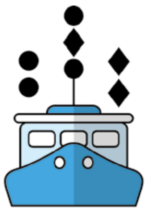
Vessels of less than 12 m in length shall not be required to exhibit the lights and shapes prescribed.

Sound signals in restricted visibility:
- A vessel restricted in her ability to manoeuvre at anchor or engaged in operation shall sound at intervals of not more than 2 minutes three blasts in succession, namely one prolonged followed by two short blasts.

A vessel engaged in dredging or underwater operations

Exhibit the lights and shapes prescribed same as a vessel restricted in her ability to manoeuvre and shall in addition, when an obstruction exists, exhibit:
- two all-round red lights or two balls in a vertical line to indicate the side on which the obstruction exists;
- two all-round green lights or two diamonds in a vertical line to indicate the side on which another vessel may pass.





Vessels of less than 12 m in length shall not be required to exhibit the lights and shapes prescribed.

Sound signals in restricted visibility:
- A vessel restricted in her ability to manoeuvre at anchor or engaged in operation shall sound at intervals of not more than 2 minutes three blasts in succession, namely one prolonged followed by two short blasts.

Vessels not under command or restricted in their ability to manoeuvre

A vessel engaged in diving operations

Shall exhibit all lights and shapes prescribed same as a vessel engaged in dredging or underwater operations, or she shall exhibit :

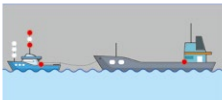
- three all-round lights in a vertical line where they can best be seen. The highest and lowest of these lights shall be red and the middle light shall be white;
- a rigid replica of the International Code flag "A" not less than 1 m in height. Measures shall be taken to ensure its all-round visibility by day.

Sound signals in restricted visibility:

- A vessel engaged in diving operations at anchor or engaged in operation shall sound at intervals of not more than 2 minutes three blasts in succession, namely one prolonged followed by two short blasts.

A power driven vessel engaged in a towing operation such as severely restricts the towing vessel and her tow in their ability to deviate from their course

A vessel shall exhibit the lights and shapes prescribed same as a vessel when towing, in addition to the lights or shapes prescribed same as a vessel restricted in her ability to manoeuvre.



Sound signals in restricted visibility:

- Towing vessel — shall sound at intervals of not more than 2 minutes three blasts in succession, namely one prolonged followed by two short blasts.
- Vessel being towed — if manned, shall at intervals of not more than 2 minutes sound four blasts in succession, namely one prolonged followed by three short blasts. When practicable, this signal shall be made immediately after the signal made by the towing vessel.
- A towing vessel and vessel being towed at anchor shall give the same sound signals as a power driven vessel at anchor.

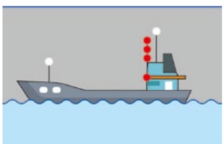
Vessels constrained by their draught

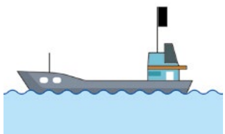
Night

- a masthead light
- a second masthead light abaft
- 2 sidelights
- a sternlight
- three all-round red lights in a vertical line.

Day

A cylinder



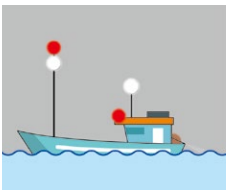
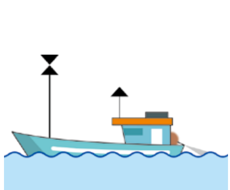


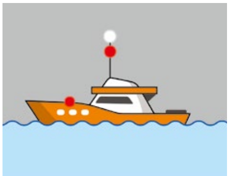
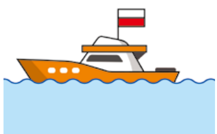
Sound signals in restricted visibility:

- A vessel constrained by her draught underway shall sound at intervals of not more than 2 minutes three blasts in succession, namely one prolonged followed by two short blasts.
- Vessels constrained by their draught at anchor shall give the same sound signals as a power driven vessel at anchor.

<table>
<tr><th colspan="3">Fishing Vessels</th></tr>
<tr><th colspan="3">A vessel engaged in trawling</th></tr>
<tr><td>Night
• two all-round lights in a vertical line, the upper being green and the lower white
• a masthead light abaft of and higher than the all-round green light; a vessel of less than 50 m in length shall not be obliged to exhibit such a light but may do so
• 2 sidelights
• a sternlight.

Day
A shape consisting of two cones with their apexes together in a vertical line one above the other.</td><td></td><td></td></tr>
<tr><td colspan="3">Sound signals in restricted visibilitsy:
• When engaging in fishing operations at anchor or underway, sound at intervals of not more than 2 minutes one prolonged followed by two short blasts.</td></tr>
<tr><th colspan="3">A vessel engaged in fishing, other than trawling</th></tr>
<tr><td>Night
• two all-round lights in a vertical line, the upper being red and the lower white
• 2 sidelights
• a sternlight.

Day
• a shape consisting of two cones with apexes together in a vertical line one above the other.</td><td>
• when there is outlying gear extending more than 150 m horizontally from the vessel, an all-round white light in the direction of the gear.</td><td>
• when there is outlying gear extending more than 150 m horizontally from the vessel, a cone apex upwards in the direction of the gear.</td></tr>
<tr><td colspan="3">Sound signals in restricted visibility:
• A vessel engaged in fishing operations at anchor or underway, sound at intervals of not more than 2 minutes one prolonged followed by two short blasts.</td></tr>
</table>

Pilot Vessels		
Night • at or near the masthead, two all-round lights in a vertical line, the upper being white and the lower red • 2 sidelights • a sternlight Day "International Regulations for Preventing Collisions at Sea, 1972" do not specify any shape for pilot vessel. A flag, upper being white and the lower red, is displayed for pilot vessels in Hong Kong waters.		
Sound signals in restricted visibility: • A pilot vessel when engaged on pilotage duty making way through water should sound at intervals of not more than 2 minutes one prolonged blast and four short blasts. • A pilot vessel underway but stopped and making no way through the water shall sound at intervals of not more than 2 minutes two prolonged blasts in succession with an interval of about 2 seconds between them and four short blasts. • A pilot vessel at anchor shall at intervals of not more than one minute ring the bell rapidly for about 5 seconds and sound four short blasts.		

Anchored Vessels and Vessels Aground

Anchored Vessels

Night

A vessel of less than 50 m in length may exhibit:

- an all-round white light.

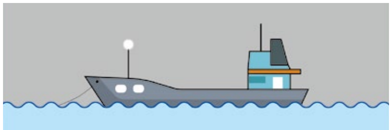
A vessel of 50 m or more in length

- in the fore part, an all-round white light; at or near the stern and at a lower level than the light in the fore part, an all-round white light.

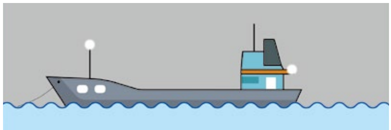
A vessel of 100 m or more in length shall also use the available working or equivalent lights to illuminate her decks.

Day

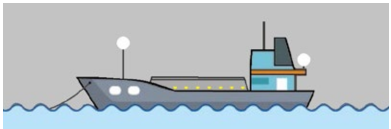
- in the fore part, one ball.



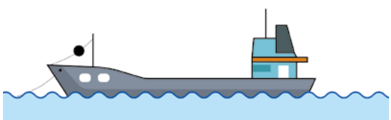
A vessel of less than 50 m in length



A vessel of 50 m or more in length



A vessel of 100 m or more in length



A power driven vessel, a sailing vessel, a towing vessel, a vessel being towed, a vessel not under command, a vessel constrained by her draught and a pilot vessel when at anchor in restricted visibility shall:

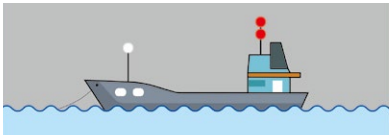
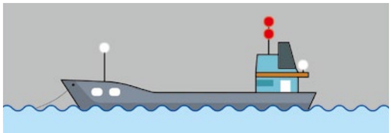
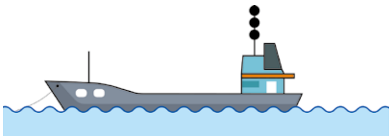
- less than 100 m in length, at intervals of not more than one minute ring the bell rapidly for about 5 seconds.
- 100 m or more in length, at intervals of not more than one minute ring the bell rapidly for about 5 seconds in the forepart of the vessel and immediately after the ringing of the bell the gong shall be sounded rapidly for about 5 seconds in the after part of the vessel.
- A vessel at anchor may in addition sound three blasts in succession, namely one short, one prolonged and one short blast, to give warning of her position and of the possibility of collision to an approaching vessel.

- A vessel engaged in fishing, when at anchor in restricted visibility, and a vessel restricted in her ability to manoeuvre when carrying out her work at anchor in restricted visibility, shall sound at intervals of not more than 2 minutes three blasts in succession, namely one prolonged followed by two short blasts.

- A vessel of less than 12 m in length shall not be obliged to give the prescribed signals but, if she does not, shall make some other efficient sound signals at intervals of not more than 2 minutes.

<table>
<tr><th colspan="2">Anchored Vessels and Vessels Aground</th></tr>
<tr><th colspan="2">Vessels Aground</th></tr>
<tr><td rowspan="3">Night
A vessel of less than 50 m in length may exhibit:
• an all-round white light where it can best be seen;
• two all-round red lights in a vertical line.

A vessel of 50 m or more in length
• in the fore part, an all-round white light; at or near the stern and at a lower level than the light in the fore part, an all-round white light;
• two all-round red lights in a vertical line.

Day
• three balls in a vertical line.</td><td>
A vessel of less than 50 m in length
(A vessel of less than 12 m in length, when aground, shall not be required to exhibit two all-round red lights in a vertical line)</td></tr>
<tr><td>
A vessel of 50 m or more in length</td></tr>
<tr><td>
(A vessel of less than 12 m in length, when aground, shall not be required to exhibit three balls in a vertical line)</td></tr>
<tr><td colspan="2">• A vessel aground in or near an area of restricted visibility shall give the bell signal and if required the gong signal prescribed same as a vessel at anchor, in addition, give three separate and distinct strokes on the bell immediately before and after the rapid ringing of the bell. In a vessel of 100 m or more in length the bell shall be sounded in the forepart of the vessel and immediately after the ringing of the bell the gong shall be sounded rapidly for about 5 seconds in the after part of the vessel. A vessel aground may in addition sound an appropriate whistle signal.</td></tr>
<tr><td colspan="2">• A vessel of less than 12 m in length aground shall not be obliged to give the prescribed signals but, if she does not, shall make some other efficient sound signals at intervals of not more than 2 minutes.</td></tr>
</table>

(e) Manoeuvring and warning signals

- When vessels are in sight of one another, a power driven vessel underway, and required by these Rules to take avoiding action, shall indicate its manoeuvring by the following signals on her whistle:
  - one short blast to mean "I am altering my course to starboard";
  - two short blasts to mean "I am altering my course to port";
  - three short blasts to mean "I am operating astern propulsion".

  Any vessel may supplement the whistle signals prescribed by light signals, repeated as appropriate, whilst the manoeuvre is being carried out.
- When in sight of one another in a narrow channel or fairway:

  (i) a vessel intending to overtake another shall in accordance with Rule 9(e)(i) indicate her intention by the following signals on her whistle:
  - two prolonged blasts followed by one short blast to mean "I intend to overtake you on your starboard side";
  - two prolonged blasts followed by two short blasts to mean "I intend to overtake you on your port side".

  (ii) the vessel about to be overtaken when acting in accordance with Rule 9(e)(i) shall indicate her agreement by the following signal on her whistle:
  - one prolonged, one short, one prolonged and one short blast, in that order.
- When vessels in sight of one another are approaching each other and from any cause either vessel fails to understand the intentions or actions of the other, or is in doubt whether sufficient action is being taken by the other to avoid collision, the vessel in doubt shall immediately indicate such doubt by giving at least five short and rapid blasts on the whistle. Such signal may be supplemented by a light signal of at least five short and rapid flashes.
- A vessel nearing a bend or an area of a channel or fairway where other vessels may be obscured by an intervening obstruction shall sound one prolonged blast. Such signal shall be answered with a prolonged blast by any approaching vessel that may be within hearing around the bend or behind the intervening obstruction.

(f) Signals of distress

1. The following signals, used or exhibited either together or separately, indicate distress and need of assistance:

   (a) a gun or other explosive signal fired at intervals of about a minute;

   (b) a continuous sounding with any fog-signalling apparatus;

(c) rockets or shells, throwing red stars fired one at a time at short intervals;

(d) a signal made by any signalling method consisting of the group
••• ——— ••• (SOS) in the Morse Code;

(e) a signal sent by radiotelephony consisting of the spoken word "Mayday";

(f) the international Code Signal of distress indicated by N.C.;

(g) a signal consisting of a square flag having above or below it a ball or anything resembling a ball;

(h) flames on the vessel (as from a burning tar barrel, oil barrel, etc.);

(i) a rocket parachute flare or a hand flare showing a red light;

(j) a smoke signal giving off orange-coloured smoke;

(k) slowly and repeatedly raising and lowering arms outstretched to each side;

(l) a distress alert by means of digital selective calling (DSC) transmitted on:
  (i) VHF channel 70, or
  (ii) MF/HF on the frequencies 2187.5 kHz, 8414.5 kHz, 4207.5 kHz, 6312 kHz, 12577 kHz or 16804.5 kHz;

(m) a ship-to-shore distress alert transmitted by the ship's Inmarsat or other mobile satellite service provider ship earth station;

(n) signals transmitted by emergency position-indicating radio beacons;

(o) approved signals transmitted by radiocommunication systems, including survival craft radar transponders.

2. The use or exhibition of any of the foregoing signals except for the purpose of indicating distress and need of assistance and the use of other signals which may be confused with any of the above signals is prohibited.

3. Attention is drawn to the relevant sections of the International Code of Signals, the Merchant Ship Search and Rescue Manual, and the following signals:

(a) a piece of orange-coloured canvas with either a black square and circle or other appropriate symbol (for identification from the air);

(b) a dye marker.

(9) Safety equipment to be carried on board

(a) Statutory requirement to carry lifesaving appliances and fire-fighting equipment on pleasure vessel that is of not more than 15 m in length overall

Class IV vessels that are licensed to carry not more than 60 passengers and are not let for hire or reward and operate within waters of Hong Kong:

Life-saving appliances	Quantity	
Lifejacket*	100% (for each and every adult and child on board)	
Lifebuoy	Vessel length (L) (m)	Number
	$L<12$	1
	$12 \le L<21$	2
Buoyant lifeline (Minimum length of buoyant lifeline is 18 m)	1	

Class IV vessels that are licensed to carry more than 60 passengers:

Class IV vessels that are licensed to carry 13 to 60 passengers but are let for hire or reward:

Life-saving appliances	Quantity	
Lifejacket*	100% (for each and every adult and child on board)	
Lifebuoy	Vessel length (L) (m)	Number
	$L<12$	2
	$12 \le L<15$	4
	$15 \le L<18$	6
Buoyant lifeline (Minimum length of buoyant lifeline is 30 m)	$L<12$	1
	$L \ge 12$	2

*Remarks:

1. The number of lifejackets must be not less than the total number of persons which the vessel is licensed to carry as specified in the Operating License.
2. Commercial Passenger-Carrying Local Vessels licensed to carry more than 12 passengers (Including Class IV Vessels which are let for hire / reward) is required to provide infant lifejackets, the number of which must be not less than 2.5% of the number of passengers that the vessel is licensed to carry as specified in the Operating License.

Storage of lifesaving appliances

1. Whenever a vessel is used or operated, every lifesaving appliance carried on board shall be:
   a. working properly;
   b. available for immediate use; and
   c. stowed at a place with easy access and not obliged to be made fast, so that it may set free on its own when necessary.
2. The life buoys shall be placed on both sides of the ship and shall be put on the shelves but are not obliged to be fastened, so that they may set free on their own when necessary.
3. Life jackets shall be stowed on the shelves or under the seats and clearly marked, and shall be equally distributed according to the location of passengers on the vessel.

Approximate fire-extinguishing capacity of each type of portable fire extinguisher

Vessel Length (L) (m) / Media	L≤9	9<L<15	L≥15	
Foam, water (litres)	2.8	4.6	9	• Fire extinguishers to be used for switchboards, control panels, batteries, etc. shall be of a type suitable for electrical fires, e.g. dry-powder or CO_2 fire extinguishers. • Fire extinguishers to be used for machinery spaces shall be of the type suitable for oil fires, e.g. foam, dry powder or CO_2 fire extinguishers. • Carbon dioxide fire extinguishers shall not be used in accommodation spaces. • Portable extinguishers are to be suitably distributed throughout the protected spaces. Normally at least one shall be stowed near the entrance to that space.
CO_2 (kg)	1	1.5	3	
Dry Powder (kg)	1.4	2.3	4.5	

Class IV vessels that are licensed to carry not more than 60 passengers and are not let for hire or reward and operate within waters of Hong Kong:

<table>
<tr><th colspan="2">Vessel Length (L) (m) / Fire-fighting apparatus</th><th>L<5.5</th><th>5.5≤L≤9</th><th>9<L<15</th><th>15≤L<24</th></tr>
<tr><td rowspan="4">Portable fire extinguisher (Two extinguishers shall be provided if there is a galley on board)</td><td>1.4kg</td><td>1</td><td>2</td><td>—</td><td>—</td></tr>
<tr><td>2.3kg</td><td>—</td><td>—</td><td>2</td><td>—</td></tr>
<tr><td>4.5kg</td><td>—</td><td>—</td><td>—</td><td>2</td></tr>
<tr><td>Engine room</td><td>—</td><td>—</td><td>2</td><td>2</td></tr>
<tr><td colspan="4"></td><td colspan="2">(For engine room that contains internal combustion type machinery having in aggregate a total power output of not less than 375 kW)</td></tr>
<tr><td colspan="2">Fire bucket with lanyard</td><td>1
(or 1 bailer)</td><td>2</td><td>2</td><td>2</td></tr>
<tr><td colspan="2">Main fire pump</td><td>—</td><td>—</td><td>—</td><td>1
(sea suction shall be situated outside the engine room)</td></tr>
<tr><td colspan="2">Hydrant</td><td></td><td></td><td></td><td>1</td></tr>
<tr><td colspan="2">Hose</td><td></td><td></td><td></td><td>1</td></tr>
<tr><td colspan="2">Nozzle</td><td></td><td></td><td></td><td>1</td></tr>
</table>

Class IV vessels that are licensed to carry more than 60 passengers:

Class IV vessels that are licensed to carry 13 to 60 passengers but are let for hire or reward:

<table>
<tr><th colspan="2">Vessel length (L) (m) / Fire-fighting apparatus</th><th>L<15</th><th>15≤L<24</th></tr>
<tr><td rowspan="6">Portable fire extinguisher</td><td>Passenger accommodation space</td><td colspan="2">1 on each deck (minimum 2)</td></tr>
<tr><td>Wheel house</td><td colspan="2">1</td></tr>
<tr><td>Galley</td><td colspan="2">1</td></tr>
<tr><td>Engine control room</td><td colspan="2">1</td></tr>
<tr><td>Engine room</td><td>3</td><td>4</td></tr>
<tr><td>Machinery space</td><td colspan="2">1 within each space</td></tr>
<tr><td colspan="2">Main fire pump</td><td></td><td>1
(its sea suction shall be situated outside the engine room.)</td></tr>
<tr><td colspan="2">Fire main + hose + hydrant + jet nozzle</td><td colspan="2">1 set</td></tr>
</table>

Storage and maintenance of fire-fighting apparatus

1. Whenever a vessel is being operated, every fire-fighting apparatus carried on board shall be:

   a. working properly;

   b. available for immediate use; and

   c. stowed at a place with easy access.

2. Fire-fighting apparatus should be inspected every 12 months or less.

(b) Proper use of lifesaving apparatus for pleasure vessels

(i) Lifejackets: Every passenger and crew should be provided with a recognized lifejacket. Lifejackets should be intact, with strong lanyard and appearance of bright colour (such as bright orange), and is affixed with night reflectors, making them easy to be found by rescue personnel. Lifejackets must be designed to be easy to wear with sufficient buoyancy. Children's lifejackets must be marked with "Children Only" or "Children's Logo" recognized by the International Maritime Organization. Lifejackets are accompanied by whistles to enable the person in water to make sounds for attracting the attention of rescue personnel. Ensure that passengers know how to wear lifejackets and their storage location before sailing. Children should wear lifejackets throughout the voyage. Lifejackets must be worn when operating open pleasure vessels or being engaged in other water sports activities such as water skiing, windsurfing, driving or riding a water scooter, canoeing, banana vessel riding and so forth.

(ii) Lifebuoys: It is a kind of life-saving appliance to rescue people from drowning. Lifebuoys are bright orange in colour and affixed with night reflector. Both sides of the buoy body are printed with the name of the vessel or the ownership certificate number, and placed near the ship side of the vessel. Every lifebuoy with a diameter of 760 mm can be used to serve two persons, must be attached with a floating life-saving rope and surrounded by four handrail rope rings of average length, a diameter of 9.5 mm. The ring body of buoy should be free of damages and have sufficient buoyancy. When someone falls into the sea or drowns, throw the lifebuoy to him for support while awaiting rescue.

(iii) Buoyant items such as plastic seats: The seat cushion is not fixed to a chair or bench. When someone accidentally falls into the sea, the seat cushion is the most convenient and handy substance to help floating. It can be thrown to the person in the sea for support, and serves as a mark for the approximate position of the person in the sea.

(c) Maintenance procedures for lifesaving equipment on pleasure vessel

- Regularly inspect all types of lifesaving appliances on board to make sure the number of the appliances has met the requirements on the certificate of survey / certificate of inspection;
- Make sure that the lifesaving appliances are in good condition; the surfaces of the lifejackets and lifebuoys are not contaminated by grease or other substances, and the lifejacket whistles can sound;
- There must be sufficient signs to indicate the location of the lifejackets;
- Lifebuoys shall be placed on the shelves for immediate use, and they shall be so located as not to be affected by the wind and waves and capable of falling free into the water.

(d) Distress signals and their use

(i) Red Flares (hand held or parachute): The hand held red flares are applicable in situations when the rescue parties are within a short distance from the scene of distress, and is stored in a waterproof container with easy-to-follow instructions. Bright red flares should last for not less than 1 minute in duration. Parachute red flares are applicable for alerting the rescue parties in long distances away. Red parachute flares can be seen at the height of over 300 meters, fall at the speed of not more than 5 meters per second and last for more than 40 seconds.

(ii) Orange Smoke signal: It is a kind of distress signals carried on vessels, lifeboats and liferafts. It is stored in waterproof containers with easy-to-follow instructions for use during daytime distress situations. A group of bright orange smoke can be issued evenly, which last for not less than 3 minutes.

(10) Use of VHF

(a) Radiotelephone procedures

Reception — For vessels in the waters of Hong Kong equipped with VHF Radio Telephone, the master can listen to the VHF radio channels as appropriate in the area. In the event of an emergency, VHF Radio Telephone can be used to report the situation to the Vessel Traffic Centre of the Marine Department. Call sign of the Marine Department: "MARDEP" or "MARDEP, HONG KONG".

Vessels can receive broadcasts of navigation information or navigation advice from the Vessel Traffic Centre through the VHF radio network on channels 02, 12, 14, 63 and 67 at 15 minutes past in Cantonese and at 45 minutes past in English each hour, as well as the navigation safety messages on channel 20. Navigation safety messages concern the general matters which affect the vessel navigation in port, such as the marine works in progress, the dislocation or replacement of navigational aids, the visibility reports in various parts of port when the visibility decreases to less than 2 nautical miles, the news of an approaching typhoon and etc.

Transmission — When ships are communicating on VHF Radiotelephone, the following rules should be observed:

- No vessel should conduct dialogue on VHF channels 02, 12, 14, 63 and 67;
- Do not interfere the communication between the Marine Department and other vessels;
- When hearing the Marine Department is in dialogue with other vessels, the person in charge / master / crew of the vessel intending to call must wait patiently and call "MARDEP" only at the end of their dialogue.

Abbreviations used by Radiotelephone:

ETA - Estimated Time of Arrival

ETD - Estimated Time of Departure

Over - Message is over, waiting for reply; or message has been received

Out - Call ended, no need to reply

Roger/Message Received - Message received and understood

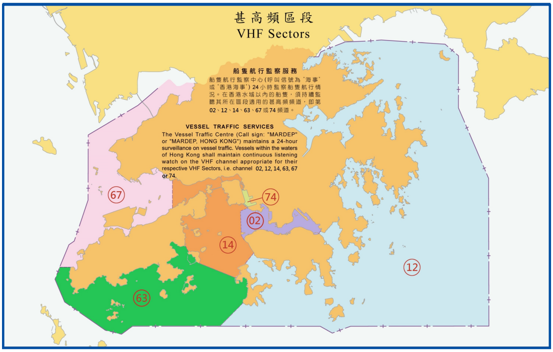
Stand by - Listen carefully, message will be passed to you

Wait - Please wait until I inform you that your message can be delivered

Repeat - Repeat all messages at last

(b) VHF channels in use in Hong Kong waters

The entire Hong Kong waters are divided into six sectors: Harbour East to use VHF channel 02; Eastern Approaches channel 12; Harbour channel 14; Lantau South channel 63; Western Approaches channel 67 and Kwai Chung Control Station channel 74. Vessels may use the assigned channels to communicate with the Vessel Traffic Centre.



VHF Sectors

VHF Sectors

02 Harbour East
12 Eastern Approaches
14 Harbour
16 International Distress
20 Navigational Warning
63 Lantau South
67 Western Approaches
74 Kwai Chung Control Station

(c) Procedures for transmitting Distress Calls

Distress signals can only be issued when a vessel is in danger and needs assistance. Using the VHF Radiotelephone is one of the handy methods of sending distress signals to any vessel or Vessel Traffic Center. When any vessel receives a distress signal from another vessel, it should immediately approach the vessel in distress and render assistance if it is safe for itself to do so. If it is unable to take the approach due to a long distance away or some other reasons, it may record the details of the distress signal received and relay it to the Marine Department. Vessels in distress within the Hong Kong waters may send distress messages using the frequency channels 02, 12, 14, 63 or 67 as appropriate in the area, and may use channel 16 in case of distress outside the waters of Hong Kong by following steps:

1. Use appropriate VHF channel according to the location of the vessel: (02, 12, 14, 63 or 67) or 16;
2. Speak the word "MAYDAY" three times;
3. Speak the vessel's name, or its licence number or its call sign three times;

4. message should consist of position of the vessel in latitude and longitude or a true bearing and distance from a popular or a well known geographical point;
5. message should consist of the nature of the distress and the number of persons injured/missing;
6. message should consist of the kind of assistance desired and any other information which might be of values to the rescues;
7. message should consist of the particulars of the vessel including: type, length and colour of vessel and also the number of crew and passengers on board;
8. speak the word "Over" for invitation to reply.

Operators of pleasure vessels may post a notice containing the procedures to follow near the VHF Radiotelephone to enable other people on board to send distress messages in complete format using VHF Radiotelephone when the vessel is in distress.

(11) Marine Department services

(a) Vessel Traffic Centre (VTC) - Radio navigation warnings

The Vessel Traffic Centre utilizes land mounted radars and computer surveillance systems to monitor the maritime traffic in various parts of waters in Hong Kong. The on-scene traffic situations at various locations and the pictorial image of any vessel in the port can be displayed on electronic monitors in the VTC to facilitate instant traffic measures. When a traffic regulator on watch detects a vessel in breach of the international or local shipping regulations or posing a risk to other vessels, he or she will issue advices or instruction to this vessel for taking remedial actions. The main clients that the VTC serves are the ocean going vessels and as they enter or leave the port of Hong Kong, they are required to establish constant VHF radio communications with the VTC throughout the passage for ensuring their navigation safety. Local vessels may also seek guidance or assistance from the VTC should they run into accidents.

(b) Marine Rescue Co-ordination Centre (MRCC)

Hong Kong Maritime Rescue Coordination Centre (MRCC) is responsible to co-ordinate all maritime search and rescue (SAR) operations in the international waters of South China Sea, bounded by Latitude 10° North and Longitude 120° East. Hong Kong MRCC however, has no direct command over the actual SAR resources. The role of Hong Kong MRCC is to co-ordinate all available SAR resources to carry out a maritime search and rescue mission. In response to a report of a suspected or an actual distress situation of a vessel, Hong Kong MRCC will initiate a series of basic rescue control and co-ordination procedures. Initially the duty officers in MRCC will investigate and assess the distress report to determine if a SAR response is needed. If the need is validated, efforts will be directed towards determining the type of assistance required taking into consideration of such variables as the nature of the distress, assistance involved, and the availability of SAR resources. Once the need for a SAR response has been justified and the type of response selected, a SAR plan will be drawn up. MRCC duty officers will first co-ordinate the available SAR resources to execute the SAR plan. They will then be fully engaged in tracking the progress of each resource responding to the mission, updating participants on any changes to the distress situation, coordinating support requirement and documenting all activity associated with the mission. For SAR cases within Hong Kong waters, MRCC will draw resources from Government Flying Service, Hong Kong Marine Police, Fire Services Department and Marine Department.

(c) Notices to Mariners

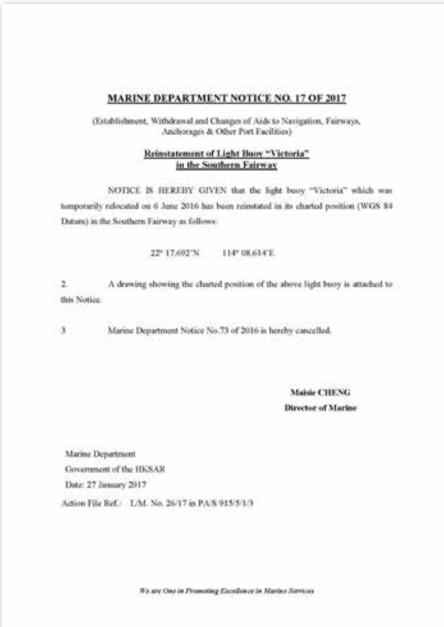
The main content of the notices to mariners concerns the correction of nautical charts. Information such as establishment and alternation of, any navigational aids in the waters of Hong Kong, detection and removal of dangerous substances and obstructions in the water, correction of fairway delineation and water depth etc. are given in the notices to mariners. The Hydrographic Office of the Marine Department issues a set of notices to mariners every two weeks. Mariners should regularly correct their nautical chart according to the notices to mariners to avoid running into dangers due to lack of knowledge about the changes in the water concerned. Latest or previous notices to mariners are available on the website of the Hydrographic Office (www.hydro.gov.hk/eng/ntm.php) (as updated).

For any sighting of new or suspects of hazards to navigation, or damage or defects noticed on the aids to navigation, ship masters should report directly to the Vessel Traffic Centre through the VHF channels, applicable to the area, or call the Centre hotline (24 Hours) at (852) 2233 7801. They can also use the Hydrographic Note from the above website to make the report.

(d) Marine Department Notices

The contents of the notices include maritime warnings and related information; the erection, revocation and alternation of Aids to Navigation, fairways, anchorages and other port facilities; maritime works; statutory provisions and related information; port operations procedures; safety codes for sailing and navigation skills; maritime industrial safety; local vessel licensing, safety inspection, manning and crew certification requirements; and miscellaneous information.

The notices are available on the website of the Marine Department (www.mardep.gov.hk/en/notices/notices.html) (as updated).



MARINE DEPARTMENT NOTICE NO. 17 OF 2017

(Establishment, Withdrawal and Changes of Aids to Navigation, Fairways, Anchorages & Other Port Facilities)

Reinstatement of Light Buoy "Victoria" in the Southern Fairway

NOTICE IS HEREBY GIVEN that the light buoy "Victoria" which was temporarily relocated on 6 June 2016 has been reinstated in its charted position (WGS 84 Datum) in the Southern Fairway as follows:

22° 17.692'N 114° 08.614'E

2. A drawing showing the charted position of the above light buoy is attached to this Notice.

3 Marine Department Notice No.73 of 2016 is hereby cancelled.

Maisie CHENG
Director of Marine

Marine Department
Government of the HKSAR
Date: 27 January 2017
Action File Ref.: L/M. No. 26/17 in PA/S 915/5/1/3

We are One in Promoting Excellence in Marine Services

(12) Storm signals and weather

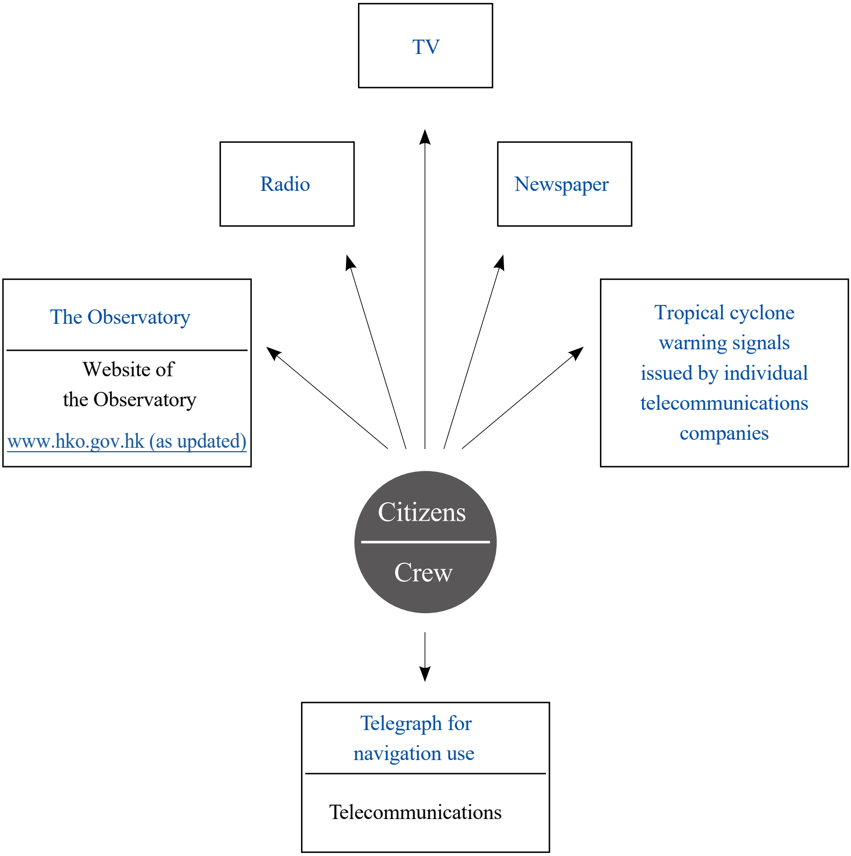
(a) Understanding of the significance of Typhoon Signals and the Strong Monsoon Signal together with associated sea and swell conditions

<table>
<tr><th colspan="2">Signal</th><th>Shape</th><th>Meaning</th></tr>
<tr><td>Standby Signal</td><td>1</td><td></td><td>A tropical cyclone is centred within about 800 km of Hong Kong and may affect the territory.</td></tr>
<tr><td>Strong Wind Signal</td><td>3</td><td></td><td>Strong wind is expected or blowing generally in Hong Kong near sea level, with a sustained speed of 41-62 km/h, and gusts which may exceed 110 km/h, and the wind condition is expected to persist.</td></tr>
<tr><td>NW' LY Gale or Storm Signal</td><td>8 NW</td><td></td><td rowspan="4">Gale or storm force wind is expected or blowing generally in Hong Kong near sea level, with a sustained wind speed of 63-117 km/h from the quarter indicated and gusts which may exceed 180 km/h, and the wind condition is expected to persist.</td></tr>
<tr><td>SW' LY Gale or Storm Signal</td><td>8 SW</td><td></td></tr>
<tr><td>NE' LY Gale or Storm Signal</td><td>8 NE</td><td></td></tr>
<tr><td>SE' LY Gale or Storm Signal</td><td>8 SE</td><td></td></tr>
<tr><td>Increasing Gale or Storm Signal</td><td>9</td><td></td><td>Gale or storm force wind is increasing or expected to increase significantly in strength.</td></tr>
<tr><td>Hurricane Signal</td><td>10</td><td></td><td>Hurricane force wind is expected or blowing with sustained speed reaching 118 km/h or above and gusts that may exceed 220 km/h.</td></tr>
<tr><td>Strong Monsoon Signal</td><td></td><td></td><td>Winds associated with the summer or winter monsoon are blowing in excess of or are expected to exceed 40 km/h per hour near sea level anywhere in Hong Kong. Winter monsoon normally blows from the north or from the east while summer monsoon typically blows from the southwest. In very exposed places, monsoon winds may exceed 70 km/h.</td></tr>
</table>

(b) The effect of fetch on wave height

The characteristics of waves are affected by wind and sea conditions. Greater wind speed results in the larger sea area (longer fetch), longer duration of wind (longer duration of strong wind) results in higher waves. On the contrary, smaller wind speed results in a narrower sea area (shorter fetch), shorter duration of wind results in lower waves.

(c) Available sources of weather information and warnings. Types of report available



Before going to sea, a pleasure vessel operator should note the weather, assess the impact, and prepare precautionary measures before the voyage. Other than obtaining weather information from the radio or TV, he/she can also use the "Dial-a-Weather" service (1878200) or the Observatory's website (www.hko.gov.hk) (as updated) for various weather reports such as Hong Kong Water Visibility Report, Hong Kong Zoning Weather and Tropical Cyclone Warnings and other relevant information. In addition, if Strong Monsoon Signal or any typhoon signal is issued, the Vessel Traffic Centre of the Marine Department will make hourly broadcast via the VHF channels to different areas.

(d) Correct interpretation of weather information received

Local weather forecast

The anticyclone in southern China is bringing generally sunny weather to the area.

At 8 am, the super typhoon Morandi gathered at about 140 kilometers southeast of Kaohsiung and was expected to move northwest or west-northwestward at a speed of about 22 kilometers per hour and cross the Luzon Strait. In the meantime, intense tropical storm Marek gathered at about 1,330 km south-southeast of Okinawa and is expected to move west-northwestward at a speed of about 22 kilometers per hour, moving roughly east of Taiwan.

Today's weather forecast for Hong Kong

Generally fine, but hazy. The weather is very hot, the maximum temperature is about 33 degrees. Gradually turn cloudy later, showers and thunderstorms in some areas. Winds are light to moderate from the north to northwest.

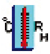
Outlook: A few squally showers and thunderstorms during Mid-Autumn Festival. The rain will be gradually weakened on Friday.

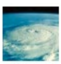
The above is extracted from the Observatory's weather forecast on 14 September 2016. The blue and underlined weather terms contain special meanings as below:

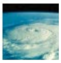
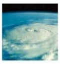
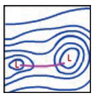
Description	Temperature (℃)	Description	Relative Humidity (%)
Very Cold	≤ 7 ℃	Very Dry	0 - 40 %
Cold	8 - 12 ℃	Dry	40 - 70 %
Cool	13 - 17 ℃	Humid	85 - 95 %
Mild	18 - 22 ℃	Very Humid	95 - 100 %
Warm	23 - 27 ℃		
Hot	28 - 32 ℃		
Very Hot	≥ 33 ℃		

Description	Beaufort Force	Wind Speed (km/h)
Calm	Force 0	< 2
Light	Force 1 - 2	2 - 12
Moderate	Force 3 - 4	13 - 30
Fresh	Force 5	31 - 40
Strong	Force 6 - 7	41 - 62
Gale	Force 8 - 9	63 - 87
Storm	Force 10 - 11	88 - 117
Hurricane	Force 12	≥ 118

Description	Interpretation	Description	Interpretation
 Fine	The sky is covered by a total cloud amount of less than six eighths. However, it can still be described as fine even though the total cloud amount is greater than six eighths if the cloud layer is thin enough to let plenty of sunshine to penetrate.	 Cloudy	The sky is covered with a total cloud amount of between six eighths and eight eighths.
 Overcast	The whole sky is covered completely by a continuous, thick and opaque cloud layer.	 Spissatus	Sometimes cloudy and sometimes overcast.
 Sunny	Plenty of sunshine for most time of the day.	 Sunny periods	The sunshine is continuous and the total sunshine duration is longer than half of the forecast period.
 Sunny intervals	The sunshine is intermittent and the total sunshine duration is shorter than half of the forecast period.	 Bright	The sky is covered by a large amount of thin cloud with sunshine occasionally.
 Showers	Brief precipitation usually from convective clouds. It is characterized by the sudden start and end of the precipitation as well as the fine weather before and after its occurrence.	 Occasional showers	There is a large amount of convective clouds in the sky. Showers occur in most parts of the territory occasionally but the rainy periods may be different for different places.
 Scattered showers	The rain-bearing clouds do not stay together and are distributed spatially, resulting in showers occurring in parts of the territory. It may be rain-free in other parts of the territory.	 Isolated showers	The rain-bearing cloud amount is small and isolated, resulting in showers occurring only in small parts of the territory at a time.
 Squall	A very strong wind that arises suddenly and lasts for at least one minute with a longer duration than gust. It is usually accompanied by thunderstorms. Besides the sudden changes in wind speed and direction, other meteorological elements such as temperature also change abruptly. Although the affected area is comparatively small, the destruction caused is not less than that of a tropical cyclone in some cases.	 Thunderstorm	Regional severe weather coming from cumulonimbus clouds. Usually, a thunderstorm is accompanied by lightning and a rumbling sound (thunder), strong gust and occasional heavy rain. Under suitable weather conditions there will also be hails. The rumbling sound is caused by the sudden expansion and contraction of the air, as a result of heating and cooling of the air brought about by the passage of lightning through the atmosphere. One can calculate how far away the lightning area is, by multiplying the time between sighting of lightning and hearing of the thunder with the ratio of 3 seconds to 1 000 m.

Description	Interpretation	Description	Interpretation
 Thundery showers	Precipitation of water drops from cumulonimbus clouds. It is characterized by its sudden start and end with rapid changes in the intensity of rain, accompanied by thunders.	 Drizzle	Precipitation of water drops of very small size.
 Rain	Precipitation of water drops from deep and thick cloud layers. It is more persistent than showers but the rainfall amount is less.	 Squally showers	Showers accompanied by brief but sudden strong or gale force winds.
 Fog, Mist, Haze	Fog is the suspension of small particles formed by the condensation of water vapour in the air near the ground surface, reducing the visibility to less than 1 000 m; it is called mist if the reduced visibility is equal to or above 1 000 m; it is called haze if the visibility is reduced due to small dust or smoke particles.	 Frost	Frost will occur in very cold conditions. When the temperature near the ground falls to the ice-point or below, frost will usually form. There are two kinds of frost: ground frost and hoar frost. Ground frost is the frost formed from the condensation of water vapour in the air when the temperature of the ground surface falls below ice-point. Hoar frost is the ice crystals sublimated directly from water vapour near the ground and is usually deposited on the rim of leaves and cable masts.
 Dew	Radiation cooling at night causes the air temperature to drop. When the air temperature falls below the dew-point, which is the temperature that the air becomes saturated with moisture, some water vapour condenses from saturated air near the ground to form dew. Dew usually appears in the early morning and condenses on grass or other ground objects.	 Hail	Hard pieces of ice falling from thick cumulonimbus cloud and accompanied by thunderstorms.

<table>
<tr><th>Description</th><th>Interpretation</th><th>Description</th><th>Interpretation</th></tr>
<tr><td>
Seas</td><td>Winds blow over the sea surface and generate water waves called seas or sea waves. Sea waves can be described according to their wave heights as below:
<table>
<tr><th>Desciption of seas or sea waves</th><th>Height of seas or sea waves</th></tr>
<tr><td>Calm</td><td>0 - 0.1 m</td></tr>
<tr><td>Smooth</td><td>0.1 - 0.5 m</td></tr>
<tr><td>Slight</td><td>0.5 - 1.25 m</td></tr>
<tr><td>Moderate</td><td>1.25 - 2.5 m</td></tr>
<tr><td>Rough</td><td>2.5 - 4 m</td></tr>
<tr><td>Very rough</td><td>4 - 6 m</td></tr>
<tr><td>High</td><td>6 - 9 m</td></tr>
<tr><td>Very high</td><td>9 - 14 m</td></tr>
<tr><td>Phenomenal</td><td>over 14 m</td></tr>
</table></td><td>
Swells</td><td>Winds blow over the ocean surface and generate water waves called seas or sea waves. Propagating outward across the oceans, they are referred to as swells when they reach a distance far away from their originating area. Swells generated by the winds of a tropical cyclone travel at a speed much higher than the speed of movement of the tropical cyclone itself. As such, even though windy and rainy weather associated with a distant tropical cyclone is yet to affect Hong Kong, swells generated by the tropical cyclone may already have reached the coastal areas. When swells enter shallow waters, their wave heights would increase drastically, posing threats to people near the shoreline or operating over near-shore waters.</td></tr>
<tr><td rowspan="2">
Cold front</td><td rowspan="2">The boundary line between an advancing cold air mass and a warm air mass. During the passage of a cold front, the local weather changes as follows: pressure increasing, temperature falling, wind veering (clockwise change in direction), accompanied by showers and thunderstorms. Generally, the cold fronts in southern China is not strong and may not bring so remarkable weather changes as mentioned above.</td><td>
Warm front</td><td>The boundary line between an advancing warm air mass and a cold air mass. The warm air mass climbs over the cold air mass, resulting in widespread rain areas ahead of the warm front.</td></tr>
<tr><td>
Upper Level Disturbance</td><td>A disturbance in the upper atmospheric flow pattern which usually makes the air aloft more unstable and conducive to clouds and precipitation.</td></tr>
<tr><td>
Tropical cyclone</td><td>A generic term for tropical depression, tropical storm, severe tropical storm, typhoon, severe typhoon and super typhoon.</td><td>
Tropical depression</td><td>A tropical depression is a cyclone formed over the tropical region and its maximum sustained wind speed is less than 63 km/h.</td></tr>
<tr><td>
Tropical storm</td><td>A tropical storm is more intense than a tropical depression and its maximum sustained wind speed ranges between 63 to 87 km/h.</td><td>
Severe tropical storm</td><td>If a tropical storm strengthens to the extent that its maximum sustained wind speed ranges between 88 to 117 km/h, it will be called a severe tropical storm.</td></tr>
</table>

Description	Interpretation	Description	Interpretation
 Typhoon	A tropical cyclone with maximum sustained wind speed between 118 and 149 km/h.	 Severe typhoon	A severe typhoon is more intense than a typhoon and its maximum sustained wind speed ranges between 150 to 184 km/h.
 Super typhoon	A super typhoon is the most intense tropical cyclone with a maximum sustained wind speed reaching 185 km/h or above.	 Monsoon	A monsoon is a seasonal wind flow due to the difference in surface pressure caused by the differential heating of seas and lands. The northeast monsoon generally prevails over the coast of China in winter while the southwest monsoon dominates in summer.
 Depression / Cyclone / Area of low pressure	When the atmospheric pressure over a region is lower than its surrounding, the system is called a depression or cyclone. The area of a depression has no definite size and its diameter can range from 100 km to 2 000 km. The weather under an area of low pressure is generally unstable. The air mass surrounding a depression will move counterclockwise in the northern hemisphere, and clockwise in the southern hemisphere.	 Anticyclone / Area of high pressure	When the atmospheric pressure over a region is higher than its surrounding, it is called an anticyclone or an area of high pressure. The air mass surrounding an anticyclone will move clockwise in the northern hemisphere. The weather under an area of high pressure is generally stable and fine.
 Ridge of high pressure	A ridge of high pressure is an extension of an area of high pressure. The atmospheric pressure over such a region is higher than its two adjacent sides, figuratively similar to the ridge of a high mountain. The weather under a ridge of high pressure is generally stable and fine.	 Trough of low pressure	A trough of low pressure is an extension of an area of low pressure. It is called a trough because the atmospheric pressure over the region is lower than its two adjacent sides, in contrast to a ridge of high pressure.
Descriptive Terms used in Weather Forecast			
At first	Mainly used to describe the weather conditions or changes during the first half of the forecast period.	Later	Mainly used to describe the weather conditions or changes during the second half of the forecast period.

(From Observatory's website)

(e) Knowledge of local weather patterns

Tropical cyclones — Tropical cyclones normally occur during the months of May to November, and are particularly prevalent during September. Tropical cyclone advisory bulletins and/or warnings are issued by the Hong Kong observatory whenever a tropical cyclone centred within 800 km of Hong Kong poses a threat to the territory.

Monsoons — Monsoons are large-scale wind systems caused by differences in the temperature of land and sea over the seasons.

In winter, the continental land mass cools off rapidly, resulting in very low temperatures over central Asia. As the cold air accumulates, the atmospheric pressure rises and a huge continental anticyclone develops over Siberia with the Tibetan Plateau forming an effective barrier blocking the southward spread of cold air from the anticyclone. From time to time, under the influence of the upper air disturbances, cold air from this anticyclone plunges southward through China and brings outbursts of cold air to the south China coastal areas. Depending on the time of the season, and the juxtaposition of various weather systems, these surges will arrive in Hong Kong as northerlies, northeasterlies or easterlies.

In summer, intense solar heating leads to scorching temperatures over the Asian land masses. As a result, the overlying air heats up, expands and rises upwards. This leads to the formation of a semi-permanent low pressure area near the heart of the continent. Warm and moist air from the Indian Ocean and the South China Sea flowing into this low pressure area is experienced as the summer monsoon over the South and Southeast Asia.

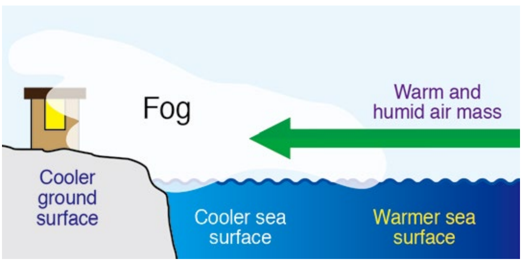
Monsoon winds are generally more persistent than those brought by tropical cyclones and may last for days. In intense surges of the winter monsoon, northeasterlies of up to gale force are common over the south China coastal waters. However, the full impact of these winds is not always felt in Hong Kong, particularly in heavily built-up areas or where nearby terrain provides some forms of sheltering.

Occasionally, in winter, tropical cyclones traversing the South China Sea may pass to the south of Hong Kong just when a monsoon is affecting the coastal areas of south China. Winds in Hong Kong are greatly enhanced due to the very large pressure difference between the continental anticyclone and the centre of the tropical cyclone.

Shi Hu Feng — It is the layman's description of the gust associated with squall lines. A squall line is a cluster of severe thunderstorms or storm cells along a line. Squall lines are fast moving and destructive, and will lead to sudden changes in the wind direction with an abrupt increase in wind speed. The severe gust associated with squall lines can exceed 100 kilometres per hour. Apart from heavy downpour and thunder, some of the squall lines even carry hail and tornadoes. On the radar display, a squall line will normally appear as a narrow band of intense rain area, sometimes bow-shaped, with a width of about ten to a few tens of kilometers, but its length will extend from tens to hundreds of kilometers.

In late spring and early summer, cold fronts or troughs of low pressure often drift south and affect southern China and its coastal area. Formation of Northwest Shi Hu Feng is probable when upper atmospheric disturbances propagate from west to east near the trough. A bow-shaped squall line associated with a Northwest Shi Hu Feng will normally approach Hong Kong from the northwestern part of the Pearl River Estuary. The squall line will first affect the northwestern part New Territories including Lau Fau Shan and Yuen Long before sweeping across other parts of the territory.

Fog — The atmosphere is in motion all the time so that heat and moisture around the world can be exchanged. The climate of Hong Kong is subtropical with distinctive features in each of the four seasons. In springtime, Hong Kong is occasionally affected by cold fronts followed by dry northerly winds. On the other hand, it is sometimes affected by warm and humid maritime airstream, causing very humid weather and even the occurrence of mist or fog. In Hong Kong, the most common type of fog in spring is advection fog. During this time, as the water along the coast of Guangdong is still rather cool, the warm and humid air coming from the distant ocean will be cooled by the underlying water. This results in condensation of water vapour into droplets and hence formation of fog. When it is humid, the refrigerators, washing machines or walls are "sweating", i.e. water droplets are formed on the surfaces. This phenomenon is called "Returning South" by the locals. From the perspective of meteorology and physics, this always happens as soon as the cold air recedes from one place; the warm and humid maritime airstream fills in rapidly. As the surface temperatures of walls, floors and outdoor glasses still remain low, water vapour in the warmer air can easily condense into tiny water droplets. The low water-absorbing capacity of these surfaces favours the aggregation of tiny droplets into water droplets, which become visible to us. However, as temperatures rise later on, moisture begins to vaporize and the weather phenomena of "Returning South" will disappear gradually.



Schematic diagram showing the formation of advection fog

(f) Understanding of the Beaufort Wind Scale

"Beaufort wind scale" or "Beaufort wind force scale" was introduced by British Admiral Sir Francis Beaufort in 1805. At that time, ships included fishing boats and warships employed, canvas sails to ride onwaves using wind power. Anemometer was not yet available.

Wind and waves are inter-related. The stronger the winds, the higher will be the waves. The strength of wind will have a direct effect on the state of the sea. Beaufort developed the scale based on his experience and observations on board a warship (called "44 gun man-of-war"). The scale on strength of wind is graded from force 0 to force 12 (a total of 13 categories).

The Beaufort wind scale was originally drawn up to provide reference to the setting of number of canvas sails under different grade of wind forces. The higher the wind force, the less canvas sails would be required.

Descriptive term	Beaufort scale number	Mean velocity (knot)	Mean velocity (m/s)	Sea criterion	Probable height of waves (m)	Probable maximum height of waves (m)
Calm	0	< 1	< 0.5	Sea like a mirror.	–	–
Light	1	1 - 3	0.5 - 1.5	Ripples with appearance of scales are formed but without foam crests.	0.1	0.1
Light	2	4 - 6	2 - 3	Small wavelets, still short but more pronounced; crests have a glassy appearance and do not break.	0.2	0.3
Moderate	3	7 - 10	3.5 - 5	Large wavelets; crests begin to break; foam of glassy appearance; perhaps scattered white horses.	0.6	1
Moderate	4	11 - 16	5.5 - 8	Small waves, becoming longer; fairly frequent white horses.	1	1.5

Descriptive term	Beaufort scale number	Mean velocity (knot)	Mean velocity (m/s)	Sea criterion	Probable height of waves (m)	Probable maximum height of waves (m)
Fresh	5	17 - 21	8.5 - 11	Moderate waves, taking a more pronounced long form; many white horses are formed (chance of some spray).	2	2.5
Strong	6	22 - 27	11.5 - 14	Large waves begin to form; the white foam crests are more extensive everywhere (probably some spray).	3	4
Strong	7	28 - 33	14.5 - 17	Sea heaps up and white foam from breaking waves begins to be blown in streaks along the direction of the wind.	4	5.5
Gale	8	34 - 40	17.5 - 20.5	Moderately high waves of greater length; edges of crests begin to break into spindrift; the foam is blown in well-marked streaks along the direction of the wind.	5.5	7.5
Gale	9	41 - 47	21 - 24	High waves; dense streaks of foam along the direction of the wind; crests of waves begin to topple, tumble and roll over; spray may affect visibility.	7	10

Descriptive term	Beaufort scale number	Mean velocity (knot)	Mean velocity (m/s)	Sea criterion	Probable height of waves (m)	Probable maximum height of waves (m)
Storm	10	48 - 55	24.5 - 28.5	Very high waves with long overhanging crests; the resulting foam, in great patches, is blown in dense white streaks along the direction of the wind; on the whole, the surface of the sea takes on a white appearance; the tumbling of the sea becomes heavy and shocklike; visibility affected.	9	12.5
Storm	11	56 - 63	29 - 32.5	Exceptionally high waves (small and medium-sized vessels might be for a time lost to view behind the waves); the sea is completely covered with long white patches of foam lying along the direction of the wind; everywhere the edges of the wave crests are blown into froth; visibility affected.	11.5	16
Hurricane	12	≥ 64	≥ 33	The air is filled with foam and spray; sea completely white with driving spray; visibility very seriously affected.	≥ 14	–

(13) Handling of emergency situations

(a) Action to be taken in event of collision, grounding, springing a leak, or fire on board

Collision

1. Depending on the collision impact, stop engine or maintain slow ahead with engine if necessary to avoid rushing in of water to the collided vessel and risk of sinking following the separation of the two vessels;
2. Raise the emergency signal to alert all crew members and passengers and ensure they put on life jackets;
3. Check the position of vessel;
4. Check the number and presence of passengers on board, attending the injured and search for any missing persons;
5. Assess the vessel's extent of damage, see if there is any ingress of water or oil leakage as a result of collision; discharge the ingress water if any;
6. Inform Marine Department of the vessel position and condition of the vessel by VHF;
7. If the hull integrity of the vessel is breached, cover externally the damaged areas with mattress or use appropriate means to plug internally to avoid ingress of water or reduce its rate. Close all watertight compartments;
8. After ensuring the safety of the own vessel and crew, the master is obliged to render assistance to the other vessel. A master can only leave the scene of collision when the master of the other vessel inform him/her that no further assistance is needed;
9. Masters of both vessels should exchange the following information:
   (a) Name of the master;
   (b) Vessel's name and registration number;
   (c) Destination;
   (d) Name, address and contact method of the vessels' owner;
10. Record the details in the navigation log;
11. Report to Marine Department within 24 hours of the incident.

Grounding

1. Shut down the main engine and electric generator;
2. Raise the emergency signal to alert all crew members and passengers and ensure they put on life jackets;
3. Check the number and presence of passengers on board, attending the injured and search for any missing persons;

4. Assess the vessel's extent of damage, see if there is any ingress of water or oil leakage as a result of collision; discharge the ingress water if any;
5. Ascertain the position of vessel (coordinates of grounding). Inform Marine Department of the vessel position and condition of the vessel by VHF;
6. Check the draft at various parts of the vessel and the water depths around the vessel to ascertain the stranded location;
7. If the hull integrity of the vessel is breached, cover externally the damaged areas with mattress or use appropriate means to plug internally to avoid ingress of water or reduce its rate. Close all watertight compartments;
8. Hoist the stranding signals (day time: three black balls; night time: two all-round red light in a vertical line and anchor lights);
9. Secure the vessel in position with ropes;
10. Consider to refloat the vessel only when overall safety of vessel is ensured;
11. Refloating of the vessel may be carried out during rising tide;
12. If the vessel is stranded at the bow, consider trimming the vessel by the stern with ballast water or shifting of weights to the stern;
13. After preparation is completed, operate the main engine on full astern to drag the vessel away from the shoal patch;
14. For setting up grounding tackles for assisting refloating of vessel, toss the anchors in an appropriate location by using small vessel and lower them to the sea bottom;
15. If possible, consider to employ other vessels to tow the stranded vessel off;
16. Record the details in the relevant log book;
17. Report to Marine Department within 24 hours of the incident.

Springing a leak

1. Raise the emergency signal to alert all crew members and passengers and ensure they put on life jackets;
2. Check if there is any water ingress or oil leakage;
3. Close all watertight compartments; inform Marine Department of the vessel's position and condition by VHF;
4. If the leak is below waterline, patch the leaks to reduce the rate of water ingress by using canvas mattress or plugs. Alternatively, means such as trimming or listing of vessel can be used to raise the leaked location to above the water level;
5. Pump out the ingressed water, if any;
6. Closely monitor if there is any ingressed water in other compartments;
7. Request for external assistance when needed;
8. Exhibit appropriate signals when the vessel is not under command (day time: two black balls; night time: two all-round red light in a vertical line);

9. If ingress of water cannot be controlled, consider beaching or abandoning the vessel if necessary;
10. Record the details in the relevant log book;
11. Report to Marine Department within 24 hours of the incident.

Fire on board

1. Activate the emergency signal and fire alarm. Inform Marine Department of the vessel's position and condition of the vessel by VHF;
2. Check the number of passengers and their presence on board, deploy fire-fighting teams in action immediately;
3. Shut down ventilation and fuel supply as required, close the water-tight door and cool down the surroundings at the fire scene;
4. Ensure the power supply/circuit is off that it would not cause further spread of fire and cause danger to the fire-fighters;
5. Move inflammable articles away from the scene of fire;
6. Attend the injured and search for any missing persons;
7. Adjust the ship's head to downwind direction to provide a sheltering to the fire scene;
8. In case the fire becomes uncontrollable, broadcast the distress signal and instruct everybody to put on life jacket;
9. Record the details in the relevant log book;
10. Report to Marine Department within 24 hours of the incident.

(b) Action to be taken in event of loss of rudder, lost or fouled propeller or loss of anchor

Loss of rudder

1. Shut down the main engine immediately;
2. Inform Marine Department of the vessel's position and condition of the vessel by VHF;
3. Hoist the not under command signal (day time: two black balls; night time: two all-round red light in a vertical line);
4. Prepare for anchoring. When the vessel drifts to coastal area which is suitable for anchoring, drop the anchor and prevent the vessel from further drifting;
5. Remove the signal of not under command immediately after anchoring. Change to hoist the anchoring signal (day time: one black ball at bow; night time: one all-round white light);
6. Arrange for assistance of tug boats to tow the vessel for repairs;
7. If for any reason the request for assistance cannot be delivered, the hampered vessel may attempt the following temporary measures, if weather permitting:-

   (i) to create a temporary rudder by means of a boat hook and a wood board, or
   (ii) to operate a dinghy boat by the side of the vessel and use the outboard drive to assist the manoeuving of the vessel.

   When adopting these measures, care must be taken for the vessel to proceed at safe speed and exhibit the proper not under command signals.

Loss of anchor

When the anchor is found to be entangled by foul wires or other obstacles rendering it impossible to retrieve, it might be necessary to abandon it so that the vessel can set sail. Use a rope with length greater than the depth of water, fastened the rope end to an anchor chain link and the other end to a buoy, which will serve as an identification mark for subsequent recovery of the anchor at a later date. Disconnect the anchor chain and abandon the anchor. Note down the location and report the incident to the Marine Department.

Loss of propeller

1. Immediately shut down the engine;
2. Inform Marine Department of the vessel position and condition of the vessel by VHF;
3. Hoist the signal of vessel not under command (day time: two black balls; night time: two all-round red light in a vertical line);
4. Prepare for anchoring. When the vessel drifts to coastal area which is suitable for anchoring, drop the anchor and prevent the vessel from further drifting;
5. Remove the signal of not under command immediately after anchoring. Change to hoist the anchoring signal (day time: one black ball at bow; night time: one all-round white light);
6. Arrange for assistance of tug boats to tow the vessel for repairs.

Fouled propeller

When the propeller is entangled by unknown underwater objects, the crew could immediately feel an abrupt reduction of speed and abnormal vibrations of the vessel. Stop the main engine immediately. If rope is found at the propeller, use a boat hook to free it. If this fails, re-start the main engine and operate it alternately forward and backward for a few times to try to clear the fouls.

If this continues to fail, the last solution is to send a diver. Equip the diver with a life line and knives. Before going into the water, make sure the engine is completely off and ignition keys are removed. Exhibit the appropriate light signals or shapes prescribed in Colregs for vessel engaged in diving operations. Assign another crew member to serve as a look out and the master to stay alert to warn off any vessels coming too close through sound signals or spot lights. Set up proper communication signals with the diver. Do not attempt to carry out any diving operation in busy traffic areas.

(c) Handling a partially disabled or completely disabled vessel

1. Inform Marine Department of the vessel position and condition of the vessel by VHF;
2. Exhibit the signals of a vessel not under command (day time: two black balls; night time: two all-round red light in a vertical line);
3. Prepare for anchoring. When the vessel drifts to coastal area which is suitable for anchoring, drop the anchor and prevent the vessel from further drifting.
4. Remove the signal of not under command immediately after anchoring. Change to hoist the anchoring signal (day time: one black ball at bow; night time: one all-round white light);
5. Arrange tug boats to tow the vessel for repairs.

(d) Beaching

When the vessels is not able to control the flooding of water as a result of collision, or severe weather conditions, it would be better to beach the vessel to avoid sinking.

1. Alert all members on the vessel, to ensure they put on life jackets and advise them the intention of beaching;
2. Choose the appropriate location of beaching (best to be a sandy beach than a rocky one);
3. Inform Marine Department of the location, condition and the beaching intention of the vessel by VHF;
4. Shift the weights on vessel to adjust the trim as close to the gradient of the beach as possible;
5. Direct the ship's bow at right angle to the beach;
6. Move in at slow speed. When the vessel is close to the shore, stop the engine and let the residual momentum carry the vessel onto the beach;
7. Immediately shut down the main engine and electric generator;
8. Ascertain the position of vessel (coordinates of beaching). Inform Marine Department of the beaching location of the vessel by VHF;
9. Check the draft at various parts of the vessel and the depth of water around vessel to ascertain the contacting locations. Check the extent of damages for oil leakage and water ingress. Pump the flood water out if any;
10. If the hull of the vessel is damaged, patch the damage for reducing the rate of water ingress. Close all the watertight compartments;
11. Exhibit the stranding signals (day time: three black balls in a vertical line; night time: two all-round red lights in a vertical line and anchor lights);
12. Secure the vessel in position with ropes fastened to strong points ashore;
13. Only consider to refloat the vessel when it is ascertained safe to do so;
14. Consider to refloat the vessel when the tide level is high;
15. If the vessel is beached at its bow, shift weights to the aft or fill up the ballast astern to assist refloating;
16. Operate the engine on full astern in attempt to free the vessel from the beaching spot;
17. If a grounding tackle is needed, lay the anchor in an appropriate location with the aids of small dinghy boats;
18. Employ other vessels for assisting in the refloating operation if needed;
19. Record the details in the relevant log book;
20. Report to Marine Department within 24 hours of the incident.

(e) Rendering assistance to other vessels in distress. Taking a disabled vessel in tow

Upon receiving a distress signals from another vessel, the master is under obligation to immediately proceed to the location of the vessel in distress and render assistance.

If for any reason the vessel is unable to proceed because of inadequate fuel or other reasons, the master should note down the distress message carefully and relay it to Marine Department. If you are the first vessel to arrive at the distress location, carefully evaluate the situation and assess the assistance that the vessel in distress would need, and render appropriate assistance without causing danger to own vessel and crew members. Inform the Marine Department of the on-scene situation from time to time.

As stated in Section 93 of the Merchant Shipping (Local Vessels) (General) Regulation (Cap 548F): except with the permission from the Director of Marine, a local vessel shall not be used for towing another vessel, unless such towing is undertaken in order to save that other vessel, its crew or passengers from danger.

Before making attempts to tow a distressed vessel, the master should first evaluate the following factors:

i. Is the vessel powerful enough to tow?
ii. Is the structure of the vessel suitable for towing?
iii. Do the crew members have relevant experiences in operation?

If the master is not sure of the capability of his pleasure vessel, he/she should standby the distressed vessel for other assistance and wait for the arrival of the proper towing vessel.

Attention should be paid to the following points when towing a vessel:

i. Once the hauling rope is securely fastened, gently pick up the slack of the hauling rope in order not to create a sudden jerking force to it;
ii. Establish good communication between tug and tow;
iii. While the hauling rope should be fastened at the most secured position on both the tug and tow, quick release arrangement of the hauling rope should be readily available for both parties in case of emergency.

(f) Obligations of a pleasure vessel operator to his/her passengers and crew

As an operator of a pleasure vessel, his/her obligations are to manage and operate the vessel. He/she must hold a valid certificate, which prove that he/she is qualified to administer the vessel, and ensure it is in possession of all necessary statutory certificate and license, as well as the Third Party Risks Insurance according to the law.

In terms of vessel management, the operator should regularly conduct thorough inspection to the vessel, especially on its main engine, electric generator, pump, all kinds of life-saving equipment, fire equipment and navigation equipment. If any problem is found, take immediate remediation and make sure the vessel is sea worthy at all times. Record the repair and maintenance work of the vessel in details. Maintain the minimum manning according to the license requirement during the navigation. Conduct different drills on a regular basis, such as fire drill, drowning, taking in of water, abandonment of vessel etc., so as to ensure that the crew members are familiar with the procedures when dealing with emergencies.

In terms of vessel operation, the operator is obliged to provide the passengers with a safe and clean environment, and transport them to the destination. Before sailing, the operator should prepare the vessel well by ensuring sufficient manning scale and conducting safety checks as described in paragraph 3(a) of this chapter. When navigating, the vessel must fully comply with the requirements in the "International Regulations for Preventing Collisions at Sea" and proceed at a safe speed. Post sufficient look out as appropriate. Never overload and over speed the vessel.

In marine accidents where the safety of the passengers and property on board is endangered, the master (the operator of the vessel) should organize his/her crew members for carrying out emergency measures as far as practicable. In collision between vessels, according to Cap 548 s 29 of Merchant Shipping (Local Vessels) Ordinance, the master or the operator of the vessel is obliged to render necessary assistance to another vessel, its master, crew members and passengers (if any) when the safety of the own vessel, crew members and passengers are secured. Standby next to the distressed vessel until the master or the operator of that vessel confirms that no further assistance is needed.

Safety Briefing

(1) For any pleasure vessel that is chartered in exchange of charter fee or remuneration, the master (the operator of the vessel) must inform all members on board of the stowing location of the life-saving equipment, correct way of wearing the life jacket, and the location of all emergency exits before sailing. In addition, the master must ensure that all children have put on life jackets at all times, keep a complete name list of the passengers and crew members on board and comply with the limitations in terms of the passenger capacity as stated on the Operating Licence for Local Vessel.

(2) Other than the stipulations as stated in section 1 above, the master must provide a briefing to at least one assistant on board regarding the following:-

  i. the procedures of rescuing a person in water;
  ii. the location of the first aid kit (if any);
  iii. the operation procedures of radiotelephone (if any) and the manners of sending out emergency or distress calls;

iv. the switches of navigation lights and other lighting devices;

v. location and application of the fire equipment;

vi. ways to start, stop and control the main engine; and

vii. the procedures for handling emergency situations and communication arrangements.

(3) To publicize the required information as stated in section 2 above, safety signs or boards erected at conspicuous locations are also acceptable.

(g) Disposition of persons and crew to ensure satisfactory stability and trim of vessel

Pay attention to the following items to avoid creating impacts to vessel stability:-

i. the hull is in sound and good condition without any damages or leakages;

ii. there is no overload whatsoever and a sufficient freeboard is maintained;

iii. all hatch coverings, sidescuttles, watertight doors should remain watertight at all times;

iv. vessel should stay on a vertical line and should be slightly trimmed by stern (with the draft of the stern appropriately deeper than that of the bow);

v. do not place miscellaneous items of goods on the upper deck or any higher position;

vi. bulky and heavy objects should be stowed on the lower deck and lashed properly;

vii. evenly distribute heavy objects to the left and right sides of the vessel, make sure they will not list the vessel to either one side;

viii. when navigating in severe weather conditions, other than the working crew members, other passengers and crew members should stay as close to the centre line of the vessel in the lower deck as practicable and do not move around;

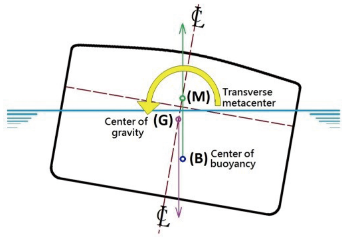
ix. avoid having oil tanks and water tanks half full;

x. avoid excessive accumulation of sewage at the bilge, and frequent pumping is necessary; and

xi. keep all the draining holes on deck clear of fouls and obstacles.

Three factors to determine the stability of vessel: Metacentre (M), Centre of Gravity (G) and Centre of Buoyancy (B).

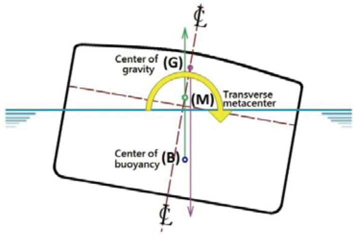
Stable



The stability of a vessel depends on the righting moment or the "anti-tilting effect" generated when the hull is tilted due to external forces. Once the external force is removed, the vessel will return to the original floating position of balance, then the vessel is said to be in stable equilibrium.

When M is above G, GM is positive in value.

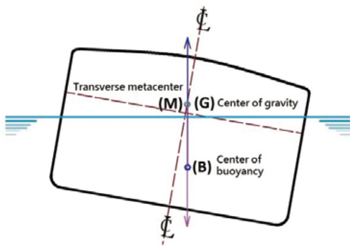
Unstable



If M is below G, as the vessel is inclined, it will not be able to return, but the tilting moment increases and causes the vessel to heel further or even to capsize.

When M is below G, GM is negative in value.

Neutral Equilibrium



When the vessel is subjected to external forces and slowly heels, should G meets with M, resulting in the righting moment equal to zero, the vessel will stay what she is when the external forces are removed, i.e. the vessel will neither return to its original floating position of balance nor continue to change, but will adapt as circumstance may evolve. In such case, the ship is in a neutral equilibrium.

When M and G are in the same position, GM is 0.

Tender ships (GM is still positive, its value is relatively small)

It means when navigating at sea, the vessel rolls slowly from side to side. If the rolling cycle is longer in duration, people on board would feel more comfortable and substances will not break loose easily. Because the righting moment is weak, when the vessel rolls to one side but cannot return to its original position in time, the second sea wave could push over further and capsize it. In this case, we must respond quickly to lower the centre of gravity of the vessel to increase the GM.

(h) Man overboard. Immediate response; action to recover person from the water; signals

i. Raise emergency signal to alert the crew and passengers (or shout loudly if vessel is relatively small);

ii. Turn the vessel immediately so that its propeller moves away from the man overboard direction (turn left helm if someone falls into the sea from port side, and turn right helm if someone falls into the sea from starboard side);

iii. Throw the lifebuoy;

iv. Post extra lookout and point his/her arm to the direction of person overboard;

v. Make a U-turn and hoist appropriate signal;

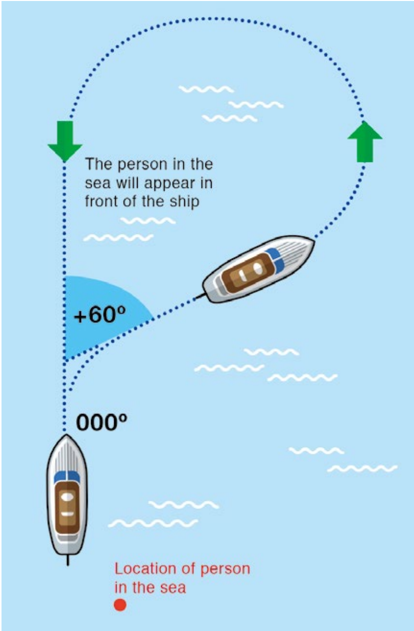
vi. Prepare for rescue (use ropes, rope ladders, or craft as appropriate);

vii. Turn the vessel to downwind position so as to offer a leeside to the person in water;

viii. Effect appropriate rescue procedures and notify the Marine Department;

ix. Record the operation details in the logbook and report to the Marine Department within 24 hours after the accident.

If at night in area of restricted visibility, or the person overboard could not be seen, try using the following means (Williamson Turn) to navigate the vessel back to its original course for effecting rescue.



Man overboard from starboard side of the vessel

1. Turn the vessel to the right until the ship head is 60° away from the original course;
2. At this point, turn the helm hard over to left until the ship head is 180° to the original course and the vessel should be able to recover its original man overboard position.

(In case man overboard from the port side turn the vessel to port and repeat process in a reverse direction.)

Signal for man overboard incidents

1. Hoist the international signal flag "O" during the day and sound three prolonged blast (———);

2. In the event the person fallen into the sea cannot be recovered, PAN PAN or MAYDAY messages should be sent out via the allocated VHF channels to request nearby vessels for assistance for the search of the missing person.

(14) Accident reports

Statutory duty to report an accident on board

According to Section 57 of the Merchant Shipping (Local Vessels) Ordinance (Cap 548):

(1) Where, within the waters of Hong Kong or elsewhere —

(a) a local vessel is involved in a collision with another vessel, a port facility or other property;

(b) a local vessel sinks or becomes stranded or disabled;

(c) a person is killed or seriously injured on board a local vessel as a result of an accident;

(d) an explosion or fire occurs on a local vessel;

(e) damage is caused by a local vessel to a port facility or other property; or

(f) a person, cargo or equipment is lost overboard from a local vessel,

the owner of the vessel, his agent or the coxswain shall report the occurrence forthwith to the Director of Marine orally, by means of signals, or in writing and shall furnish to the Director in writing with full particulars thereof within 24 hours after the occurrence.

(2) The owner of a local vessel, his agent or the master of the said vessel who —

(a) without reasonable excuse fails to comply with subsection (1); or

(b) makes a report or furnishes any particulars under subsection (1) which he knows to be false in any material particular, commits an offence and is liable on conviction to a fine at level 3 ($10,000).

(3) For the purpose of subsection (1)(c), a person shall be deemed to be seriously injured if he is admitted to a hospital immediately after he sustains the injury for observation or treatment.

An oral report shall include the following:

- Name of vessel, particulars of vessel and name of master.
- Time, date and place of the accident.
- Nature of the accident.
- Number of people on board, any person injured or missing.
- The degree of damage to the vessel, the risk of imminent sinking or oil pollution.
- Any information requested by the Marine Department.

If the accident is minor in nature, the vessel can proceed on with the voyage with the Marine Department's approval, but it must advise the latter of the destination and the estimated time of arrival.

The marine accident report should be completed according to the requirements as stipulated in the report form.

(Report M.O.822 Rev.1/2011 is available on the Marine Department website at: www.mardep.gov.hk/en/forms/pdf/mo822nf.pdf (as updated))

(15) Part A Questions and Answers

Q: How many entry-prohibited areas are there in Hong Kong that vessels are not allowed to enter?

A: Except with the permission of the Director of Marine, no vessel shall enter any of the following four areas:

1. 100 metres from the low water mark of Green Island.
2. The Ngong Shuen Chau Barracks area.
3. 100 metres from the low water mark of Waglan Island.
4. Shing Mun River Channel.

Q: What does the red line in the diagram mean?

A: It is the boundary between the Speed Limit Zone A and Zone B.

Q: What does the red line in the diagram mean?

A: Port boundary.

Q: Which fairway does the black part refer to?

A: Northern Fairway.

Q: Which fairway does the red portion in the diagram refer to?

A: Southern Fairway.

Q: Which fairway does the black portion in the diagram refer to?

A: Hung Hom Fairway.

Q: Which fairway does the dotted line in the diagram refer to?

A: East Lamma Channel Traffic Separation Scheme.

Q: Which fairway does the red portion in the diagram refer to?

A: Tathong Channel Traffic Separation Scheme.

Q: Which fairway stretches from Lei Yue Mun in a southeast direction to the north of Waglan Island?

A: Tathong Channel.

Q: What is the waterway that stretches from the sea off Kennedy Town (Western District) in a southeast direction to the southwest of Flat Island?

A: East Lamma Channel

Q: What latitude marks the most southerly boundary of Hong Kong waters?

A: Latitude 22°18'12.2".

Q: What is the maximum allowable length of a vessel using a government pier?

A: Except with the permission of the Director of Marine, vessels of a total length exceeding 35 meters shall not berth any government pier.

Q: How should a vessel use the government pier lawfully?

A: The government piers can only be used for loading and unloading passengers and luggages. Vessels can not berth the government piers for any other purposes.

Q: If a vessel violates the requirements on using government piers, what penalty can be imposed on the master of the vessel on conviction?

A: Upon conviction, the master is liable to a fine of level 1 ($2,000).

Q: What is the highest penalty for a 15-meter-long power-driven vessel that speeding in zone A of Victoria Harbour?

A: The master of the vessel is liable to a fine at level 3 ($10,000) and to imprisonment for 6 months.

Q: It will be an offence if a vessel violates the Merchant Shipping (Local Vessels) (General) Regulation and enters the special area of Kap Shui Mun without reasonable excuse. What is the highest penalty for the master of the vessel on conviction?

A: The master of the vessel is liable to a fine at level 3 ($10,000) and to imprisonment for 6 months.

Q: It will be an offence if a vessel violates the Merchant Shipping (Local Vessels) (General) Regulation and enters the restricted area of Chek Lap Kok airport without reasonable excuse. What is the highest penalty for the master of the vessel on conviction?

A: The master of the vessel is liable to a fine at level 3 ($10,000) and to imprisonment for 6 months.

Q: Under the Merchant Shipping (Local Vessels) Ordinance, it is an offence for any person to discharge oil or oil-bearing mixture into the waters of Hong Kong. What is the maximum penalty for the master of the vessel on conviction?

A: The master of the vessel may be fined $200,000.

Q: Under the Merchant Shipping (Local Vessels) Ordinance, it is an offence for any local vessel to emit dark smoke for 3 minutes or more continuously at any one time in the waters of Hong Kong if it is safe to do so. What, if convicted, is the highest penalty for the owner and master as a first-time offender?

A: First-time offenders may be fined at level 3 ($10,000).

Q: In which direction does the water flow in Victoria Harbour in flood tide?

A: From east to west.

Q: Please describe the light quality of a port side buoy.

A: Any red light, except [Fl. (2 + 1) R].

Q: Which buoy emits two flashing red flashes every ten seconds [Fl. (2) R.10s]?

A: A port hand buoy.

Q: Please describe the colour of a special area buoy (special sign).

A: Yellow.

Q: Please describe the colour of a buoy with isolated danger mark.

A: Black, with one or more red horizontal stripes in the middle.

Q: Please describe the top mark shape of a special area buoy (special sign).

A: It is a yellow "X" if the special area buoy has a topmark.

Q: Please describe the top mark shape of a buoy with isolated danger mark.

A: The topmark of a buoy with isolated danger mark is two black spheres hanging vertically.

Q: Please describe the light quality of an isolated dangerous buoy.

A: White group flashing repeating a group of two flashes [Fl. (2)].

Q: On the way from Lei Yue Mun to Discovery Bay at night, a buoy with a long white flash every ten seconds is seen in front of Hung Hom Fairway. Please state the name of the buoy.

A: The safe water mark.

Q: When your vessel leaves Pakse Bay and sails to the sea, you see a red tank buoy directly in front of your vessel. Which side of the vessel will you use to pass the buoy?

A: Starboard side.

Q: When your vessel in proceeding southwestwards after leaving the Ma Wan Channel to the north of Lantau Island, and you see this buoy in front of your vessel, which side of the buoy will you pass through?

A: I will pass to the south of the buoy.

Q: When your vessel is proceeding on a true course of 165°, and you see this buoy in front of your vessel, what should you do?

A: Turn right and if there is another vessel nearby, sound a short blast on whistle. Keep this buoy on the port side of the vessel while passing through.

Q: When your vessel is proceeding on a true course of 270°, and you see this buoy in front of your vessel, what should you do?

A: Immediately stop the vessel and determine the location of the vessel. Thereafter carefully alter course as needed and leave the scene at slow speed.

Q: When your vessel is proceeding on a true course of 090°, and you see this buoy in front of your vessel, what should you do?

A: Immediately stop the vessel and determine the location of the vessel. Thereafter carefully alter course as needed and leave the scene at slow speed.

Q: When your vessel is proceeding on a true course of 005° at night, you see a buoy at 30° on the port bow, with 3 very quick flashes white light within 5 seconds. The location of the buoy moves slowly backwards. What should you do?

A: I see an east cardinal buoy on my port bow. I should keep course and speed.

Q: When your vessel is proceeding on a true course of 010°, and you see this buoy in front of your vessel, what should you do?

A: Turn right and if there is another vessel nearby, sound a short blast on whistle. Keep this buoy on the port side of the vessel while passing through.

Q: When your vessel is proceeding on a true course of 260° at night, and you see a buoy in front of your vessel, with 6 very quick flashes followed by a long flash white light within 10 seconds, what should you do?

A: I see a south cardinal buoy in front of my vessel. I should immediately turn left and if there is another vessel nearby, sound two short blasts on whistle. Keep this buoy on the starboard side of the vessel while passing through.

Q: When your vessel is proceeding on a true course of 080°, and you see this buoy in front of your vessel, what should you do?

A: Turn right and if there is another vessel nearby, sound a short blast on whistle. Keep this buoy on the port side of the vessel while passing through.

Q: When your vessel is proceeding on a true course of 105°, and you see this buoy on 1 point of your starboard bow, what should you do?

A: Turn left and if there is another vessel nearby, sound two short blasts on whistle. Keep this buoy on the starboard side of the vessel while passing through.

Q: When your vessel is proceeding on a true course of 260°, and you see this buoy in front of your vessel, what should you do?

A: Turn right and if there is another vessel nearby, sound one short blast on whistle. Keep this buoy on the port side of the vessel while passing through.

Q: What is the speed limit in vessel speed restricted areas on Saturday or public holidays from 8:00 a.m. to 12:00 midnight?

A: Five knots.

Q: When any local vessel is being used to tow a person for water skiing, the master of the vessel must be accompanied by another person on that vessel. What is the age of that person?

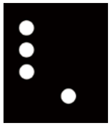
A: Not less than 18 years old.

Q: What kind of vessel exhibits these lights?

A: A hovercraft or a high speed vessel, displaying the lights at the stern of the vessel

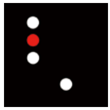
Q: What kind of vessel exhibits these lights?

A: An anchored vessel requesting for the Immigration Department's clearance.



Q: What kind of vessel exhibits these lights?

A: An anchored vessel that needs immediate assistance.



Q: What kind of vessel exhibits this signal?

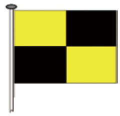
A: A police launch.

Q: What is the meaning of hoisting this flag signal?

A: This vessel has divers working under water. Please stay away from this vessel and pass at a low speed.

Q: How do you react if you see a government vessel nearby (Marine Department, Police, Immigration Department or Customs) showing you this flag signal?

A: I should stop immediately and wait for the government officials to board.



Q: How do you react if a police launch to the stern of your vessel sends you one short, one long and two short Morse code whistle blasts?

A: I should stop immediately and wait for the police officers to board.

Q: How do you react if a patrol launch of the Marine Department to the stern of your vessel sends you one short, one long and two short Morse code whistle blasts?

A: I should stop immediately and wait for the officers of the Marine Department to board.

Q: At night, a vessel with blue flashing light sends one short, one long and two short Morse code signals to your vessel with a white flashing light. How should you react?

A: This is the signal from a police launch requesting me to stop immediately. I should stop immediately and wait for the police officers to board.

Q: At night, a vessel with blue flashing light sends one short, one long and two short blast signals (• — • •) to your vessel. How should you react?

A: I should stop immediately and wait for the police officers to board.

Q: What sound signals should be given when the sailing vessel turns to the right after entering the Causeway Bay Typhoon Shelter using an auxiliary engine?

A: One short blast.

Q: When your vessel is approaching the entrance of the typhoon shelter, you cannot see the inside of the shelter. What kind of sound signal should you give?

A: One prolonged blast.

Q: The vessel you are steering is on a waterway in the mooring area of Cheung Chau Typhoon Shelter. Both sides of the line are obstructed by large fishing vessels. What sound signal should you give when your vessel approaches the corner?

A: One prolonged blast.

Q: Your vessel experiences machine failure when sailing in the water marked in black of this picture. For the safety of the vessel which VHF channel should you use to inform the Vessel Traffic Centre of your situation?

A: Channel 12.

Q: Your vessel experiences machine failure when sailing in the water marked in black of this picture. For the safety of the vessel, which VHF channel should you use to inform the Vessel Traffic Centre of your situation?

A: Channel 63.

Q: Someone falls into the sea when sailing in the water marked in black of this picture. In addition to carrying out the rescue, which VHF channel should you use to immediately report this matter to the Vessel Traffic Centre?

A: Channel 14.

Q: When you see another vessel speeding in the typhoon shelter, which section of the Marine Department should you report to?

A: Harbour Patrol Section or Vessel Traffic Centre.

Q: Please briefly describe the responsibilities of the Hong Kong Maritime Rescue Coordination Center (MRCC).

A: The Hong Kong Maritime Rescue Coordination Center is responsible for the coordination of all maritime search and rescue in international waters of South China Sea, bounded by Latitude 10° North and Longitude 120° East.

Q: What does the "Marine Department Notices" include?

A: The contents of the Marine Department Notices include maritime warnings and related information; the installation, revocation and modification of auxiliary equipment, fairways, anchorages and other port facilities; maritime works; statutory requirements and related information; port operation procedures; safety codes for sailing and navigation skills ; marine industrial safety; licensing of local vessels, safety inspection, manning and crew certification requirements; and miscellaneous information.

Q: Please briefly describe the main contents of the "Notices to Mariners".

A: The main contents of the "Notices to Mariners" concern chart corrections.

Q: What kinds of radio equipment on board can send distress signals?

A:
i) Send the signal ••• — — — ••• (SOS) composed of the Morse code by radiotelegraphy;
ii) Say "Mayday" on a radiotelephone;
iii) Radiotelegraph alarm signal (DSC);
iv) Radiotelephone alarm signal (Inmarsat);
v) Signals from the Emergency Position Indicating Radio Beacon (EPIRB);
vi) Survival craft radar transponder.

Q: What does it mean if you see a large orange smoke signal on the horizon?

A: It means there is a vessel in distress and needs assistance.

Q: How do you send signals to distant vessels during the day to indicate that you are in distress and need assistance?

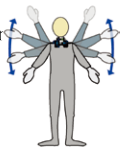
A: i) sending flames (such as tar-barrel or oil barrel etc.) on the vessel;
ii) emitting an orange smoke signal.

Q: How do you send signals to distant vessels at night to indicate that you are in distress and need assistance?

A: Ignite red hand flares or rocket parachute flare.

Q: You see someone on a vessel with his arms extended sideways and swinging up and down slowly and repeatedly. What does this action represent?

A: His vessel is in distress and needs assistance.



Q: What does it mean if you see a rocket with red star scattering across the horizon in a short interval of time?

A: It means there is a vessel in distress and needs assistance.

Q: Can you send out distress signal with the light?

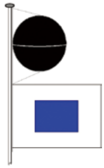
A: I can use the light to emit signals composed of the Morse code ••• — — — ••• (SOS).

Q: A vessel shows these signals. What does it mean?

A: It is in distress and needs assistance.

Q: A vessel shows these signals. What does it mean?

A: It is in distress and needs assistance.



Q: A vessel shows these signals. What does it mean?

A: It is in distress and needs assistance.

Q: You are the master of a power-driven vessel that has just collided heavily with a sailing river trade vessel off Tuen Mun Typhoon Shelter. Within how many hours after the accident should you report in writing to the Director of Marine with all the relevant information?

A: Within 24 hours.

Q: Is there any additional manning on board a vessel to be deployed when engaged in towing a glider or water skier except for the master/vessel operator?

A: Yes. The master / vessel operator of the vessel must be accompanied by another person over the age of 18 who is responsible for notifying the master / vessel operator of any accident that occurs during a water skiing.

Q: When you are steering a vessel at sea, how can you obtain the news about tropical cyclones?

A: I can get the latest news about tropical cyclones from the radio, television and the navigation safety messages of the Marine Department, or by calling the Hong Kong Observatory.

Q: Please explain the significance of the strong monsoon signal issued by the Observatory.

A: The average wind speed of a strong monsoon is now exceeding or will exceed 40 kilometers per hour. In very open areas, the monsoon wind speed may exceed 70 kilometers per hour.

Q: Which level of the Beaufort scale is equal to the average wind speed of 20 nautical miles per hour?

A: Level 5.

Q: Describes the sea conditions with the wind at level 5 of the Beaufort scale.

A: Moderate waves taking a more pronounced long form, where many white horses are formed with chances of some spray.

Q: Briefly describe the causes of "fog" in Hong Kong in spring.

A: In spring, as the water along the coast of Guangdong is still rather cool, the warm and humid air coming from the distant ocean will be cooled by the underlying water. This results in condensation of water vapour into droplets and hence the formation of fog.

Q: What is the wind direction of the winter monsoon in Hong Kong?

A: Northeast.

Q: What kind of weather will be brought by "Shi Hu Feng"?

A: Very bad weather. In addition to heavy rains and violent thunderstorms, sudden changes in wind direction and sharp increases in wind speed may occur. The speed of winds in relation thereto may reach over 100 kilometers per hour and will also be mixed with hail and tornadoes.

Q: What is the purpose of the bearing of objects in transit?

A: It can be used as a leading course for the vessel to proceed along or a position line.

Q: What is a compass bearing of the objects in transit?

A: The compass bearing of the objects in transit is a bearing taken with a compass by observing two targets onshore in a straight line.

Q: How could we determine the compass error with the aid of a compass bearing of objects in transit?

A: The compass error can directly be determined as the difference in comparing the objects' true transit bearing as measured on the chart and their compass transit bearing as read out from the compass dial card.

Q: How to choose objects onshore for determining a transit bearing?

A: Two objects onshore (e.g. lighthouses, chimneys, peaks, wire towers) in a straight line, one after the other, one taller than the other, with a moderate distance can best be used for determining a transit bearing.

Q: What does this symbol mean in chart work studies?

A: Dead Reckon position.

Q: What is Dead Reckon position?

A: Dead Reckon position is one simply based on the true course the vessel undertook and the distance it travelled (speed x sailing time).

Q: What does this symbol mean in charting?

A: Estimated position.

Q: What is Estimated position?

A: Estimated position is one the vessel would reach having regard to the course it undertook; distance it travelled as well as the effects of wind and current.

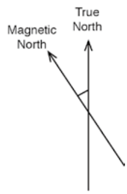
Q: What does this symbol mean in chart work studies?

A: True Course Made Good.

Q: What is True Course Made Good?

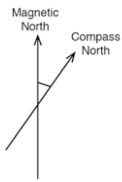
A: True Course Made Good is the sailing track of a vessel over a period of time.

Q: What is the angle formed between true north and magnetic north?



A: Variation.

Q: What is the angle formed between magnetic north and compass north?

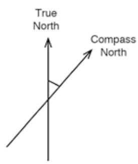


A: Deviation.

Q: Is the deviation of each vessel fixed?

A: No. The iron containing substances on board a vessel including the hull, its cargo or instrument will generate magnetic fields and affect the accuracy of a magnetic compass. The Magnitude of Deviation varies mainly with the changes of ship's head.

Q: What is the angle formed between true north and compass north?



A: Compass error.

Q: How to calculate the compass error of the vessel?

A: The compass error of the vessel can be calculated by the following methods:

a) Comparing deviation with variation;
b) Comparing the true bearing of objects in transit with their compass one;
c) Comparing the true bearing of a leading beacon ashore as given by the chart with the vessel's compass when it is proceeding along the leading course directed by this beacon.

Q: Given: Variation = 3.5° (east); Deviation = 1.5° (west). Find the compass error.

A: Compass error = Variation + / - Deviation (+ if in the same direction, - if in different directions, and the resultant direction of compass error to follow the one with larger degrees)
= 3.5° (east) - 1.5° (west)
= 2° (east)

Q: Given: Variation = 1.5° (east); Deviation = 2° (east). Find the compass error.

A: Compass error = 1.5° (east) + 2° (east)
= 3.5° (east)

Q: The compass course of a vessel is 240°. Given: Variation = 3° (east); Deviation = 2° (west). Find the true course of the vessel.

A: Compass error = Variation + / - Deviation
= 3° (east) + / - 2° (west) (+ if in the same direction, - if in different directions, and the resultant direction of compass error follows the one with larger degrees)
= 1° (east)

True course = Compass course + / - Compass error
= 240° + / - 1° (east)
= 241° (Please refer to the CADET Rule in Part A (4)(f) of Chapter 4 of this guidebook for the calculation method)

Q: The compass course of a vessel is 140°, and the compass bearing of the Waglan Lighthouse is noted to be 340°. Given: Deviation 5° (west); Variation 2° (east). Find the true bearing of the lighthouse.

A: Compass error = Deviation + / - Variation
= Deviation 5° (west) + / - 2° (east)
= 3° (west)

True bearing = Compass bearing + / - Compass error
= 340° - 3° (west)
= 337°

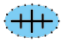
Q: What does this symbol mean on the chart?

A: The major light.

Q: What does this symbol mean on the chart?

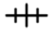
A: Dangerous reefs.

Q: What does this symbol mean on the chart?



A: A wreck with an unknown minimum depth, which is potentially dangerous to navigation.

Q: What does this symbol mean on the chart?



A: A wreck with an unknown minimum depth, but should be at more than 20 meters underwater.

Q: What does this symbol mean on the chart?

A: Dangerous line.

Q: What does this symbol mean on the chart?

A: The established direction of traffic flow.

Q: What does this symbol mean on the chart?

A: A shipwreck with unknown least depth, but the depth indicated should be sufficient for the vessel to pass over.

Q: What does this symbol mean on the chart?

A: Submarine cable.

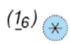
Q: What does this symbol mean on the chart?

A: Non-dangerous reef (known depth).

Q: What does this symbol mean on the chart?

A: Rock (height above high water mark).

Q: What does this symbol mean on the chart?



A: Rock (height above chart datum).

Q: What does this symbol mean on the chart?

A: Remains of a wreck inside a foul area which is not dangerous to navigation, but anchoring, trawling, etc. should be avoided.

Q: In determining the location of the vessel by observing the cross bearing of two objects onshore, what is the best angle between the bearings?

A: The best angle between two bearings is close to 90°.

Q: In determining the location of the vessel by observing the cross bearing of three objects onshore, what is the best angle between the bearings?

A: The best angle between two bearings is close to 60°.

Q: What is one nautical mile equal to?

A: It is equal to 6,080 feet, 1,853 meters or 1.853 kilometers.

Q: How is the distance between two points measured on the chart?

A: Subtend the arms of a divider on the two points and place the divider, without altering the spread of the arms, on the scale of latitude on either the left or right side of the chart, to directly read out the distance in units of nautical miles.

Q: What information can the compass rose on the chart provide?

A: (1) The value of variation of the waters near the center of the compass rose and the changes of the variation every year;
(2) True bearings from 0° to 360°.

Q: What is one fathom equal to?

A: Fathom is the unit for measuring water depth. One fathom is equal to 6 feet or 1.829 meters.

Q: What does 5_9 mean if it is shown as water depth on the chart?

A: 5.9 meters.

Q: What does this symbol mean on the chart?

A: Rock (height above chart datum).

Q: What does this symbol mean on the chart?

A: Rock (height above high water mark).

Q: What does this symbol mean on the chart?

A: A shipwreck with a known least depth (swept by a wire drag or diver).

Q: Try to list two types of seabed with nature suitable for anchoring vessels.

A: M (mud) and S/M (double substrates, such as the mud under sands) seabeds are suitable for anchoring vessels.

Q: When your vessel is proceeding on a true course of 080°, you see a target at 6 points on the starboard bow. Find the true bearing of the target.

A: As a circle has a total of 360º or 32 points; each point is 11¼º. The angle from straight ahead to the starboard beam is 90°.

The relative bearing of the target = 11¼º x 6
= 67.5º

The true bearing of the target = true course +/- relative bearing of the target
= 080º + 67.5º
= 147.5º

Q: The direction of your ship's head is northeast, and there is a target on the starboard beam of your vessel. Find the compass cardinal bearing of the target.

A: The compass cardinal bearing of the target = Direction of ship's head +/- Relative bearing of the target
= "Northeast" + 090º
= "Southeast".

Q: The direction of your ship's head is the northeast, and there is a vessel on the port beam of your vessel. Find the compass cardinal bearing of the target.

A: The compass cardinal bearing of the target = Direction of ship's head +/- Relative bearing of the target
= "Northeast" - 090º
= "Northwest".

Q: How many compass points are there on the Compass Card?

A: 32 points.

Q: What is the second compass point from north to west on the Compass Card?

A: North-northwest (NNW).

Q: The direction of your ship's head is south-southeast (SSE), and a passenger falls into the sea. What course should you alter for searching for the passenger in the sea?

A: I should turn immediately and steer in the opposite direction of the original course. The opposite direction of south-southeast (SSE) is north-northwest (NNW).

Q: The height of the Waglan Lighthouse as stated on the chart is 68 meters. Where is this height measured from?

A: The height of the lighthouse is measured from the high water mark.

Q: What is chart datum?

A: It is the level to which soundings or tide heights are referenced.

Q: How many low tides are there in Hong Kong every day in general?

A: Two.

Q: What does "short blast" mean?

A: It means a sound signal emitted on whistle lasting for about one second.

Q: What does "prolonged blast" mean?

A: It means a sound signal emitted on whistle lasting for four to six seconds.

Q: Your vessel is sailing in the fog, and you see another vessel crossing from your starboard bow. When you turn to starboard to avoid collision, what blast signal should you give?

A: One short blast.

Q: When vessel gives five short blasts, what does it mean?

A: It suspects whether sufficient action is being taken by the other vessel to avoid collision.

Q: According to Rule 10 of the International Regulations for Preventing Collisions at Sea, which types of vessels shall not impede the safe passage of vessels using a traffic lane?

A: (1) A sailing vessel or a vessel of less than 20 meters in length shall not impede the safe passage of a power driven vessel following a traffic lane;

(2) A vessel engaged in fishing shall not impede the passage of any vessel following a traffic lane.

Q: How should vessels cross traffic lanes?

A: When crossing traffic lanes, the direction of the ship's head must be at right angle to the general direction of traffic flow.

Q: In case of good visibility, a vessel intends to overtake another vessel in a narrow fairway. What sound signal can be issued to indicate her intention?

A: (1) Two prolonged blasts followed by one short blast mean "I intend to overtake you on your starboard side"; or

(2) Two prolonged blasts followed by two short blasts mean "I intend to overtake you on your port side".

Q: Which side of the fairway should a vessel get close to and pass by when it is travelling along a narrow channel or fairway?

A: It shall keep as close to the outer boundary of the channel or fairway at its starboard side as is safe and practicable.

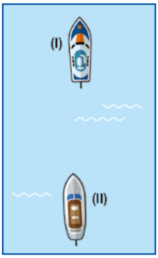
Q: When your vessel is approaching the corner of a fairway, other vessels may be obscured by intervening obstacles. What blast signal should you give?

A: A prolonged blast.

Q: In case of good visibility, a vessel on the starboard quarter of your vessel gives two long blasts followed by two short blasts. If you do not understand her intention, how should you react?

A: Immediately send 5 short blasts to indicate that you could not understand her intention.

Q: (I) and (II) are power-driven vessel that are navigating in the sea with good visibility. (II) runs faster and is getting close to (I), and intends to overtake (I). In this case, does (II) need to give any sound signal for her intention to overtake?



A: No.

Q: Is "safe speed" only applicable in fog?

A: No. Every vessel must proceed at a safe speed at all times.

Q: What does the word "underway" mean?

A: It means the vessel is not at anchor, or made fast to the shore, or aground.

Q: What are the conditions to be considered as "restricted visibility"?

A: Any condition in which the visibility is restricted by fog, mist, snow, heavy rainstorms, sandstorm or any other similar causes.

Q: What are the factors in determining a safe speed for a vessel without radars?

A:
- i) the state of visibility;
- ii) the traffic density including concentrations of fishing vessels or any other vessels;
- iii) the manoeuvrability of the vessel with special reference to stopping distance and turning ability in the prevailing conditions;
- iv) at night the presence of background light such as from shore lights or from back scatter of her own lights;
- v) the state of wind, wave and current, and the proximity of navigational hazards;
- vi) the draught in relation to the available depth of water.

Q: What is "safe speed"?

A: Every vessel shall at all times proceed at a safe speed so that she can take proper and effective action to avoid collision and be stopped within a distance appropriate to the prevailing circumstances and conditions.

Q: When vessels are in sight of one another, how to determine whether there is a risk of collision with another vessel?

A: Such risk shall be deemed to exist if the compass bearing of an approaching vessel does not appreciably change and the distance between the two vessels is getting shorter.

Q: Please describe the harmful effects of continuous and slight change of course / speed when taking action to avoid a collision.

A: If you change course / speed continuously and slightly, it is not easy for other vessels to perceive your changes visually or by radar.

Q: What is the most effective action to avoid a close quarters situation when there is sufficient room for maneuvering the vessel?

A: The timely and drastic change of course without causing another close quarters situation is the most effective action to avoid a close quarters situation.

Q: Under what circumstances are two vessels classified as "in sight of one another"?

A: Vessels are in sight of one another only when one vessel can be visually observed from another.

Q: When two vessels are approaching each other, and the stand-on vessel discovers that it is impossible to avoid collision through action by the give-way vessel alone, what action should be taken by the stand-on vessel?

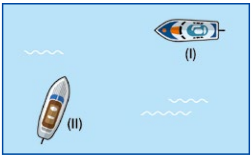
A: The stand-on vessel must take such actions as will best aid to avoid collision.

Q: (I) and (II) are power-driven vessels underway. (II) notices that the compass bearing of (I) remains unchanged. Which one is the stand-on vessel?

A: (II) is the stand-on vessel.

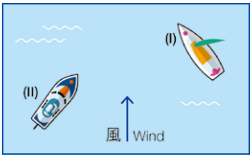
Q: (I) and (II) are power-driven vessels underway. What actions should be taken by (II) when they are approaching each other with a risk of collision?

A: (II) should keep out of the way from (I), and immediately give a short blast and alter course to starboard.



Q: (I) is a sailing vessel, and (II) is a trawling vessel. When the two vessels are approaching each other with a risk of collision, which one should be the give-way vessel?

A: (I) should be the give-way vessel, because (II) is a trawler being engaged in fishing.

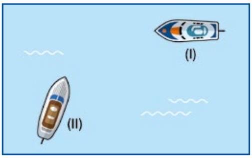


Q: (I) and (II) are both power-driven vessels. What actions should be taken when they meet in the opposite course with a risk of collision?

A: Each vessel should give a short blast and alter course to starboard.

Q: (I) and (II) are both power-driven vessels. What actions should (II) take when (I) gives five short blasts?

A: Give a short blast and alter course to starboard.



Q: When two vessels are approaching each other with a risk of collision, under what circumstances can the stand-on vessel take actions to avoid collision?

A: As soon as it becomes apparent to the stand-on vessel that:

i) the vessel required to keep out of the way is not taking appropriate action in compliance with the rules on prevention of collisions;

ii) it is impossible to avoid collision through action by the give-way vessel alone, then it must take such actions as will best aid to avoid collision.

Q: What kind of vessels would exhibit these shapes?

A: Vessels not under command.

Q: What kind of vessels would exhibit these shapes?

A: Vessels with restricted ability to manoeuvre.

Q: What kind of vessels would exhibit this shape?

A: i) When the towing length exceeds 200 meters, both the tug and the tow should exhibit this shape where it can best be seen;

ii) A partly submerged vessel or object being towed should exhibit this shape near its after end.

Q: What kind of vessels would exhibit these shapes?

A: Vessels with restricted ability to manoeuvre, with the two black balls in a vertical line to indicate the side on which the obstruction exists.

Q: What kind of vessels would exhibit this shape?

A: Vessels proceeding under sail when also being propelled by machinery.

Q: What kind of vessels would exhibit this shape?

A: Vessels constrained by their draught.

Q: What kind of vessels would exhibit this shape?

A: Vessels engaged in fishing (both trawler and non-trawler vessels have to exhibit this shape).

Q: What kind of vessels would exhibit this shape?

A: Vessels engaged in fishing (other than trawling), indicating that its outlying gear is extending more than 150 meters horizontally from the vessel in the direction as indicated by the cone.

Q: What kind of vessels would exhibit this shape?

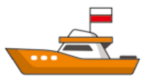
A: Vessels at anchor.

Q: What kind of vessels would exhibit this shape?

A: Vessels aground.

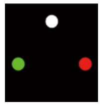
Q: What kind of vessels would exhibit this shape?

A: Pilot vessels.



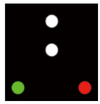
Q: What kind of vessels would exhibit this light?

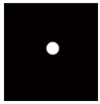
A: Power driven vessels of less than 50 meters in length being seen at their ship's head.



Q: What kind of vessels would exhibit these lights?

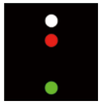
A: Power driven vessels of any length, being seen at their ships' head; or a tug (less than 50 m in length) engaged in a towing operation with the length of tow not more than 200 meters, being seen at their ships' head.





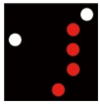
Q: What kind of vessels would exhibit this light?

A: The stern light of a vessel underway; the all-round light of a vessel at anchor less than 50 meters in length; the all-round white light of a power driven vessel of less than 7 meters in length with a maximum speed of 7 knots; the white light of a yacht under oars of less than 7 meters in length.



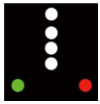
Q: What kind of vessels would exhibit these lights?

A: Vessels engaged on pilotage duty, being seen on their starboard side.



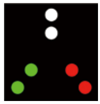
Q: What kind of vessels would exhibit these lights?

A: Vessels constrained by their draught, being seen on their port side.



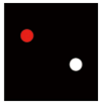
Q: What kind of vessels would exhibit these lights?

A: Tugs engaged in a towing operation with the length of tow more than 200 meters, being seen at their ships' head.



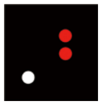
Q: What kind of vessels would exhibit these lights?

A: Power driven vessels pushing another vessel, being seen at their ships' head.



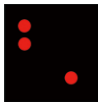
Q: What kind of vessels would exhibit these lights?

A: Vessels carrying dangerous goods at anchor or underway, being seen at its stern.



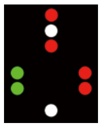
Q: What kind of vessels would exhibit these lights?

A: A vessel not under command being seen at their stern, or a vessel aground.



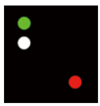
Q: What kind of vessels would exhibit these lights?

A: Vessels not under command, being seen on their port side.



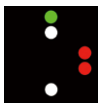
Q: What kind of vessels would exhibit these lights?

A: Vessels with restricted ability to manoeuvre, making way through water and being seen from stern with the obstruction existing on their starboard side.



Q: What kind of vessels would exhibit these lights?

A: Vessels engaged in trawling, being seen on their port side.

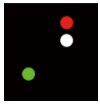


Q: What kind of vessels would exhibit these lights?

A: Vessels engaged in trawling underway and being seen from stern, with their nets come fast on an obstruction.

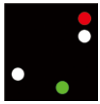
Q: What kind of vessels would exhibit these lights?

A: Vessels engaged in fishing, being seen on their starboard side.



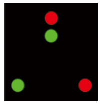
Q: What kind of vessels would exhibit these lights?

A: Vessels engaged in fishing (other than trawling), being seen on their starboard side with an all-round white light to indicate the direction the vessel's outlying gear is extending for more than 150 meters horizontally from the vessel.



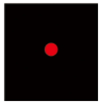
Q: What kind of vessels would exhibit these lights?

A: Sailing vessels underway, being seen at their ships' head. (The two red and green all-round lights at masthead are not a compulsory installation).



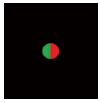
Q: What kind of vessels would exhibit this light?

A: Sailing vessels underway, being seen on their port side.



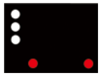
Q: What kind of vessels would exhibit these lights?

A: Sailing vessels underway with their length of less than 20 meters, being seen at their ships' head.



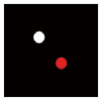
Q: When you are steering a power driven vessel at sea, you see these lights at five points on your starboard bow, and they are getting closer without any change in bearing. What actions should be taken?

A: Sound a short blast and alter course to starboard and pass by the stern of the tug, or immediately stop/slow down my vessel and allow the tug to cross ahead of my vessel.



Q: When you are steering a power driven vessel at sea, you see these lights at four points on your starboard bow, and they are getting closer without any change in the bearing. What actions should be taken?

A: Sound a short blast and alter course to starboard, or immediately stop/slow down my vessel.

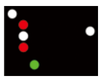


Q: When you are steering a power driven vessel at sea, you see these lights at 30 degrees on your port bow, and their bearings on the compass are reducing. What actions should be taken?

A: Maintain the speed and course.

Q: When you are steering a power driven vessel at sea, you see these lights at 30 degrees on your port bow, and they are getting closer without significant change in their compass bearings. What actions should be taken?

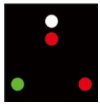
A: Sound two short blasts and alter course to port in order to stay away from that vessel.



Q: When you are steering a power driven vessel at sea, you see these lights at 30 degrees on your port bow, and they are getting closer without significant change in their compass bearings. What actions should be taken?

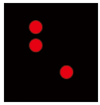
A: Immediately slow down or stop the vessel and allow that vessel to cross ahead of my vessel.

Q: When you are steering a power driven vessel at sea, you see these lights at your stern, and they are getting closer. What actions should be taken?



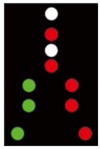
A: Maintain the course and speed and continue with the passage.

Q: When you are steering a power driven vessel at sea, you see these lights at one point on your port bow. What actions should be taken?



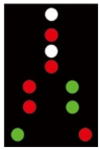
A: Sound a short blast and alter course to starboard in order to stay away from that vessel.

Q: When you are steering a power driven vessel at sea, you see these lights at 5 degrees on your port bow at a distance of 1 nautical mile. These lights are getting closer without any change in the compass bearing. What actions should be taken?



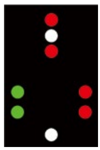
A: Sound two short blasts and alter course to port.

Q: When you are steering a power driven vessel at sea, you see these lights at 5 degrees on your starboard bow at a distance of 1 nautical mile. These lights are getting closer without any change in the compass bearing. What actions should be taken?



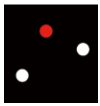
A: Sound a short blast and alter course to starboard.

Q: When you are steering a power driven vessel at sea, you see these lights at 10 degrees on your port bow. These lights are getting closer without any change in the compass bearing. What actions should be taken?



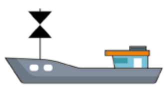
A: Sound two short blasts and alter course to port.

Q: When you are steering a power driven vessel at sea, you see these lights at two points on your port bow. What actions should be taken in order to pass by the stern of this vessel?



A: This is a vessel at anchor loaded with dangerous goods. I will sound two short blasts and alter course to port in order to pass by the stern of this vessel.

Q: When you are steering a motorized vessel, you see this vessel located at 4 points on your starboard bow. This vessel is getting closer to you while its bearing remains unchanged. What would you do?

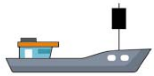


A: Sound a short blast then alter course to starboard, or stop/slow down my vessel immediately.

Q: When you are steering a motorized vessel and notice another vessel at 3 points on your starboard bow. This vessel is getting closer while its bearing remains unchanged. What would you do?

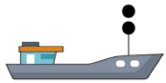
A: Sound a short blast and alter course to starboard side or stop/slow down my vessel immediately.

Q: When you are steering a motorized vessel, you see this vessel located at 4 points on your port bow. This vessel is getting closer while its bearing remains unchanged. What would you do?



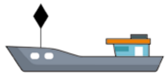
A: Stop/slow down my vessel immediately and let it pass ahead of my vessel.

Q: When you are steering a motorized vessel, you see this vessel located at 4 points on your port bow. This vessel is getting closer while its bearing remains unchanged. What would you do?



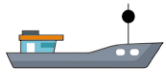
A: Sound two short blasts and alter course to port side in order to stay away from that vessel.

Q: When you are steering a motorized vessel, you see this vessel at 3 points on your starboard bow towing another vessel. Both vessels are slowly getting closer while their bearings remain unchanged. What would you do?



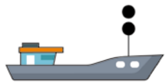
A: Sound a short blast and alter course to starboard; or stop/slow down my vessel immediately.

Q: When you are steering a motorized vessel, you see this vessel located at 2 points on your port bow. What would you do in order to pass by its stern?



A: This is an anchored vessel. I will sound 2 short blasts, alter course to port and pass by its stern.

Q: When you are steering a motorized vessel, you see this vessel at one point forward of your port beam and drawing slowly astern. What would you do?

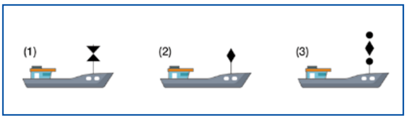


A: Maintain my vessel's course and speed.

Q: When you are steering a motorized vessel, you see this vessel at 20° on your port bow. This vessel is getting closer while its bearing remains unchanged. What would you do?

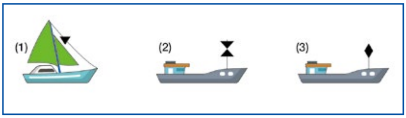
A: Sound 2 short blasts and alter course to port.

Q: When two vessels are visible to each other with a risk of collision, which vessel(s) in the diagram should a sailing vessel give way to?



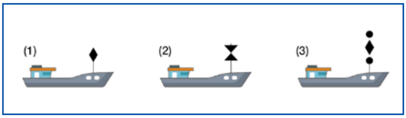
A: A sailing vessel should give way to the fishing vessel in (1), and to the vessel with restricted ability to manoeuvre in (3).

Q: When vessels in sight of one another with a risk of collision, a motorized vessel underway must give way to which vessel(s) as shown in the diagram?



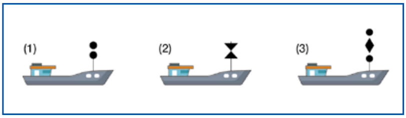
A: A motorized vessel underway must give way to the fishing vessel in (2).

Q: When vessels in sight of one another with a risk of collision, a motorized vessel underway must give way to which vessel(s) as shown in the diagram?



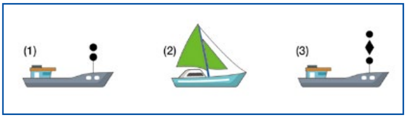
A: A motorized vessel underway must give way to the fishing vessel in (2) and to the vessel restricted in its ability to manoeuvre in (3).

Q: When vessels in sight of one another with a risk of collision, a sailing vessel underway must give way to which vessel(s) as shown in the diagram?



A: A sailing vessel underway must give way to the vessel not under command in (1), to the fishing vessel in (2) and to the vessel restricted in its ability to manoeuvre in (3).

Q: When vessels in sight of one another with a risk of collision, a fishing vessel underway must give way to which vessel(s) as shown in the diagram?



A: A fishing vessel underway must give way to the vessel not under command in (1) and to the vessel restricted in its ability to manoeuvre in (3).

Q: What is the length of vessels that are not required to exhibit the lights and shapes of those not under command or restricted in its ability to manoeuvre?

A: Vessels of not more than 12m in length, which is not under command or restricted in its ability to manoeuvre (except for those engaged in diving operations), are not required to exhibit the statutory lights and shapes.

Q: Which kinds of vessels are not required to exhibit the anchor light and shape when anchoring?

A:
(i) vessels of not more than 7m in length, when at anchor, not in a narrow channel, fairway or anchorage, or where other vessel normally navigate;
(ii) fishing vessels; and
(iii) vessels engaged in dredging or underwater operations.

Q: Under what circumstances, could a vessel use the three-colour combined lantern as a replacement for sidelights and sternlight?

A: A sailing vessel of not more than 20 m in length which is underway could use a combined lantern of two sidelights and one sternlight carried at the top of the mast in lieu.

Q: If a motorized vessel of not more than 12m in length underway does not have a masthead light, what kind of lights should it exhibit?

A: It could exhibit an all-round white light and two sidelights.

Q: Is it true that while underway, a motorized vessel of not more than 7m in length does not need to exhibit any lights during night navigation?

A: No. It shall exhibit an all-round white light.

Q: What is the specification of the sidelight inboard screen of a vessel of not more than 20m in length?

A: The sidelight inboard screen must be painted in matt black.

Q: What is the required colour for the inboard screen of the starboard sidelight?

A: It should be painted in matt black.

Q: What is the minimum distance that the light intensity of a masthead light should be visible for a vessel of not more than 12m in length?

A: At least 2 sea miles.

Q: What is "towing light"?

A: A yellow light that has the same characteristics as the sternlight.

Q: What is the arc of the horizon of a yellow "towing light"?

A: 135°. The light should be shown 67.5° from right aft to each side of the vessel.

Q: What is the arc of the horizon of the "masthead light" of a tow?

A: 225°. The light should be shown from right ahead to 22.5° abaft the beam on either side of the vessel.

Q: What is the arc of the horizon of the "anchor light"?

A: The light should be shown over an arc of the horizon of 360°.

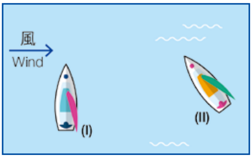
Q: What is the arc of the horizon of the "sidelights"?

A: 112.5°. The light should be shown from right ahead to 22.5° abaft the beam on its respective side.

Q: What is the arc of the horizon of the "sternlight"?

A: 135°. The light should be shown 67.5° from right aft to each side of the vessel.

Q: Two sailing vessels meet one another as shown in the diagram. If there is a risk of collision, which vessel is the give-way vessel?



A: (I) is to windward. It must give way to the vessel which is to leeward.

Q: When vessels in sight of one another are approaching each other and from any cause either vessel fails to understand the intentions or actions of the other, or is in doubt whether sufficient action is being taken by the other to avoid collision, what actions could be taken by the vessel in doubt to indicate its doubt?

A: The vessel in doubt shall immediately indicate such doubt by giving at least five short and rapid blasts on the whistle.

Q: When is your vessel deemed to be overtaking another vessel?

A: When my vessel is coming up with another vessel from a direction more than 22.5°abaft its beam, my vessel is deemed to be overtaking (at night you would be able to see only the sternlight of that vessel but neither of its sidelights).

Q: In restricted visibility, what kind of sound signal should be given by a sailing vessel underway?

A: One prolonged blast followed by two short blasts should be sounded at intervals of not more than two minutes.

Q: In restricted visibility, what kind of sound signal should be given by a sailing vessel underway but stopped and not making way through the water?

A: One prolonged blast followed by two short blasts should be sounded at intervals of not more than two minutes.

Q: In restricted visibility, what kind of sound signal should be given by a jetfoil vessel underway but stopped and not making way through the water?

A: Two prolonged blasts should be sounded at intervals of not more than two minutes.

Q: In restricted visibility, what kind of sound signal should be given by a jetfoil vessel underway?

A: One prolonged blast should be sounded at intervals of not more than two minutes.

Q: In restricted visibility, what kind of sound signal should be given by a non-fishing motorized vessel underway?

A: One prolonged blast should be sounded at intervals of not more than two minutes.

Q: In restricted visibility, what kind of sound signal should be given by a non-fishing motorized vessel stopped and not making way through the water?

A: Two prolonged blasts should be sounded at intervals of not more than two minutes.

Q: In restricted visibility, which kinds of vessels will sound one prolonged blast followed by two short blasts?

A: Vessels not under command, vessels restricted in its ability to manoeuvre, vessels constrained by its draught, sailing vessels, fishing vessels and vessels engaged in towing or pushing other vessels shall sound one prolonged blast followed by two short blasts at intervals of not more than two minutes.

Q: In restricted visibility, what kind of sound signal should be given by a motorized vessel underway that is not on pilotage duty?

A: One prolonged blast should be sounded at intervals of not more than two minutes.

Q: When a pilot vessel on pilotage duty is navigating in the fog outside Lei Yue Mun, if its engine is put at neutral gear and it is drifting, what kind of sound signal should be given?

A: Two prolonged blasts followed by four short blasts should be sounded at intervals of not more than two minutes.

Q: When a pilot vessel on pilotage duty is navigating in the fog in the vicinity of Tolo Harbour, what kind of sound signal should be given on the way?

A: One prolonged blast followed by four short blasts should be sounded at intervals of not more than two minutes.

Q: What kind of sound signal should be given by a motorized vessel of less than 12m in length equipped with no whistle sounding apparatus navigating in the fog?

A: Some other efficient sound signals at intervals of not more than two minutes.

Q: In poor visibility, what kind of sound signal should be given by a tug boat underway that has stopped and is no longer moving forward?

A: One prolonged blast followed by two short blasts should be sounded at intervals of not more than two minutes.

Q: In poor visibility, what kind of sound signal should be given by a manned vessel which is under tow as the last vessel of the tow?

A: One prolonged blast followed by three short blasts should be sounded at intervals of not more than two minutes. When practicable, this signal shall be made immediately after the signal made by the towing vessel.

Q: In poor visibility, what kind of sound signal should be given by a vessel constrained by its draught underway when it stops and no longer moves forward?

A: One prolonged blast followed by two short blasts should be sounded at intervals of not more than two minutes.

Q: In poor visibility, what kind of sound signal should be given by a vessel engaged in submarine pipeline laying at anchor?

A: One prolonged blast followed by two short blasts should be sounded at intervals of not more than two minutes.

Q: In poor visibility, what kind of sound signal should be given by a vessel restricted in its ability to manoeuvre when underway?

A: One prolonged blast followed by two short blasts should be sounded at intervals of not more than two minutes.

Q: In poor visibility, what kind of sound signal should be given by a vessel underway but not under command?

A: One prolonged blast followed by two short blasts should be sounded at intervals of not more than two minutes.

Q: In poor visibility, what kind of sound signal should be given by a vessel aground that is around 50m in length?

A: The bell should be rung rapidly for about 5 seconds at intervals of not more than one minute.
In addition, give three separate and distinct strokes on the bell right before and after the rapid ringing of the bell.

Q: In the fog, what kind of sound signal should be given by a vessel at anchor to give warning of its position to approaching vessels in addition to the bell and gong sound signals?

A: One short, one prolonged and one short blast on whistle should be given to give warning of its position and of the possibility of collision to an approaching vessel.

Q: In the fog, you have heard a rapid bell ringing for 5 seconds followed by 5 seconds of rapid gonging. What does it mean?

A: A vessel of 100m or more than 100m in length is at anchor.

Q: In the fog, a vessel at anchor engaged in picking up a navigation mark, what is its sound signal?

A: One prolonged blast followed by two short blasts should be sounded at intervals of not more than two minutes.

Q: In the fog, what kind of sound signal should be given by a fishing vessel at anchor?

A: One prolonged blast followed by two short blasts should be sounded at intervals of not more than two minutes.

Q: A vessel navigating from Pun Shan Shek Anchorage to Tuen Mun Typhoon Shelter has encountered thick fog in the way and the visibility is lower than 0.2 sea miles. What actions should be taken by the master of the vessel?

A:
i) immediately slow down and proceed at a safe speed with caution;
ii) post more crew for look-out and send crew to prepare for anchoring, and drop the anchor in case of emergency;
iii) sound one prolonged blast at intervals not more than two minutes;
iv) switch on the navigation lights;
v) reduce the noise on board;
vi) listen to the weather report from the Hong Kong Observatory and the visibility report from the Vessel Traffic Centre.

Q: A small wooden boat is proceeding in the fog, and what measures could it take in order that other vessels with radar can detect it?

A: Hang up a radar reflector, metal objects or wet canvas high in the boat.

Q: When navigating in thick fog, a sound signal is heard at forward of the starboard abeam from another vessel, what action(s) should be taken?

A: Slow down the speed immediately and sound one prolonged blast; or stop the vessel immediately and sound two prolonged blasts.

Q: When navigating in thick fog, a prolonged blast is heard at 45° on the port bow. What action(s) should be taken?

A: Slow down the speed immediately and sound one prolonged blast or stop the vessel immediately and sound two prolonged blasts.

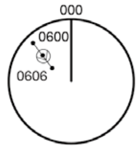
Q: You are steering a motorized vessel from Repulse Bay to Cheung Chau in the fog, and you hear a prolonged blast from right ahead. What action(s) should you take?

A: Slow down the speed immediately and sound one prolonged blast; or stop the vessel immediately and sound two prolonged blasts.

Q: In thick fog, when should a vessel equipped with radar take action to avoid collision with another vessel?

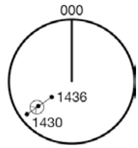
A: When the radar detects that there is another vessel in the vicinity and risk of collision is confirmed, then action should be taken to avoid collision.

Q: In thick fog, the radar screen onboard is adjusted to the 2 miles range. The radar plotting shows that you are having a risk of collision with the vessel on the port bow, what action(s) should you take to avoid collision?



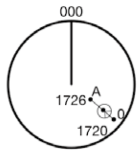
A: Take a substantial alteration of course to starboard.

Q: In thick fog, the radar screen onboard is adjusted to the 2 miles range. The radar plotting shows that you are having a risk of collision with the vessel on the port quarter, what action(s) should you take to avoid collision?



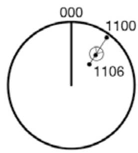
A: Take a substantial alteration of course to starboard.

Q: In thick fog, the radar screen onboard is adjusted to the 2 miles range. The radar plotting shows that you are having a risk of collision with the vessel on the starboard quarter, what action(s) should you take to avoid collision?



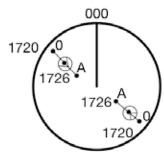
A: Take a substantial alteration of course to port.

Q: In thick fog, the radar screen onboard is adjusted to the 2 miles range. The radar plotting shows that you are having a risk of collision with the vessel on the starboard bow, what action(s) should you take to avoid collision?



A: Take a substantial alteration of course to starboard.

Q: In thick fog, the radar screen onboard is adjusted to the 2 miles range. The radar plotting shows that you are having risks of collision with a vessel on the port bow and another vessel on the starboard quarter, what action(s) should you take to avoid collision?



A: Stop the vessel immediately.

Q: What is the purpose of maintaining a proper look-out?

A: To make a thorough appraisal of the situation and of the risk of collision.

Q: The radar bearing of a buoy is "Starboard 35°". When your vessel is running on020° true course, what is the true bearing of the buoy?

A: 055°.

Q: The radar bearing of a buoy is "Port 60°". When your vessel is proceeding on 030° true course, what is the true bearing of the buoy?

A: 330°.

Q: What is a left-handed propeller?

A: When the engine is pushing ahead, the propeller could be seen turning anti-clockwise from astern.

Q: What is a right-handed propeller?

A: When the engine is pushing ahead, the propeller could be seen turning clockwise from astern.

Q: In the absence of wind and current, in which direction will a twin-screw vessel equipped with outward turning propellers and its rudder being in midship position move?

A: The vessel will move forward in a straight line.

Q: Your vessel is equipped with a right-handed propeller. From still to astern, in which direction will the effect of transverse thrust push the stern to?

A: It will push the stern to the port side.

Q: A vessel equipped with a single right-handed propeller is moving from still to astern. Which direction will the effect of transverse thrust push the bow to?

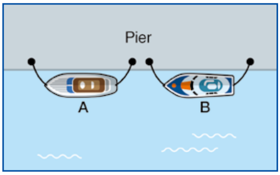
A: It will push the bow to the starboard side.

Q: When is the effect of transverse thrust of the propeller most apparent?

A: At the start of going astern from a still situation.

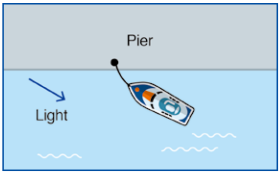
Q: Without any influence of the wind and the tide, how should we cast a twin-screw (outward-turning) vessel B off the berth as shown in the diagram?

A: Firstly, let go the stern line, then work the port engine ahead, and the starboard engine astern at the same time.



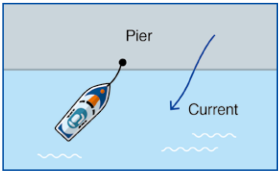
Q: The vessel in the diagram is equipped with a left-handed propeller. What is the easiest way to push the vessel's stern to the berth?

A: Put the engine astern.



Q: The pier in the diagram is built on an open pontoon. The head line of the vessel is already made fast tightly. The current is flowing pass the pier at a speed of 1 mile per hour, which makes the vessel to lie at a 40 degree angle with the pier, what is the first step to berth the vessel?

A: First of all, make fast a forward spring line to the pier, then work the engine ahead.



Q: When the current is flowing to the south, what course should you take to approach the mooring buoy?

A: A northerly course.

Q: Other than for mooring, what is the use of the anchor?

A: If the depth of the water is appropriate, the anchor could be used for making an emergency stop.

Q: What is the advantage for berthing a vessel or mooring it to a buoy against the wind and current?

A: It could increase the control of the vessel, making it easier to steer and to stop the vessel.

Q: When there are big waves, how should you control the vessel?

A: Slow down the speed and stem against the waves at small angles.

Q: How to ensure a life jacket to be suitable for children?

A: The life jacket should have a label "suitable for children" on it.

Q: If the vessel is equipped with inflatable life jackets, and you have to wear it, when is the most appropriate time to inflate it?

A: It should be inflated after everyone has arrived at the assembly point onboard.

Q: In what document(s) onboard could you find the information on number of life jackets that should be carried by a local vessel?

A: According to The Certificate of Survey of the vessel.

Q: What signaling tool(s) should be fastened to a life jacket bought from the market?

A: A whistle.

Q: Could you use the whistle to send distress signals?

A: Yes. Method i) Send continuous audible signal

Method ii) Send Morse code signal: ••• ——— ••• (SOS)

Q: What safety measures should be taken by the crew before going into the water to save a person?

A: He/she must wear a life jacket first of all and tie up a safety line connected to the vessel before entering the water.

Q: What safety measures should be taken by the crew to be sent for checking the damage of the vessel over board?

A: He/she must wear a life jacket and tie up a safety line. Other crew(s) must be posted on deck to oversee him/her in water.

Q: If the vessel will be left unattended for a few days, how should you handle the liquefied petroleum gas (LPG) used for cooking purposes onboard?

A: I will detach the regulator on the top of the LPG cylinders, and put the LPG cylinders in a well ventilated place away from direct sunlight and all heat sources.

Q: How should a LPG hose be tested for leakage?

A: Soapy water could be rubbed on the LPG hose for testing its leak-proof condition, but never test with open fire.

Q: What is the danger of using electrical fan to blow out the LPG inside the cabin?

A: Dangers of explosion.

Q: What is the best way to remove the LPG accumulated in the cabin?

A: Open the doors and windows on the vessel and swing blankets or cardboards vigorously to blow out the LPG.

Q: On knowing that a storm is coming soon, what instructions should be given to the crews by the pleasure vessel operator?

A:
1. Strengthen up the water-tight measures;
2. Keep all the water outlets and draining channels on deck clear;
3. Secure up all the loose items onboard;
4. Prevent any possible shifting of the centre of gravity of the vessel;
5. Enhance steps for ensuring the seaworthiness, e.g. to protect the main engine, and especially the steering gear;
6. Evaluate the influence of the weather to the vessel and adopt appropriate measures;
7. For safety, find an appropriate shelter as soon as possible;
8. Keep in touch with the contact persons ashore.

Q: If it is not possible to close to a person in water or send a crew in water to approach him, how can we rescue that person?

A: Throw a lifebuoy tied with a rope to that person.

Q: When you see a person floating cum sinking in the sea in the vicinity of a vessel that has stopped moving forward, what action(s) will you take?

A: Approach that vessel slowly, check what has happened and provide assistance as needed.

Q: When you see a person fell into the sea at the stern, what should you do first?

A: Throw a lifebuoy to him.

Q: For a person fallen into the sea, how do you use audio signal to alert other vessels?

A: Sounding three prolonged blasts.

Q: If you find that the propeller is fouled by floating debris in the water, how could you remove the debris?

A: Drive the main engine forward and astern several times.

Q: If your vessel collides with a raft and there is no person on the raft, what action(s) should you take?

A: Check the damage to the vessel immediately, ascertain if any crew member has been injured, and report to the Marine Department.

Q: If your vessel runs aground at a shallow shoal, the tide is ebbing quickly, and the vessel is listing rapidly, what action(s) should you take?

A: Ensure that all people onboard wear a life jacket and leave the stranded vessel as soon as possible.

Q: If your vessel collides vigorously with a large log, what action will you take first?

A: Check the ship body for damages and check whether any person is injured onboard.

Q: If your vessel collides with a reef at full speed, what first action will you take to prevent further damage to the main engine of the vessel?

A: Turn off the engine immediately.

Q: If your vessel collides with another vessel, taking the safety of the vessel and the crew into consideration, what will you do immediately?

A: Check the damage on the ship body and if any person onboard is injured.

Q: If your vessel springs a crack and takes in a large amount of water, what method could you use for repair to lessen the ingress of water?

A: Make emergency repair for the hull damage and pump out the flooding water in tank(s).

Q: If your vessel collides with another vessel, with the stem of the other boat embedded in your ship body, and sea water keeps penetrating your vessel, what action(s) should you take to protect the safety of your passengers?

A: All passengers should wear life jackets immediately and transit to the other vessel.

Q: When your vessel is navigating in shallow water area, the only propeller drops off suddenly, and the wind speed is 13 miles per hour, what action(s) will you take?

A: Turn off the engine immediately and drop the anchor.

Q: If there is a fire at the bow during navigation, how should you drive your vessel?

A: Alter course and steer it downwind.

Q: If there are 5 crew members and 50 passengers onboard, how should you handle a serious collision accident?

A:
1. Stop the vessel immediately, inform the crew and passengers and check if any person is injured;
2. Use VHF to notify the Marine Department or call the emergency number 999 to seek assistance from the Police and the Fire Services Department;
3. Plug the leak at the damaged parts and pump out the flood water if any in the cabin using a pump;
4. If the intake of water is substantial, immediately remind the passengers to wear life jackets and prepare to escape;
5. Ask the other collided vessel if any assistance is needed.

Q: When you hear another vessel is giving out a sound signal in the form of continuous blasts, what action(s) will you take?

A: This vessel is giving out a distress signal. If it is safe and practicable, I should approach this vessel and provide assistance immediately.

Q: When you see another vessel giving out distress signal, what action(s) will you take?

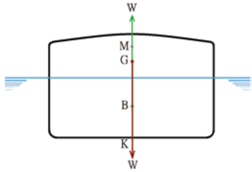
A: If it is safe and practicable, I should approach this vessel and provide assistance.

Q: If there are 5 crew members and 20 passengers onboard, how should you handle a fire in the cabin?

A:
1. At the outbreak of fire, sound the alarm bell immediately and advise the crew to evacuate passengers to a safe location onboard;
2. Send crew members to try to put out the fire directly using appropriate fire-fighting apparatus;
3. Use VHF to call the Marine Department or call the emergency number 999 to seek assistance;
4. Turn the vessel in order to shift the scene of fire leeward for lowering the chance of fire spreading by the wind;
5. If the fire spreads, close the doors and windows of the cabin, turn off the ventilation system, and direct water jets near the scene of fire for lowering the temperature;
6. If the fire cannot be extinguished, hoist the fire signal, move away from the fairway immediately and stop the vessel as soon as possible. If the main engine becomes inoperational, the signal of not under command should be hoisted immediately;
7. Comfort the passengers and advise them to wear life jackets to prepare for escape immediately.

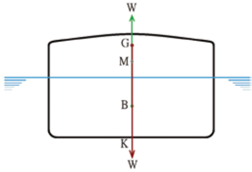
Q: What is the stability condition of the vessel as shown in the diagram?

A: Stable.



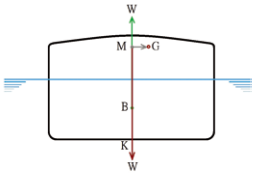
Q: What is the stability condition of the vessel as shown in the diagram?

A: Unstable.



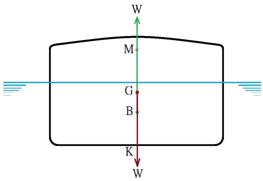
Q: What is the stability condition of the vessel as shown in the diagram?

A: Neutral equilibrium.



Q: How to define "too stable"?

A: When the GM value is very large.



(16) Basic principles

Basic principle of the main engine

A The main engine is the machine being used for propelling of vessels. Apart from the main engines, other machines that installed on board are all referred to as auxiliary machineries (e.g. electric generators, compressors and hydraulic steering gears).

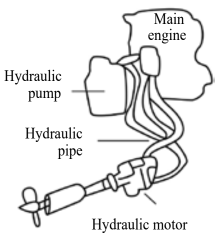
Diesel, petrol or liquefied gas can be used as fuel of main engines on small boats. In recent years, some main engines can only be driven by electric power.

The basic structure and operational characteristics of diesel engines and petrol engines are very similar, since they are both reciprocating internal combustion engines. However the composition of fuel for power generation in the two types of engine is different. Although diesel and petrol oil are refined from fractional distilled crude oil, the boiling point and specific gravity of petrol are much lower than diesel. Different fuels are used for these two types of engine, which have different engine structures.

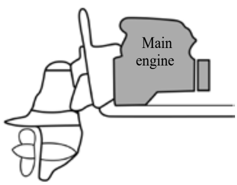
Diesel engine, is operated on the principle of compression ignition engine. The air inside the combustion chamber is compressed to produce high pressure and temperature so as to ignite the injected atomized fuel. Due to the high internal pressure of the combustion chamber, a higher strength, rigidity and construction of diesel engine in compared to petrol engine are required. Thus, with the same engine horsepower, the body of a diesel engine is thicker than that of a petrol engine. Petrol engine, also known as spark ignition engine, the vaporized fuel-air mixture inside the combustion chamber is ignited by spark plug. The compression ratio of petrol engine is lower than diesel engine, and thus the engine structure is relatively lighter and not as thick as the diesel engine.

In general, many motor yachts are fitted with diesel engines or petrol engine. With the introduction of rechargeable battery, electric motors and corresponding control technologies, nowadays electric power propulsion engines are also installed on these motor yachts.

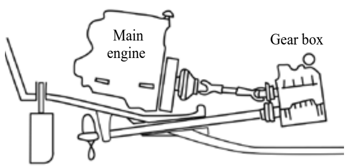
B Basic configuration method of the main engine and propelling system



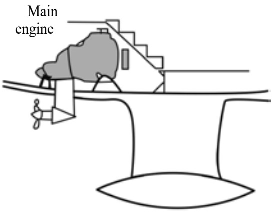
Hydraulic drive



Stern drive engines

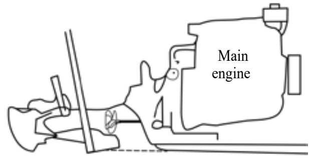


V drive



Motorized sailboat

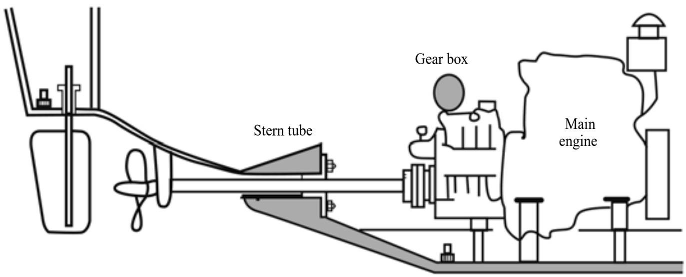
Outbound engine



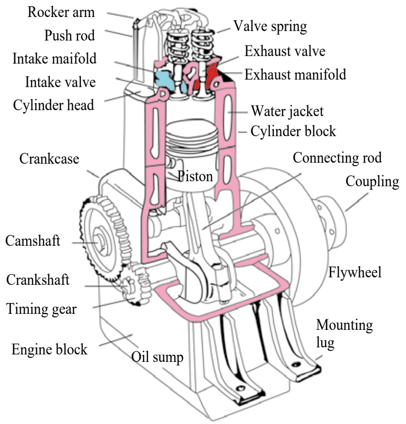
Waterjet

C Internal Combustion Engine

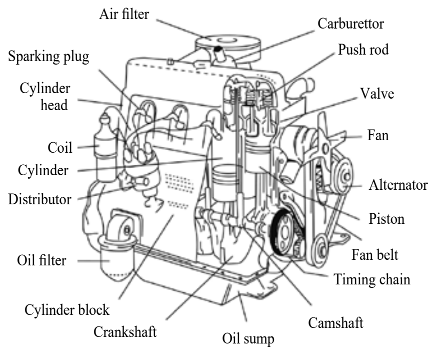
The driving force of an internal combustion engine is generated from the fuel burning rapidly inside the combustion chamber with gas expansion and pressure to push the piston. As the fuel burns in the combustion chamber, the gas expands rapidly to create pressure and push the piston down. The piston is connected to the connecting rod, and the other end of the rod is connected to the crank shaft. The reciprocating linear motion of the piston is transformed to rotary motion by the crank shaft, and the power is transferred to the flywheel and is then exported through the coupling. Then, the rotating speed is lowered through gears (commonly known as gear box) to the tail shaft, and it is transported to the propulsion mechanism (e.g. Propeller, Jet pump).



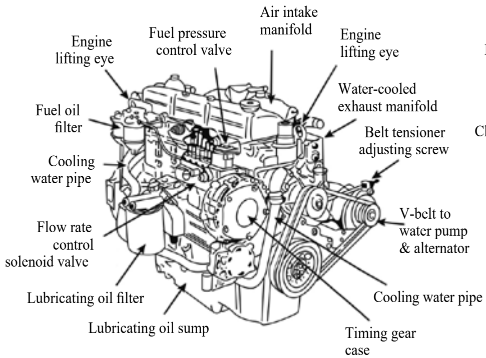
Basic structure of the internal combustion engine



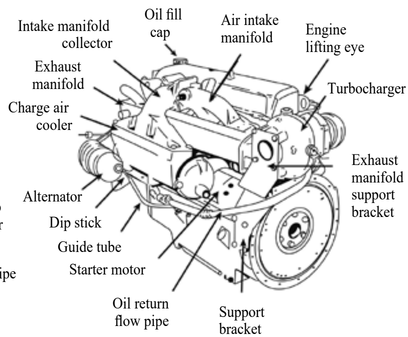
Internal Structure of a Basic Single Cylinder Water-cooled Diesel Engine



Internal Structure of a Basic 4 Cylinder Petrol Engine



Front structure of a Basic 6 Cylinder Water-cooled Diesel Engine

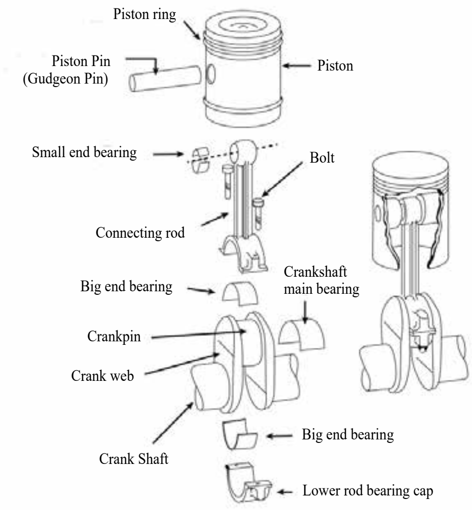


Back structure of a Basic 6 Cylinder Water-cooled Diesel Engine

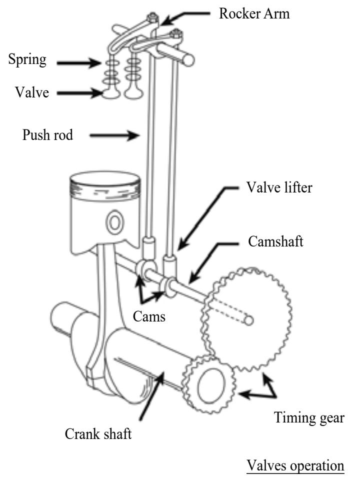
Glossary of some terms

English	Chinese	Commonly known as
Main engine	主機	大車 主車
Auxiliary engine	輔機	
Electric generator	發電機	燈車
Dynamo	發電機	打南磨
Diesel engine	柴油引擎	油渣車
Petrol engine	電油引擎	電油車
Cylinder head	汽缸蓋	盆頭 盆頂
Cylinder	汽缸	盆司 司筒
Piston	活塞	遮
Piston ring	活塞環	遮呤
Gudgeon pin	活塞銷	雞春鞭
Connection rod	連桿	遮栗
Bearing / Bushing	軸承 襯套	啤呤 杯士
Connection rod bushing	連桿襯套 連桿軸承	遮栗杯士 遮栗啤呤
Big end bearing	大端軸承	大頭啤呤
Small end bearing	小端軸承	細頭啤呤
Push rod	推桿	筷子
Intake valve	進氣閥門	生氣哇佬
Exhaust valve	排氣閥門	死氣哇佬
Valve spring	氣閥彈簧	哇佬彈弓
Rocker arm	搖臂	呢化 拮雞
Cam	凸輪 歪輪	歪桃 衿
Camshaft	凸輪軸 歪輪軸	衿雯
Crank case	曲軸箱	馬肚
Crank shaft timing gear	曲軸同步齒輪	
Seawater suction valve	海水進水閥	海水閥 司閥
Fresh water tank / Fuel tank	淡水箱	水箱 油箱
Flange coupling	凸緣聯軸節	佛蘭急輪
Fly wheel	飛輪	飛輪
Engine mounting	機腳	偈躉
Lithium battery	鋰電池	鋰電
Lead acid battery	鉛酸電池	水電 水池
Positive pole	正極	十字
Negative pole	負極	一字
Earth lamps	接地燈 漏電測試燈	地氣燈

Piston and Camshaft compartments

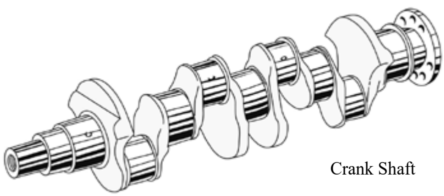


Piston components



Cam shaft components

The fuel burn in the combustion chamber (power stroke) the combusted gases inside the combustion chamber expanded and pushes the piston in linear motion along the cylinder. The crank shaft transfers the linear motion to rotary motion. As the crank shaft is connected to the fly wheel, the fly wheel will store rotational kinetic energy during the power stroke; the fly wheel will then release the rotational kinetic energy and push the piston to top dead centre during the compression stroke and exhaust stroke. This kind of back and forth motion of the piston is called reciprocating movement, and this type of engines is called reciprocating engines.

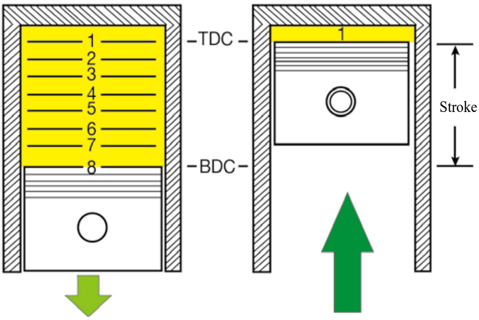

Crank Shaft

Stroke

The length of travelling of the reciprocating motion of the piston in the cylinder from the top dead centre (T.D.C.) to the bottom dead centre (B.D.C.); or the length of the reciprocating motion of the piston in the cylinder from the B.D.C. to the T.D.C.

The piston of a combustion chamber moves in repeating cycle of a displacement between T.D.C. and B.D.C. so as to perform the air induction, compression, power output and gas exhaust process. The internal combustion process series operates in repeating cycles.

Internal combustion engines are basically had 2 types, 2-stroke and 4-stroke. No matter the operation cycle of the engine is 2-stroke or 4-stroke, there will be a power stroke in each operation cycle.



(B.D.C. – Bottom Dead Centre)   (T.D.C. – Top Dead Centre)

2-stroke means that a set of pistons completes a power stroke when completing two strokes in the cylinder (simultaneously the crank shaft completes a full 360˚ rotation).

4-stroke means a set of pistons completes a power stroke when completing four strokes inthe cylinder (simultaneously the crank shaft completes a full 720˚ rotation).

Fuel

In general, small vessels use diesel or petrol (gasoline) as fuels for engines. Some outboard engines use propane (LPG) as fuel. In recent years, there are some small boats are propelled by electric motors.

The main difference between the internal combustion engines using different fuels lies in the way the fuels are ignited. The petrol engine uses a high-voltage electric spark to ignite atomized air-fuel mixture; while diesel engine uses the heat that is generated when the air is compressed to ignite the atomized diesel fuel injected in the power stroke. As for LPG engine, the liquefied fuel is first vaporized and mixed with air before it is injected into the cylinder (combustion chamber), and then ignited with a high-pressure electric spark, which is similar to a petrol engine.

Petrol fuel and diesel fuel

Flash Point

Flash point is the temperature at which a spark can ignite a fuel vapour.

The flash point of diesel is about +63℃ while that of petrol is about -40℃. The Flash points of fuel products from petroleum with quality differences, may have a few degree differences, but they are all flammable and should be handled with care.

Compared with diesel, petrol fuels are more dangerous. In room temperature, petrol will vaporize and mix with the air, forming flammable gas mist, which can be ignited and forming explosion when encountering with sparks. Diesel fuel in metal containers, if which is exposed to the sunlight on the deck, it can be warm up rapidly to about 60 ℃ and release flammable aerosols.

Therefore, both petrol and diesel fuels, even lubricant fluid with higher flash point and relatively stable, are needed to be handled carefully.

Specific gravity

Comparison of the density of one substance with the density of a reference standard substance (pure water is commonly used as a reference standard substance, unless otherwise specified).

Density of pure water = 1.000 g/cm^3; specific gravity = 1.00

Density of sea water = 1.025 g/cm^3; specific gravity = 1.025

Density of diesel = 0.840 g/cm^3; specific gravity = 0.84

Density of petrol = 0.730 g/cm^3; specific gravity = 0.73

Example 1: Lubricant oil of XX Brand = 0.970 g/cm^3; specific gravity = 0.97

Example 2: Lubricant greases of XX Brand = 1.10 g/cm^3; specific gravity = 1.10

Apply the density above to the routine calculations:

	Specific gravity (SG)	Volume Per cubic Metre	Weight of every 1,000 L
Fresh water	1.000	$1\ m^3$ = 1,000 L	1,000 kg
Sea water	1.025		1,025 kg
Diesel	0.840		840 kg
Petrol	0.730		730 kg
Lubricating fluid	0.970		970 kg
Grease of XX Brand	1.100		1,100 kg

The specific gravity of diesel is 0.84, and the specific gravity of petrol is 0.73. The specific gravities of both diesel and petrol are lower than 1.025 and 1.000. That means, they are lighter than sea water and freshwater, and will float on the water surfaces of sea water or river water. The specific gravity of grease (1.100) is higher than that (1.025) of sea water, so it will sink in the sea water. However, regardless of its specific gravity, it will float or sink in water, in any cases, oil spills in water pollutes the environment such as the oceans, rivers and lakes.

Octane number and Cetane number

Octane number is an indicator of the fuel's resistance to knock, and is commonly used to describe the nature of petrol. The higher the octane number, the harder to burn by self-ignition of the fuel when it's mixture is pressurized. So the compression ratio of a petrol engine can be increased so as to enhance the thermal efficiency and prevented from unwanted self-ignition inside the combustion Chamber. That make the ignition of the compressed fuel-air mixture in the combustion chamber is controlled by the presence of sparks from spark plug in a petrol engine. Therefore, the higher the octane number, the better anti-knocking ability.

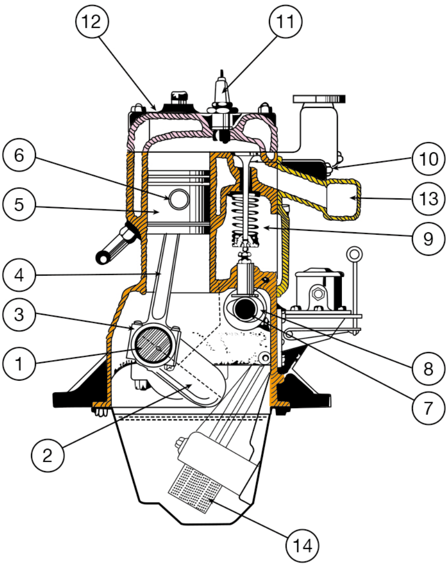
Traditional methods to improve the octane number of petrol include adding anti-knocking additions such as tetraethyl lead, methyl tert-butyl ether, dimethyl carbonate, and methylcyclopentadienyl manganese tricarbonyl (MMT). Since lead is a poisonous substance that can be easily absorbed by human bodies and will impose severe harm, many countries have banned the use of lead-containing petrol and only allow petrol with lead-free additives, i.e. unleaded petrol.

Cetane number represents the flammability of diesel. The higher of the value, the easier of the fuel mixture to burn by self-ignition when in compressed. After the diesel is injected into the combustion chamber, the ideal condition is that the fuel burns immediately after the injection, and linear increasing the pressure within the combustion chamber. If the fuel is not ignited after the diesel is injected into the combustion chamber, but it is then suddenly burns with the injecting fuel, the pressure in the combustion chamber will rise suddenly, forming pulse pressure and diesel knocking. The situation is similar to a delayed ignition or a wrong fire position. Therefore, diesel fuels with higher cetane number will make the machine operates more smoothly and less noise. High-speed diesel engines may require diesel fuel with higher cetane number.

D Petrol engine and Diesel engine

The design of petrol engines and diesel engines is mainly divided into two major categories ─ 2-stroke and 4-stroke, both of which rely on the rapid increase of pressure inside the cylinder after the combustion of fuels to push the pistons and rotate the crank shaft. In fact, petrol and diesel engines are different in fuel types, fuel delivery methods, and ignition systems.

For petrol engines, the fuel is first mixed up with the air and then enters into the cylinder. When the piston reaches the top dead center in its compression stroke, spark ignition is triggered by a spark plug at the top of the cylinder head cover.



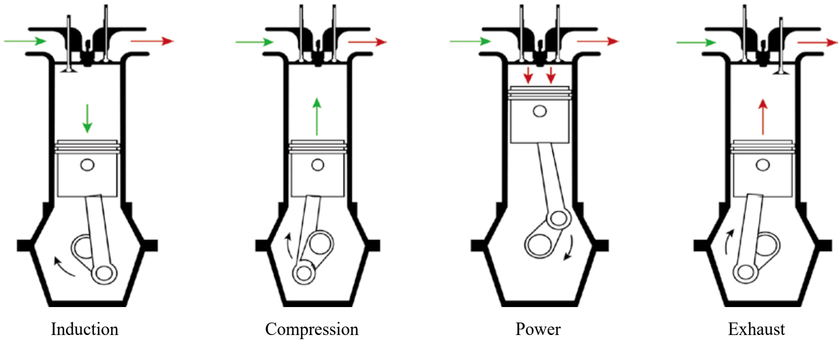
1. Connection rod
2. Crank web
3. Connection rod bearing
4. Connection rod
5. Piston
6. Piston pin
7. Camshaft
8. Cam
9. Valve spring
10. Exhaust valve
11. Spark plug
12. Cylinder head
13. Exhaust manifold
14. Oil strainer

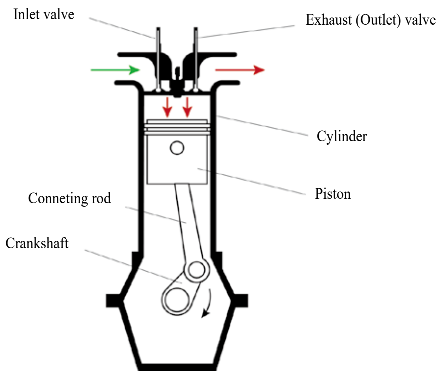
Name of the components of a petrol engine

The fuel delivery system of a diesel engine first sucks air into the cylinder for compression and then injects diesel fuel into the cylinder through a fuel injector on the cylinder head. When the fuel is injected, the piston reaches the top dead centre of the compression stroke. As air compression increases the heat, the fuel injected into the cylinder will burn immediately.

Operation cycle

4-Stroke cycle





<u>Induction</u>

When the induction stroke begins, the intake valve on the cylinder head will be opened. As the crank shaft cranks, and drives the connecting rod to pull down the piston, the cylinder becomes vacuum and sucks air in from the intake valve.

<u>Compression</u>

At this time, the crank shaft has driven the piston to the bottom dead centre. When the piston starts to move upward, the intake valve will close immediately and the piston in the upward direction will compress the originally inhaled air.

Power

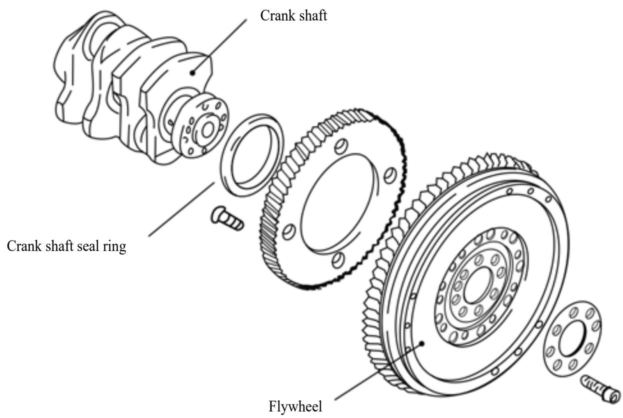
When the crank shaft is about to complete a revolution, and the piston has reached the top dead centre, the fuel will be injected into the cylinder through the injector and be mixed with the compressed air above the piston. The fuel will start burning with the heat produced by the compression of air (as for a petrol engine, the fuel will be mixed with the air and be compressed, and then be ignited by the sparks from the plug). The pressure produced in the combustion of the compressed air and diesel will push the piston down, making the crank shaft rotates via the connecting rod.

Exhaust Blow

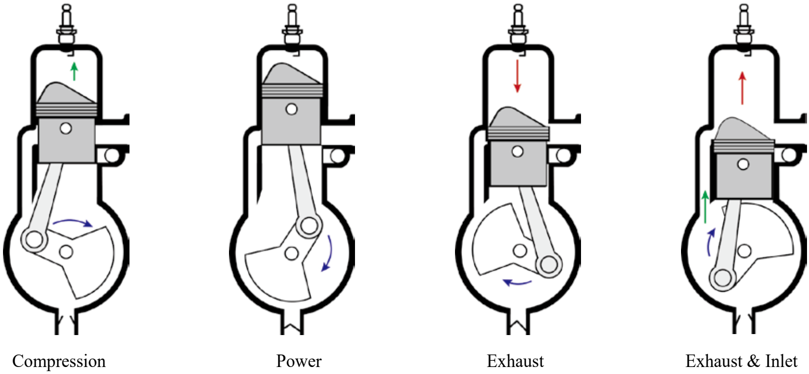
When the piston descends to bottom dead centre, the exhaust valve on the cylinder head will open immediately. The ascending piston discharges the burnt exhaust gas from the exhaust valve. When the crank shaft pushes the piston upwards to the top dead centre, the exhaust valve will be closed, and the action will be restarted from the air induction stroke, and the process will run in cycle.

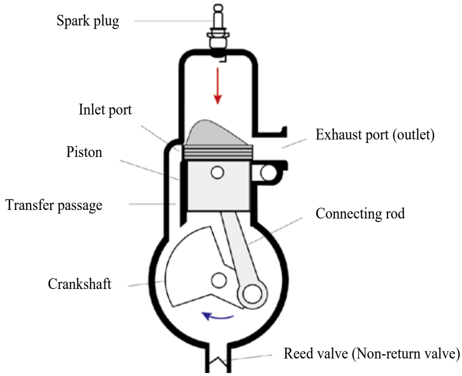
Flywheel

The fly wheel is a mechanical device for storing rotational kinetic energy during a rotational motion. It tends to resist the speed change, so it can reduce the fluctuation of the speed of reciprocating engines, making the rotational motion smoother. In a 4-stroke engine, part of the energy generated by the power stroke is stored in the fly wheel, which will later release rotational kinetic energy during the other three strokes of induction, compression and exhaust to provide power to complete the motion, and ensure the smooth operation of the machine.



2-Stroke cycle





This kind of 2-stroke engine can be commonly seen in outboard petrol engines and small power devices. When the piston moves upward, the mixture of fuel, air and oil enters the crank case through the reed valve. When the piston descends, the reed valve is closed, and the mixture of fuel, air and oil are pressurized. This process lasts all the time till the transfer passage is opened, so that the mixture of fuel, air and lubricating oil is pressed in the cylinder (i.e., combustion chamber), and the cycle will start all over again.

Compression

The piston moves from bottom dead centre to top dead centre reach about half of the stroke, and compression of the mixture of petrol and air starts when the inlet port and exhaust port are covered. The spark plug gives out sparks to light the compressed fuel-air mixture, when the piston continually moves upward to reach the top dead centre.

Power

Gas burns and rapidly expands, compelling the piston to go down to bottom dead centre and drive the crank shaft to rotate through the connecting rod. The expansion power drives the piston to go down to about half of the stroke, till the exhaust port is exposed.

Exhaust

The piston descends to expose the exhaust port, exhaust gas is emitted from the exhaust port through the exhaust manifold.

After the exhaust port is exposed, the piston descends further till the inlet port is exposed, this allow the mixture of fresh air and fuel enters the combustion chamber , and the exhaust gas remains in the combustion chamber is pushed out by the pressurized induction gas. This is a circumstance under which induction and exhaust (scavenging) are carried out at the same time.

Exhaust & Inlet (Scavenge)

The inlet port and exhaust port are opened at the same time to conduct induction and exhaust at the same time. The specially shaped piston top guides the induced mixed gas to the upper layer of cylinder, and this scavenge motion can make the mixed gas circulate in the whole cylinder and remove the residual exhaust gas; the piston continually rises to seal the exhaust and inlet ports in succession. The motion is started by the compression stroke in a cyclic way.

When the piston rises, the under piston space of cylinder is vacuum in some time, and thus it can induce mixed gas through the non-return valve; when the piston lowers, mixed gas will be compressed, and the gas is pressed in the cylinder through the inlet manifold when the inlet port is opened.

Timing Diagram

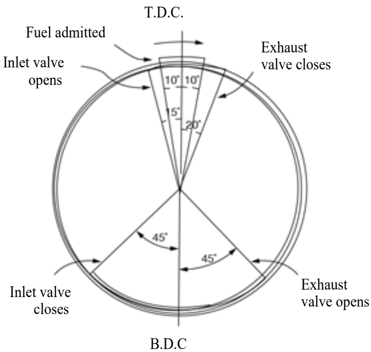


Diagram of the Operation of 4-stroke diesel engine

The diagram indicates the operation of internal combustion engine and explains the process in which the crank shaft rotates to every angle shown on the diagram.

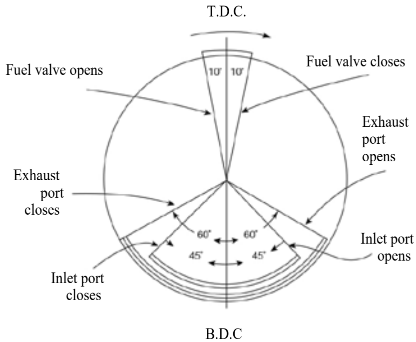
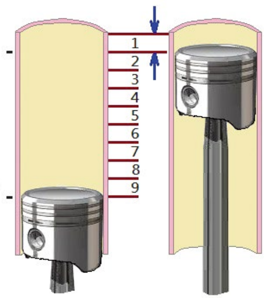


Diagram of the operation of 2-stroke diesel engine

Let's take the fuel injection time as an example; the switching angles of the valves of differently structured fuel engines shown on the diagram may be different.

Compression ratio



The reciprocating movement of piston can change the volume of combustion chamber (cylinder) at the same time. Compression ratio means the ratio between the largest and smallest volumes of a combustion chamber.

Compression ratio (r) = largest effective volume of air cylinder/clearance volume. Let's take the diagram on the right as an example:

For example, as shown in the diagram:

The largest effective volume of air cylinder = 9-unit clearance volume = 1-unit

Compression ratio (r) = $^{9}/_{1}$ = 9:1

In general:

The compression ratio of compression ignition internal combustion engine (diesel engine) is about 12:1 to 30:1

The compression ratio of spark ignition internal combustion engine (petrol engine) is about 7:1 to 9:1

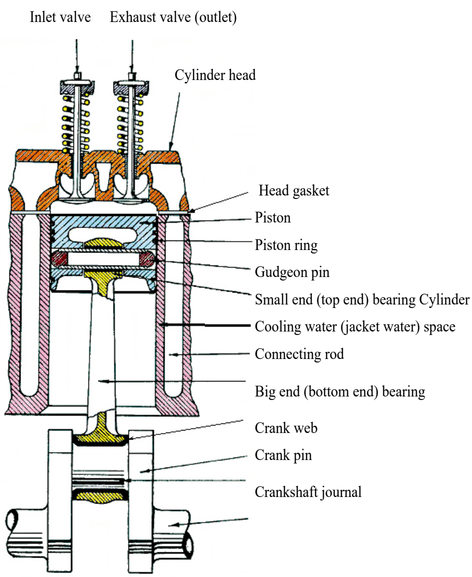
(17) Main Engine — Petrol Engine and Diesel Engine

Existing vessels can be installed with different types of inboard engines, range from single cylinder to more than 12 cylinders or even more. In multi-cylinders engine, the cylinders can be arranged in line or in V-shape. Most of small vessels and boats are installed with 4-stroke diesel engines, while 2-stroke diesel engines are mostly used for large ocean going vessels. The basic structures and working principles of the engines in all forms are the same as those of single-cylinder engines.

Single cylinder diesel engine

V-12 cylinder diesel engine

Petrol engine



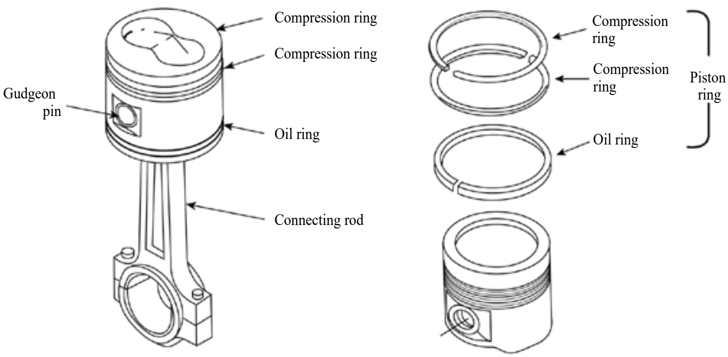
Overhead valve engine

I Components of Engine

A. Piston

The piston is a component moving upward and downward in a cylinder, which can be made by cast iron, steel or aluminium alloy, some are made by ceramic. Ring grooves are carved around the piston, facilitating the embedment of piston rings. When the piston moves reciprocating in a cylinder, the piston rings are clung onto the inner wall of the cylinder liner by virtue of its own elasticity, preventing the combustion gas pressure on the piston top leaks through the gap between the inner wall of cylinder liner and the piston (compression ring). If pressure leaks to the outside, some pressure force loss, and the efficiency of the engine decreases. The piston ring (oil ring) in the lower part of the piston can scrape off the oil stuck on the cylinder wall, avoiding oil entering the combustion chamber. An asymmetrical shape is designed for the edge of piston ring that contacts with the cylinder liner wall, to reduce the resistance during the piston movement. The up and down oriented directions of the piston rings should be noted during replacement and installation.

The steel pin running through the piston is called gudgeon pin, and is used to connect the piston with the sleeve on the top end of connecting rod (small end bearing)



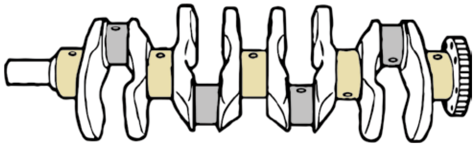
B. Connecting Rod

In every working stroke, the connecting rod conveys the thrust of piston to the crank shaft to make it rotate. The connecting rod is generally made of steel, with bearings mounted on both ends. It can be connected with the piston to constitute the small end bearing, and connected with the crank shaft to constitute the large end bearing. The inner wall of bearing is smooth for reducing friction. The bearing is usually made of tin alloy or copper alloy.

C. Crank Shaft

The crank shaft is used to turn the reciprocating motion of piston in the cylinder of engine into rotary motion, so as to drive the propeller. Each cylinder is connected by "One throw". One throw consists of one crank pin journal which connected with the main journal by two crank webs. The crank pin journal is connected to the connecting rod bearing. There is a smooth bearing (main bearing) in the engine bed, which supports the crank shaft during rotation. The crank shaft is made by high grades steel, and the crank shaft pin and drive shaft bearing are quite hard and need to be polished to smoothness for reducing resistance. An oil hole is reserved in the crank shaft, so that oil can be conveyed through the hole for bearings lubrication.

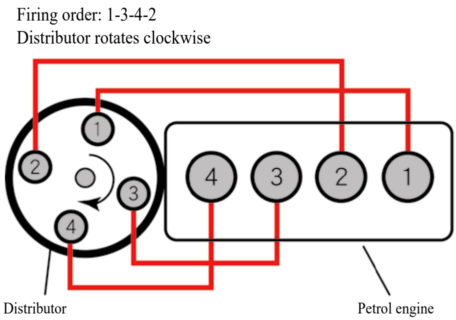
The propeller is driven by the crank shaft which connect with other gears (gear box), but there are also propellers that are connected with the crank shaft and propeller shaft for direct driving.



Crank shaft (used for 4-cylinder engine)

D. Firing Order

The firing order is the sequence on execution of power strokes in a multi-cylinders engine. For instance, a 4-cylinder internal combustion engine, the firing order is "1-3-4-2"; for a 6-cylinder internal combustion engine, the firing order is "1-5-3-6-2-4" or "1-4-2-6-3-5"; for an 8-cylinder internal combustion engine, the firing order is "1-5-7-3-8-4-2-6" or "1-2-4-6-8-7-5-3" and so on. The firing order of multi-cylinders engines are designed in this way is to improve the balancing and to reduce the vibration from power strokes of engines, making the engines running smoothly and more durably. The firing order leads to the angle arrangement of the crank shaft and camshaft, the wiring sequence of petrol engine ignition distributor and the design and arrangement of the high pressure fuel pump of diesel engine.

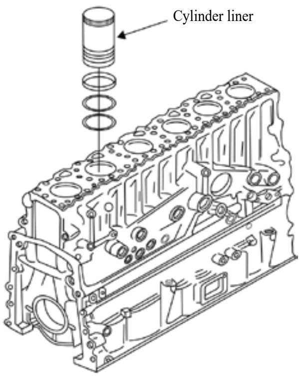


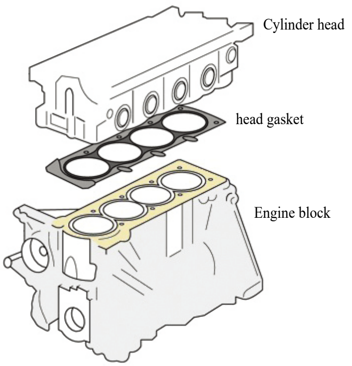
Firing order of 4-cylinder petrol engine (1 – 3 – 4 – 2)

E. Cylinder

The fuel is burned in cylinders (combustion chambers) of an engine. The cylinder of an engine is shaped through milling and accurate polishing after the cylinder block is cast. The cylinder blocks are usually made of high grade cast iron or refined steel. The cylinder liners are surrounded by water jackets, which the heat generated from fuel combustion in the combustion chambers, is cooled by the water jacket. The mechanical polishing roundness of the inner walls of the cylinder must be accurate, so that the friction from reciprocating linear motion of the pistons inside the cylinder liners could be reduced.

The cylinders liners of most large engines are manufactured, polished and assembled to the engine blocks. Whenever the inner walls of the cylinder liners were worn down from long-time usage, the cylinder liners could be replaced during engine overhaul.





F. Cylinder head

The cylinder heads are covered on the cylinders, the cylinder heads of the diesel engines are fitted with fuel injectors, or can be fitted with inlet and exhaust valves also. There are no fuel injectors in the cylinder heads of the petrol engine, and they have been replaced with spark plugs.

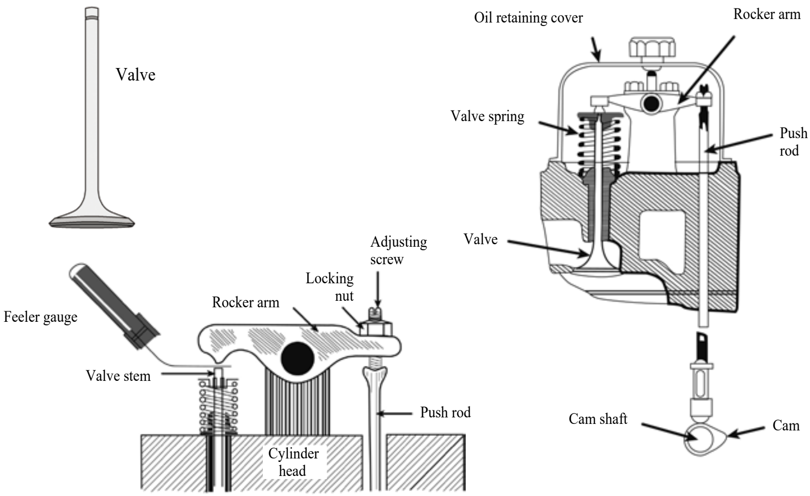
G. Head gasket

Gaskets are sealing mechanism of metal parts which they are used to prevent from leaking of fluid such as water, oil or air pressure, etc. The cylinder head gasket is a sealing piece placed between two metal pieces and is used to separate the water passages among all cylinders.

H. Inlet valve

The inlet (intake) valve is made of steel alloy in mushroom-shaped with a long and thin stem connected to cylinder head by strong spring. The valve disc rests on the valve seat of the cylinder.

The camshaft is used to control the opening/closing of inlet valves, and air will be sucked or pressed into the cylinder when the intake valve is opened. The camshaft is specially designed, and the inlet valve will close due to spring force, after the cam falls back.



I. Exhaust valve

The exhaust valve has a similar operation principle to the intake valve. When the exhaust valve is opened, the burned exhaust gas is discharged through the exhaust valve, exhaust manifold and silencer to the atmosphere.

The clearance between the rocker arm and the stem of the exhaust and intake valves when they are closed, is called valve clearance.

Valves clearance is set to ensure that the valve can be tightly closed. A larger clearance of exhaust valve would be set as required for compensating the thermal expansion caused by the heat of exhaust gas.

J. Fuel injector

The fuel from the high pressure fuel pump supplied to the fuel injector may reach - a pressure up to 69 bar (1,000 pounds per square inch (psi)) to 140 bar (2,000 psi) or even higher. When the pressurized fuel reaches the injector, the injector nozzle that is closed by spring pressing will be forced open by the pressure, and then fuel will be injected into the upper space in the cylinder through a nozzle with a small hole or multiple holes. The small hole of the nozzle is used to transform the injected fuel into oil mist, and then such atomized fuel will be immediately be burned by the heat of the compressed air in the cylinder. Afterwards, this burning fuel-air mixture will expand and push the piston downward during the working (power) stroke.


K. Safety valve

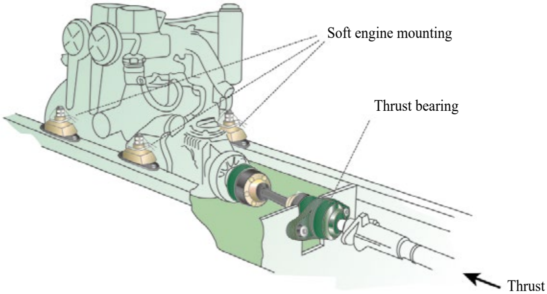
Some engines are provided with cylinder safety valves for preventing excessive internal gas pressure of the combustion chamber. When the internal gas pressure reaches its upper limit, the valve with springs will be forced open by pressure to discharge excessive gas pressure. The valve will close automatically when the internal gas pressure restores to its safety level.

Excessive internal gas pressure in combustion chamber can cause damages to engine, it can cause the cylinder liner, cylinder head or head gasket damage. Excessive gas pressure can also result in overload of pistons and the inefficiency of piston crowns, and more possibly, impede the supply of oil in the connecting rod for lubrication on cylinder liner and main bearings, causing direct abrasion between surfaces of metallic components that can seriously damages the engine.

During the annual maintenance of engines, the safety valves of cylinders should be completely dismantled from cylinder head to cleaned, checked, tested and adjusted. Afterwards, they should be carefully installed back to their original positions. Such work are required be carried out with special tools, and is usually carried out by specified workshop during the annual maintenance.

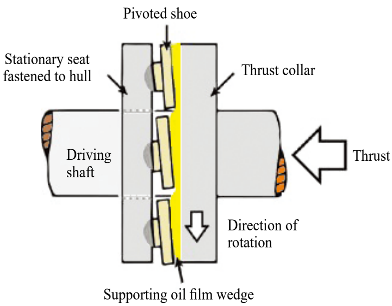
L. Thrust bearing

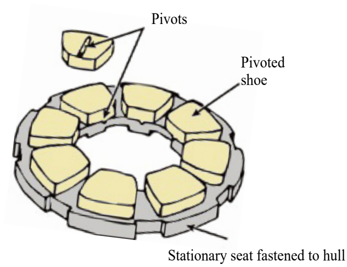
Reaction force will be generated against on the ship structure when the engine runs and rotates the propeller to propel the vessel on water. The propulsion force of the propeller must be handled properly. In order to prevent such reaction force from affecting the engine running and the precise alignment position of the crank shaft, a thrust collar and a thrust bearing can be fixed at a proper position between the propeller shaft and the engine crank shaft. The thrust bearing is tightly fastened onto the stiffened structural member of vessel body to absorb the thrust and avoid transmitting of thrust to the crank shaft, engine main bearing, engine body, engine mount (soft engine mounting), engine casing and holding down bolts at the member of the engine fixing position.



The thrust collar is a simple, smooth, disc-shaped collar fixed to the propeller shaft. The thrust bearing of low horsepower engine is of planar type which is installed between the fore and aft thrust collars with small clearance in between. Besides, the thrust bearing bears the thrust when the vessel moves ahead or astern. The disc-shaped collars and bearing assembly was splashed with oil inside the thrust bearing housing while shaft rotation.

Engines with Large horsepower are usually equipped with tilting pads or Michell thrust bearings. Those thrust bearings are simple and compact structure while capable to handle huge thrust. Between the thrust collars, the thrust bearing equipped with horseshoe shape tilting pads cladded with tin alloy. These steel tilting pads are designed to allow micro tilting when the driving shaft rotates, so that the oil inside the bearing housing can be brought by the thrust collar and enter the wedge-shaped position between the steel pad and the thrust collar. This design make the thrust bearing can absorb huge thrust without damaging the inner surface of the collars and has lubrication to the surfaces.





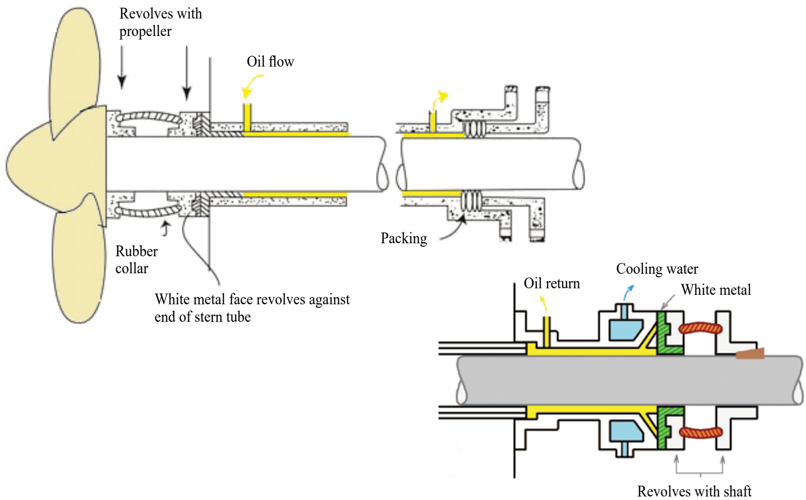
The clearance between the thrust collar and steel tilting pads is extremely small, and should be carefully calibrated with liners behind the carrier. The standard clearance is listed clearly in the Manufacturer's manual, normal ranged from 0.001 to 0.002 unit of the diameter of driving shaft.

This type of thrust bearing is also called Fluid-film Thrust bearing, as the pivoted shoe geometry allow the formation of fluid film between the collar surface for supporting the load and lubrication.

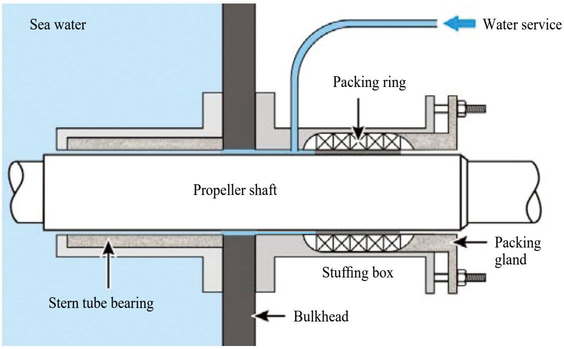
M. Stern tube arrangement

A seal is fitted between the end of stern tube and the propeller to prevent seawater from infiltrating to the oil filled stern tube. A stuffing box with gland is usually mounted at the inboard end of stern tube with packing inside the stuffing box. Some vessel may have special seals mounted on the outboard end.

The bearings supporting the propeller shaft in the stern tube, of which being lubricated by seawater are usually made of hard wood or rubber and those lubricated by oil are mostly made of white metal.



There are multiple arrangements of stern tubes. See the most common two types in the diagram.



Water-cooled stern tube

N. Flywheel

The flywheel is a heavy round disc object installed at the end of the crank shaft, and is usually made by cast iron. The engine rotates and accelerates with the power generated by the power stroke, it will decelerate for a bit and re-accelerates when the power stroke is started again. This situation is more obvious in an engine with less than 4 cylinders. The flywheel is used to store part of the rotational energy generated by the stroke, and release those stored energy when the crank shaft starts to rotate slowly, so that the crank shaft can rotate at a steady speed.

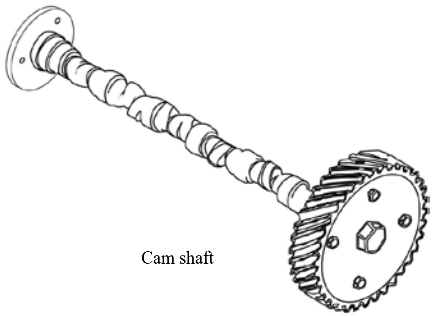

Flywheel

Gears are manufactured on the periphery of the flywheel for the engine can be initially drive to run by an electrical power driven system, and then the machine can run by its own power after the engine is started.

O. Cam Shaft

The cam shaft is driven by chain or gears where they are driven by the crank shaft. When the cam shaft rotates, the cam on the cam shaft rotates pushing the fuel pump plunger piston move up and down synchronously.

The intake and exhaust valves are also controlled by the cam shaft. The motions of the cam shaft drive the valves to open and close as per the designated sequence through the push rods and rocker arms.


Cam shaft

For 4-stroke engines, the rotational speed of camshaft is equal to ½ of that of crank shaft. This is because the valves (and pump of diesel engine) for each cylinder is driven only once per each 2 cycles of the crank shaft rotate.

For 2-stroke engines, the rotational speed of camshaft is the same as the crank shaft.

II Different systems of internal combustion engines

Internal combustion engines must have the lubrication, cooling, fuel supply, starting up and air supply systems. Large engine may have a compressed air system for engine starting and reversing operation.

The operating methods of the above-mentioned systems may vary depends on the design and construction of engines from different manufacturers. Always refer to the relevant details in the Manufacturer's manual for each engine. Despite of some differences among each engine, all engines are running by the same operation principles and similar structure.

A Lubrication

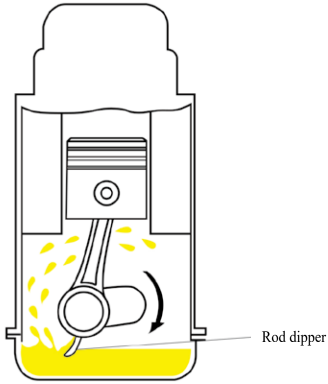
Lubrication has the following main effects:

- Abrasion reduction — reducing the abrasion and loss between the contact surface of any moving parts, reducing as well as heat and noise.
- Heat dissipation — Removing heat from the areas which cannot be cooled by cooling water or air.
- Seal — forming oil film along the piston ring and cylinder wall to better seal the combustion chamber thus prevent loss of pressure in the cylinder.
- Washing — The friction surface is washed constantly to remove metallic particles, debris and impurities, and maintain oil film that can reduce the rubbing effect.
- Corrosion reduction — The oil film covers and maintains all metal parts surfaces to prevent from contacting with air, so as to avoid oxidative.

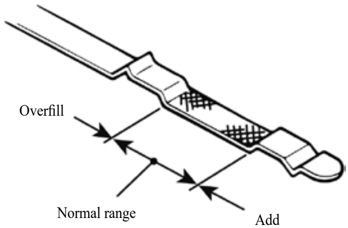
The oil grade for each engine as specified by the manufacturer manual must be referred, otherwise the above-said functions may not be achieved and may cause risk.

A high speed rotating bearing that requires to be impregnated in suitable grade of oil for lubrication, if the lubrication was replaced by grease with high viscosity instead, the generated heat won't be able to be transfer as grease doesn't flow easily. Finally, heat will be generated as a result of the failure in reduction of mechanical abrasion. If such situation persists and heat accumulates to reach a certain temperature, the lubricating grease will be lit, causing a fire alarm, and the bearing will be damaged irreparably. Therefore, it is recommended to select the suitable grade of oil of (by its mobility) for onboard operation.

Lubricating mode



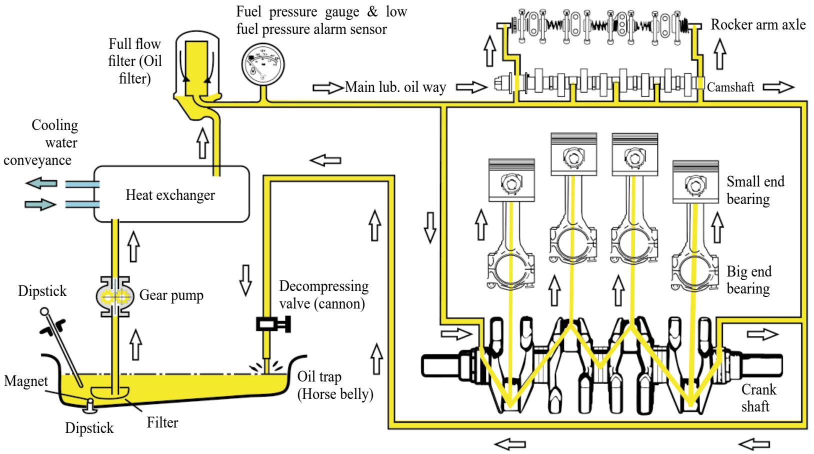
Splash type: Most of small petrol engines are lubricated in this way, oil was filled into the oil sump of the crank case. When the crank shaft rotates, the crank pin journal, connecting rod big end bearing and the rod dipper attached to the big end bearing are dipped into the oil sump to bring some oil to the big end bearing, while some oil flows into the crank shaft bearing through the small hole in crank shaft. Oil is splashed to the piston and piston pin, and then back to the oil sump of the crank case. Oil heat dissipation: oil can be cooled by heat transfer from oil to water in the heat exchanger. For small engine, the casing is equipped with extended surfaces such as fins which can sufficient for reducing temperature by air cooling.



Dipstick

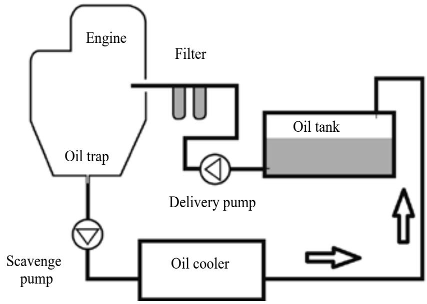
Pressure type: Large and high horsepower engines are mostly provided with pressure type lubrication system. Piston pumps acting in reciprocating motion can be driven by cam shaft gear pumps can be driven by the chains or gears. Oil in trap is pumped out and transferred to the heat exchanger for cooling, then conveyed to all bearings through the small holes in the crank shaft and connecting rod, and to cam shaft and all valve components, found in cylinder head. The oil pressure in the system is about 45 psi (3 bar) (for reference only).

A relief valve is mounted on the end of oil line. When the oil pressure is too high, oil will be discharged into the oil trap through the valve. An alarm will be activated by a pressure sensor in the oil line when the pressure is abnormal. A magnet is in the tray for collecting iron particles in system. Check the oil level and quality in crank case before starting engine. Check oil level and quality of hydraulic oil storage tanks, gear box and hydraulic device, etc. before sailing.



Dry Collecting Basin type lubrication

Bigger engine has an individual lubricating oil tank. Scavenge pump extracts lubricating oil from collecting basin, stored in a lubricating oil tank. Another independent lubricating oil pump transfers lubricating oil to engine for lubrication. Collecting basin is not completely dry, but do not accumulate big amount of lubricating oil. This type of lubricating oil supply method is more suitable to tilted engine, but it should ensure keeping suction of pump to prevent air ingress.



The temperature of after cooled oil from the heat exchanger should not exceed the highest temperature as set by the manufacturer, which is usually between 32°C to 48°C. The viscosity of oil changed depends on the temperature. For too high of temperature of oil, the viscosity may became insufficiency to form the protective oil film in between the contact surfaces of metal of bearings, and as the abrasion among metal surfaces, resulting in overheating of components.

The level of oil in the oil sump should be checked regularly. Generally, the oil level to be checked before the engine start up, and checked once with dipsticks every four hours after that. The manufacturer recommended oil should be filled if oil level was found below the normal level. Otherwise, the oil film will be damaged due to insufficient oil for lubrication, causing damage to components due to overheating. If significant loss of oil in the oil sump is frequently found, it may indicates that oil leakage or oil has infiltrated into the combustion chamber and burned. In any case of oil loss, it should be investigated as soon as possible and rectify.

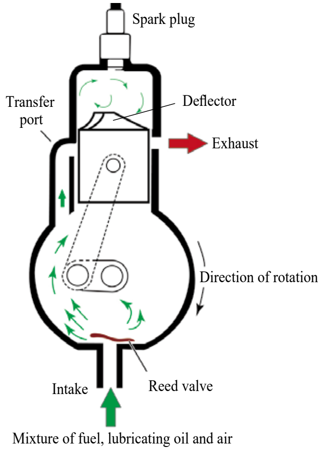
When the engine runs, oil forms oil film between two metal surfaces so as to reduce the rubbing fiction of metal contacting surfaces. At the instant of engine start or stop, overload or runs at an extremely low speed, the formation of oil film may be incomplete and cause excess wear down.

Certain amount of oil will be consumed as engine ran for some length of hours. The oil level should be regularly checked. If oil consumption is abnormal or too quick it should be checked whether oil has fed into the combustion chamber and burned, with production of abnormal exhaust gas. It indicates that cooling water has leaked into the crank case if oil is emulsified with excess high oil level. If oil became darker with lower viscosity and high oil level may reflect infiltration of fuel from combustion chamber to crank case. It may indicate that insufficient compressing force of cylinder and the injected fuel hasn't burned and leaked into the oil sump.

Lubricants are classified to different grades base on their viscosity. Viscosity is the capability of resisting mobility of a fluid. The grading of oil viscosity is determined by SAE (Society of Automotive Engineers). The SAE designation, such as 10W-40, is a multi-grade oil including oil has oil viscosity can pass the limitations of single grade “10W” at cold temperature and the number “40” is the grade of the equivalent single-grade oil that viscosity at 100 °C. The two numbers are not the value of viscosity and are used individually as defined by SAE. A high number (i.e. 40) indicates high viscosity. High oil viscosity can flow easily under a high temperature, and thus is suitable to machines running under high temperatures. A small number (i.e.10) indicates low viscosity. Low oil viscosity can flow easily under a low temperature, and thus is suitable for machines running under low temperatures. Letter W indicates the suitability for winter, i.e. the flowing degree indicated by the digital display can still be kept when it is cold. Number 60/40 means that two sorts of oil are mixed together (but doesn't mean that the viscosity is 50). The oil viscosity is affected by temperature. The higher temperature of the engine in operation leads to the lower viscosity of oil.

Motor oil for 4-stroke petrol engines

Motor oil for 2-stroke petrol engines



Lubrication of small 2-stroke petrol engines

Lubrication of mixed fuel

Small 2-stroke petrol engines can be lubricated by mixing certain amount of lubricant with petrol fuel. When the engine runs, the oil from the mixed fuel can deposits on the crank case, moving parts, and the walls of cylinders, some burn up with fuel. The amount and grade of lubricant should be selected and added as specified by the manufacturer of the engines, Generally, the mixing ratio of a typical engine can be to add one litre of lubricant per every 50 litres of petrol fuel (always refer to the operator manuals of the engine when do this). Unless an automatic mixing device is provided, it is required to fill in the required amount of lubricant into the portable oil tank then adding a small amount of petrol fuel and mixing up by manual shaking, and finally fill in petrol fuel in succession.

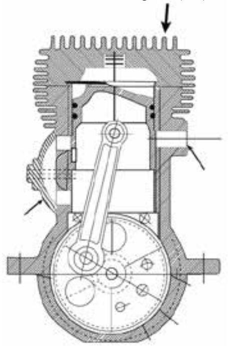
Cooling system

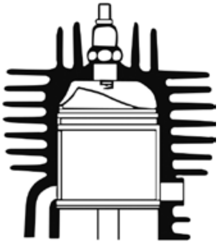
B

All parts of engines must undergo cooling for heat reduction. In small engine, the inlet porthole and exhaust porthole can be agglutinated thus affect the efficiency of engine if the temperature of the cylinder head is too high. Cooling to the cylinder head can reduce the heat of piston and piston ring to avoid agglutination. As hot exhaust gas frequently passes through the exhaust manifold, it may have equipped with cooling system. Cooling system can be divided into the following types:

(1) **Direct cooling (air-cooled)**: By the air surrounding the small engine (e.g., engine less than 5 kW), it can usually be sufficiently to reduce the heat generated while engine running. Some small engines may equipped with fans those are driven by the crank shaft of the engines to blow the air toward the engines surface to enhance the heat dissipation effect. The cylinder heads and cylinder walls of air-cooled

engines are facilitated with fins or pit patterns (like small electric generators or small grass mowers) to increase the contact surfaces between the engine bodies with air to enhance heat dissipation.

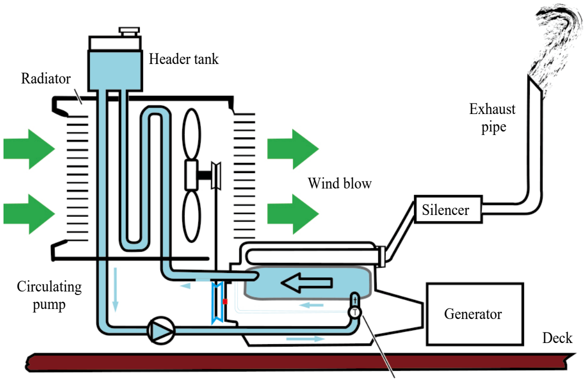




Air-cooled outboard engine

(2) **Indirect cooling**: Another common method for cooling is to fill in water into the water jacket of cylinder and cylinder head of the water passages, operates in a closed loop circulation.

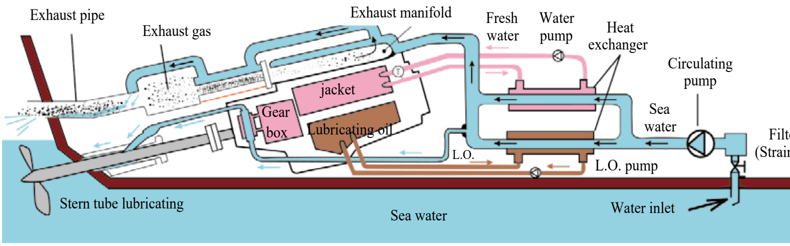
A fan being driven by the crank shaft of the engine blows air through the radiator to cool the circulating cooling water. This method is frequently used for the cooling of engine in car or the emergency generator installed on the deck level.



(3) **Fresh water cooling**: A common method being used for engine cooling on vessels is to fill fresh water into the water jackets of the cylinder heads and cylinders of the engine and operates in a closed loop circulation between the heat exchanger.

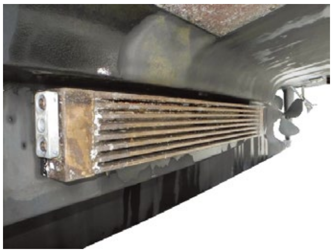
Different types of pump are commonly used for pumping of cooling water in engines, e.g. centrifugal pumps, impeller pumps are commonly found for pumping of water in engine cooling system.

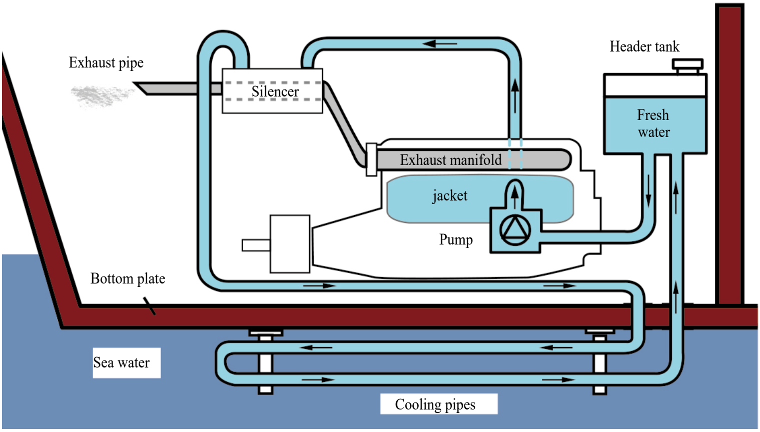
The fresh water bring out the heat from the engine through the water jackets of cylinder and cylinder head being pumped through the heat exchanger in a closed loop circulation, while seawater being pumped through the heat exchanger in opened loop circulation for heat transfer from the fresh water circulation and heat is dissipated to seawater. Sea water may bring in fouling of sea lives to accumulate inside the heat exchanger, it narrows the passage of flow and reduce the efficiency of heat exchange, and causing overheat of the engine. Those fouling inside the heat exchanger are required to be cleaned regularly.



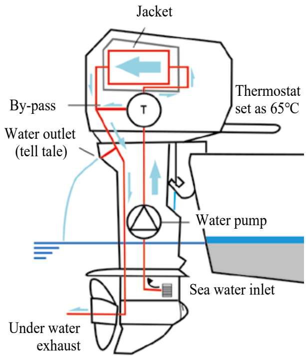
Fresh water indirect cooling

(4) **Keel cooling**: The vessel bottom cooling method means that fresh water is conveyed to the metal cooler mounted outboard, so that heat can be absorbed by the seawater around the vessel bottom shell. By adopting this method, it needs not the installation of heat exchangers, seawater pumps or evaporators and fans, etc.; the shortcoming, is that the water tube mounted outside the vessel bottom is exposed, and thus is liable to damage when contacting half-floating and half-sinking objects in the sea or when the vessel is stranded.

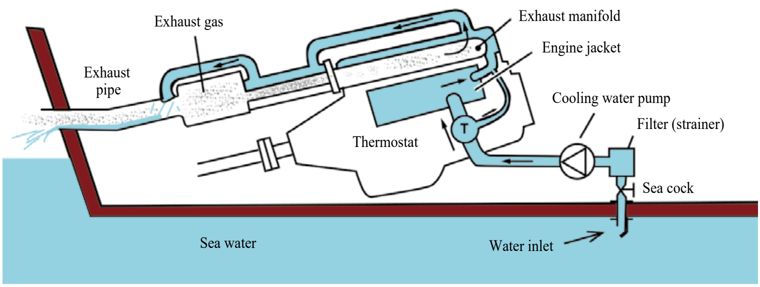




(5) **Direct seawater cooling**: the direct seawater cooling method is adopted for some engines. That is, to remove the heat by raw water (salty water of the sea, fresh water of rivers and lakes, etc.) at the location of the vessel. If this method is adopted, it isn't required to install the heat exchanger or vessel bottom cooler. Seawater passes through the water jacket of the engine after passing through strainer, and is discharged outboard with absorbed heat (some systems may have cooling water passes to the muffler and discharged outboard along with the exhaust gas). Fouling of sea lives or sand can accumulate in the water jacket after long-term usage and causing engine overheating. Therefore occasional cleaning is required.



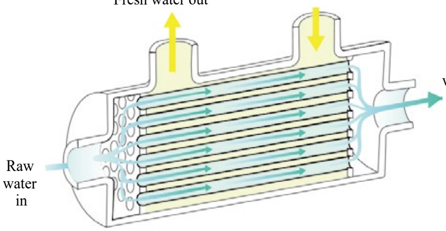
Direct seawater cooling method for 2-stroke engine

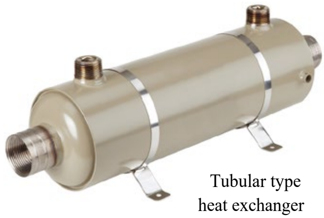


Heat exchanger

The heat exchangers allow heat transfer between two liquid without direct contact and mixing of the liquid. On vessel, heat exchangers are commonly used for cooling of fresh cooling water and oil of lubrication system of main engine. Tubular type heat exchanger and plate type heat exchanger are widely used in cooling system of engine and machineries.


Plate type heat exchanger




Tubular type heat exchanger

Cathodic protection

As salty water (seawater) is good conductor and can act as electrolyte, when two different electrochemical potential metals are immersed in the electrolyte, micro voltage will be generated between the metals. The galvanic action occurs with electron flows from the more negative electrochemical potential metal (the anode) to the hull metal (the cathode) where the anode corrodes and dissolves into the electrolyte, (galvanic corrosion).

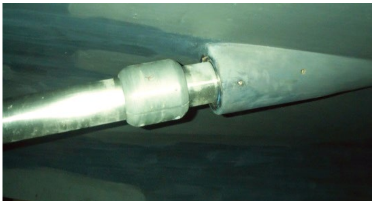
The corrosion of metal hull is due to the tendency on electrochemical potential of the hull metal to form compounds with other elements when immersed to seawater (electrolyte). To form a compound, electrons have to be removed from the atom of metal of hull so as to change the atom from neutral to positive charge ion, and which will combine with negative charge anions to forms compound.

The sacrificial anodes on hull is more negative electrochemical potential than the metal of hull thus provides electrons to restore the atom which has been lost with electrons thus to stop the metal of hull to corrode. Besides, the sacrificial anodes keeping provide electrons to the atoms of hull metal, causing its molecular structure to loose and decomposed.

During each overhaul of vessel on dry dock, the sacrificial anodes (e.g. zinc block) of metal hull should be replaced. The sacrificial anodes in the sea water pipeline should be checked from time to time, and to replace all significant corroded anodes for better protection of pipeline and heat exchanger.

Zinc bar

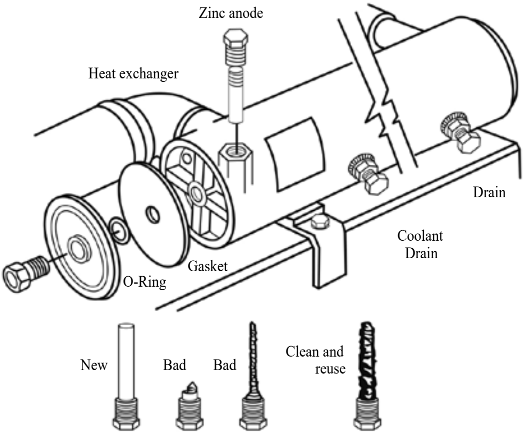
The zinc block is common type of sacrificial anodes



The zinc block mounted on the propeller shaft

The most commonly used sacrificial anode is made of zinc, and is widely used for protecting of metal hull, propeller, rudder blade, ballast tank, heat exchanger, sea valve, sea chest and outboard machine that contact with seawater.

An outboard engine should not be immersed in seawater for long period when not in use to avoid galvanic corrosion.



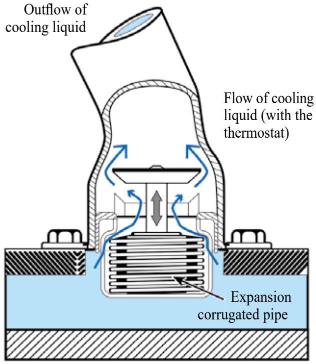
Bar-shaped sacrificial anode

The zinc bar should have well electrical connection with the heat exchanger. So, it only requires to be tightly fastened without installing of gasket.

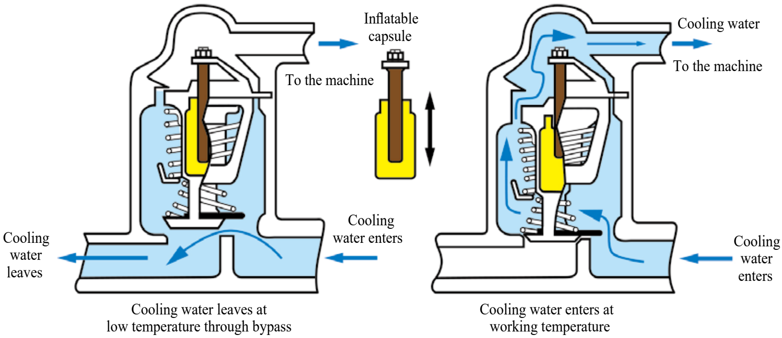
Thermostat

The engine that is cooled with the fresh water or sea water system is mostly equipped with a water temperature controlling device (thermostat) to ensure that the temperature of water in cooling system is within the appropriate range when leaving the engine. Overheating or overcooling of engine parts may result in seizure of moving parts and cause serious damages of the engine.

The thermostat is designed to control the flow of cold water to the heat exchanger, so as to ensure that the engine runs under the most proper temperature range.



Bellow-type thermostat



Common inflatable gas pocket thermostat

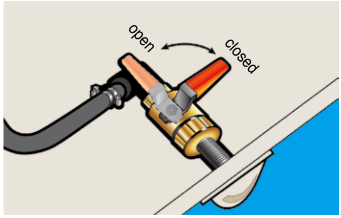
Function of cooling system

Cooling aims to absorb or remove the heat generated by engine operation through cooling water flows, engine oil or surrounding air circulation, the heat of combustion chamber, intake valve, exhaust valve and exhaust pipe must be suitable considered so that all parts run under the appropriate temperature.

If the engine is overheated, the metal of the engine body can be deform due to high temperature, the intake valve and exhaust valve can overheat and jam, the piston can over expand, and the cylinder will crack and drag (cylinder seizure).

Lubricating oil temperature gauge

In most old engine temperature sensor of cooling water would be installed with visual and audible alarms when the water temperature is too high. Recently, the engine will be fitted with various types of sensors, such as tachometer, water temperature, water pressure, oil pressure, oil temperature etc., and the respective abnormal situation will be displayed on the computer screen or control panel.



Sea valve

Before sailing, one should familiarised with the layout and operation of system on board a vessel, pipelines of the cooling system, operation of pumps and valves, and all positions of equipment, as well as the methods of cleaning the heat exchanger and seawater strainer.

The temperature of seawater of Hong Kong Waters changes with seasons from temperature of about 17°C in winter to about 30°C in summer; the temperature of seawater at outlet cooling line of about 35°C to up to 50°C (in case of wet exhaust system, the water temperature from exhaust pipe will be higher, and the discharged cooling water can reach a temperature of 60°C or above after the cooling water passed through the high-temperature exhaust gas pipe).

The temperature of internal cooling circulation of fresh water in an operating engine of about 78°C to 82°C, and the high-temperature alarm of cooling water is normally set at about 90°C. The engine oil in an operating engine of about 50°C to 80°C, and the high-temperature alarm of engine oil is normally set at about 95°C.

An engine operator should have thoughtful understanding with the working parameters of engines. Periodical checking and monitoring on the operating temperatures, pressures, oil level, etc. of the engine operation, and record the readings in the Engine Log book. Any abnormal condition on engine operation in compared with the previous records in the Engine Log book and should refer to the operating manual of the engine for rectification.

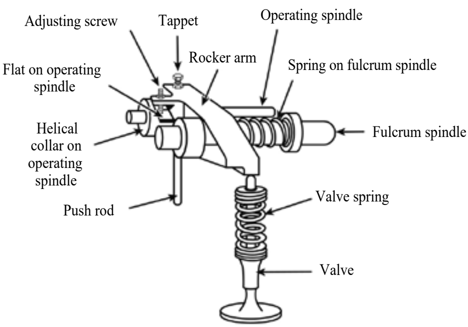
C Starting of main engine

Hand cranking

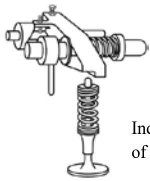
This method is frequently used for start-up of small engines. The engine is cranked manually till a reasonably fast rotational speed during start up (by store with inertial energy into the fly wheel), with fuel supply, the engine can start to run by its own power. For engine can be started up in hand cranking method, is mostly provides with compression release mechanism for slightly open of valves and so to reduce the force required when hand cranking. When the piston rises during hand cranking, compression force can be released by escaping of air through the opened valves. When the engine cranks in sufficient speed, supplying fuel and restoring the compression release mechanism back to the original position, and the engine should runs by its own power accordingly.

When the operating spindle rotates 180°, the helical collar on the operating spindle can push the rocker arm and shifts rightward along the fulcrum spindle under the action of springs, and the recess face on the left of the rocker arm is shifted onto the top end of the valve spindle. At the same time, the planar face on the operating spindle is rotated till, the adjusting screw acts on the planar face reaches the circumference of the operating spindle, so that a small clearance exists between the recess face of the rocker arm and the valve spindle that allows the intake valve can be open slightly.

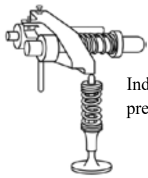
A well-designed compression release mechanism can restore the valve to the full pressure position. Rotating of the operating spindle, the spring on fulcrum spindle will restore the rocker arm position back to the left, and reset the adjusting screw on the planar face of operating spindle, the adjusting screw shorten the opening time of intake valve and increase the compressed pressure.



Indicating the normal rotational position



Indicating the position of pressure weakening

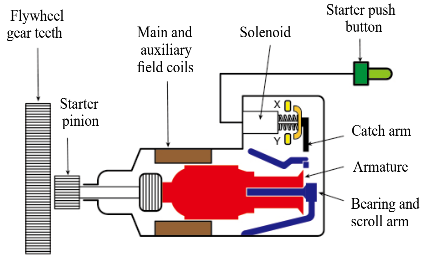


Indicating the full pressure position

Some engines adopting other starting methods are often associated with hand cranking mechanism.

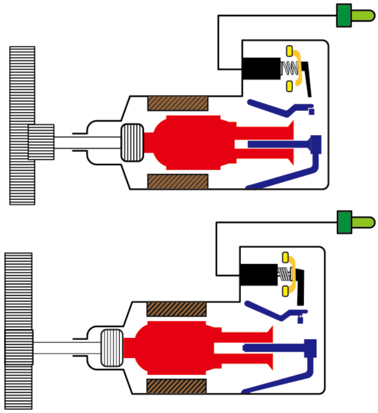
Electric starting

The electrical starting method was widely applies for small petrol engines and diesel engines start up. Once the starting button of the engine is pressed, driving pinion gear of the battery powered starter will engage with the ring gear on the fly wheel of main engine instantly. The flywheel is turned and cranks the engine to rotate until the engine can rotate with its own power.



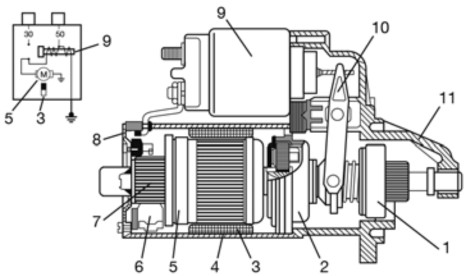
The position of a still starter

In the pictures, when the starting button is pressed down, the starter solenoid switch is energized and which will operates the main current switch of the starter with the close of contact point X, and thus the auxiliary field coil and armature coil are energized, so that the armature starts to rotate. At the same time, the scroll on the rotating shaft makes the armature to move leftward, leading to the starting pinion gear engages with the flywheel ring gear. With contact point Y is closed during the gear engagement, the main current flow through the starter and rotates so as to crank the engine.

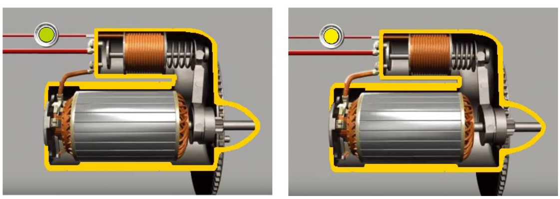


When the main engine can run with own power, the starting button released, the circuit of the starter will be opened. The position of the starter will be restored back to their original positions.

In addition, some devices are starting pinion poked with coils (commonly known as locking switches). In below pictures, when the starting button is activated , the solenoid switch make the inner plunger shift leftward and pulled the shift lever to make the starting pinion gear moves rightward to engage with the ring gear of the fly wheel of main engine. On the other hand, the solenoid closes the connecting point of the starter circuit (act as relay) so as to allow current supply to the armature and field coil of the starter. The rotation of the armature drives the driving pinion gear which engaged with the ring gear of the flywheel so as to cranks the engine.



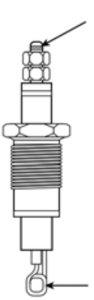
1. Overrunning clutch
2. Internal gear
3. Field coil
4. Enclosure
5. Armature
6. Brush
7. Commutator
8. Commutator end bracket
9. Solenoid switch
10. Shift lever
11. Drive housing

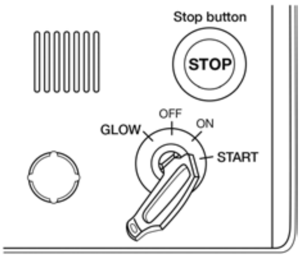


Glow plug auxiliary starting

Some engines are provided with glow plug for the assisting of engine start up in "cold start" condition. For modern engines, the glow plug is located at in the combustion chamber, and is provided with heating elements (heating wires) at the tip. For cold start, current passes through the heating element of the glow plug so as to heat the surrounding inside the combustion chamber, with the engine preheated, so that the engine can be start up easily. The glow plug can be turned off after the engine is started.

The glow plug makes the injected fuel mixture in the combustion chamber easier to be self-ignite by the compressed hot air.





"GLOW" on the left of the starting key switch is preheat of engine

Ignited Glow plug

Air start system - Compressed air is used in starting of large diesel engines. Compressed air from air receiver is supplied into the cylinder which the piston just passed the top dead centre and so to push the piston to move downward and to rotate the crank shaft of the engine. The compressed air is injected into next cylinders which the piston just passed the top dead centre based on the sequence of fire order so as to keep the engine keep rotating, and at the same time the rotational kinetic energy is stored by the fly wheel. When the engine rotates and reaches sufficient speed, compressed air injection will be stopped, and the fuel supply valve will be opened for the internal combustion and the engine will rotate with its own power. The whole starting process is completed within several seconds. The pressure of some air start system is about 25 bar (350 psi) or even higher, and that depends on the types of machines.

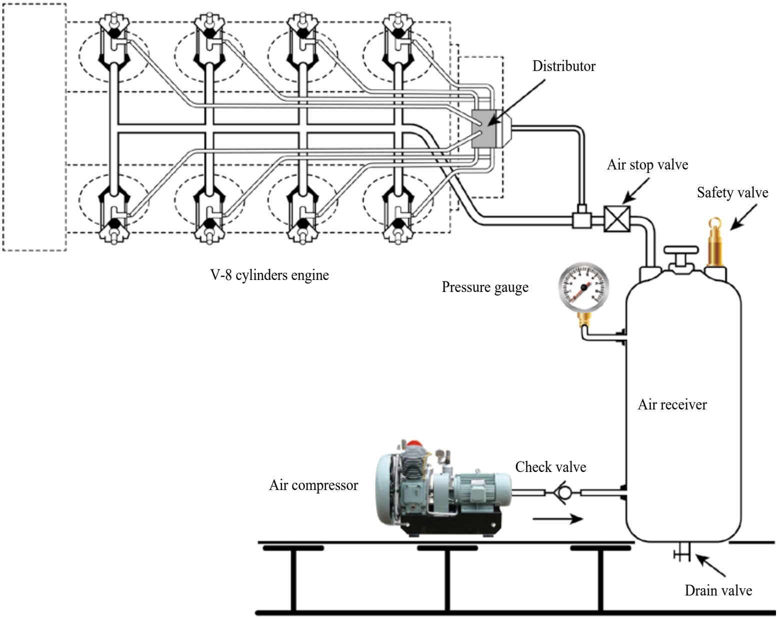


Diagram of the air starting system of cylinder engine

Compressed air is supplied by air compressors and stored in an air receiver. Most Compressors are driven by electric motors or by engines. The structures and operation of piston-type air compressors are similar to those of internal combustion engines. Similarly, the crank shaft drives the connecting rod to push the piston move up and down. With the piston moves downward, air is sucked into the cylinder space through the inlet valve, when the piston moves upward, the air inside the cylinder is compressed, and conveyed to the air receiver through a spring-controlled air delivery valve.

Although it is relative easy and reliable to start the engine with compressed air, safety on using of compressed air should be considered.

The compressed air starting system may be subject to the following risks:

- The air pipe or air receiver is subjected to over-pressurised and exceeded the limit of materials can cause material failure. The preventive measure is installed with a spring-controlled pressure relief valve so as to protect the air receiver and all system components from over pressurised. When the compressed air system pressure exceeds the specified pressure, the pressure relief valve will automatically open to release excessive air pressure. Once the compressed air system pressure returns to the set value, the relief valve will close automatically. To maintain the pressure receiver and relief valve in good condition, periodically inspection, and tested by the appoint examiner and obtain the certificates of fitness after the inspection.

- Oil that accumulates in pipelines and air receiver can cause explosion. When the air compressor runs, the dust in air can pass through the filter and pipelines and acuminates in air receiver. Those air-dust mixture can further mixed with the oil that used for lubricating the piston of the air compressor. When the engine runs, if leakage of starting air valve occurs, and the hot gas from the cylinder of engine is draw back into the compressed starting air pipeline and mixed with the accumulated oil and dust mixture, it can cause explosion.
- In case a high pressure pipeline bursts or a connector leaks, dust with fragments may be ejected out, it can endangering the safety of the personnel.

Precautions:

- To frequently check and clear any liquid or debris accumulated in the air receiver, filters and pipelines; keep the starting air valve tight and free from leakage, and ensure that there is a proper but not excessive amount of oil for the lubrication of the air compressor.
- If the air compressor is directly drive by the main engine, the air receiver should always keep sufficient compressed air to ensure there is enough air when needed. As a standby arrangement, an auxiliary small air compressor should be equipped on the vessel, so that compressed air to the air receiver can be supplied by the small air compressor in case the main engine directly drive compressor in failure.
- Only compressed air could be used for air starting. In case there is insufficient compressed air for in the air receiver, one should try to supply compressed air into the air receiver. It is prohibited to connect any other gases (e.g., acetylene gas for welding or oxygen) for air starting.
- The compressed air in the compressed air system can be used for engine starting, power source for the pneumatic tools and equipment in the engine room, and sound the horn.
- The quality of air in the compressed air system for the engine starting is not suitable for being breathed by human. It is prohibited to supply air to any compressed air cylinders for diving purposed or the breathing mask that is used for entering an enclosed space for work.
- In case diving work is necessary, an independent clean air system should be provided on the vessel for supplying of compressed air to air cylinders and divers.

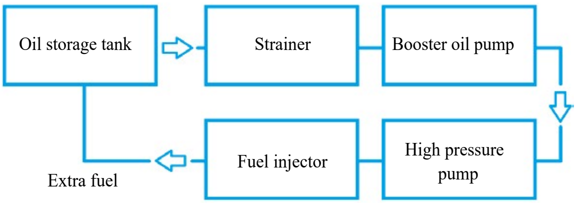
Generally, the compressed air pressure required for air starting of engines is about 25 bar (350psi) to 69 bar (1,000 psi). The rated pressure values are different and depending on the engine designs.

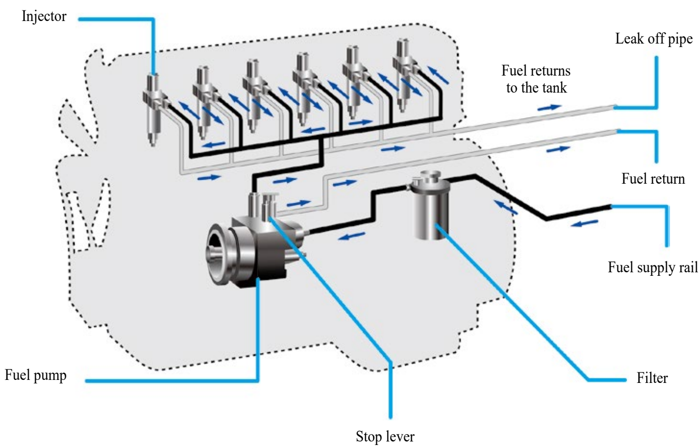
D Diesel engine fuel system

The fuel system of diesel engine consists of different designs and arrangements of the high pressure fuel pump and injectors. Two common fuel systems are illustrated below.

Common rail direct fuel injection: The rotary or distributor type high pressure fuel injection pump supplies fuel oil to each fuel injector through a high pressure common rail, while the injection timing of each injector is controlled by an engine control unit (ECU). The traditional system supply fuel by individual high pressure jerk type pump for each fuel injector, for most small engines, the jerk pumps are housed inline as a whole assembly, while the timing on action of each pump and the fuel injection relies on the upward stroke of roller tappet which operating on the camshaft.

Diesel fuel stored in fuel oil tank (daily tank) is supplied to engine, from fuel tank, fuel passes through filters removing impurities, debris and water (some systems may have fuel transfer pump and primary filters), and then to the high pressure fuel pump and fuel injectors.





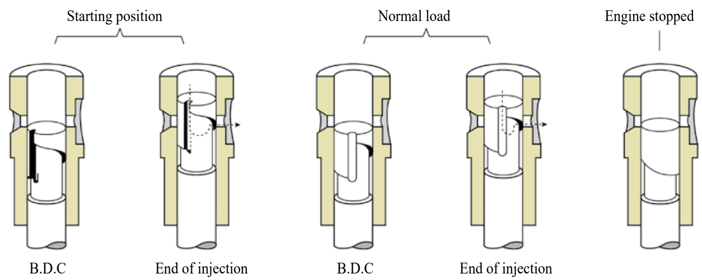
Common rail direct fuel injection diagram

The high pressure fuel pump ejects fuel into the combustion chamber under an extremely high pressure (1,000 psi to 3,000 psi or over).

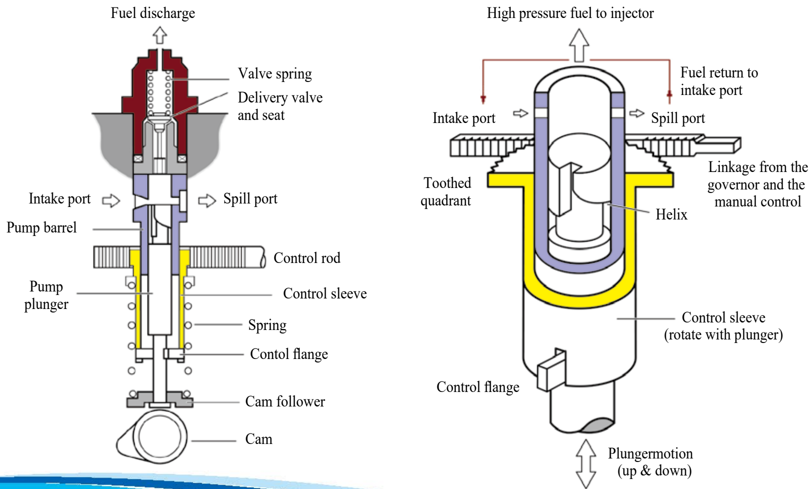
Operation of CAV Bosch fuel pump

The fuel pump element consist of plunger and barrel combinations made with high strength tooling metal in extremely lease of clearance between the sliding surfaces. The plunger moves up relies on the upward stroke of roller tappet which operating on the camshaft and restore position by the spring force. When the plunger moves down, the whole oil chamber is filled with fuel from supply port, where the plunger rises with the follower by the action of drive cam. The fuel inlet port will be closed with the plunger rise, and the fuel in the chamber will be compressed until the set pressure is reached and the fuel is forced to the fuel injector via high pressure pipe and inject into the combustion chamber of the engine.

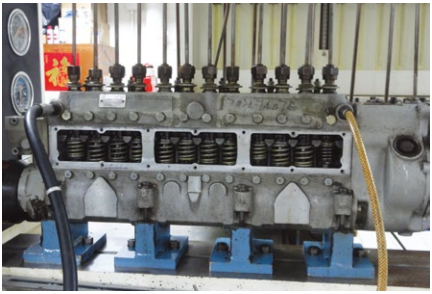
Fuel is continually delivered to injector from the delivery valve as sufficient of pressure due to the plunger rise, till the fuel pressure drop suddenly when the plunger helix reach the spill ports and the pressured fuel can pass through the groove from plunger upper to below and flow out from the opened spill port. As the loss of fuel pressure, fuel injection stops. The engine speed depends on the amount of injected fuel which is relied on the controlling of the angular position of the plunger by control rack and pinion.

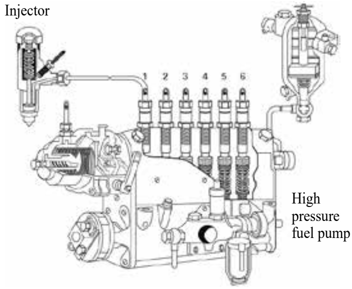


CAV Bosch fuel pump, cut-away view



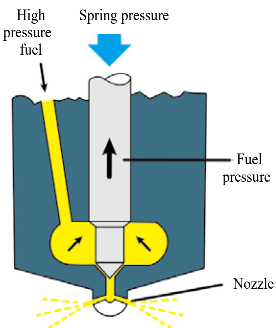
Fuel supply to each injector on combustion chamber of a multi-cylinders engine is provided by a high pressure fuel pump. In most small engines, fuel pumps are housed together as an inline pump assembly. In order to equalize the power generated by cylinders, the helix position of each fuel pump plunger of the inline pump must be in the same angular position which is controlled by the fuel control rack.

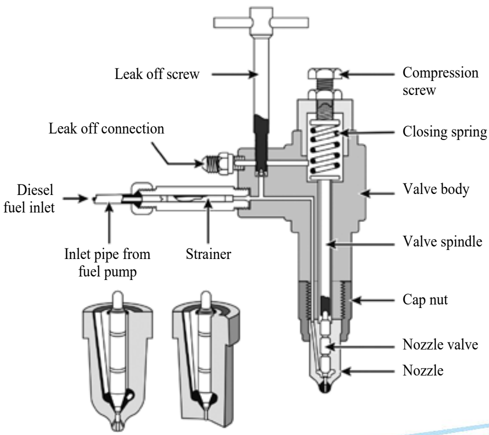




The high pressure fuel pump of diesel engine (for 12 cylinders) is commonly known as flush pump

Injected fuel must be atomized and mixed with hot air in combustion chamber for power generation. For better fuel atomization, the injection pressure of fuel to be sufficient high before jet out from the very tiny holes on the tip of the jet nozzle of the injector. When the fuel pump supplies fuel to the injector with the set pressure, the fuel pressure will jack up and open the needle valve against the spring force of the injector, and fuel is ejected through the tiny holes of the nozzle. As fuel pump stops pressurizing of fuel in respected to the position of the plunger helix, the fuel pressure in the high pressure fuel line drop, the needle valve of the injector will be closed by spring force, and so spraying of the atomized fuel stop as well. The pipelines of the whole fuel system are full of fuel, but the supplying of fuel to the combustion chamber is relied on the action of the fuel pump where the plunger action depends on the drive cam and the control rack.

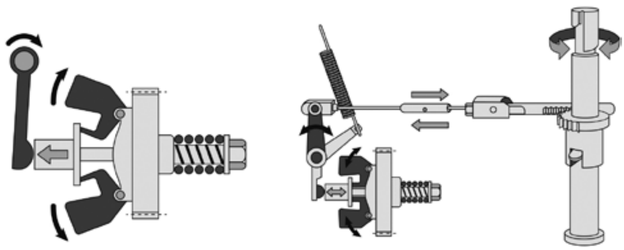




Governor

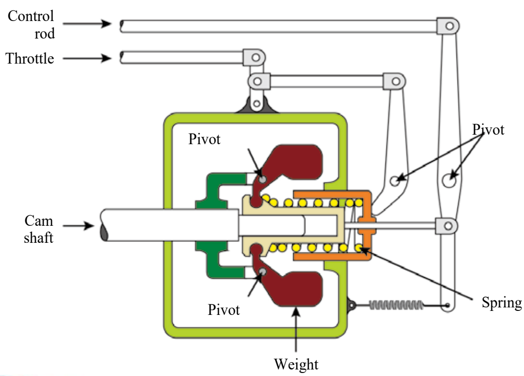
Almost all engines that have adopted jerk type fuel pump are installed with a governor for controlling of the engine speed. The governor controls the movement of control fuel rack which engaged with the pinion for controlling of the angular position of plunger of fuel pump.

The governor aims to controls the engine to run at the lowest idling speed steadily, so that the engine keeps running unless the engine stop switch turned on. On the other hand, it avoids the engine from over speed running such as the force acting on the propeller may become excessive momentary due to exposure of propeller to the sea surface when vessel navigates in bad weather.



Centrifugal governor

The cam shaft drives the flyweights to rotate with the yoke while engine running. The centrifugal force of the rotating weights is balanced by the speeder spring force and the control fuel rack will be kept in steady position. If the rotational speed of the engine increase by sudden decrease of engine load, the centrifugal force of the rotating weights leads the weights move outwards to compress the speeder spring, that move the control fuel rack drive the pinion of fuel pump so as to reduce fuel input. When the rotational speed decreases due to increasing of load, the rotating weights move inwards, the speeder spring extents, and the control lever will move toward an opposite direction to increase fuel input. The force of the speeder spring can be controlled by fuel valve control rod and the engine rotational speed depends on the position of the throttle control lever. The governors on some engines may operate with hydraulic, pneumatic or electric control fuel valve.



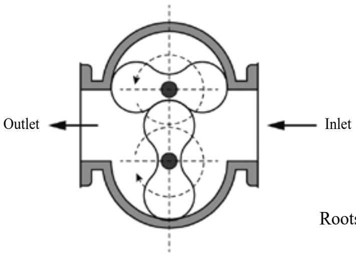
E Air Intake

In the induction stroke of 4-stroke engine, the combustion chamber will become partial vacuum due to the suction of piston so as to induce air (natural induction) for combustion. In most 2-stroke engine, air is forced into the combustion chamber. The following are several common air supply methods applicable to 4-stroke engines and 2-stroke engines: Super charger, Turbo charger, Crank case scavenging.

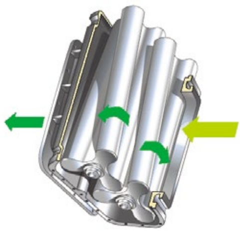
Super charger

Roots type blower is one of the commonly found superchargers. There are two lobed rotors (rotating vanes) in the blower, some roots blower could have 3 or 4 lobes, which are driven by the crank shaft through belts, chains or gears. When the rotors rotate, air is induced through the suction filter and discharged to the air inlet manifold, then to the combustion chamber during the induction stroke.

This type of supercharger is mostly used in the jet ski and speed racing boats.

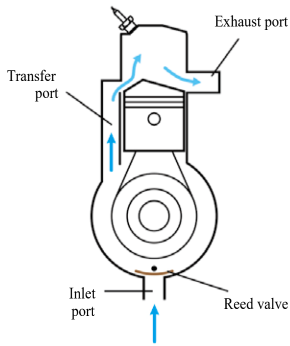


Roots blower



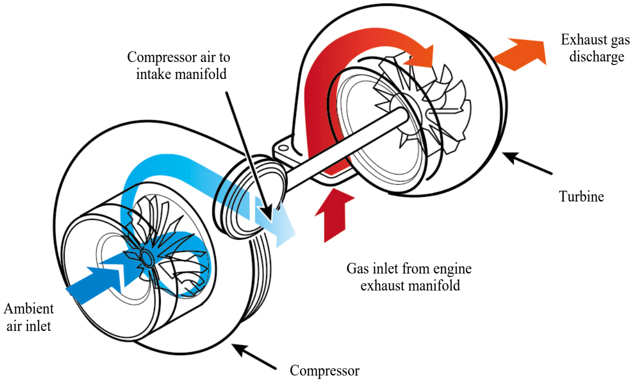
Crank case scavenging

When the piston rises in compression stroke, which makes the internal space of crankcase becomes partial vacuum, and air is induced from the inlet port through the carburettor and the opened reed valve. When the piston descends in the power stroke, the reed valve is closed and the trapped fuel-air mixture in the crank case is compressed by the pumping action of the descending piston. As the piston moves down the bore, the exhaust port will open so the exhaust gas discharges. Further descending of the piston opens the transfer port from where the compressed fuel-air mixture in the crankcase is inducted into the combustion chamber through the transfer port, and repeating the compression stroke. The designs of the ports and shape of the piston head improves the efficiency of the air- fuel induction and gas exhaust. This method is frequently used for small petrol 2-stroke engines.



Turbo charger

The turbine and the compressor are fixed on the same shaft so that both of them rotate synchronously. The compressor wheel is driven by the turbine wheel which is force to rotate by the exhaust gas from combustion chamber of the engine. The compressor induces air through the air filter and then the compressed air is blow into the air intake manifold.



Turbo charger

Both the supercharger and turbo charger enhance the total amount of induction air in diesel engine (this also applies to petrol engines) by the compression of the supplied air (or fuel-air mixture) to a pressure which is higher than the atmospheric pressure before being induced into the combustion chamber.

Air induction of diesel 4-stroke engines can be enhanced by addition of a supercharger or turbo charger. As diesel 2-stroke engines require for force induction in operation, supercharger will be used in most cases. The opening of the air intake ports and exhaust ports/valves in the cylinder is designed to let the exhaust gas passage has to be sealed before closing the intake ports so as to ensure that the air in the cylinder has been filled up with the compressed air before the piston starts the compression stroke. In petrol 4-stroke engines, it is required to make suitable measures concerning engine detonation when adding for force induction from naturally aspiration engine, including the engine compression ratio, fuel system, cooling system, valve timing, engine parts, body and cylinder head strength, etc.

The advantage of adding the supercharger or turbocharger for engine is to increase the amount of the induction air in the cylinder before compression, enabling combustion of more fuel in the same size of engine so as to increase the generated power. If the turbo charger is adopted, the exhaust gas heat discharged from the cylinder can change into power to improve the engine efficiency. A slightly power advantage can be obtained in comparing on the fuel consumption.

Inboard devices - Petrol engine

The inboard petrol engines can be 2-stroke engines or 4-stroke engines, the latter one is more common when used inboard.

The parts of a petrol engine are similar to an inboard diesel engine. Since the fuel being used on petrol engine is different from diesel engine, designs on the intake of fuel into the combustion chamber are different. Diesel engines require compressed air for intake in induction stroke due to high compression ratio so as to generate enough heat to ignite the injected diesel for combustion. In order to resist against the internal stress under high pressure from compression, the construction of diesel engines and the parts are normally stronger than a petrol engine with the same power.

The fuel combustion in petrol engine is ignited by electric sparks. However, detonation of the fuel-air mixture that passed the carburettor may happen if subjected to high pressure, which can seriously damage the engine. Therefore high compression ratio is not being adopted for petrol engine to prevent engine knocking.

The compression ratio of a traditional petrol engine is designed from around 7:1 to 10:1, and that of the compression ratio of diesel engines can reach 20:1 or higher. The higher compression ratio of the stroke results the higher work efficiency of the engine.

Compression Ratio (r)

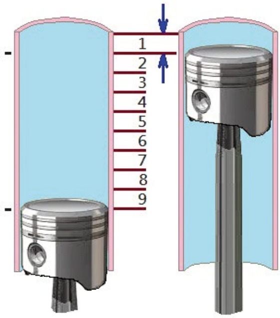
$r = {}^{v_2}/v_1$

v_1 = Initial volume (Clearance volume)

v_2 = Ultimate volume (Max. effec r volume) Let's take

the diagram on the right as an example: $r = {}^{9}/_{1} = 9$

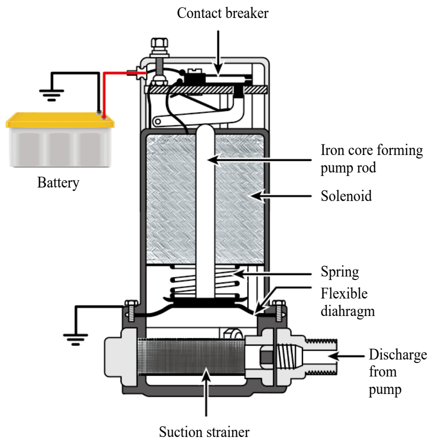
Compression ratio = 9:1



The major differences between petrol and diesel engines are their fuel supply systems and ignition processes. Before the compression stroke of a petrol engine starts, the injected fuel first mixed with air, and such mixed fuel-air mixture inside the combustion chamber is ignited by the electric sparks generated by the spark plug. For diesel engine, when the compression stroke is about to complete, the air in the combustion chamber is compressed and became hot. When the piston reaches near the top dead centre (TDC), the temperature of the compressed air is almost at the highest point, the diesel fuel then was injected into the combustion chamber and atomized through a high pressure injector nozzle, and the fuel is self-ignited immediately as contacting with the high temperature air.

Fuel Supply - Petrol Engine

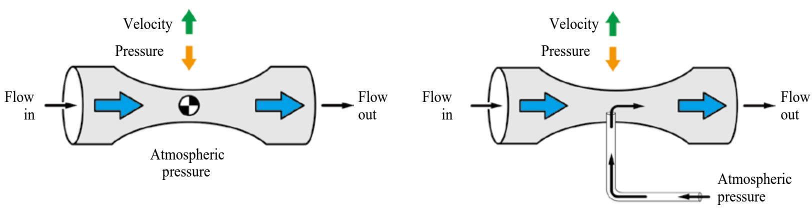
Petrol in the fuel tank is sucked by fuel pump and transferred into the carburettor. The fuel pump can be mechanically driven by the camshaft of engine, or electrically driven. For mechanical pump, the spring-forced diaphragm is pulled by the lever arm, which is under the reaction from the eccentric motion of the cam on camshaft and forces down by the spring force when the eccentric cam relax. As the connected diaphragm is pulled up, causes to the partial vacuum in the space below and sucking in fuel from the opening of check valve at inlet, on the contrary, when the diaphragm is pushed down, the check valve at inlet will close while the check valve at outlet open to let fuel pass to the carburettor. The pull and push motion of the diaphragm pumps the fuel into the carburettor.



For electric pump, current passes through the solenoid and creates magnetic field, which attracts the iron core upwards. As the iron core continuous to moves up until and acts to the contact lever to activate the contact breaker to open the circuit for the solenoid, the pulling force from the magnetic field will releases and then the diaphragm will be pushed by the spring force and restore its position. When the diaphragm is pushed down, the contact lever position is restored and so to reconnect the contact breaker again. This process repeats until the circuit is turned off.

A Carburettor

Carburettor is designed to work as a Venturi tube, according to Bernoulli's principle, the inflow and outflow of fluid (air) would be passing through the throat in equal amount. As the fluid entering a narrower section, its velocity increases while pressure decreases.



According to fluid mechanics, pressure changes as induced by fluid movements when passing through the throat, where the atmospheric pressure is higher than that of the throat (narrow section), and petrol will be sucked into the throat of Venturi tube by the vacuum to mix with the passing air before entering the combustion chamber.

In a petrol four-stroke engine, air enters and passes the air filter before reaching the carburettor. The petrol supplied from the fuel pump is attached to the narrow section of the carburettor would be sucked out by the vacuum as spray and immediate to mix with the passing air to for air-fuel mixture. The fuel-air mixture then enters the combustion chamber through intake valve. The throttle valve by means of controlling the airflow rate controls the amount of fuel supply. The fuel supply on multi-cylinders engine can be shared by a carburettor and an intake manifold. However, for high power engine, multiple carburettors may be employed.

When the engine running, the absorbed heat of the intake manifold can leads to the fuel-air mixture more easy to combust after being compressed in the combustion chamber.

The engine speed is controlled by throttle valve. The valve is after the flow out of the carburettor's Venturi tube. Lever control was arranged for the degree of opening of the throttle valve, thus the amount of fuel-air mixture to be transferred into the combustion chamber and so as the desire engine running speed could be achieved.

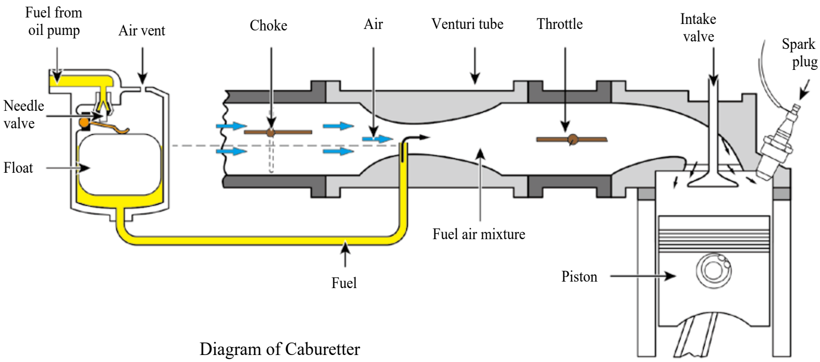


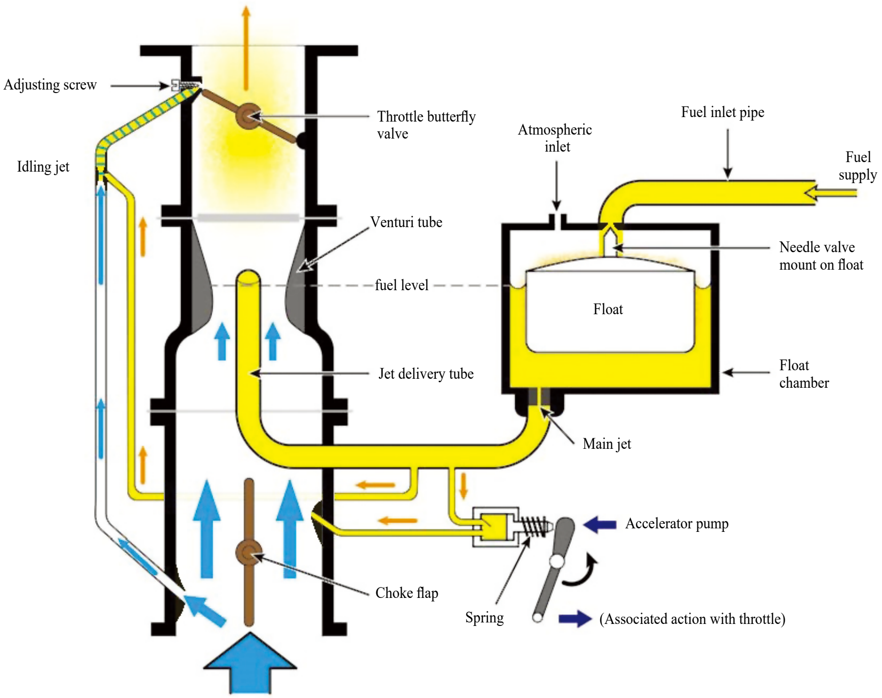
Diagram of Caburetter

The above diagram shows a simplified mode of works of a carburettor. Some carburettors may include the following components:

Idling jet —ensures the engine to run smoothly in low (idling) speed;

Accelerating pump — Its associated action with throttle valve and injects extra fuel as the throttle open to allow more air to pass the Venturi tube, more air cause reducing of fuel-air mixture concentration, acceleration pump supplies a little amount of fuel by the linkage action of the throttle valve so as to make the fuel-air mixture more concentrated, so that the engine can has better respond to the throttling control on acceleration;

Choke — most engines have chokes for cold engine start. In order to start the engine easier, the choke the airflow of the carburettor thus enhance the vacuum in the venture tube and enrich the fuel concentration in the fuel-air mixture. As soon as the engine warmed up, the choke to be reset to its original position manually or automatically to reduce the fuel consumption and emission.



B **Injector Modern petrol outboard engines**

Injector Modern petrol outboard engines usually adopted with fuel injection technique. Each combustion chamber in the engine equipped with its own fuel injector that directly injects fuel into the intake line before the intake valve, where the fuel mixes with air, the fuel-air mixture then be sucked into the combustion chamber during induction and then for compression.

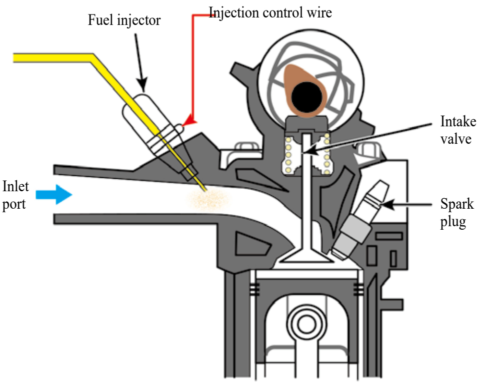


Diagram of Petrol Engine Fuel Injection

Fuel injection system includes an injection pump and an engine control unit (ECU). In each combustion chamber, there is a fuel injector. A set of sensors will collect the parameters of engine, including temperature of the engine, intake air temperature, pressure and flow rate, exhaust temperature, crankshaft position, Engine RPM and load, throttle position (to indicate acceleration and deceleration). Parameters will be converted into electronic signal and imported into the ECU. The ECU will calculate and export commands to adjust the amount of fuel injection.

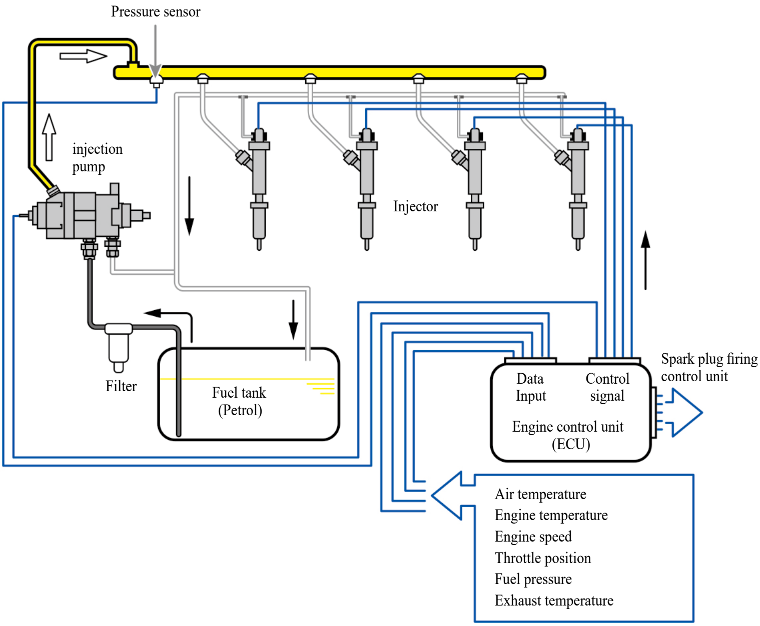
The fuel injection system allows fuel to be injected in precise amount according to the needs of the engine under different loads. Because enhancement of fuel control, the fuel can be completely burned in the combustion chamber and hence the better fuel efficiency.

Fuel injection is monitored and controlled by the ECU and the parameters that collected from various sensors are used to determine the amount of fuel required to be injected and the ignition time of the spark plug. The regular maintenance of engine is usually performed by the engine supplier. An external computer is connected to the monitoring and controlling of the fuel injection system for precision adjustment on performance of engine. The fuel injection system for petrol engine is well developed and reliable in recent years. The electronic system has many delicate parts that are sensitive to humid environment. Despite of their waterproof design of each component, one should pay attention to check if the waterproof caps, seals and covers are attached and working in good condition. Long-term exposure of electric or electronic components to humid environment might result in poor contacts between sensors and connectors.

Petrol is volatile and flammable, compressed fuel-air mixture in the fuel system leads to higher risk of fire if there is any leakage on the fuel line. One should stop the engine immediately for rectification if any leakage was found on the fuel line.

The full electronic controlled system of the engine cannot be started up manually if the starting battery and main system battery are out of power. Always familiar the engine’s features and precautions with the operator manual beforehand.

The electronic control system of fuel-injected engine is more complicated than the engine with carburettor. The fuel-injected engine is normally used on median to large sized outboard or inboard engine. Most small outboard engines still equipped with traditional carburettors.

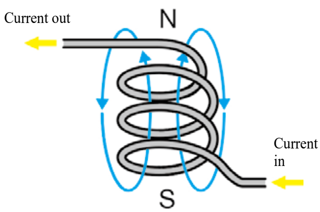


The engine equipped with fuel injection system is more efficient than engine with traditional carburettor, as the former gives a better atomization effect than the traditional carburettor which allows a better fuel-air mixture for complete combustion. The electronic control system also allows automatic, precise and quick adjustments of fuel injection timing and amount. As a result, the new generation engines are more power efficiency and emit cleaner exhaust.

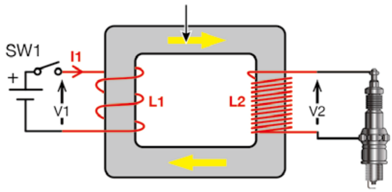
Solenoid ignition system

C

As electric currents passing through the wire, a magnetic field is generated around the wire. Magnetic field is a form of energy that is invisible. The magnetic field of a coiled wire become stronger and can act as a solenoid. If the soft iron core is placed and surrounded by the solenoid, the magnetic field can be temporarily stored in the magnetic flux in the iron core.



When the switch SW1 in the circuit is closed, electric currents can passing through the primary coil L1, as current in the coil is increase from zero to I1 gradually, the magnetic flux in the iron core at L1 would increase gradually as well (this is because L1 would encounter an electromotive force which is opposite to the increase of input voltage V1 as the change of induced magnetic flux in the iron core. As a result, both I1 and the magnetic flux increase gradually). A small amount of voltage difference could be detected against the increase of magnetic flux on the secondary coil L2. The changes of magnetic flux Φ in the core will stop when the saturated level is met; further increasing of the electric currents I1 in coil L1 was stopped. As no changes on the magnetic flux Φ, no induced voltage difference will be detected on L2 (no voltage difference between the two electrodes of the spark plug).



Transformer core

When the switch SW1 was opened, the electric currents on the primary circuit of coil L1 drops to zero immediately (the magnetic flux Φ also drop to zero immediately). Because of the rapid drop in magnetic flux, change of voltage difference V2 can be detected on L2. The sharper the change of magnetic flux, the higher the induced voltage difference V2. Since SW1 was opened, no counter acting electromotive force from L1 is will resist the change of magnetic flux in the core, in addition to the amplified effect in relating to the numbers of turns in coils L1 and L2, an sudden induced of voltage difference in the amplified level can be detected on L2 (generation of high voltage electric pulse in between the two electrodes of the spark plug).

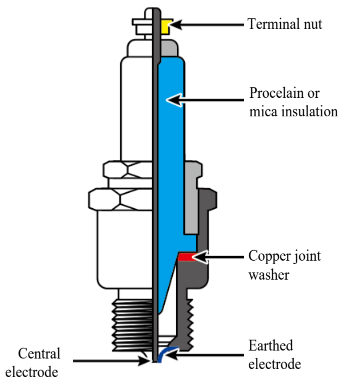
Thus, the switch SW1 can be seen as the contact breaker of the ignition system. The diagram illustrates the sparks occur as the contact breaker opens.

As the rapid changes in the magnetic flux resulting in high voltage on the solenoids, most manufacturers place a condenser or capacitor at the contact breaker to prevent arcing or damaging. On the other hand, the capacitor also facilitates the store of electric energy between the solenoid and the capacitor and forms resonance to prolong the time to produce the high voltage.

<u>Spark plug</u>

The fuel-air mixture in the petrol engine is ignited by sparks at a particular moment (the moment when the piston reaches the top dead centre). This is known as the ignition timing.

The spark generated from the spark plug provide extra heat source in the ignition process, in which sparks must occur at an appropriate timing to ignite the compressed fuel-air mixture to combust. The high voltage electrical source of the spark plug is generated by the dynamo, which is driven by the engine.



Most of the engine bodies are designed to act as the return path for electric circuits of engine. In a multi-cylinders engine, the timing on supplying of high voltage to the spark plugs is determined and controlled by the contact breaker through a distributor. An easy way to inspect the ignition system is to remove the spark plug (with the high voltage cable connected) and put the case of spark plug in contact with the engine body while manual cranking the crankshaft. Check for sparks occur and find whether the system is running normally.

(Before conducting the above inspection, ensure a safe operating environment as the operation is treated as operating in naked light. No petrol leakage or accumulated flammable substance should be in proximity. Keep the engine room well ventilated.)

The spark plug is made of two electrodes that allow sparks to jump over. Inspect the spark plug with the following steps: take out the spark plug from the cylinder head. The high voltage wire should still be connected to the distributor; crank the engine and blue-white sparks should occur between the two electrodes.

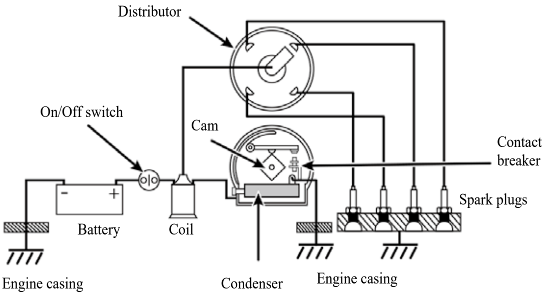
Engines should be equipped with spark plugs with appropriate length or of specific model, which they are installed at the centre or special assigned position on top of the combustion chamber. If a spark plug that is too long which will be crashed by upward motion of the piston. Spark plugs are designed to operate in high temperature to avoid accumulation of carbon particle due to incomplete combustion. However, if the temperature is too high, a hotspot might occur, which would ignite the fuel-air mixture before the spark ignition, results in false timing and power loss. If the engine will be operating in full speed for long period (hot engine), a cold-type spark plug should be installed; if the engine will be operates in full speed intermittently (cold engine), a hot-type spark plug should be installed.

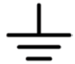
Spark plugs should be maintained constantly, keep the insulation clean, no damage or crack. The electrode clearance of spark plug can be in range from 0.6 to 1.8 mm depends on the engine type. The clearance can be measured by a feeler gauge.

The colour of the tip of the spark plug indicates the physical wellness of the engine:

White	indicates a deficiency of fuel in fuel-air mixture
Black	indicates an excess of fuel in fuel-air mixture indicates
Brown	the normal level of fuel in fuel-air mixture

Caution: Without special arrangement, earth wire and hull metal must not be used as part of electric circuits, while the latter can only be used for the purpose of earthing.





There are two sets of circuit in a coil ignition system, high voltage and low voltage. The metal casings of the components are connected to the engine body and forms return paths in both circuits. The electric current of low voltage path from the power source passed through the On/Off switch and primary coil to the contact breaker. The casing of the contact breaker forms the return path of current.

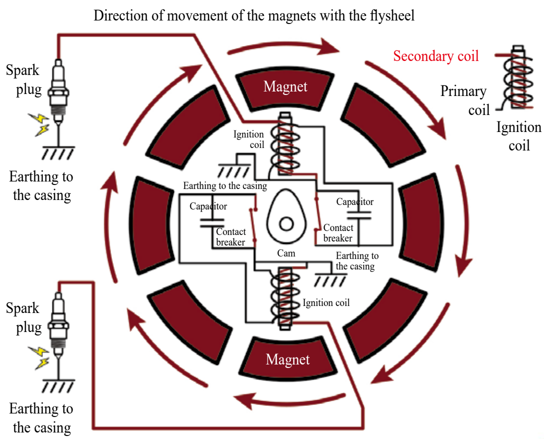
The electric current of high voltage path comes from the secondary coil which contacts to the rotor of the distributor. Then, through the copper distribution points, current can arrives to the spark plugs. Electric current jumps through spark plug's clearance to produce sparks. The electric circuit is completed with the return path by the electric path through the spark plug casings contacting to engine body.

Condenser/Capacitor

The condenser can stores electric charges and as a protection to the contact breaker. As the electric currents break in the circuit, the induced high voltage electric sparking produce by the coil can damage the surface of the contact breaker. A condenser is connected in parallel to the contact breaker points for arc suppression.

<u>Ignition magneto</u>

A magneto is commonly seen in a small petrol engine which is considered to be a small electric generator to generate the ignition current to replace current supplying from batteries. The magneto consists of a set of permanent magnets and the field coil surrounding the soft iron magnetic core.



The set of permanent magnets installed on the flywheel. According to electromagnetic induction, magnetic flux can be detected on the stationary coils as the flywheel rotates to generate electricity on the primary coil. As the engine rotates, about 10 to 20 volts (V) of electricity will be generated on the primary coil. When the contact breaker opens, (at the moment it opens, power is cut out in the primary coil will release the magnetic flux stored in the iron core, which can be detected by the secondary coil) the primary coil can detect high voltage electricity. Since the turns ratio between the secondary coil and the primary coil makes the voltage in secondary coil increases.

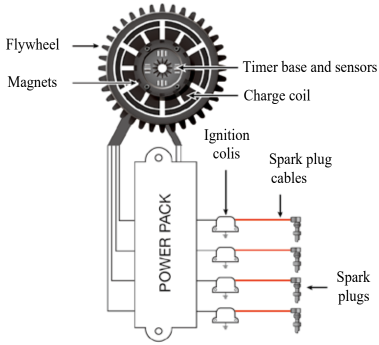
The secondary coil will generate about 5,000 up to 40,000 V of extremely high voltage (depends on the engine design). Since the secondary coil is connected to a spark plug, arc of sparks will be generated at the end of the spark plug. Each coil in the magneto only connects to one spark plug and no distributor. There might be 2, 4 or 16 pieces in a set of permanent magnets depend on the size and design of the engine.

Common faults for magneto malfunction are electrical leakages, overheating from short circuit or other reasons. These could cause damages in the insulated enameled wires between the coils. The damages in the insulation would be subjected to wear due to prolonged friction or accidental impact during maintenance, which can lead to short circuit in coils, loosen or damaged iron core. The power pack in the electric circuit in the diagram replaces the contact breaker to produce ignition electric pulse. If fuel injection system is used, the ignition time should be determined with the installed engine control unit (ECU).

Diagram of electrical ignition by a magneto

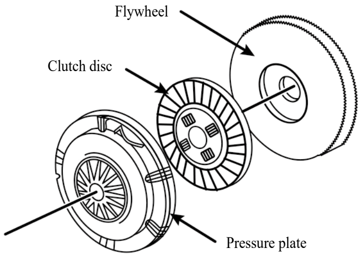
The electric circuit in the power pack replaces the contact breaker to produce ignition electric pulse, which is transferred to the ignition coil.

The "ignition coil" is in fact a boost converter or device. The red lines indicate the high voltage spark plugs wires.

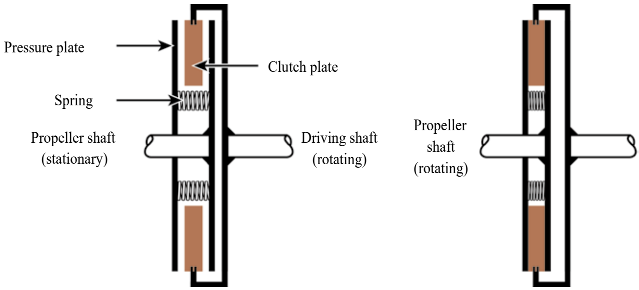


Clutch

A clutch separates the power transfer between the engine and its driving shaft. The surfaces of clutch disc and pressure plate are coated with abrasive substances. The clutch connects the surfaces of two metal discs. One disc is attached to the main engine (flywheel) and the other disc is attached to the propeller shaft's gear system. When the rotating disc on the main engine flywheel connects with the disc on the gear system of the stationery propeller shaft, the latter would start to rotate due to surface friction between the clutch discs and starts to accelerate until its rotation speed matches that of the main engine, and the clutch vibration will stop when clutch is fully engaged.



The clutch can deliver more power with multiple clutch plates. Occasional adjustment is needed to prevent the clutch from slipping and damaging the connected surfaces. A damaged clutch will lose its connectivity, thus it can no longer deliver power to the propeller shaft. The clutch will drag if it does not have enough gaps in neutral position (e.g. the gear shift lever is not in the centre).



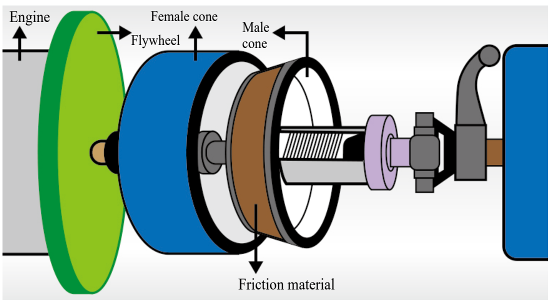
Clutch disengaged

Clutch engaged

Cone Clutch

Cone clutch runs in similar mechanism as the disc clutch. It uses two cone shaped curved surfaces for transferring of torque.

With the same diameter, the cone clutch is able to transfer higher torque than the disc clutch (it is because of the wedging effect and the increase of contact surface area).



Flywheel

In a rotating engine, a flywheel is the component for storing of rotational energy. It tends to resist changes in rotating speed. The force acting on the crankshaft is came from the reciprocating action of the piston stroke motion of engine. A flywheel reduces fluctuation and maintains the smooth rotation motion of the crankshaft rotation. Single-cylinder engine needs a heavier flywheel to provide the required power for strokes other than power stroke such as induction, compression and exhaust.

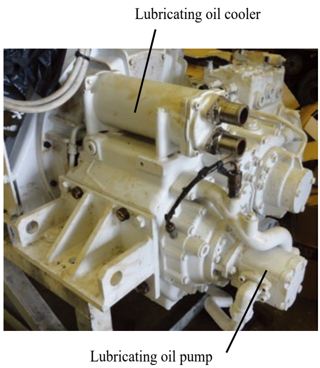
Gear box

The gearbox is used to reduce the rotating speed of crankshaft in order to meet the required rotational speed of the propeller shaft. The gearbox can also change the direction of rotation of the propeller shaft when in astern.

The crankshaft of the engine is connected to the gearbox where the rotational speed of the engine is reduced by gears and pinions. The power of the engine is transferred by these gears, which are lubricated with oil in the gearbox. The oil used in gearbox and engine are different and separated for their differences in function.

The ratio between the number of teeth on the gear and pinion determines the ratio of rotational speed between the driving shaft and the propeller shaft. For example, if the input gear has 11 teeth and the output gear has 110 teeth, then the gear ratio is 1:10. Given that the engine speed is 1,300 revolutions per minute (r.p.m), the propeller shaft would have 130 r.p.m. An addition gear (usually with the same teeth number as the input gear) for reversing of rotation direction can change the propelling direction when astern.

The lubrication system of gearbox including oil pump, safety valve, filter, oil cooler, etc. The oil level, pressure and conditions of the lubrication system (the oil pump, filter, tubes, heat exchanger, etc.) should be checked prior to each sail. Any leakages found should be rectified immediately.



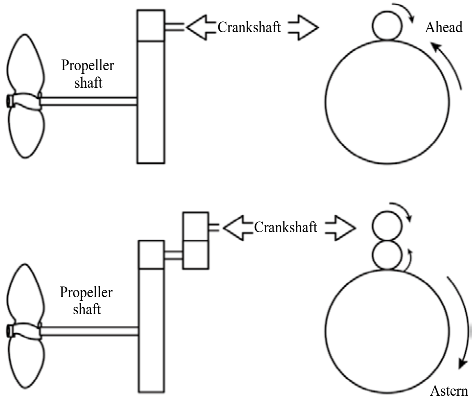


Diagram for the mechanism of a gearbox

Example:

If the input gear has 11 teeth and the output gear has 55 teeth, the gear ratio is 55/11 = 5:1.

If the engine is rotating at 1300 r.p.m., the rotation speed of the propeller shaft would be 1300r.p.m./5 = 260 r.p.m.

Changing the rotating direction of the driving shaft can be done with different methods, such as by the aforementioned gear for reversing in gearbox, or can be done by a set of bevel gears in outboard engines.

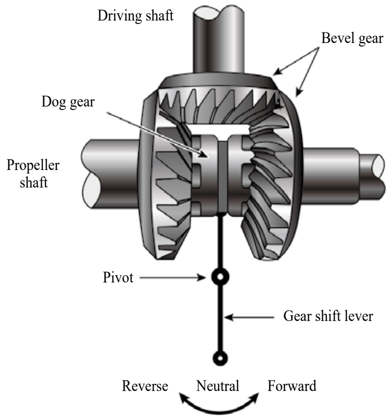
Main engine –
1,300 revolutions per minute
(r.p.m)

<u>Outboard engine gearbox</u>

The bevel gear in an outboard engine can reverse the rotating direction of the propeller shaft.

- The driving shaft is powered by the engine and connected to the bevel gears on the propeller shaft.
- When the driving shaft rotates, the bevel gears rotate in opposite direction.
- There is a dog gear (dog clutch) between the two bevel gears on the propeller shaft. The dog gear is gearing with the propeller shaft and can slide back and forth between the bevel gears on the propeller shaft.
- The gear shift lever controls the dog gear's position on the propeller shaft.
- When the dog gear is in the middle, it has no contact with the two bevel gears. Therefore, the driving shaft and dog gear rotate without contacting. This is the neutral position.
- When the dog gear is shifted to forward or reverse, it contact with one of the bevel gears. The bevel gears are engaged and transfer power from the driving shaft to rotate the propeller shaft (forward and backward).
- The dog clutch and the bevel gears need to be lubricated with specified grade of oil which required regular replacement.

Some small outboard engines are equipped only with throttle control but without gear or clutch control. For such vessels, the engines need to be turned off when not underway. Once the engine was started, the vessel can only move ahead. Astern motion of vessel can only be done by turning the entire outboard engine to reverse direction. Extra attention should be paid when operating such vessels. This design is found on small outboard engines with 2-4 horsepower.

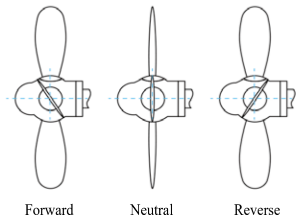


On large size 2-stroke diesel engine, The direction change on rotation of propeller shaft is done by stopping of the main engine first, then reset and adjust the camshaft position, after that, restart the main engine in reverse direction sequence. The operation of oil pump and starting system would enter reverse mode driven by the reverse rotation of the reset cam.

Another method to make the vessel to move astern is to install with a controllable pitch propeller. By changing of the orientation of blades of the propeller without changing on the rotation speed or direction of the propeller shaft, the ahead, neutral, astern and vessel speed could be controlled.

Pitch

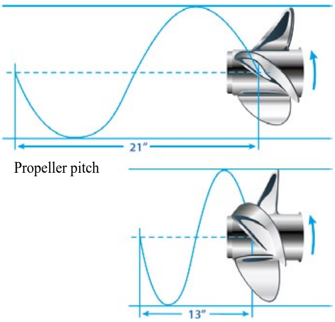
Pitch of a propeller is the distance of an arbitrary point on the propeller will travel by one revolution of the propeller. The unit of pitch is usually measured in metre (m), centimetre (cm) or inch (in). The pitch of a controllable pitch propeller can be controlled to positive (ahead), negative (astern) or zero (neutral). In neutral position, the engine keeps driving the propeller shaft to rotate steadily, but there is no thrust from the propeller to the vessel motion is generated.



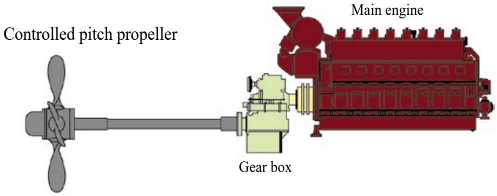
Controlled pitch propeller

If the propeller pitch was too large, it would bring excessive load to the engine when sailing. The engine will difficult to reach the highest engine speed and lead to excessive vibration and emission of black smoke. If the pitch is too small, there is too least load to the engine. The highest engine speed can be reached without fully utilize the engine power.

If a new vessel is equipped with outboard engine, the optimum propeller pitches can be tested during the sea trial to see if the propeller that allows the highest speed of the vessel and the engine.

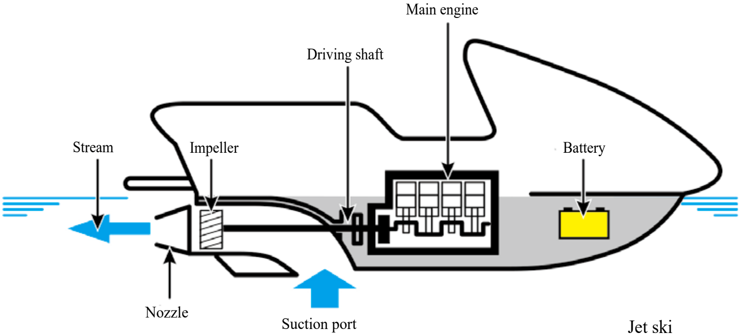


Propeller pitch

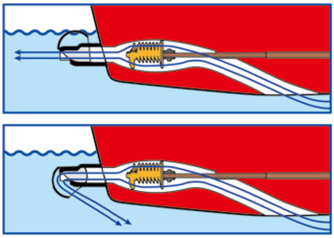


Jet Ski

Jet Ski does not equip with propeller shaft. Instead, it uses petrol engine to drive impeller in, a pump jet. The pump jet sucks in water from the suction port at hull bottom, as water is pumped by the engine drive impeller and discharged as jet stream at the stern through the nozzle, the reaction force as generate from the jet stream push the Jet Ski forward. The nozzle can be controlled to swing left or right to change course, thus a jet ski needs not to have a rudder. Most jet skis are equipped with clutches for motion ahead but do not have reverse gear for motion astern. In order to move astern, a reversing bucket installed at the nozzle outlet to change the direction of water jet flow. Then the return thrust from the water jet pushes the jet ski move backwards.



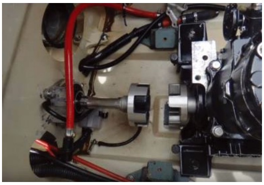
Jet ski

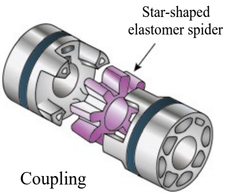


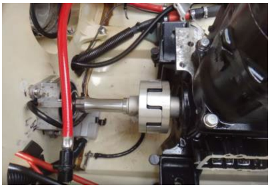
Cooling Water Tell Tale

Engine Alignment

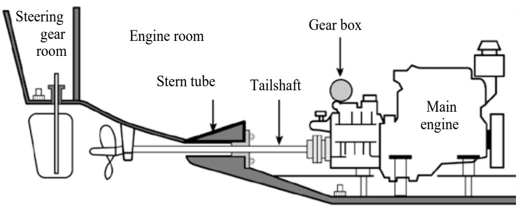
For better efficiency on transferring of the engine power to the propeller shaft, the proper alignment between the couplings of the propeller shaft and the engine, (in most cases through a gearbox) is necessary.

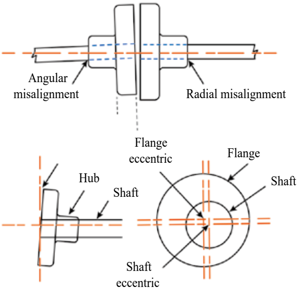


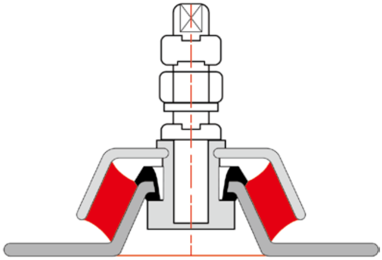




If there is misalignment between the engine and the propeller shaft, the engine may running with excess vibration that can causes overloading to bearings, and damages the engine mountings. If the excess vibration happens in the shafting, it can cause the screw bolts on the couplings be broken or the stern tube bearing be damaged. It can leads to water leakage and flooding in the engine room, or even sink the boat. Some vessels would install a flexible coupling to allow slight deviation in engine alignment.



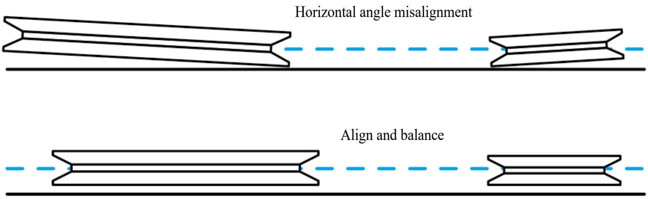




Red part: rubber damping

Engine mount

- All engines shafts alignment of new vessels are proper aligned and checked by the ship yards when the vessels are delivered. However, the bearings, couplings, engine mounts, other parts, etc. of the engine may subjects to wear and tear according to the frequency and period of vessel to be used. The hull rigidity may be changed slightly because of external forces and defects of structural members where the hull experienced, which change the engine alignment, cause gearbox mounting screws come loose due to unbalanced holding force or excessive vibration. All of these may affect the accuracy of the engine alignment.
- If excess vibration is found during the engine operation while the vessel not having been stranded or encountered with accident previously, it should be checked at once if there is anything is entangling with the propeller shaft. If that was not the problem, the rubber damping on the engine mounts, engine mounting screws, the flexible element of the coupling etc. should be checked if any crack or damage.
- On the other hand, the transmission belt drive and pulleys might also experience regarding alignment adjustments and excess vibration of engine. The problem could be caused by prolonged stretching of a tight belt, wears in the bearing or lack of lubrication in the bearing.
- The engine should be slowed down and checked immediately if any abnormal arises. Under safe condition, stop the engine for a thorough check up.
- The engine alignment is normally handled by shipyards or registered contractors.



Belt adjustment criteria

If the propeller is damaged or subjected to contact with seabed, it should be replaced. It should be aware that if any bends or damages on the propeller shaft and bearings occur, replacement of the related stern tube bearing and conducting the engine alignment if required.

(18) Outboard engine

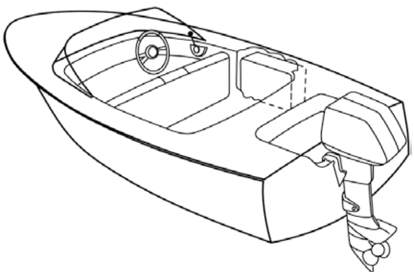
The outboard engine is similar to inboard ones. The major differences are the method of engine installation and power transmission to the propeller

The power transmission of inboard engine the propeller through the propeller shaft which passing through the stern. Propeller thrust is from the propeller will reach the thrust collar and bearing and transferred to the hull via the thrust bearing.

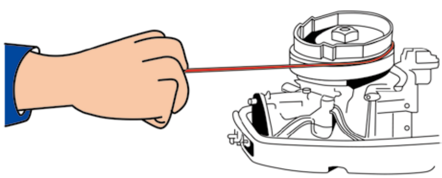
Normally the propulsion system of an outboard engine is more compact and lighter than an inboard engines propulsion system. The outboard engine transmits power to the propeller through bevel gears and vertical gear shaft. The thrust from the propeller will act on the structural stern plate and there is no need for thrust bearing.

Most of the earlier outboard engines are petrol 2-stroke engines, where the fuel-air mixture was inducted into the internal space of crankcase via the reed valve at the bottom of the cylinder. For these petrol 2-stroke engines, the fuel should be mixed with engine lubricating oil before being combusted. For the old model engines that the exhaust gas produced does not fulfil the current environmental protection requirements are being phased out. The power range of outboard engines is generally started from 2.5 horsepower single-cylinder engine to 350 horsepower multi-cylinder engine.

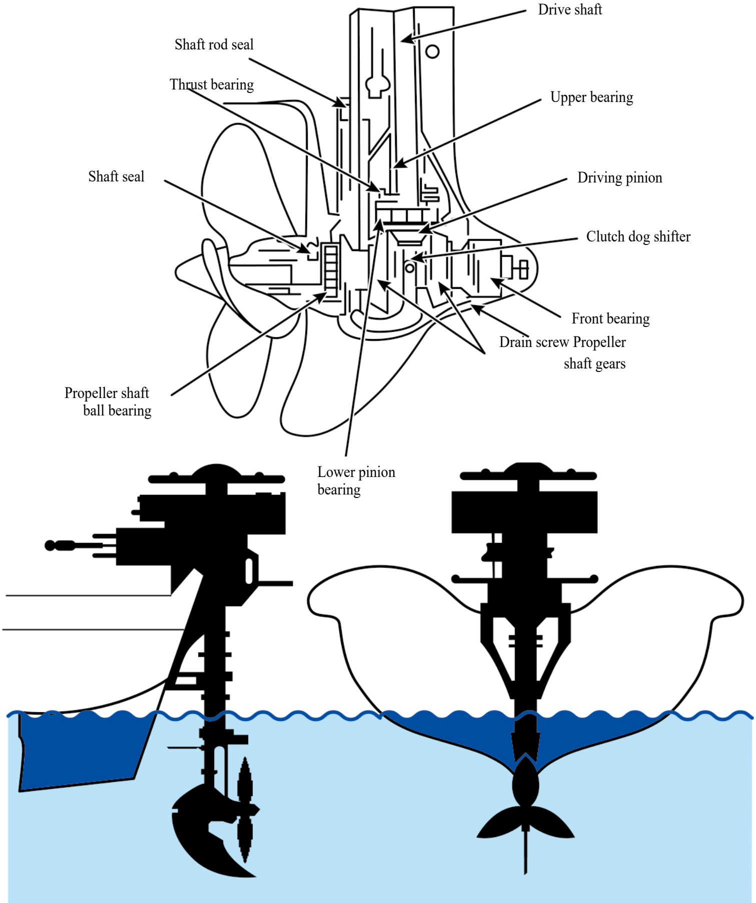
Most of small outboard engines can be started manually. To manual start the outboard engine, a lanyard is wrapped around the ratchet on the flywheel of crankshaft. Pulling the lanyard to crank the engine, hence the reciprocating piston creates vacuum and sucks the fuel-air mixture into the combustion chamber. Manual engine start may also be applied to start a medium-sized outboard engine. Larger size outboard engines are usually equipped with electrical starting system, which includes a starting motor, a battery, a dynamo and a battery recharge circuit. Besides the dynamo of the outboard engine can recharge the battery, it can also produce electricity on board for electrical equipment.



Pleasure craft with outboard engine installed in place



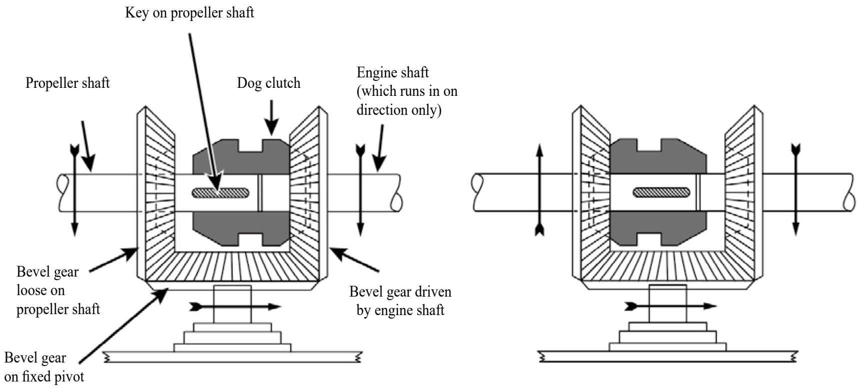
Hand starting system



Details of outboard engine drive shafting

Reverse

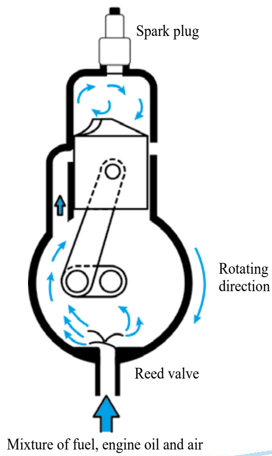
Besides of the small power outboard engines (2.4 horsepower or below), most vessels are equipped with reverse system for motion astern. The reverse system as shown in below diagram is general used in outboard engines. Astern motion of vessel with outboard engine is to engage the drive shaft with the bevel gears on the propeller shaft by shifting of the dog clutch from (A) to (B) as below. The shift of dog clutch separates the propeller shaft from the engine shaft in motion ahead, and then the propeller shaft rotation will follow the bevel gears, which is engaged by the shifted dog clutch. Thus the rotational direction of the propeller is controlled by the shifting position of the dog clutch.



Some small outboard engines are not equipped with dog clutch. For those vessels equipped with such engine, the entire engine is needed to be turned backward in order to go astern. This type of engine needs to be switched off when not underway.

Outboard engine fuel system

The outboard petrol 2-stroke engine intakes fuel-air mixture from the bottom of the cylinder lubricant was added and mixed with the fuel in the fuel tank for lubrication of engine. The ratio of lubricant to fuel is listed in the manufacturer manual for each engine model (50 parts of petrol to 1 part of lubricant in most cases). The fuel air mixture with added lubricant provides lubrication for the bearings and cylinder liner when getting into the engine. Some outboard engines equipped with gear driven lubrication.



Outboard engine cooling system

The engine drives the circulating pump to pumps seawater to circulate the water jacket and cylinder head for direct cooling. The seawater inlet is located below the anti-ventilation plate of the propeller shaft and gear housing. The outboard engine on vessel can act as the rudder in changing of course during navigation. By turning the direction of the entire engine, which accompanied with the propeller shaft, gear and propeller, as the direction of the thrust from the propeller was changed, the steering of vessel's course was made.

Some small vessels equipped with outboard engines are also equipped with bilge water pump. This help to keep the bilge dry. All the strainers at the suction heads of the manual bilge pump or electrical pump should be kept clean. The bilge system should be maintained, examined and test regularly.

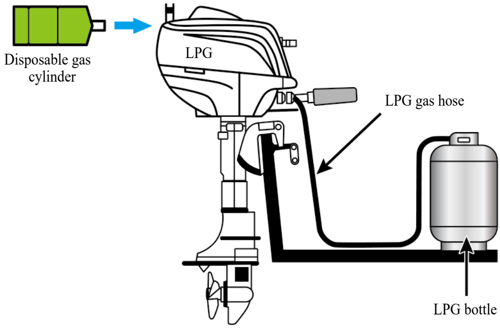
Safety measures for fuel storage and usage

1. Do not store excessive petrol fuel on vessel. (Fuel not stored in the designated fuel oil tank is considered as excessive oil storage).
2. Only manufacturer specified portable fuel containers for outboard engines are used for handling of petrol on board. The container must be equipped with suitable ventilation arrangement.
3. Portable fuel containers should be stored in well-ventilated spaces, such as on open deck. Fuel containers, valves, tubes, connecters, fittings, etc., to be made by suitable materials, and should be secured and protected to prevent from collision, drastic temperature changes or exposure to direct sunlight. Fuel container, storage rack, related valves, tubes and connectors must not have any leakages. Check and rectify immediately if any leakage found.
4. Storage places must be kept away from any heat source, if needed, display with signs of "NO SMOKING" and "NO NAKED LIGHT".
5. Except as fuel supply to outboard engine, petrol fuel cannot be used for any other purposes so to prevent potential fire hazard.
6. Remove all petrol and containers from the storage place if there are considered lack of monitoring for an extended period unless the storage place has good ventilation.

Outboard engines using Liquefied Petroleum Gas

Vessels with outboard engines using liquefied petroleum gas (LPG) are mostly small open sampans that are being used for sightseeing purpose in inland rivers or lakes. Pay attention to ventilation when using LPG to prevent any leakage or accumulation of flammable gas. Carburettor, tubes and connecting ports should be checked regularly for any blockage or leakage. Naked fire is strictly prohibited to avoid any accidents. Carburettor is equipped on these outboard engines in using LPG to turn gas to mix with air to form fuel air mixture. Then the fuel air mixture will passed to the combustion chamber (cylinder) to generate power. In some conditions, the carburettor might freeze and block the fuel system. Cautious should be taken during operation.

This type of outboard engine is not commonly found. Always read the operator manual for normal operation, understand the potential fault and solutions to prevent danger.



Small open sampan with engine using LPG

Tool kit

A set of tool kit supplied by the outboard engine manufacturer should be kept on board for urgent repairing, it should including basic tools and components such as pliers, screwdriver, box spanner, spare shear pin, cotter pin, spare spark plug, etc., The rope with a handle is used for manual starting of the outboard engine in case of electric starting system malfunction. Always keep a spare safety lanyard on board for emergency purpose.

Tool kit

Safety lanyard

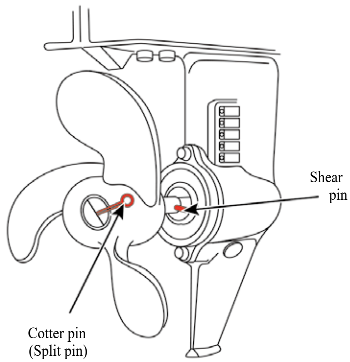
Protection of propeller for outboard engine

Shear pin

A shear pin is inserted into the hole at the back of the propeller shaft. When the propeller shaft rotates, power would transmit through the shear pin to the propeller. In the case of collision between the propeller and rocks in seabed, the shear pin would be sheared if the force is strong enough, which lead to separating of the propeller from the propeller shaft. Thus, the propeller is protected from severe damaging.

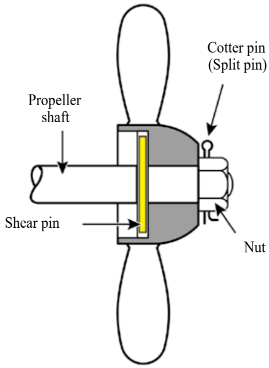
Regardless of the force of the collision between the propeller and rocks in seabed, the shear pin is likely being damaged even if it seems not broken or deformed. Always keep a spare shear pin on board for replacement.

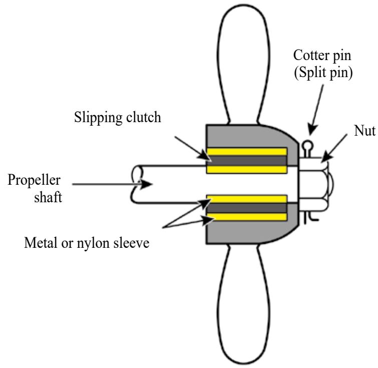
It requires a specified force to break the shear pin. Some pins might have indent for reducing of the shear force. It is important not to use other metals to replace the shear pin, or cannot protect the propeller from severe damaging.



Cotter pin

The cotter pin is inserted into the hole or slot of the propeller nut and through the propeller shaft hole to prevent the propeller to separate from the propeller shaft.





Propeller clutch ring

Propeller clutch ring is a rubber ring located between the hub of the propeller and the propeller shaft. In case of collision between the propeller and rocks in seabed, it cause damage of the rubber ring and allow the propeller shaft to spin itself without transmitting sufficient torque to spin the propeller. In such cases, the propeller was protected from serious damages.

Regardless of the force of the collision, the slip clutch is likely damaged. There should have a spare propeller clutch ring set on board for replacement or it should be replaced immediately after sailing.

Propeller guard

The propeller guard is usually made from aluminium, stainless steel or plastic. It is a mechanical protection device to protect the propeller from damage as it avoids the propeller to collide with rocks from sea bed. It cannot prevent animals or swimmers in water to be injured by the propeller.

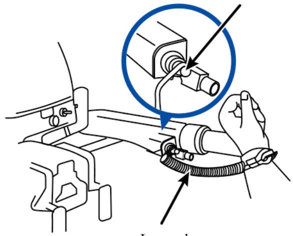
Safety lanyard/Kill cord

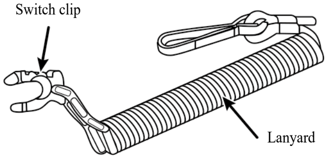
The safety measures as recommended by manufacturer should be followed when operating on high speed open-deck vessels (such as speed boat and jet ski) so the engine can be stop when the vessel is out of control.

On outboard engine, there is usually an engine stop switch on the control stick or main engine control panel. Apart from normal start and stop, it can also be used for emergency braking.

Safety lanyard should be connected to the operator's wrist or life jacket. In emergency, if the operator leaves the control position, the safety clip would separate and turn off the main engine immediately.

Caution: If the main engine cannot be switched on while starting, it is likely because the switch clip of the safety lanyard is not properly clipped.





(19) Auxiliary Engine — steering gear, pump and electric generator

(A) Steering gear

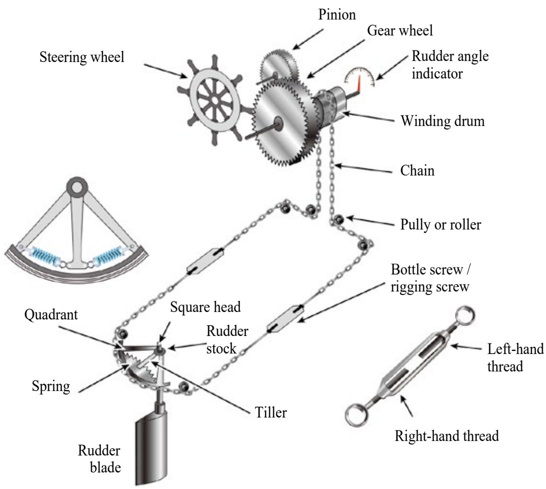
Gear, chain and connecting rod are commonly used as steering gears on small size vessels in Hong Kong. The mechanism of this type steering gear is simple, reliable and easier for maintenance. The gears, chains and rods should undergo regular check and lubricate to avoid rusting. Rusty parts should be rectified or replaced. Keep the rod passage clear, lubricate and check of pulleys and bearings regularly. Check the wear of the components for arranging of repairing.

Helmsman changes course of the vessel with the steering wheel. Through the connected gears, chain and rod, the quadrant on the rudder stock is steered to the intended angular position. Springs might be installed in the quadrant to allow slight swings of rudder to offset the impact from heavy waves in navigation. The rudder will return to its original angular position by the spring force after the wave passed. This prevents from damage to the steering gear caused by external force. The rudder should be stripped to check the clearance between the rudder stock and the rudder trunk bearing regularly. Too large clearance between rudder stock and bearing could cause difficulties in steering control.

Larger vessels may be equipped with power steering gear such as hydraulic steering gear. The oil pump on the steering wheel pumps hydraulic fluid to the hydraulic cylinder when the steering wheel is turned. The hydraulic fluid in the cylinder pushes the piston inside which drive the ram to turn the connected tiller arm of rudder.

In case of hydraulic system of the steering gear malfunctions, an emergency tiller kept on board could be used to connect to the rudder stock immediately for emergency manual control of steering.

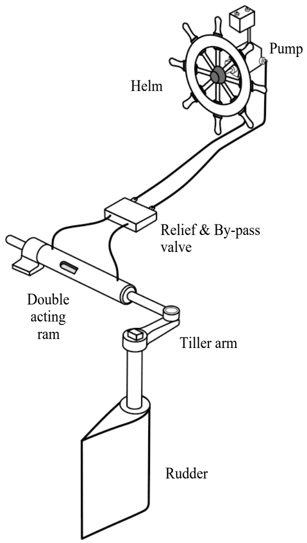
The hydraulic steering gear should be maintenance and checked thoroughly by professionals regularly. The emergency control of steering should be tested regularly to ensure the operation and performance of the steering gear system. Crew members should be familiar with the handling and operation of the steering gear.



Chain & Rod Steering System

The steering gear system consists of the following parts:

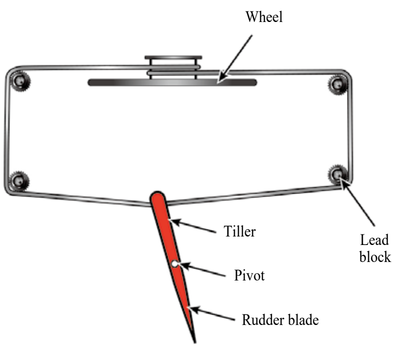
1. Remote control: a transmitter on the bridge and a receiver in the steering gear compartment.
2. Actuator: The actuating unit of steering gear. It can be manual, electrical, pneumatic or electro-hydraulic actuated.
3. Tiller: to transmits the torque from actuator to rudder.
4. Rudder: It changes the vessel's course direction by the generated torque from thrust act on the rudder blade while change of water flow direction.
5. Auxiliary steering system/arrangement must be equipped on board vessel for emergency steering control.
6. The rudder can be steered to 35° at each port and starboard. The movement from the 35° right to 35° left (or vice versa) should be completed within 28 seconds. (The time limit also applies to power steering system.)

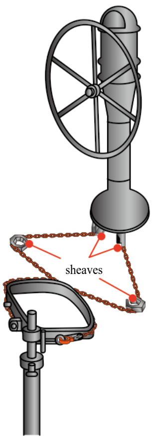


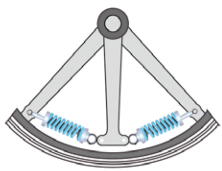
Simple hydraulic steering system

Mechanical Steering System

1. Manual steering: a simple lever.
2. Consists of pulleys and wire/chain.






Pivot control panel

The Mechanical Steering System components

- Chain, flexible axle cable, gear or handle
- Pulley
- Rudder trunk, gland and packing
- Control panel
- Mechanical stopper to prevent the tiller of rudder from turning too far to the port or starboard
- Adjusting device on the chain or flexible axle (such as turnbuckle)

Mechanism of the Hydraulic Steering Gear

1. When the helm turns the steering wheel which is in connected with hydraulic pump, the hydraulic fluid in the oil line would be pumped to inlet of one of the double acting steering cylinder ends of the steering cylinder to drive the piston (ram) to extent while hydraulic fluid would be push back to return to the pump through the opposite oil end of the cylinder.
2. The ram of the piston rod connected with the tiller would turn the rudder to turn clockwise or counter-clockwise.
3. When the steering is stationary, the pressure in the oil line is neutral so the rudder angle stays in position

Electro-hydraulic Steering Gear

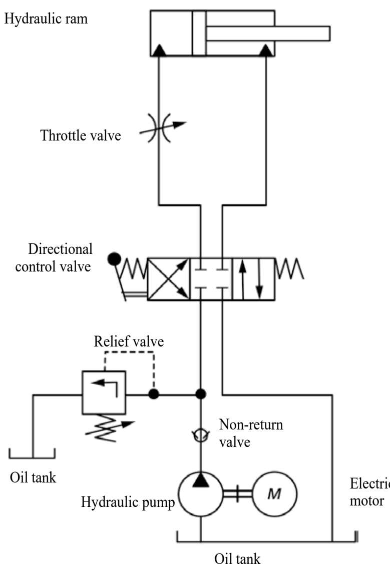
1. By the non-compressible property and the flowing of hydraulic fluid, the electro-hydraulic steering gear steers the rudder angle by controlling the pressure and flow of the fluid.
2. The system transfer electrical power into fluid dynamic energy (pressure and flow), then turn the fluid dynamic energy into mechanical energy (steering torque and speed) in rudder steering.
3. The electrohydraulic steering gear is equipped with transmission system (steering control rod), actuator (control valve), hydraulic pump, hydraulic oil tank, tiller, rudder post, rudder, etc.
4. The operation of electrohydraulic steering gear:
    - When the helm is steered, the signal and control system on the bridge transmits control signals to the actuator located in the steering gear compartment.
    - The actuator can change the amount of oil pumped from the hydraulic pump. Hydraulic fluid is injected into and expelled from the hydraulic cylinder through the control valves and steer the connected tiller to turn the rudder to port or starboard.

Equipment in the Hydraulic Steering System

- Oil Storage Tank — Tanks with oil level indicator and alarm for high oil temperature and low oil level are installed on large vessels.
- Hydraulic Pump — Positive displacement pump driven by electricity. There should be two sets of hydraulic pumps on large vessels. One is operated by electricity and another one would be operated manually for emergency purpose.
- Control Valve — It controls the hydraulic fluid flows into the inlet ports of the cylinder for turning port or starboard.
- Hydraulic Cylinder — The double acting cylinder can steer the rudder to turn to port or starboard. Both ends of oil line are equipped with breather plugs.
- Safety Valve — It releases excess pressure in the hydraulic line to protect the system from damages.
- Bypass Valve — A valve is connecting in pipeline to engage for the emergency steering gear arrangement. Some may install with the safety valve assembly.
- Rudder Angle Indicator and Sensor.
- Hydraulic fluid pressure gauge.

Safety equipment of the hydraulic steering gear

The hydraulic steering gear is equipped with safety valve. Impacts to the rudder from waves or hard objects increase pressure on rudder post and cause the oil pressure in the ram to increase, which might damage the steering system. When the oil pressure exceeds the default level, the safety valve would automatically open to release the high pressure oil to and the low pressure oil channels to reduce the additional pressure and to protect the steering gear system.



Inspection before use

1. Check the steering wheel is smooth to turn; check the rudder angle indicator and pressure gauge function normally.
2. Check the amount and quality of oil in oil storage tank. Hydraulic fluid should be clean and. Low oil level might indicate a leakage in steering gear system. Milky fluid might indicate contamination.
3. Check the sensitivity of rudder. Under normal circumstances, the rudder should complete its travel from the far starboard

to port and vice versa within 20 seconds. A travel with 28 seconds is the maximum time allowed (applied to power steering system).

Common faults of hydraulic steering system **Air lock**

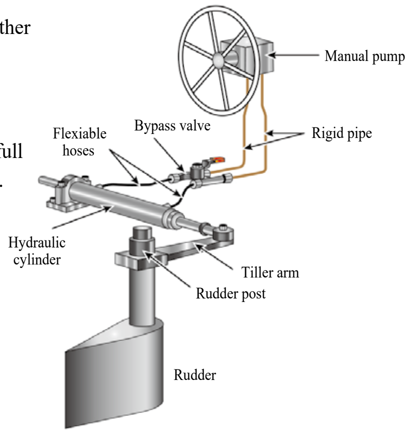
1. The air lock occurs when air is trapped inside the hydraulic system.
2. The compressible property of air causes the system's pressure unstable.
3. The air lock results in slower or unstable motions of steering components.
4. Insufficient turning angle of rudder, the pressure gauge indicates instability and unpredictable movements of rudder.

The causes for air lock include leakage in oil line, valves or hydraulic cylinder, leakage in the ram sealing ring and insufficient amount of oil.

Solutions to air lock

1. Make sure the oil in the oil tank in normal level.
2. Check the oil line and the hydraulic cylinder seal.
3. Priming:
   - Release the hydraulic cylinder's breather plug on port ends, turn full helm to starboard and tighten the breather plug.
   - Release the hydraulic cylinder's breather plug on starboard ends, turn full helm to port and tighten the breather plug.

   (Repeat the above steps until there are no bubbles released from the breather plugs)
4. Check if the helm is back to normal and smooth to turn. Repeat the priming and relief procedures if it continues to perform abnormally.

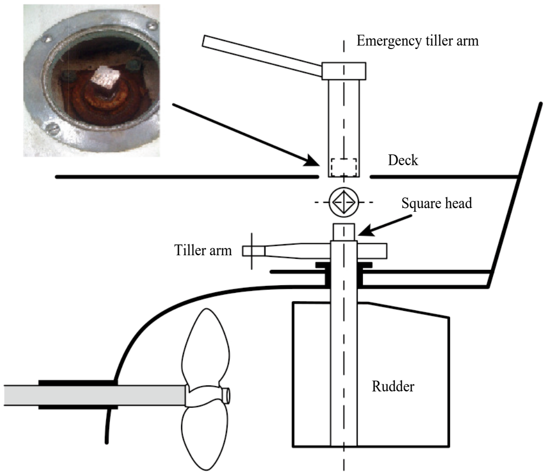


Under normal circumstances, air would not enter the hydraulic system. The occurrence of air lock indicates damages of components. A thorough check is needed when the vessel returns to berth. If hydraulic fluid is lost during sail, one can consider replacing it with clean lubricant if necessary.

Solution to steering system malfunction

1. Use the emergency steering system.
2. The emergency tiller is generally stored in the steering gear compartment.
3. Connect the emergency tiller to the head of the rudder post.
4. Release the bypass valve first if it is a hydraulic steering gear.

The reliability of the steering system is determined by the cleanliness of the hydraulic fluid and the lack of air in the system. If the fluid is contaminated or deteriorated, sediments in the fluid might damage the seals of the ram and even the wall liner of the hydraulic cylinder. The fluid would leak through from the tiny scratches, making it difficult for the helm to manoeuvring the vessel. Crew on board should ensure the cleanliness of the hydraulic fluid in the system and make sure there is sufficient amount of quality fluid. In the case of abnormal or deterioration, the system line should be checked for leakages. If there is air trapped inside the steering gear system, the steering control of the rudder would be affected or the rudder would have uncontrollable vibration. If air lock in steering gear system was noted, conduct the priming of air to the system.



(B) Pump

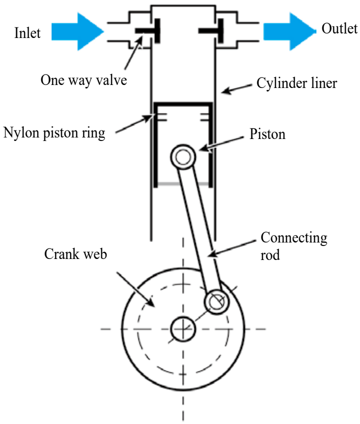
Depending on the types of fluid and functions as needed, various types of pumps are used on vessels in Hong Kong. Pumps can be mainly driven by belts, gears, chains, camshafts, eccentric cams, shafts or other mechanical components of the main or auxiliary engines. There are also pumps that are driven by separate electrical motors.

Types of pumps

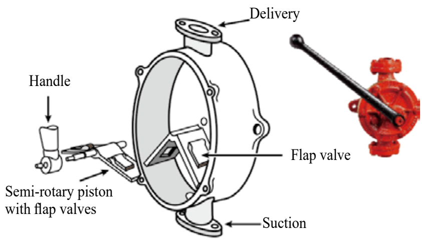
There are two major categories of pumps – dynamic pump and positive displacement pump.

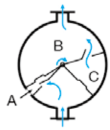
Reciprocating pump, diaphragm pump, vane pump and gear pump are common types of positive displacements pumps.

Common dynamic pumps include centrifugal pump. Jet pump is a type of dynamic pump. For instance the Venturi tube in the carburettor of a petrol engine is a small-scale jet pump that operates by the principle of fluid mechanics, i.e. increase in air flow lowers the pressure, to extract petrol.



Single acting reciprocating pump



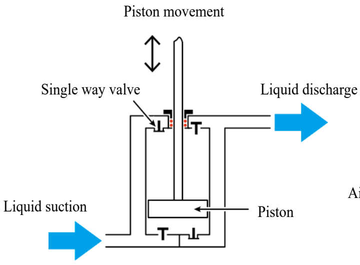


The action of the pump is as follows:

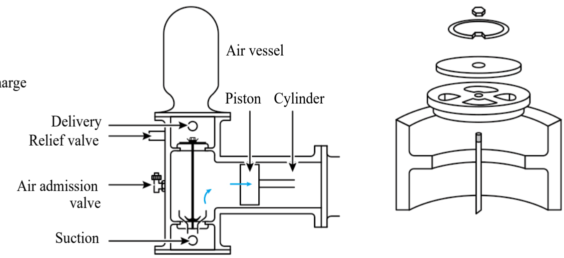
As the piston rotates the volume of compartment A increases & flap valve opens to allow A to fill. Simultaneously the other side of the piston is descending, reducing volume C. The liquid in C is therefore forced into compartment B. However, B already filled with liquid & thus A volume equivalent to C is forced out through the delivery pipe.

Reciprocating pump

In a reciprocating pump, the piston moves up and down inside the cylinder liner, sucking in fluid from a one-way inlet valve and ejecting the fluid through another one-way outlet valve. This type of pumps can be converted to as a double acting pump. That double acting pump acts with both up and down motions for pumping. Fibre or nylon piston rings are installed on the piston to eliminate any gaps and leakages between the piston and the cylinder liner. The piston rings and cylinder liner should be checked for wear and tear during maintenance, replaces the deteriorated parts if necessary. The cylinder liner might need to be polished to smooth. The connecting rod should also be checked to see if polishing is required, scratches can damage the gasket and the gland.



Double acting



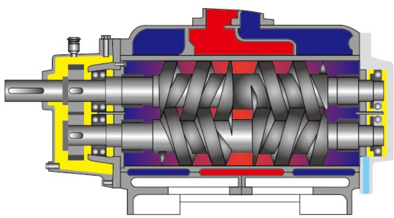
Single acting pump

The one way valve for suction and discharging of pump should always be kept in good working condition. Any cracks of the valve or gaps between seating would lower the efficiency, pressure and flow rate of the pump.

Diaphragm pump

Gear pump

Vane pump



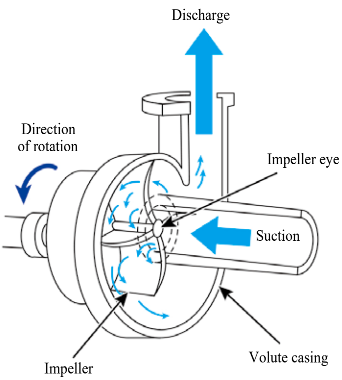
Screw pump

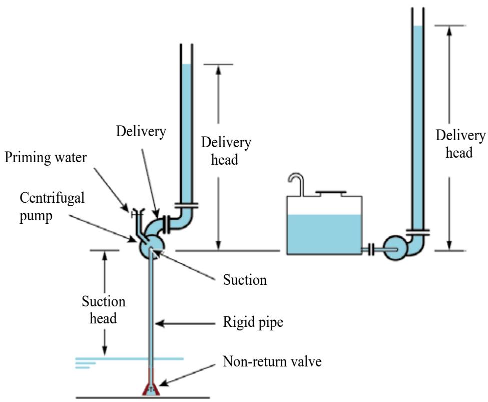
Centrifugal pump

Centrifugal pump is a common type of pump. The impeller spins in high speed in a specially shaped pump casing so the inside fluid is pressed outward. The fluid is sucked into the central of pump at high speed and the speed is slower at the outer rim of the impeller, thus increases the pressure of the fluid which is transferred to the outlet while creates a vacuum at the central of the pump. Fluid is then sucking into the inlet by the vacuum. The structure of a centrifugal pump is simpler than that of a reciprocating pump, since there is no any one-way valve for suction or discharging. Maintenance is thus easier because a centrifugal pump has fewer movable components. However, the disadvantage of centrifugal pump is that its seal ring is easier to wear and may require of replacement more frequently. The friction between the impeller shaft and the gland causes high rate of material loss and demands frequent polishing or replacement of the bushing.

For the purpose of easier for priming of pump, most Hong Kong vessels install centrifugal pump under the level of fluid surface being pumped. If the pump is installed above the fluid level, the pump should be primed before operating of the pump. A one-way valve should be installed at the end of the suction inlet to prevent loss of primed fluid. The centrifugal bilge pump is a typical example.

A pressure gauge on the discharge line can help to comprehend the flow and suction condition of fluid. The temperature difference between the suction and discharge of the pump indicates lack of flow or discharge from the pump, priming to the pump should be repeated.



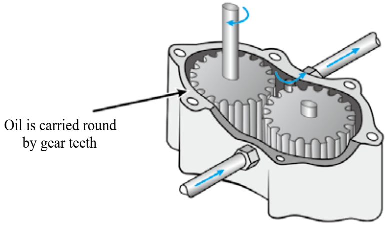


Malfunction in suction usually results from leakage in the one-way valve at the end of the suction inlet or blockage of the filter. Regular check and cleaning are required. Avoid connecting plastic hose to suction line, damages or cracks due to aging of plastic that will result in air being sucked into the tube and affect the suction effect. Metal pipe should be used in suction line. If the use of a plastic one is required, a rigid reinforced plastic hose is preferred to prevent the vacuum created by suction would collapse the hose and block the suction inlet.

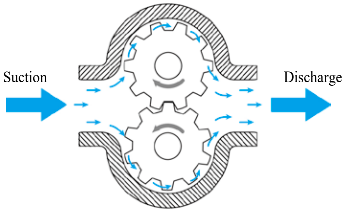
Centrifugal pump cannot be operated for an extended period without fluid passing the pump. A dry operation of pump will damage the bearing and sealing.

Gear pump

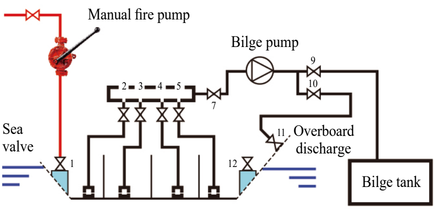
Gear pump is commonly used on Hong Kong vessels. Its structure is simple and easy to maintain. In most cases, checking for wear and tear in the gears and the bearings during overhaul, repair as necessary will be sufficient. The fluid (usually oil) passing in the gear pump would provide lubricating and cooling effect to the pump during operation. Damages will occur if the pump runs for an extended period without fluid passing.

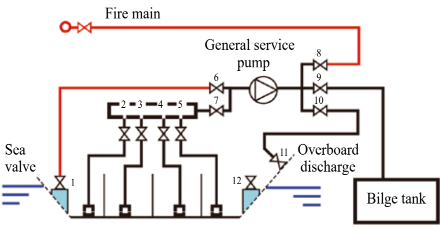


Gear type pump



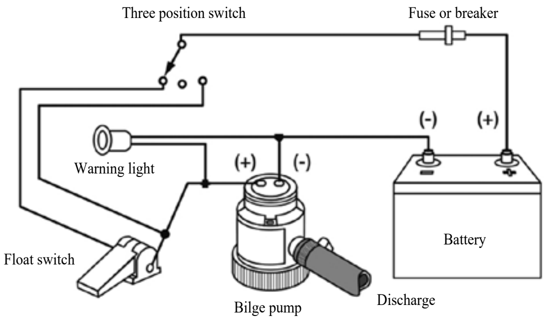
In the bilge system, there is usually an independent pump with strainers and check valves at the suction inlet to prevent blockage or return flow. The bilge water can be transferred through selecting valves (number 2, 3, 4, 5 in the diagram) on manifold and the bilge pump and store in the bilge tank for discharging with shore connection or directly discharge overboard (no oily water could be discharged overboard unless the oil content is less than 15 ppm).





Some bilge pump is connected with the fire system. The pump in the system is operated as bilge pump under normal circumstances and can be used as a fire pump during emergency. To turn the pump into a fire pump, it is required to open valve number 1, 6, and 8 and close valve number 7, 9 and 10. Crew members should be familiar with the operation of the system valves through regular drills on.

Small vessels usually installed with electric motor driven bilge pumps, which are activated with float switches to adapt high / low water level.



(C) Electrical system

The maintenance and repairing of the electrical system should be handled by shipyards or registered electrical contractors. Before any works on the electrical system, the electrical power source must be isolated. Maintenance signs should be hung on the main switchboard and distribution board to prevent the switches being turned on accidentally and causes electric shock. Regular check, tests and maintenance the electrical system of the vessels should be conducted by shipyards or registered electrical contractors.

Wiring Colour Coding

Name / use of the wire Three-

Colour

phase circuit L1 (Live wire) Three-

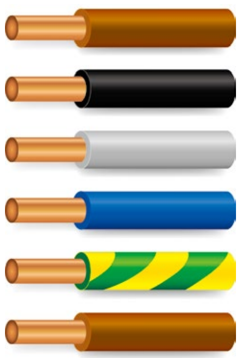
phase circuit L2 (Live wire) Three-

phase circuit L3 (Live wire) Neutral

wire

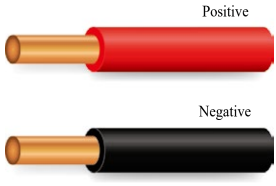
Ground / earth

Single-phase circuit (Live wire)



A three-phrase circuit contains three live wires, L1, L2 and L3. They are brown, black and grey in colours. A single-phase circuit contains a live wire in brown. The neutral wire is in blue; the earth wire is in green and yellow stripes.

Foreign vessels might follow different colour coding. Be cautious when connecting.



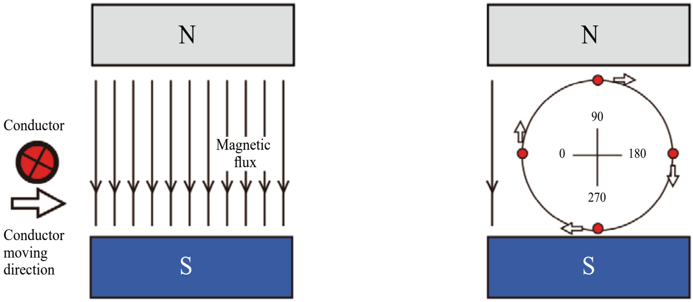
Direct current system has two colour wires – a positive pole wire in red and a negative pole wire in black. The earth is in green and yellow stripes.

The above colour coding is not universal for all vessels. If in doubt, try to find shipyards or registered electrical contractors to handle the case.

Except for special arrangements, earth (ground) wire must not be connect as return path in the electric circuit for both alternating current and low voltage direct current system.

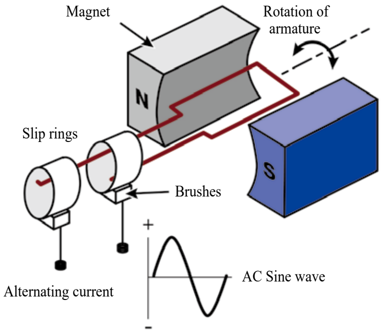
Direct current system

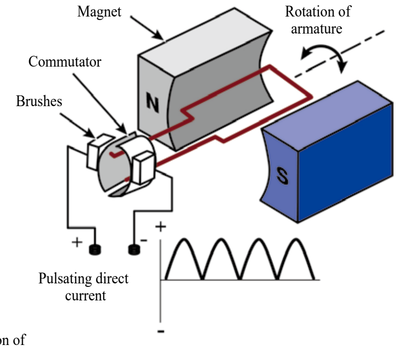
Most large vessels in Hong Kong are installed with electric generators. However, most small vessels are commonly employed with dynamos (electric generators with direct current output). A brief explanation of the working principles of generator and dynamo are shown as below:

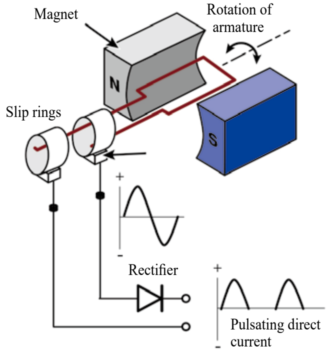


When the conductor wire passes through between a pair of permanent magnets, the wire would induce electromotive force because of electromagnetic induction. When the motion of the wire and the magnetic flux lines form right angles (such as at 90˚ and 270˚), the induced electromotive force would be the maximum value. If the wire travels parallel with the magnetic flux lines (such as 0˚ or 180˚), no electromotive force would be induced.

The coil of wire in the generator rotates in the magnetic field. When the wire moves in the magnetic field with an angle to the magnetic flux is at 0˚ or 180˚, the least electromotive force can be induced; when the wire moves in the magnetic with an angle to the magnetic flux is 90˚ or 270˚, the maximum electromotive force can be induced. The induction of the electromotive force follows the sinusoidal waveform as in trigonometric functions. Therefore, the induced electromotive force from a generator will forms in sinusoidal waveform. Commutators are used in generator to transfer the negative half the sinusoidal waveform to positive half to form a pulsating direct current. Semiconductor such as diode or rectifier can be used to attain direct current by blocking the negative half of the sinusoidal waveform (half wave rectification). A full-wave rectifier as configured by four diodes can be used for full wave rectification.







The magnitude of induced electromotive force depends on the density of the magnetic flux (the strength of the magnetic field) and the number of turns of coil. The magnetic field could come from the permanent magnets or generated by another set of coil. The strength of the output voltage of an electric generator can be made through controlling on the strength of the magnetic field.

If the coil takes one second to rotate 360˚ to generate a full sine waveform of electromotive force, the frequency of the electromotive force is 1Hz. If the coil takes one second to complete 50 sine waveforms of electromotive force, the frequency of the electromotive force is 50Hz. The frequency of the alternating current of most electric generators on board Hong Kong vessels is 50 Hz. However, the frequency of alternating current of the electric generators on some pleasure crafts imported from foreign countries could be 60Hz.

If there is only one set of coil in the alternator of an electric generator, then only one set of alternating current is generated. It is called single-phase current. Some large electric generators would contain three sets of coil in the alternators, with an interval of 120˚ between each set of coil. There are three sets of alternating currents are generated by the generator and that is three-phase alternating current.

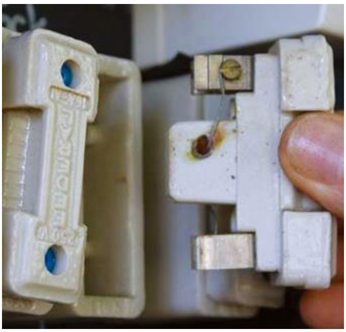
In 50Hz electric generator, the output voltage for single-phase current is 220V. In three-phase current, the output voltage between a live wire and a neutral wire is 220V; the output voltage between two live wires is 380V.

Alternator on a vessel

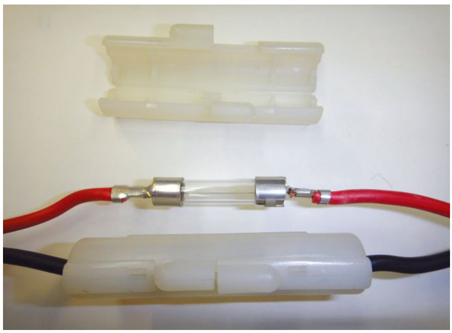
Insulated rubber tape (for temporary repair)

Old and faulty electric generator, circuits and electric appliances are the main causes for electrical hazards. Therefore, the insulations of all wire cable and equipment should always be kept in good condition. If any damage on insulations of equipment is found, the electric power supply should be shut down and repair. The faulty parts should be replaced as soon as possible.

All electrical devices and equipment should be kept in dry and clean; humid environment can cause damages to the insulations. If the fuses are burnt frequently, or the circuit breakers are tripped often, there must be underlying problems with the circuit and the cause of the fault should be found out. Do not replace the fuses or circuit breaker with oversized wires, or the circuit and equipment could be overloaded or overheated and leads to fire. Ship fire is a serious hazard to maritime safety. Fuse is a common electric safety device. If the current flow in the circuit is over the limit of the fuse, the fuse will be burnt and broken to open the circuit to protect the circuit from overloading or overheating.

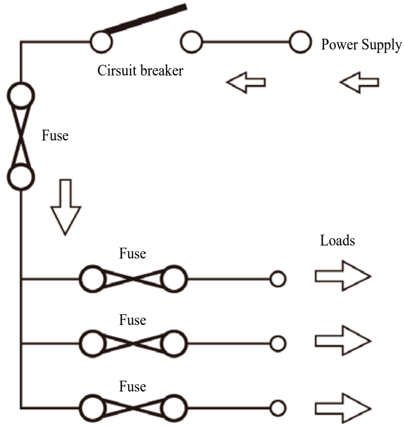


Old style fuse



Glass tube fuse

Circuit breaker system

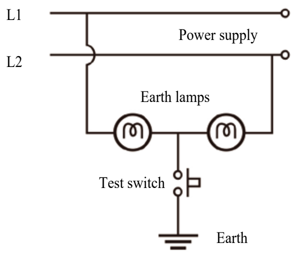


Electrical distribution system

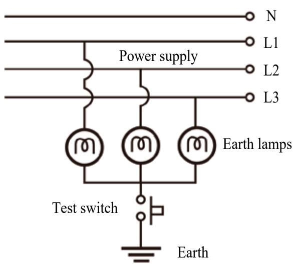
Earth Lamp

Earth lamp is another safety measure of electrical system on board Hong Kong vessels. A pair of earth lamps can be used on direct current or single-phase electrical system. Under normal circumstances, both lamps would light up to the same half brightness. If any live circuits is short circuit with the earth connection (most likely due to damages in insulations of equipment or cable, which result in the live wires short circuit with the metal hull of the vessel or the casing of machine), the two lamps would light up in different brightness. When this happens, it is required to look for the faulty parts immediately by switch off each circuit one by one (or take away the related fuse) for checking. If the lamps are light up to the same brightness again whenever the switch of a circuit is switched off, the circuit with the faulty part is identified and repairing is needed.

Caution: Earth wire cannot be connected as return path of electric circuit.



Earth fault monitoring for D.C. or single phase A.C. system



Earth fault monitoring three phase A.C. system

The voltage value of the light bulbs of the earth lamps equals to the system's voltage value. Under normal circumstances, pressing the test button would result in same degree of half brightness in both lamps. Check regularly for electric leakage to prevent electric shock and ensure there is reliable source of electricity. Any Electrical leakage would accelerate the corrosion of the anodes on the hull. The anodes are installed on hull structures to prevent corrosion to the hull structures. In order to avoid the safety hazards that are caused by the stray current on the hull, the earth wire should be connected to the metal hull. Earth wire can only be used for earthing system and can never be connected as return path of electric circuit (the voltage of earth wire should always remain at 0 V).

Electric generators are reliable in general. Regular check on the temperature and the carbon brush of generator to ensure that there is no sign of overheating and no excess sparks from the carbon brush. Keeping the electric generator clean and dry to prolong its life span reduce repairing. Overhaul of the electric generator and the wiring should be carried out by the manufacturer, shipyards or registered electrical contractors. The commutator and the carbon brush should be cleaned regularly and the bearing should be replaced during overhaul if needed.

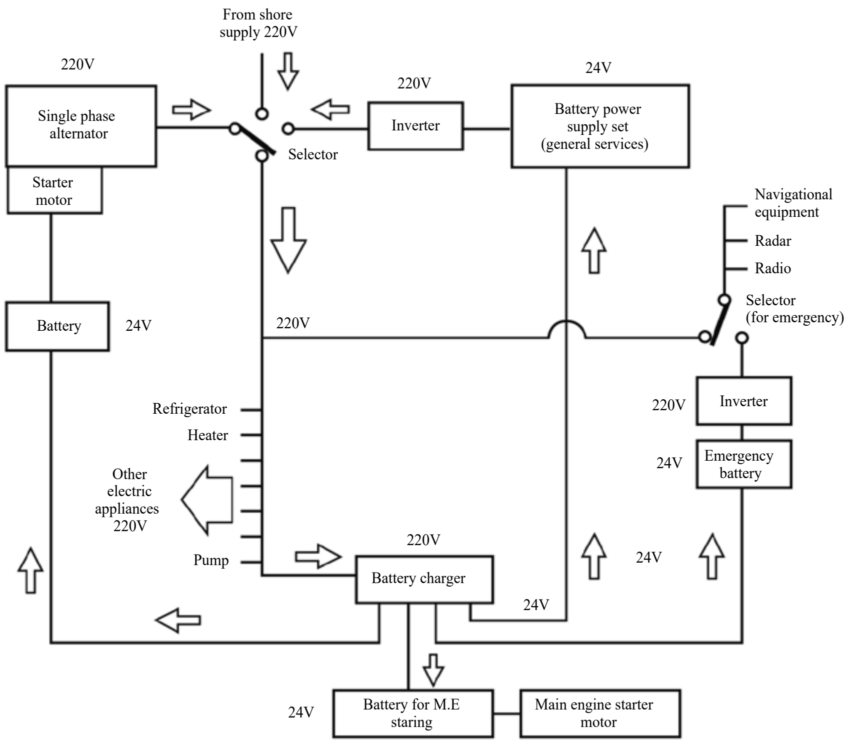


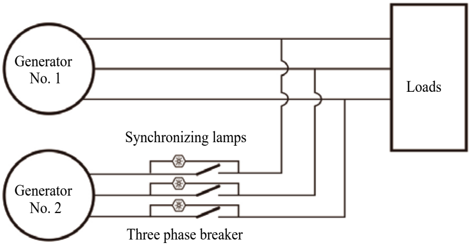
Diagram of alternating and direct current system (220 V as A.C. and 24V D.C.)

When the vessel is underway, the electricity on board is powered by generator on vessel. When the vessel is berthed at yacht clubs, shore power supply can be selected by the switching of the power selector switch. The batteries for starting of main engines, generators, general services and emergency are generally charged by electric generators or shore power supply.

If the pleasure vessel is berthed in anchorage at night, the general services on board can be powered by the battery set via the inverter could be considered in order to avoid sound disturbance from the electric generator.

Emergency batteries are generally installed at higher level (such as the top of the bridge) so they can keep power supply to some essential equipment (such as VHF and nautical equipment) until the very last moment if the machinery space is flooded or the vessel is sinking.

Emergency battery set



Parallel operation of two generators

Parallel generators

Some large vessels are equipped with two or more electric generators which can be operated in separate or together (parallel generators). In order to synchronize the parallel generators in operation, the incoming generator should be started up to normal engine rotational speed as in operation for standby. Monitor both the tachometer and frequency meter while setting the voltage regulator until the voltage of the incoming generator matches with the loaded generator. Then check if the pointer of the synchronization meter is turning clockwise or anti-clockwise; the moving of the pointer indicates that the two generators are not yet synchronized in rotating speed. The rotational speed of the engine for the stand by generator should be adjusted until the pointer of the synchronization meter slows down and becomes almost stationed at the 12-o'clock position; this indicates the phases of the two generators are synchronized. The circuit breaker of the stand by generator should be connected to the bus bar to allow both generators to contribute power to the electric circuit through the distribution panel. In order to make equalize the loading on both generators, the load to the incoming generator should be adjusted to increase gradually while that the load to the initial generator should be adjusted to decrease gradually until the ampere meters of the generators are equalized.

Meters can be commonly found on distribution Panel

Voltmeter

Ammeter


Synchronization meter

Frequency meter

Tachometer

Power meter

Indicators lights and meters on distribution panel would show the operation of generators and circuit conditions.

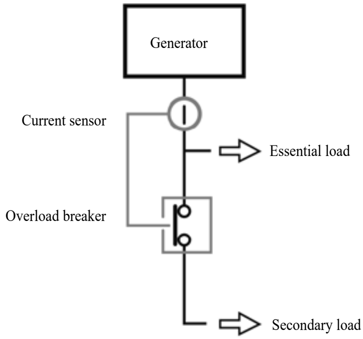
Voltmeter can indicates the voltage (Volt, V) in circuit.

Ammeter can indicates the current (Ampere, A) in circuit.

Power meter can indicates the power (kW) in circuit.

Frequency meter is equipped for distribution panel with alternating current system.

Circuit breaker can break and open the circuit for protection of system.



Overload breaker

The picture shows typical distribution panels for direct current system and alternating current (single phase) system as installed on small vessel.

Circuit with overload breaker

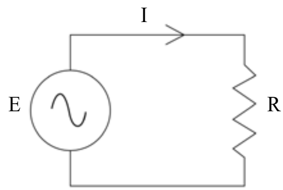
If the power supply is not capable to support the load while all equipment on board are operate simultaneously, the circuit breakers in some non-essential equipment circuits on vessel will break the power supply to these circuits to allow the essential nautical equipment, such as the navigation lights, navigation equipment and steering gear, etc. to keep in operating and to ensure the safe navigation of vessel.

Bad contact

- Physical or mechanical close contact of conductors does not imply good contact.
- Common causes for bad contacts at terminals include oxidization on the metal surface, carbonization from prolonged heating, dust, oil contamination, etc.
- Resistance (ohm, Ω) between connectors indicates the contact quality. The resistance should be 0 Ω in good contact; infinite resistance (∞Ω) indicates an open circuit; a few to dozens of ohms indicate bad contact occurs between connectors.
- It would be better the connections of wires are connected with soldering or specified connectors. Twisting of wire ends of conductors together cannot guarantee to good contact in connection.

Ohm's Law

The Ohm's Law shows the relationship between voltage, current and resistance in mathematics (see the diagram below):

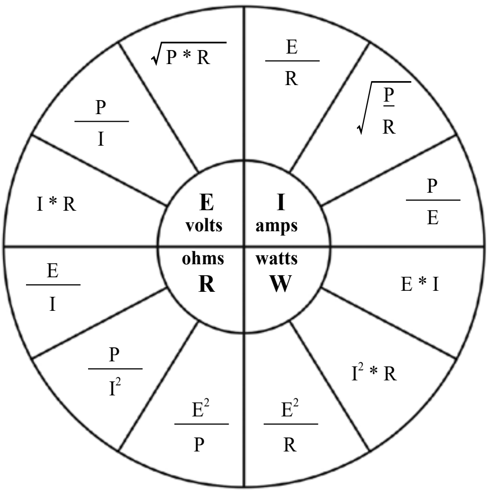


E = Electromotive force (Voltages V)

I = Electric current (Amperes A)

R = Resistance (Ohms Ω)

P = Power (Watts W)



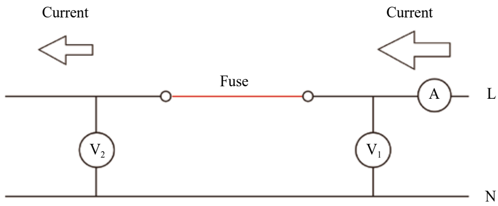
Physical phenomenon review:

Small internal resistance exists in all metal wires and should not be ignored.

The higher the temperature of the wire, the higher the resistance.

The larger the cross sectional area of the wire, the smaller the resistance and allow the more currents can pass through.

Because of the internal resistance, all metal wires will be heated up when currents pass through. Under normal circumstances, the generated heat is minimal and can be ignored.



Electric current in fuse

From the above diagram:

Let the input voltage as V_1 = 220.0V, the current is 20A, and the output voltage at V_2 is measured as 219.95V, between the two ends of the fuse (in red), there is a voltage drop of 0.05V. According to the Ohm's Law, resistance of the fuse:

$$R = V/I = 0.05/20 = 0.0025\ \Omega \text{ resistance}$$

Thermal power from the fuse could be found as below:

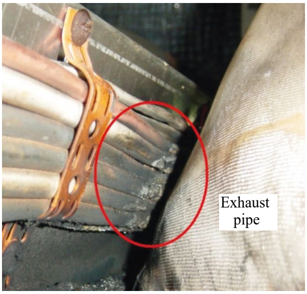
$$0.05V \times 20A = 1.0W \text{ or } 20A^2 \times 0.0025 = 1.0W$$

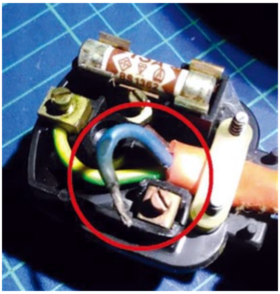
In the above case, the 1.0 joule of thermal power on the fuse every second is nearly burn the fuse out. The fuse is the weakest link in the electrical system to protect the circuit. Whenever there is overloading or short circuit, the fuse will be the first part to burn out to prevent fire from overheating of the system. The above example shows that fuse would be heated up as electric current passes through resistance.

If the fuse is replaced by a bad electrical connection (see pictures below), the bad contact terminal would heat up and cause overload in the plugs or the conductor wires. This could be leaded by the screws are not properly fastened to the wire so leads to bad contact and increases the resistance between the contact. If the situation continues, the insulations layer on the wires could be harden by the generated heat. The heat can cause to failure and damages of the insulation materials of the wires and leading to short circuit and burn the main fuse. It can also cause open circuit or even fire because of increasing of the resistance at the bad connection.

Since heat is generated when current passes through bad contact connection, the connection point should be checked regularly to ensure the contact is in good condition. The screws on the terminal blocks should be secured fastened. Repair immediately if the colour or abnormal heating up of the connection is noted.

If the wire is heated for an extended period of time or contact with the heated part of machine (such as stove, exhaust pipe of engine), the insulated cover would be carbonized and fail to protect the





conducting wire in insulation, which could cause short circuit. Therefore, all cables should be protected from heat source. Also, always keep the engine room is well-ventilated.

Shore Power

- Check if the voltage, frequency and plug specification of the shore power are compatible with those circuit on board (single- or three-phase electricity); the electric currents provided by shore power is sufficient to supply for all essential needs on board; and the power cord can handle the load.
- Beware if there may have different the connecting method about the earth wire on board and the earth wire at the berth dock. Check if an isolation transformer is needed to supply electricity for the circuit on vessel.
- Before connecting the shore power, both the isolation switch on shore and on board must be switched off. After connection, turn on the onshore switch and then the one on board.
- Make sure the power cables are long enough to handle the tidal waves. Pay attention to the connected power cable regularly as tides may pull and break the cable.
- No any part of the connected shore power be immersed in water.

Electricity requirement

Ampere hour (Ah) is the unit of battery capacity; watt (W) is the unit of power consumed by electrical devices.

$$W = V \times A \text{ (Watt = Voltage × Ampere)}$$

For example:

Let a pleasure fishing boat with 12V electrical load as following:

Electrical devices	Power consumption W (watt)	
8 nos. of 15W light bulbs	8 × 15W	120 W
5 nos. of 10W light bulbs	5 × 10W	50 W
1 no. of 40W bilge pumps	1 × 40W	40 W
1 set of 40W VHF	1 × 40W	40 W

Since W = V × A, therefore A (highest level of current in the system) = W / V = 250 /12 = 20.8A (Ampere)

To determine the required battery capacity, the consumption time of each electrical device should be determined first. For example,

Electrical device	Estimated time of consumption	Consume Wh (Watt per hour)	
15W Light bulbs × 8	3 hours	8 × 15W × 3	360
10W Light bulbs × 5	4 hours	5 × 10W × 4	200
40W Bilge pump × 1	1 hour	1 × 40W × 1	40
40W VHF system × 1	2 hours	1 × 40W × 2	80

Since W = V × A, therefore A (highest level of current in the system) = W / V = 680 /12 = 56.7 Ah (Ampere hour)

In order to satisfy the required power for consumption, the required battery capacity must exceed 56.7 Ah such as 80 Ah or 120 Ah battery suffice the need. Battery capacity indicates that the stable electric currents can be supplied continuously over a period of about 20 hours, e.g. a 150 Ah battery may indicates of supply 7.5 A (150/20) for about 20 hours. If the current in system was increased to 15 A, then the battery can only withstand for about 6 hours instead of 10 hours as by calculation.

Calculating on alternating current

The power output of mechanical driven alternating current generator usually at the level of kilowatt (kW). Electric load is calculated as power = voltage × ampere. The load of motors of electrical appliances (such as refrigerator and air conditioner) is calculated as power = voltage × electric current × 0.8 (power factor)*. The electricity output of alternating current generator is indicated by kilo-volt-ampere (kVA). The total electricity output should be 25% surpass the system requirement.

* The phase of voltage and current of alternating circuit is not synchronized, so a power factor is added when calculating the load. The power factor is generally 0.8.

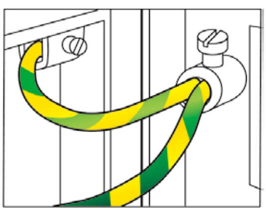
Example:

Electrical devices	Power consumption W (watts)
60W light bulbs × 4	240W
35W fans × 4	140W
1,500W stove × 1	1,500W
3,000W water heater × 1	3,000W
1,500W air conditioner × 1	1,500W
250W radio and sound system × 1 set	250W
300W radar × 1 set	300W
Total load of the system	6,930W (6.93 kW)

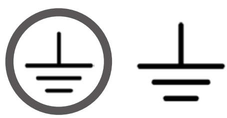
If the motor coefficient (power factor) is considered, then 6.93/0.8 = 8.66 kVA. An electric generator with 9 kVA output is sufficient for all the load needs on board.

Safety on electrical equipment

- Electrical equipment and their attachments should be checked regularly to prevent hardening or damages of the insulation. Conductors must not be exposed. Do not touch any electrical components when your hand is wet.
- The metallic housing of all electrical equipment must be connected to earth. Unless special arrangement, earth wires must not be connected as return path for electric circuit.
- The fuses or circuit breakers on the distribution board are for protection of fixed electrical installation (such as permanent installed cable or power sockets) from overloading. They are not aimed to protect any single device. The current rating of the fuses or circuit breaker is chosen according to the total current load of the circuit. If the fuse burns or circuit breaker trips frequently, it indicates the load in circuit surpasses the limit of the fuse or the circuit breaker.
- Distribution board should be secured, the water seal is in good working order and is kept in dry. All contact points should be secured and have good contacts. Bad contact would generate resistance and result in heat as electric current passes through.
- The larger the current, the higher the temperature would be produced. If the fuse does not burn out in short circuit, the wire would glow red as a heating wire which could burn the plastic insulation and cause fire.
- No excess heated should be found on the wire while electrical equipment are operated in normal condition and loads. Heated wires indicate insufficient cross sectional area of the wire for current to pass through. There is internal resistance on each length of wire. The larger the cross section area of the wire, the lesser the resistance and very few of heat would be produced when current passes through in normal condition.
- Prolonged heating of the wire's insulating material would result in carbonization. The wires near the kitchen stove, inside machinery space should be checked regularly to see if they are too close to the heat sources (such as engine exhaust pipe).
- Whenever the motor is started, the electric currents would be 6-8 times of the nominal rating.
- The electric potential of ground or earth is zero. All metallic parts on board should be earthed, including the hull, the housing of electrical equipment and metallic handles on board, etc. If the hull is made from glass fibre reinforced plastic, the earth should be connected to the conductive board at the outer part of the bilge and which should be in contact with the sea water. The conductive boards of earth should not be connected with and that of the lightning conductor and should be installed electrical separately.



Earth cable colour: green and yellow stripe



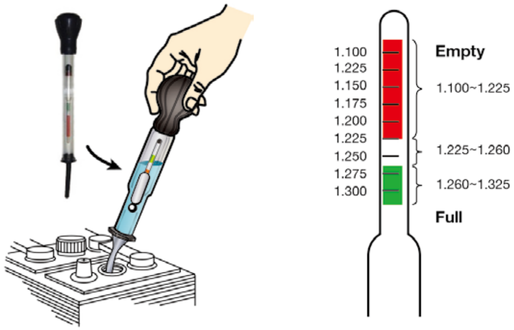
Earth sign

Caution: Earth wire must not be connected as return path in electric circuit.

Storage battery

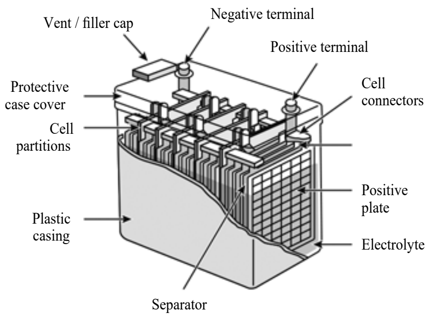
Storage battery is commonly used to start the internal combustion engine on board. There should be another set of storage battery is placed on the top of the deck house as emergency power source. Some vessels might connect batteries in series (voltage may exceed 100 V) and installed with an inverter to convert the direct current into alternating current for electrical services at night to avoid the noise from operating of engine driven generator during night-time.

Storage battery on board should undergo regular checks. It is important that the storage battery should be kept clean and dry. Ointment (such as Vaseline) can be applied to the terminals for keeping the contact clean. The electrode plates of lead-acid battery are required to be immersed in electrolyte, distilled water should be added to maintain the electrolyte at the specified level. In order to check the lead-acid battery is kept at full capacity condition, the relative density of the electrolyte could be examined with a hydrometer.



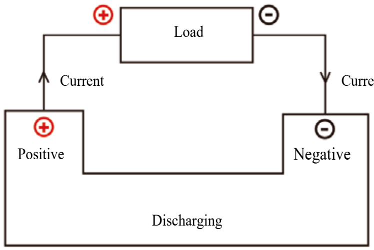
Operation of storage battery

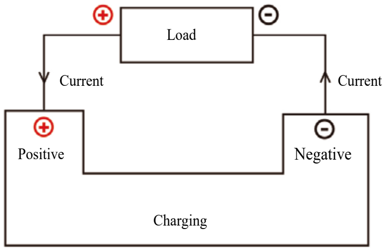
Battery is a chemical device that can produce or store electricity. Primary cell is the type of battery that can only discharges the stored chemical energy once and then to be discarded. The type of storage battery (secondary cell) can be recharged to full capacity through battery charging sequence.



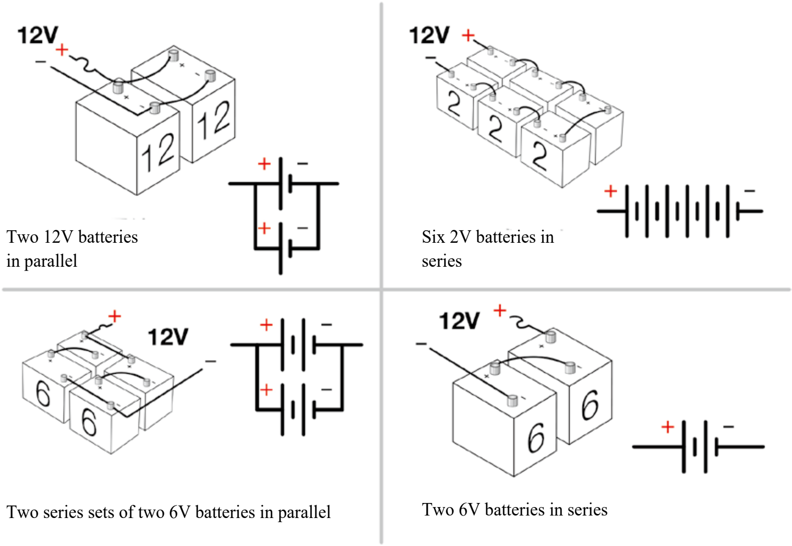
The basic unit of a battery is a cell. The entire battery is comprised of several cells connected in series or in parallel so the designed voltage and storage capacity can be reached. The cells should be stored in a suitable shell which has positive and negative terminals. The plates are immersed in electrolyte which is mostly acid, alkali or salt solution.

The electrode plates in storage battery of the same polarity are connected in parallel. The positive and negative electrode plates are immersed in the same electrolyte. Electrodes of the positive polarity is placed alternatively and separated with the negative electrodes. The more electrodes the battery has, the larger the current capacity. When cell units are connected in series, the total voltage is increased by addition, thus the more cell units are connected in series, the total voltage of the battery would be higher





- When connecting the batteries in parallel or in series, It must be sure that all batteries are the same specifications (same voltage, same capacity). It would create imbalance load and cause danger if batteries with different specification are connected.
- 12 V or 24 V lead-acid batteries are generally used as direct current supply on vessels. They can used to start main engines and electric generators. Emergency battery supply can provides electricity to fire protection, alarm system, navigational lights, navigational equipment, communication system, emergency escape lightings, etc. in case of emergency.
- Metal hull must not be wired as return path of the electric circuit (such as connecting the battery's negative terminal to the hull). Unless special arrangement, the hull should be connected with earth.
- The unit of battery capacity (C) is ampere-hour (Ah). It is the product of continuous current (A) multiplied by the discharge time (h).
- The unit voltage for cell unit of lead-acid battery is 2.0 V. The commonly seen 12 V lead-acid battery is combined by 6 cell units.



Two 12V batteries in parallel

Six 2V batteries in series

Two series sets of two 6V batteries in parallel

Two 6V batteries in series

- Cautious for operating of battery:
  When filling electrolyte into a brand new battery: make sure the sulfuric acid electrolyte is fully filled into the battery. Settle down the battery for about 20 minutes (about 70-80%battery capacity, 12.4-12.5 V will reach) before installing for services. (If battery is charged before used, it should be charged for one to two hours before installation. It would be better if capacity of battery could be fully restored) If the voltage of a battery not reach 12.5 V or above after filling of electrolyte, it should be fully charged before it is going to be discharged.
- If the output voltage from the battery charger is too high or due to malfunction (exceeds 15.0 V), the battery might be overcharged or overheated or the water content of electrolyte might be evaporated and results in insufficient electrolyte in the battery.
- Vampire load: leakage of electricity, any other loads or failing to turn off the battery main switch would result in over-discharge of battery.
- The followings might indicate the aging of the battery:
  1. Difficulty or incapable to start the engine;
  2. Dimmed control panel lights;
  3. Voltage indicated on the control panel is constantly lower than 11.5 - 11.8 V (with the engine is stopped or the battery is not charging); or
  4. Brightness of headlights or lights on control panel varies with the engine’s rotation speed.

- Hydrometer measures the electrolyte ratio. Combining the ratio with accurate voltmeter reading, the charging condition can be monitored.

Charging Condition % full	Electrolyte Relative Density 80°F*	System voltage (categories)		
		12V	24V	48V
100	1.277	12.73	25.46	50.93
90	1.258	12.62	25.24	50.47
80	1.238	12.50	25.00	49.99
70	1.217	12.37	24.74	49.49
60	1.195	12.24	24.48	48.96
50	1.172	12.10	24.20	48.41
40	1.148	11.96	23.92	47.83
30	1.124	11.81	23.63	47.26
20	1.098	11.66	23.32	46.63
10	1.073	11.51	23.02	46.03

* Correction to relative density: above 80°F, +0.004/10°F; below 80°F, -0.004/10°F

Installation of battery

- Batteries should be placed securely in the battery box with enough ventilation.
- Batteries should be placed in clean area with good ventilation.
- No naked fire operation is allowed in where the batteries are placed.
- All tools and equipment should have be proper insulated.
- When handling batteries, workers must wear protective gloves and goggles.

Maintenance of lead-acid battery

- Keep the batteries clean and always in fully-charged state
- Keep the electrolyte in the appropriate level. The normal electrolyte level should be kept within 6 mm-12 mm above the electrode plates inside the battery, and added up with distilled water when minimum level of electrolyte is not reach, or the capacity of the battery will be affected permanently.
- Regular check the followings of battery:
  - electrolyte level;
  - relative density of should be kept between 1.24 and 1.28;
  - battery terminals and conducting wires are in good contact, remove all oxides on connections;
  - the battery terminals and wire connection can be protected from oxidation with coating of Vaseline;
  - keep the vent holes of the battery clear.

Notes on charging lead-acid battery

- Battery vent cap can be opened when charging.
- Charging current cannot exceed 10% of the battery capacity, e.g. the maximum charging current of a 120 Ah storage battery should not exceed 12 A (Ampere). Batteries will generate heat and hydrogen during charging. The larger the charging current, the more heat generated and hydrogen gas bubbles. Batteries generate heat when discharging as well, with the larger the current, the more heat generated.
- Hydrogen is highly unstable gas. Any spark or flame can lead to hydrogen explosion. Whenever lead-acid batteries are charging, naked fire operation and smoking are prohibited in the surroundings, and good ventilation is maintained.
- Internal resistance of the conducting wires should be considered. Resistance of wires increase direct proportional with wire length but inverts proportional with the cross-sectional area of the wire. Heat is generated when current passes through conducting wires with internal resistance, if too much heat is generated in wire might leads to fire hazards.

If contacting with the electrolyte accidentally when handling lead-acid battery, it can may cleaned by:

- flushing with fresh running water.
- storing the leaked electrolyte with containers, take it back to shore and handle as chemical waste. No electrolyte be dumped or discharged overboard.

Lithium Battery

- Lithium batteries can be used for power supply to modern electric outboard engine.
- The voltage for each unit of lithium battery cell is around 3.73 V. High power electric outboard engine may require several or dozens of cell units in a series-parallel circuit, and the voltage of the direct current in the circuit may reach 100 V or above. Attention should be paid to the hazard of high voltage.
- Due to difference in system voltage, different models of batteries are being used for electric outboard engines with different power. Don't connect the system with batteries other than the specification.
- Original battery charger must be used for protection against overheating and over charging current.
- Basically, lithium batteries don't require special maintenance arrangement. Batteries should in general stay away from contacting with sea water except those with specific waterproof design.
- High heat will be emitted immediately due to the very high current in short circuit of lithium batteries, it can leads high risk of explosion. Therefore, the control circuit and the battery charger must be equipped with circuit protection. Batteries should not be used for purposes

other than their own equipment to prevent form any hazard caused by over discharging current.

- The voltage for each unit of lithium battery is 3.73 V, which is different from the 2.0 V of lead-acid battery. Never mix up or connect two different types of battery for any operation.

Hazards on handling of batteries

The followings are major hazards of handling batteries:

- Electric hazard
- Fire and explosion hazard
- Chemical hazard
- Hazard of manual handling

Electric hazard

Electric shock and short circuit are two major electric hazards.

Electric shock — It is generally believed that the risk of electric shock exists when the voltage is above 50 V (voltage). Although the voltage of battery itself is not very high, series connection of batteries for special services on vessel can create with system voltage of 100 V or even higher. Although the constitution of everybody is different, all batteries should be treated as high-voltage regardless their actual voltages and should pay attention to the risk of electric shock. Before handling of batteries, the safety shoes should be wore and all metallic accessories (such as watches, rings, necklaces etc.) should be taken off to reduce the risk of electric shock.

Short circuit — Heat is emitted whenever there is current flow in the battery or the wire in circuit (charging or discharging). The higher the current, the more heat will be emitted. Short circuit in system could lead to the explosion of battery and combustion of insulation of the wire. Connection on battery terminals should therefore have insulation caps. Repair or replace the electric wire immediately if any damages on the wire insulation.

Fire and explosion hazard

Hydrogen would be generated while charging of lead-acid battery. Hydrogen is a highly unstable gas; it can explode by the severe reaction with oxygen in air, by ignited with a spark or flame. Therefore, no naked fire work is carried out in the surroundings. Keep good ventilation at the area to draw away the dangerous gas. Be aware of the cross-section area of the conducting wires. Resistance could be formed if the cross-section area of the wire is too small, the length of the wire is too long, or the contact between connections of equipment has bad contacts. Heat is generated when current passed through the conducting wires or bad contact with high resistance, fire hazards may exist when too much heat is generated.

Chemical hazard

Since electrolyte is corrosive and harmful to humans. Whenever handling of battery, the personal protective equipment (such as protective goggles, apron, gloves and safety boots, etc.) should be put on. The ventilation should be enhanced as well to prevent the inhalation of acidic mist. The batteries should be installed securely to prevent damage to the housing due to collision. Batteries should be placed within the battery box to prevent electrolyte leakage (be cautious that for some "maintenance-free" batteries, electrolyte may still leaks if the housing is damaged by collision).

Hazard of handling batteries manually

A 12 V lead-acid battery with 120 Ahr can have weighed about 30 kg or even more. Assistance from others or machinery is recommend for battery handling to prevent musculoskeletal injuries. The machinery spaces on some vessels may be small and the workers may be slipped or tripped due to wires, pipes, hand tools or wet floor.

Treatment for electric shock

Compare to ashore work, it is more difficult to get immediate support at sea when emergency happen. Therefore, it would be better for safety of life if all workers on the vessel could have received first-aid and Cardiopulmonary Resuscitation (CPR) trainings.

If there is an electric shock victim in the machinery space, the victim should be rescued at once when the safety of the environment and rescuers' self-safe are secured.

Current that passes through human's body can cause serious burn. If the cardiac muscle was injured by the passed current, the fibrillation of heart may occur until there is a cardiac arrest.

Rescue procedure:

1. Cut off the current, or if in safe condition, take the electric shock victim apart from the area of electric power source when rescuer's personal safety is secured (be cautious of electric shock in succession).
2. Check if the victim from the electric shock doesn't breathe or have any heartbeat, CPR should be immediately performed.
3. If the victim from the electric shock is unconscious, but normal breathing of the victim could maintain, lay him/her in recovery position.
4. The burnt area of the victim is treated.
5. Send the victim to hospital as soon as possible.

(Extracted from the website of Labour Department)

(20) Operation and repair

(A) Pleasure crafts with outboard petrol engine — preparation before starting and starting procedure

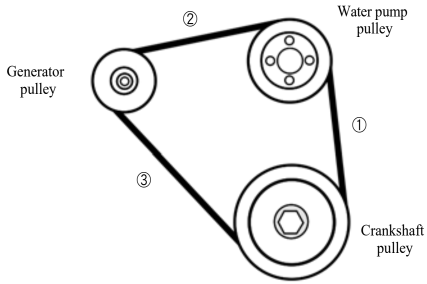
1. Check the fuel storage to ensure sufficient fuel for the voyage. If the fuel storage is insufficient, fill the portable fuel tank onshore. Mixing the petrol and lubricant in the appropriate ratio, (applicable to 2-stroke petrol engines) and shake the fuel tank to make sure the fuel and lubricant is well mixed.
2. Open the air vent hole of the fuel tank. Connect the engine and the fuel tank with fuel hose. Press the rubber pump (hand primer bulb) on the plastic hose to prime the fuel system (pipes, carburettors, etc.) Check and clear if there is any leakage on the pipes and connection plugs for the hoses, smell of petrol on deck or storage locker.
3. Check to see the outboard engine is securely installed on stern, the spark plug and cables are properly connected. Check and secure for any loosen parts. If storage battery is used to start the engine, ensure the battery was fully-charged.
4. Check the engine lubricating oil level (for 4-stroke engines, if applicable). See if there is any blockage in the seawater suction. When the outboard engine is lowered (electrical or manual operated) into water, the propeller and the sea water suction should be completely immersed below the water surface.
5. Set the clutch control operating lever in neutral position (the engine and the gears should be separated). Slightly open the choke flap and throttle, and adjust them to starting position.
6. Turn the main switch of the battery to "ON" and the operating switch to "Run"; check the position of the control lever of the clutch and the throttle again.
7. Before starting, check and ensure no any diver or swimmer in surroundings.
8. Insert the kill line or safety lanyard, and connect the other ends of the lanyard to the wrist or the life vest on the operator (the kill line must be connected with the operator).
9. Press the "Start" button to crank the engine.
10. When the engine is running smoothly, disable the choke flap function. Check the condition of the engine cooling water (observe the circulation tell-tale above the water line).

Fuel tank cap with level gauge

Fuel tank

Hand primer bulb in flexible fuel hose

Kill line or safety lanyard



(B) Motorboats and pleasure crafts with inboard diesel engine installed in place - Preparation before engine starting and starting procedures

1. Always keep the engine space well ventilated.
2. Measure the fuel oil storage in the fuel tank and add enough fuel when necessary. Be extremely careful when doing so to avoid spilling over the bilge or deck.
3. Check all parts of the engine are securely attached.
4. Open the cooling water supply valve and the sea valves; check the level of the fresh cooling water.
5. Check the condition of the driving belt and adjust if necessary. Press the longest side (③ on the above figure) of the drive belt to 25-30mm to check belt tension (would not be too hard or too soft).
6. Check the level and quality of the engine oil in the crankcase and gear box, and rectify if necessary. Check and rectify if any oil leakage.
7. Open the fuel supply valve in fuel line and prime the fuel pump. Check to the clutch control lever of gear box is in the neutral position. If there are equipped with compression release mechanism, check the control lever is in the "stop" position (if applicable).
8. Check the starting battery is fully charged and the wires are securely fastened.
9. Check all fire service installations and all fire extinguishers are securely and ready to operate at any time.
10. Check the starting battery. Turn on the main switch to supply electricity to the engine control panel.
11. Before starting, check and ensure that no any diver or swimmer in surroundings.
12. Crank the engine manually (if applicable) to ensure the smooth running of the engine and put the control lever of compression release mechanism to "Release" position (if applicable).
13. Start the engine and reset the control lever of compression release mechanism to normal position (if applicable).

14. Check the fresh cooling water system and the sea water system are operating normally. Check the pressure and temperature of engine oil are increased gradually to the normal operating range.

15. Regular check the followings when underway:
    - The pressure and temperature of the engine oil are within the appropriate range.
    - The circulation and temperature of fresh cooling water is within the appropriate range.
    - The packing gland of the stern-tube is properly lubricated and cooled.
    - The bilge is clean and dry.

16. Preparation before engine starting and starting procedures for large vessels

Entering into the machinery space

1. Before entering into the machinery space, well ventilate the machinery space with opening of all doors, ventilation covers, ventilation bowls, and switch on the air blowers, ventilation fans and lights.

2. If necessary, start the electric generator first after entering into the machinery space to change the power supply on the vessel from shore power supply to on board electric generator.

3. Disconnect and remove all shore power connecting cables.

Checking before starting of engine

1. Check the engine log book for any item is required to follow-up:
   Conduct visual inspection if any defects, leakage or looseness on turbo blower, air filter, flexible fuel hoses, fuel pipes and electric wires.
2. Ensure there is no any damage on the insulation of the exhaust pipe; the oil drip tray is clean (check for any oil leakage). Clean and dry the bilge, carry out function test to the bilge pump and bilge water level alarm sensor.
3. Ensure there is no leakage of engine oil, leakage of the fuel system and cooling system. Rectify the damaged parts, screws that are loosen or have come off etc.
4. Start the compressor to pressurize the reservoir (applicable to compressed air starting system); check the voltage, level of electrolyte, charging status, etc. of the starting battery (charge the starting battery with the charger if needed); switch on the cooling water pump (if any), engine oil pump and fuel pump (if needed) (for larger diesel engines).
5. Check the oil level and oil quality of the crank case.
6. Check the water level and water quality of the fresh cooling water tank.
7. Check the sea water strainer and open the sea valves.

8. Measure and record the oil storage level of the fuel tanks and daily service tanks, open the related fuel supply valves (prepare enough fuel in tanks according to the planned route before sailing).
9. Check the drain valves of fuel tanks, filter and air receiver (if any) etc. and drains all water and impurities.
10. Check the oil level and quality of the oil in the gear box and the hydraulic steering gear.
11. Check the condition of the drive belt. On the longest side, press down for 25 - 30 mm (would not be too hard or too soft).
12. Check and make sure the throttle control lever is in the “Start” position while the gear box control lever is in neutral position.
13. Check the stern tube, open the water valve for cooling and of the stern tube packing gland.
14. Check and adjust the tightness of the packing gland.
15. Open the oil supply valve of the oil cabinet for oil-filled stern tube, prime and check the oil flow passage is clear and without any leakage.
16. Check the voltage of the starting battery (which should be around 12.5 - 12.7 V when the battery is fully charged); turn off the charger when measuring the voltage. The voltage should be around 15 V when the battery is charging. Check the liquid level of the battery electrolyte.
17. The relative density of lead-acid battery electrolyte is about 1.27 - 1.30 for fully-charged battery; about 1.19 - 1.25 for half-charged battery and about 1.10 - 1.16 for a discharged battery.
18. Check the tightness of the battery terminals and there is no poor contact in connections. Turn on the battery main switch.
19. Turn the key switch to “ON” position (to supply power to the instrument panel and main engine controller); Check the readings on gauges of the oil pressure, oil temperature and cooling water temperature, on the control panel, as well as the low oil-pressure warning lamp buzzer etc.
20. Activate the independent cooling system water pump and oil (lubricant) pump (applicable to some large power diesel engines).
21. Rotate the crankshaft of the engine when necessary.
22. Check again whether the throttle is in the default “Start” position and the gear control lever is in the neutral position.
23. Before starting, check for any divers, swimmers and small boats etc. in the surroundings.
24. Press the “Start” button to crank the engine. Each starting should not last longer than 10 seconds. If there are three consecutive failed in starting, the reason for the failures should be investigated.
25. Check every meter reading on the control panel again after starting: the readings on gauges of the oil pressure, oil temperature and cooling water temperature are within the set value range. Be mindful whether warning signals such as the low oil-pressure alarm and the high water temperature alarm are normal.

26. Check the cooling water discharge condition from water outlets on sides of the vessel, the colour of the exhaust gases, any excess vibration of the engines and electric generators, and the water circulation of air-conditioning system, etc.
27. Record the above information and the total running hour of each engine as well as the warning signals appeared during operation into the Engine Log book.

The above is the general operation procedures in the machinery space. Specific arrangements and procedures are needed for different vessels, and the operation and maintenance manuals provided by the vessel manufacturers should be referred to.

Routine checking when the vessel is underway

1. Check the oil pressures of the gear box and main engine are within the normal ranges.
2. Check the temperatures of the fresh cooling water and the oil of the engine are within the normal ranges.
3. Check the circulation of sea water and the water discharge on sides of the vessel from time to time.
4. Pay attention to the voltage and the charging status of the battery.
5. Check any leakage on the pipelines (for seawater, fresh cooling water, engine oil, fuel oil, steering gear hydraulic oil, etc.) and each connection, gaskets, etc. for leakage; see if the oil drip tray is clean.
6. Observe the concentration, colour, temperature and smell of the exhaust. Black smoke of the exhaust could indicate the engine is overloaded.
7. Check any leakage (exhaust gas or cooling water) from the exhaust pipes and damages on the insulation of the exhaust pipes.
8. Be aware of any abnormal sound or vibration from the engines.
9. Check for overheating of the stern tube packing gland (which may require the assistance of an infra-red thermometer). If it is necessary to adjust the pressure of the packing gland, the propeller shaft must be stopped and the guard should be placed at its original position afterwards.
10. Check and keep the bilge is dry and clean, clear all bilge water as much as possible.
11. The daily services fuel tank should have sufficient fuel storage.
12. Test the earth lamp regularly to ensure the normal condition of insulation of the electrical system. Be aware of the working current and temperature of the electrical equipment to prevent overload.
13. Keep proper ventilation of the machinery space and clean the cooling vent or dust screen of electrical equipment (such as motors) to prevent overheating.
14. Check the firefighting apparatus and carry out maintenance within scope of knowledge.
15. Be aware of any other abnormality.

Operation of the launched outboard engine vessel

1. Ensure there is no any leakage of petrol, no accumulation of flammable volatile petrol gas in the bilge or other compartments. Any smell of petrol, it should be treated with ventilation first.
2. Ensure the engine is levelled down to the water (with the water inlet is immersed below the waterline and free from any blockage).
3. The gear control rod is set in the neutral position.
4. Open the ventilation port of the fuel tank. Connect the fuel inlet of the outboard engine with the fuel tank by flexible fuel hose. Check to ensure there is no any leakage on the hose and connections of the fuel line, no any smell of petrol on the vessel or any accumulation of flammable gas.

5. Connect the fuel flexible hose and make sure the engine oil is sufficient (4-stroke engine), and the ratio between fuel and lubricant is appropriate (2-stroke engine).
6. Open the oil supply cork valve (if any) and the breather plug of the fuel tank, then press the primer bulb on the hose to prime the carburettor.

7. Make sure the fuel in the fuel tank is enough for the course (the rule of thirds is generally applied for calculation: one third of the fuel is planned for the outward journey, one third is for the return journey and one third for safety reserve).
8. Check the voltage and status of the battery and turn on the main switch.

9. Check the emergency stop switch, make sure the safety lanyard is attached properly (kill cord which should always attach to the wrist or lifejacket of the operator and which can stop the engine when it is out of the operator's control). The control lever of gear box and throttle are set in appropriate position.
10. Start the engine (by manual or via electrical) and warm up the engine according to instruction manual.
11. Once the engine is started, check cooling water outlet to ensure and normal flow of the cooling seawater. If the outboard engine is equipped with thermostat, it may take several to a dozen of seconds for the cooling water to reach the water outlet. Lack of cooling water can result to engine overheating and damages to the water pump.
12. The throttle control lever is set at idling position or the engine is running in idle speed when shift the control lever of the gear control ahead or astern.

13. Procedure to stop the engine: set the control lever of throttle and gear control in idling and neutral position. Press the stop button for a few seconds to cut the electricity supply to the firing system and stop the engine. Raise the propeller above the water level (manually or by electro-hydraulic apparatus), to drain the sea water out from the engine. Turn off the main switch of the battery and disconnect the fuel hose from the fuel tank (if necessary). Clean the cooling water channels with fresh water and wipe off the moisture on the engine. Clean and dry the engine and store the outboard engine onshore.

Stopping of the diesel main engine

1. Set the throttle in idling position and the gear control in neutral position.
2. Let the engine running in idling speed for one minute to slightly cool down (if necessary).
3. Some engine models equipped with an independent control button which can stop the fuel supply from the fuel injection pump by activate the control lever. The engine will lose its power once the fuel supply is interrupted. Most of the modern engines are equipped with electric control unit and the engine is stopped by terminating the fuel supply from the fuel injection pump with solenoid valve.
4. Turn off the key switch and main switch of the starting battery. The control circuit of the stopped engine will keep consuming electricity from the battery if the engine is kept in stand-by mode by the key switch and main switch remains on. The electricity will soon be completely discharged if without keeping charging.
5. Except for emergency, avoid stopping the engine operation with the compression release installations because it would severely damage the exhaust valves. Avoid stopping the engine by turning on the emergency fuel supply stop valve either as air can enters the fuel system and forms air lock.
6. After the engine is stopped, both the fuel supply valve and sea water suction valve should be closed. Before restarting the engine again, all these valves must be opened before, to prevent, engine overheat due to the lack of heat transfer with sea water and damage to the sea water pump impeller. Leads to entering of air into the fuel system and forms air lock.
7. The ventilation of the machinery space should be maintained for minutes after the engine is stopped.

(D) Common engine parameters

Commonly found main engine instrument panel

Basic information such as the main engine speed, pressure of the engine oil, temperature of the cooling water, battery voltage and temperature of the engine oil will be displayed on general main engine instrument panels (as shown above). Some main engines may give sound and light alarm signals to indicate abnormal engine oil pressure and water temperature. The configuration of the instrument panel may vary depending on the scale, precision and requirement of the engine.

Pointer type instruments are analogue gauges. The new instruments display the operation status and different parameters of the engine in digital or by LCD monitor panel.

Tachometer

Unit: Revolutions Per Minute (r.p.m.) or (rev/min)

Tachometer shows the engine speed in revolution per minute (r.p.m. or min^{-1}). The engine speed is generally corresponded to the crank shaft rotational speed and is measured by the attaching sensors to the fly wheel. The speed of revolution per minute can then be calculated from the counted time on each revolution of the fly wheel.

The engine's rotational speed is not in linear proportion with the vessel speed. However, a high engine speed corresponds to more fuel is consumed by the engine to propel the vessel.

Lubricating oil pressure gauge

Unit: Bar, Pa, psi

The metric unit of pressure is Bar. A pressure reading of 1 Bar approximately equals to the atmospheric pressure at sea level (i.e. 100,000 Pascal). Vessel installed with instruments imported from the USA usually show imperial unit in measurements, such as pressure unit in pounds per square inch, with "psi" or "lbf/in^2" as symbols.

Engine oil warning lamp

The unit conversion is shown below:

1 Bar = 100,000 Pa = 100 kpa = 14.5 psi

When the diesel engine is running, the engine oil will be pressurized and transported to different running parts of the engine for lubricating, cleaning, sealing and facilitating heat dissipation. A rotating engine usually has an oil pressure of around 1.5 Bar to 3.5 Bar. The upper and lower limits of engine oil pressure vary depending on the features of different engines, but one should always refer to the parameters as stated on the operator manual of the engine. A high engine oil pressure that far exceeds the limit could indicate a possible blockage in the oil pipe or pressure relief valve. A low oil pressure could be caused by low oil level, altered oil viscosity due to overheat or leakage of oil hose or pressure relief valve, etc. The warning lamp will light up with the buzzer alarm when engine oil pressure low. Slow down the engine speed immediately and, if possible, stop the engine and conduction inspection.

Temperature gauge

Unit: °C (Celsius); °F (Fahrenheit)

The control panels on the vessel come with different temperature gauge, including water temperature, oil temperature, exhaust gas temperature, etc. to monitor the operating temperatures of the engines. Different parameters on the engine operating temperatures are generally referred to the operator manuals as provided by the manufacturer. The parameters on operating temperature vary depending on different engine designs and there never be a universal standard. In general, the cooling water temperature of the engine should not over the specified setting. If the cooling water temperature is far over the specified setting that can lead to overheating and damaging to the engine. If the temperature of the exhaust gas is over the normal range, it indicates that the non-combusted fuel of the engine is burning inside the exhaust pipes, which could be caused by wrong ignition time or over-injection of fuel. A low exhaust temperature could be resulted from insufficient compression or unburnt fuel.

Engine oil temperature gauge

Cooling water temperature gauge

Exhaust temperature gauge

Depends on the design of each engine model, the operating parameters form the operator manual should be referred. Generally, the temperature of fresh cooling water is around 40°C - 70°C, high temperature alarm is about 90°C;

Oil temperature is around 50°C - 80°C, high temperature alarm is about 95°C;

Exhaust gas temperature is around 300°C - 500°C.

If gradually increasing on the temperatures of the fresh cooling water was noted, maintenance of the cooling system such as cleaning of filters, heat exchangers and pipeline, etc. should be conducted.

If the water temperature raises suddenly, it could be caused by the blockage at sea water inlet, leakage or blockage of the pipelines, heat exchanger, damage on water pump, failure of pump motor, which could also affect the running of water.

The high temperature of engine oil could be caused by the clogged heat exchanger, or improper viscosity of engine oil, leakage or blockage of pipeline, etc.

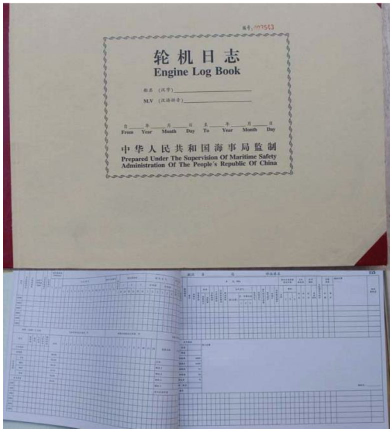
Rudder angle

Unit: Degree

The controllable range of rudder angles are 35° on each port and starboard side.

Check whether the hydraulic steering oil tank has sufficient oil and no leakage on pipes.

Engine log book



Engine log book is an important record file. If there are any incident, the book provides the records on the recent operating condition and environmental information of the machines in the machinery space.

A detailed document on records of machine parameters should be kept on board the ship (i.e. the temperatures, pressures, engine speed, consumption of fuel and oil, and all other data of different of machineries) for reference when incident happens.

Engine log book should be categorized according to time (e.g. every hour) and recorded the important parameters, the fluid levels in water tanks and oil tanks, the operating conditions of valves and the accumulated working hours of machines.

Engine log book can be written manually on a paper form notebook. With the modern computer technology, notebook can be replaced by computers on recording data. Some machines are equipped with some numbers of transducers and the computer of the machines will record all details of the machine operating condition precisely. Simply by the crew's operation, the computer can display all recorded data, chart and diagram on the screen. The computer can also provide information for maintenance and repairing.

Regular maintenance of machineries on board could reduce the happening of machine faults or malfunction. Any defect found should be rectified as soon as possible so as to minimize the developing of damage. Maintenance of engines and machineries are important whether the ship is underway or berthing.

Maintenance of main engines can be categorized to:

- Regular maintenance
- Daily maintenance
- Monthly maintenance

- Annual overhaul
- Maintenance when not in use

Daily routine:

1. Keep the engine surface and drip tray clean. (Oil drips are highly flammable, which leads to fire hazards).
2. Frequent check the fuel oil supply system. Repair immediately in case of leakage.
3. Lubricate the propeller shafts.
4. Check the engines' lubricant and fresh-water coolant levels.
5. Clean and clean the fuel filters, air filters, and sea chest strainers.
6. Clean the bilge suction strainers.
7. Check the ignition system regularly. Fasten all loose connections, repair or replace the defected spark plugs.
8. Check the tension of the drive belts of pumps and dynamos, replace if necessary.
9. Lubricate the engines according to the operator manual.
10. Always check the levels of batteries electrolyte, and charge the batteries.
11. Hire technicians to check and tune the engines regularly (usually annually, or depends on the operation hours of the engine) according to the manufacturer's instructions.

Safety always is the first priority in conducting of machines maintenance.

Before inspecting of the engine, ensure the working environment is safe; for example, the power supply of the starting motor shall be isolated. If necessary, turn off the switches of power supply and close all system valves of the engine, etc. A warning sign should be put up to avoid accidentally activate of the engine during maintenance, which can cause unintended rotation of the engine that could results to oil leakage or severe injury. If it is needed to disconnect the fuel supply pipes connections from engine, make sure the fuel supply valves are closed and there is no fire hazard near the site. A suitable container should be used to collect the oil drips. If it is needed to disconnect the sea water lines of the engine, make sure all valves from the water incoming and discharging are firmly closed and then put up a maintenance sign. Before repairing on electrical equipment, the power supply must be isolated. Put a maintenance sign on the main isolator of the electric panel to notify others not to operating of the electric system and prevent anyone from touching the switch that could lead to an electric shock to the technician on site.

If the engine fails to start or automatically stops running shortly after it starts, the cause of fault can generally be sorted out with the following methods:

(A) Check to ensure the fuel can be transmitted to the engine. For petrol engines, it can checked from the disconnected oil hose from the carburettor, check the fuel circulation while increase the tank pressure or pressing the prime bulb. Blockage of fuel circulation can indicate that the strainer requires to be cleaned or sediment accumulation in the fuel hose. However, in most time, one should check if the fuel has ran out first.

Checks the fuel system to a diesel engine can be done by disconnect the output line of the fuel pump and then crank the engine (Make sure to prepare a suitable container to collect the fuel dripped off).

(B) Check the ignition system. Loosen spark plug cables or bad contacts in electric cable connections could cause the above fault. The spark plug can be checked by contact the case of spark plug to the engine body and crank the engine to see if spark is occurred from the gap of the spark plug. This can also check if the fault on spark plug is due to the accumulation of grease (before carrying the above procedure, one should ensure the safety of the environment first. There should not be any accumulation of petrol vapour because the petrol vapour can be ignited by the spark from the spark plug which can cause explosion or fire. Some injection-type petrol engine's fuel injector would eject petrol mist when the engine revolves. Read the operator manual for particular engines before maintenance and be cautious of safety).

Some cases and services may require special tools or to be carried out by shipyards or registered contractors.

Corrective maintenance:

It is cater for the fully utilize of the life of the component, repairing would be carried out when the defect cause the operation of the engine to stop, by replacing the damaged parts.

Preventive maintenance:

Periodic maintenance and renew of consumable parts of engine to lower the chance of engine breakdown and increase its reliability.

Comply with the maintenance schedule suggested by shipyards and engine manufacturers

The engine is not going to stop working within a short period if maintenance is not carried out regularly as suggested by the manufacturers. However, there must be reasons behind the suggested maintenance schedule. The running hours and possibility of failure is of direct proportion, which means the longer the running hours, the higher the possibility of engine fault happen. Lacking on maintenance will increase the chance of engine failure and laid up.

For instance, repairing for the lightbulb in the hallway can be carried out until it is out of service. It is because which imposes little impact over the overall safety of operation. However, preventive maintenance must be carried out in accordance with the procedures of the maintenance handbook of engine, otherwise the consequence on failure of main engine can be dangerous.

Engines should be maintained regularly after a certain operating period, and the content of maintenance is usually listed on the operator manual. Regular maintenance can be divided into daily, monthly and annual maintenance, or can be carried in the light of operating hours (e.g. per 10 hours, per 100 hours and per 1,000 hours, etc.). For example:

Daily maintenance

- Check the oil level of the engine sump
- Check the oil level of the gearbox
- Check the water level inside the jacket cooling water expansion tank (closed type fresh water cooling system)
- Check the pressure of engine oil when the engine is operating
- Check the starting battery and recharging condition

Maintenance for every 3 months or 150 operating hours:

- Renew the engine oil and oil filter of the main engine
- Renew the air filter
- Check the tension of all drive belts
- Drain the cooling water of the expansion tank and wash the heat exchanger
- Check for any signs of water and oil leakage
- Grease the bearing of the alternator
- Clean the primary filter (pre-filter) of the fuel pump
- Drain water and sediment from the fuel tank

Maintenance for every 12 months or 500 operating hours:

- Renew the oil and filter of gearbox
- Clean the fuel oil storage tank
- Check all pipelines for leakage, and clean the pipelines
- Check, clean and adjust the spark plug gap for petrol engine; check and adjust the fuel delivery pressure of injector for diesel engine

Maintenance for every 3 years or 2,400 operating hours:

- Check and adjust the valve tappet clearance
- Remove and renew the fuel injection pump and fuel injector
- Drain the cooling water from expansion the tank, clean the heat exchanger and renew all flexible hoses of the cooling system
- Remove the alternator and starting motor, and renew the bearings and carbon brushes of armature
- Renew the wheels and bearings of turbo blower

PM Schedule for Diesel Engine

Maintenance Requirement	Service Time				
Activities	Daily	Weekly	Monthly	Quarterly	Yearly
General inspection: Look for abnormal noise, vibration and leaks	✓				
Check Coolant Level	✓				
Check Lube Oil Level	✓				
Check Fuel Level	✓				
Check Charge Air Piping	✓				
Clean Air Filter		✓			
Check Battery Charger		✓			
Drain Fuel Filter		✓			
Drain Water from fuel tank		✓			
Check coolant concentration			✓		
Check drive belt tension			✓		
Drain exhaust condensate			✓		
Check starting batteries			✓		
Change oil and filter *				✓	
Change coolant filter *				✓	
Clean crankcase breather				✓	
Change air Filter element *				✓	
Check radiator hoses				✓	
Clean Radiators *				✓	
Inspect belt drives and adjust tension				✓	

* Maintenance requirement are recommended in view of Sui environment.
Note:- Yearly maintenance intervals are subject to engine condition and performance pattern.

Maintenance schedule is categorized by daily weekly, monthly and annually. Some arrangements are scheduled in accordance with the operating hours of the engine

Hour meter of the engine

Besides the main engine, the maintenance other auxiliary machineries (such as hydraulic steering gear, windlass, diesel generator, etc.) should be handled in similar, and be maintained as per the schedule suggested by shipyards and machines manufacturers.

Outboard engine is submerged in seawater

If the outboard engine is immersed in seawater due to accident or sunken of vessel, the engine should be salvaged as soon as possible and the following processes should be done afterwards:

- Drain the engine oil
- Fill with fresh water for cleaning
- Remove spark plug/ fuel injector
- Lift for dewatering and dry the engine
- Slowly spin the fly wheel, and fill in oil through the hole of spark plug on the cylinder head
- Send the outboard engine to the nearby maintenance agents to disassemble for check-ups. Clean the fuel system and lubrication system, renew the engine oil, oil filter, fuel filter, etc. If it is a petrol engine, the whole firing system, control circuit board and wiring may need to be replaced as well.

Fault of all systems and other matters

1. Parts of the main engine

- Blocked air filter — lack of fresh air, which will cause emitting of black smoke in exhaust and reduces the power output.
- Leakage at fresh air intake valve or exhaust valve — insufficient pressure, emits black smoke in exhaust, or even cannot be started.
- Valve clearance — the valve clearance of exhaust valve is slightly larger than that of the fresh air intake valve to cope with the thermal expansion caused by high temperature of exhaust gas.

Excess valve clearance at fresh air intake valve — delay in intake valve opening, delay air intake and reduce the volume of air come into the combustion chamber.

Too narrow clearance at fresh air intake valve — the intake valve will open prematurely and back flow of exhaust gas.

Excess clearance at exhaust valve — delay in exhaust valve opening, delay discharging of exhaust gas and cannot fully discharge the exhaust gas.

Too narrow clearance at exhaust valve — the exhaust valve will open prematurely, wasting the engine power.

- Loosen spring of fresh air intake valve or exhaust valve — leakage, insufficient compression and emit black smoke in exhaust gas.
- Incorrect timing of ignition/fuel injection — power lost and reduce propelling force.
- Loosen piston ring with cylinder liner — insufficient compression, contamination of engine oil and engine oil on cylinder liner is combusted and emit blue smoke in exhaust gas.
- Bearing clearance excess — the speed of oil drainage is too fast, causing low engine oil pressure and knocking sound.

  Insufficient — the speed of oil flow is too slow or the flow is blocked, causing engine overheated.
- Camshaft and Transmission Mechanism

  Camshaft abrasion — changing of the open/close timing of valves and firing timing, leading to timing error.

2. Cooling system

- Blocked water channel — check the heat exchanger of water pipeline. Insufficient water flow will cause the temperature increase engine body and temperature of cooling water, leading to the happen of high water temperature alarm, black smoke in exhaust gas and low engine oil pressure. It can cause seizure and overheat of the cylinder head gasket when the situation is severe. An abruptly increasing temperature of cooling water could be caused by blockage of water strainer in sea water suction by plastic bag or rubbish, water leakage due to burst or crack of pipelines, water pump failure. If the operating temperature increases day by day, it indicates that it is the time for maintenance of the cooling system. The pipelines are cleaned with all blockages inside the heat exchanger and pipes by the marine growth, mussels and mosses are cleared.
- Loosen water pump drive belt — insufficient water flow and same faults appear as above. Regular check the tension of the drive belt and renew the drive belt regularly in accordance with the maintenance schedule.
- Damaged plastic impeller of water pump — insufficient water flow and same faults appear as above. Ensure all fragments of the plastic impeller are removed from the pipelines and heat exchanger of the system.

- Cracked cylinder liner or cylinder head — leakage of water jacket can cause to insufficient flow of cooling water.
- Rust — reduce the heat transfer efficiency, causing relatively high temperature in engines.
- In some incidents, the inlet valve or sea valve is not opened before starting the engine. Check to ensure the flow of sea water is normal immediate after the engine was started up. For vessel is installed with an in-board engine, the overboard discharge of sea water to be checked. For the vessel is equipment with an out-board engine or it is a jet ski, observing the condition of tell-tale from the water outlet is normal, and check if there is any water leakage from the engine during operation.

3. Lubrication system

- High oil pressure — the setting of the pressure relief valve is incorrect or the valve is blocked, blockage of the oil pipe or the oil filter outlet.
- Low oil pressure — insufficient engine oil, leakage of oil, low oil viscosity, high oil temperature, blocked oil filter of the inlet or loosen bearing.

Reason for failure in starting and remedies

1. Failure and remedies on starting of engine:

Electric starting:

Malfunction of starter motor or bad contacts

Insufficient charged or failure of batteries (engine starting batteries)

Loosen connections or bad contact of wires

Air start system:

Insufficient pressure in air receiver due to compressor is not operated to supply compressed air

Closed or blocked valves in the starting pipeline

Supply valve is not open, or has leakage or blockage on the compressed air pipeline

2. Failure in starting the engine due to insufficient compression in the cylinder Checking method

— set the control lever of gear control to neutral, crank the engine manually, it will require certain amount of force to push and rotate the crank if there is enough compression.

Reason — leakage of fresh air intake valve, exhaust valve, gap between cylinder liner and piston rings, and blockage in air filter.

Remedy — check and adjust the clearances between the valve seats of fresh air intake valves and exhaust valves; check the valves and valve seats are perfectly sealed or lapping is required if not; clean or replace the air filter element; arrange replacement if the cylinder liner or piston ring is worn.

3. Seized engine

If the speed of engine is not fast enough when starting, it may be caused by seized engine, e.g. the bearings of engine are set over tight, the gap of piston ring is not enough, or poor quality of engine oil.

If the engine cannot be cranked, check if there is water on the piston crown. The water could come from the leakage at the gasket of cylinder head, from damaged cylinder head or liner.

Check method —

- Check the oil level and quality of the oil in oil sump
- Crank the engine with opened valves (open on all fresh air intake valves and exhaust valves while cranking of the engine)
- Open the door of the crank case and crank the engine

4. Fuel system defects could cause difficulties in starting

<u>Diesel engine</u>

Common defects of fuel system: there is water in the fuel oil, the fuel is contaminated by impurities; the air filter is blocked; the spring force setting of fuel injector is insufficient; the injector hole is deformed or blocked; air lock due to air is sucked into the fuel pipe from suction in empty fuel tank; leakage at the valves; etc.

- check the fuel tank.
- check the fuel supply valve is fully opened.
- check any leakage and air lock in the fuel pipe.
- check any blockage of air filter.
- check any malfunction or air lock in the high pressure fuel oil pump and fuel injector.
- atomization of the fuel injector is poor — check the fuel injector and oil pump.
- water in the fuel — open the drain valve at the bottom of the fuel tank to discharge the sludge and water in the fuel tank ,then carry out priming for the fuel system.
- air inside the fuel system — carry out priming and check if there is any leakage in the oil pipeline. The fuel system of the diesel engine could be checked by removing of the fuel injector from the cylinder head, connect oil pipe to the injector and crank the engine to observe the atomization of the injected fuel.

Petrol Engine

There is water, impurities and contamination in the fuel oil; blockage of carburettor nozzle; leakage or blockage of oil pipe; leakage of flexible hoses or incomplete priming after replacing the portable oil tank; leakage at valves, etc.

Insufficient electric power to spark plug

- Check the power circuit is correctly connected, there is not loosen connection or bad contacts.
- Check the circuit of ignition magneto and each set of solenoids are normal.
- Low battery voltage or battery not properly charged.
- Check the circuit is normal, wiring of spark plug is correct, no carbon deposit or dirt at the spark plug, no damage on the porcelain or mica insulation and the correct gap distance (the normal length about 0.025") of spark plug is get.
- The contacts of the distributor are oxidized, contaminated, burnt, corroded, or the capacitor is damaged.
- The contact surfaces of the contact breaker is dirty or eroded (i.e. the contact surface area is reduced when in contact connecting; the gap between the contact breaker is around 0.015" to 0.016", which is No. 15-16).

Failure in carburettor

- the AC electric fuel pump is malfunctioned.
- the sump of the carburettor (float chamber) is empty.
- the fuel filter is blocked.
- the air vent holes of the float chamber are blocked.
- oil or gas is leaking from the broken oil pipe/hose.
- the carburettor nozzle is blocked.
- forgot to open the air vent holes of the potable oil tank and mistaken it as if failure of carburettor.

5. **Problem of exhaust gas**

Petrol engine:

- Black smoke — high concentration of fuel-air mixture (i.e. too much on the ratio of fuel to air leads to the fuel is not burnt completely. Check the atomization of the carburettor, the choke flap or air filter is not blocked, etc.).
- Blue smoke — engine oil is leaking into combustion chambers (the cylinder liner is corroded or the piston ring is too loosen), or because too much lubricant has been added (e.g. check the oil level of the engine sump if 4-stroke engine; check the mixing ratio of lubricant and fuel if 2-stroke engine).

- White smoke — water ingression of the cylinder (e.g. jacket cooling water is leaked through cylinder head gasket or damaged cylinder liner).

Diesel engine:

- Black smoke — high concentration of fuel-air mixture (check atomization of the fuel injection system, the air filter or turbo blower is not blocked), or if the engine is overloaded.
- Blue smoke — engine oil is leaking into combustion chambers (the cylinder liner is corroded or the piston ring is too loosen), or because too much engine oil has been added (check the oil level in engine sump).
- White smoke — there is water ingression of the cylinder (cooling water is leaked from through cylinder head gasket) or damaged cylinder liner.

6. Transmission system

- Loosen and corroded — emit noise and could alter the course.
- The enwound foreign object to the propeller causes imbalanced force, excess load and vibration to the propeller shaft and engine. The excess load can leading to the overloading of engine and breaks down.
- A damaged propeller from being crashed and bended could cause imbalanced force, excess load and vibration to the propeller shaft and engine. The load of the engine is increased with the vessel speed decreases.

The above listed faults and troubleshooting are for reference only. A fine and planned maintenance schedule can help preventing most faults of engine. Not only enhance reliability and durability of the engine, but also decrease the probability of repairing due to sudden fault and break down.

If counterplans are made only when the engine fault happen during navigating, it could severe affect the navigation safety. For instance, if the lubrication system is not maintained regularly, the oil quality is poor or the amount of engine oil is insufficient, causing the engine to be overheated. If the situation aggravated, it could cause the piston to be jammed, the gasket of the cylinder head to be burnt, or a more complicated chain reaction effect could occur, thus making more difficult and higher cost for repairing.

The following is a list of some relatively distinct faults:

Faults		Possible causes
The engine cannot be started up	Diesel Engine	1 2 3 4 5 6 7 8 9 10 11 12
	Petrol Engine	1 3 4 5 6 8 10 12 44
The engine stops after starting up	Diesel Engine	5 7 13
	Petrol Engine	5 15 45 46 47 50
The engine cannot be ignited	Diesel Engine	2 5 6 7 10 11 12 13 14 15 16
	Petrol Engine	5 6 10 12 13 14 15 16 47 48 50
Irregular operation	Diesel Engine	2 3 5 6 7 9 10 11 13 15 16 17 18 19
	Petrol Engine	3 5 6 10 13 47 48
The power of the engine is reduced	Diesel Engine	3 4 5 6 7 10 11 12 13 14 15 16 17 20 21
	Petrol Engine	3 4 5 6 10 12 14 15 16 17 20 21 46 49 50
Low oil pressure		19 22 23 24 25 26 27 28 29
High consumption of engine oil		16 19 21 44 45
Overheated engines	Diesel Engine	11 12 13 14 18 20 30 31 32 33 34 35 36
	Petrol Engine	12 13 14 18 20 30 31 32 33 34 35 36
Black smoke is emitted	Diesel Engine	2 4 10 11 12 13 14 15 20 21
	Petrol Engine	4 10 12 13 14 15 20 21
Blue or white smoke is emitted	Diesel Engine	2 10 12 14 18 19 21
	Petrol Engine	10 12 14 18 19 21
Knocking noise	Diesel Engine	2 4 6 11 12 15 16 18 19 21 22
	Petrol Engine	4 6 12 15 16 18 19 21 22 50 51
Abnormal vibration	Diesel Engine	10 11 14 15 16 17 18 21 37 38 39
	Petrol Engine	10 14 15 16 17 18 21 37 38 39
High oil pressure		19 24 26
High oil pressure in the crank case		14 21 40 41
Weak compression		12 13 14 15 21
High fuel consumption	Diesel Engine	2 4 10 11 12 13 14 15 17 20 21
	Petrol Engine	4 10 12 13 14 15 17 20 21 50 52

Reasons	Remedies
1. The fuel tank is empty	Inject correct grade of fuel and prime the fuel supply line to the engine.
2. The cold start device breaks down	Check the operation of the device in accordance with the operator manual of the engine.
3. The air pipe of fuel tank is blocked	Clear the obstruction.
4. The fuel is in wrong grade	Change the fuel, clean the fuel tank, and inject the correct grade of fuel and prime the fuel line to the engine in accordance with the operator manual of the engine.
5. The fuel filter is blocked	Renew the filter element of the fuel filter and prime the oil.
6. The fuel supply pump breaks down	Check the operation, and clean or renew the filter element. Check the pipes are secured connected.
7. Air lock of the fuel system	Check the fuel level inside the fuel tank, and prime the fuel oil to the fuel supply system.
8. Rotation speed of crank shaft is low	Check the starting battery and battery connector. Check the grade of the engine oil.
9. Stop control breaks down	Check the position and operation of stop control in accordance with the operator manual.
10. Poor compression	Measure the compression pressure, and the engine may have to be overhauled.
11. Fuel pump or injector failure	Listen careful to the injection sound of the injection nozzle, and test all engine parts in the repair workshop.
12. Wrong timing for valves operation	Refer to the engine operator manual for check-up.
13. The air filter is blocked	Clean or replace filter element.
14. leakage at the cylinder head gasket	Repairing processes could be complicated, and the engine may need overhauling.
15. The valves failure	The engine may need overhauling.
16. The engine is overheated	Refer to item 30 and 36.
17. The throttling control failure	Check the operation and lubricate all moving parts.
18. Piston seizure	The engine may need overhauling.
19. The engine oil is in wrong grade	Change the engine oil, with the correct grade accordance with the operator manual of the engine.
20. The exhaust pipe is not clear	Check if the exhaust pipe is deformed or blocked.

Reasons	Remedies
21. The piston ring is damaged	Replacement and repairing processes could be complicated, and the engine may need overhauling.
22. The bearing is wearing out	Replacement and repairing processes could be complicated, and the engine may need overhauling.
23. Low oil level in engine oil sump	Refill engine oil of the correct grade in accordance with the operator manual of the engine.
24. Incorrect reading from the gauge	Renew the gauge.
25. The fuel pump is wearing out	It could be time for the engine to undergo regular overhauling.
26. The safety valve failure down	Replacement and repairing processes could be complicated, and the engine may need overhauling.
27. The oil filter is blocked	Replace the filter element of the oil filer.
28. The filter of the oil sump is blocked	Replacement processes could be complicated, and the engine may need overhauling.
29. The oil is contaminated	If the engine oil is in milky white colour, that means it has been mixed with water, and the engine may need overhauling.
30. The water inlet is blocked	Clear the water inlet and other related valves.
31. The thermostat failure down	Remove the thermostat and test it in hot water.
32. The drive belt of water pump and oil pump is loosened	Check the tension of the drive belt, adjust or replace the drive belt.
33. The water pump failure	Replace the pump impeller or replace the whole pump assembly.
34. The heat exchanger is blocked	Remove the lid for cleaning.
35. The cooling water pipes are blocked	Use detergent to clean the water pipes, and the engine may need overhauling.
36. The level of cooling water is low	Check and rectify if there is any leakage, and refill the water.
37. The mounting of the engine failure	Check the tightness of the bolts and if they are damaged, replace as soon as possible.
38. There is error in shaft alignment of the engine	Check and carry out engine alignment.
39. The blades of propeller are damaged	Check the propeller and replace as soon as possible.

Reasons	Remedies
40. The valve guide failure	The engine may need overhauling.
41. The air vent of the crank case is blocked	Clear the obstruction inside the air vent.
42. The piston ring is damaged	Same as 21.
43. Oil leakage	Find out the point of leaking and rectify.
44. There is no spark	Check if the porcelain of the spark plug is damaged or wet. Check the high voltage cable connection is secured connected, and make sure the contact in connection is well and has no oil dirt and water. Check the surface of the contact breaker and measure the clearance. Check the plug of the distributor, clean the inner parts of the plug and check for any damages. Check if the pivot arm and the connection of carbon brush and pivot arm, battery terminals and main switch, etc.
45. Fault in ignition	Check all the connectors of electric devices are connected securely, clean all grease on the connection point. Check the starting switch.
46. Gas leakage	Check the connection (flange) of carburettor and the air intake manifold of the engine.
47. The carburettor failure down	Check if the needle valve can open and close freely, and if float chamber is dirty.
48. Fault in ignition	Check if there is short circuit at the high voltage cable connection; check the spark plug clearance, spark plug porcelain insulation and connection of the distributor are not wet; and check if the coil connector is connected securely.
49. The fuel air mixture is too dilute	Adjust to increase the concentration.
50. Incorrect timing for ignition	Check the clearance of the contact breaker, and adjust the timing of ignition in accordance with the manual.
51. The high voltage connector of spark plug is wrongly connected	Check the plugs are arranged in accordance with the ignition sequence.
52. The fuel air mixture is too concentrated	Adjust to lower the concentration.

(21) Fire Safety, Emergency Response and Environmental Protection

All vessels must be equipped with fire-fighting apparatus and life-saving appliances. Licensed local vessels must install appropriate types and amount of fire-fighting apparatus and life-saving appliances.

Fire-fighting apparatus and life-saving appliances are for emergency only. All personal on the vessel must aware of fire precautions:

Fire Prevention

- Keep the vessel clean; do not keep waste cloth, papers, or any other wastes on board.
- Have a well-maintained fuel system. In cases of oil pipe leakage, rectify immediately, clean the floor and oil residue on floor and from the bilge of the vessel. Keep the drip tray clean and dry. Mixture of different types of oil with water is collected at bilge of the vessel that would increases the risk of fire hazard. Pump and collect oily bilge water into bilge tank and discharge to shore for chemical waste treatment and process.
- Be cautious when filling of fuel oil, smoking and naked light are strictly prohibited. Fuel filling for portable fuel tank of outboard engine could be carried out onshore. In case of accidental spill of oil on board, remove oil with cloth, collected that into a sealed container, and bring it back to shore for chemical waste treatment and process.
- Be cautious when using naked fire on the vessel. Ensure that the cooking stove is securely installed to avoid spilling.
- Fire-fighting apparatus equipment, fire extinguishers, fire pump, fixed fire-fighting apparatus and fire alarm system on the vessel should be well-maintained and functional.

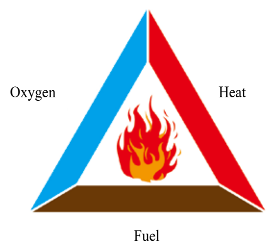
If there is a fire, please do the followings as soon as possible:

- Inform all personal on the vessel. Fire-fighting is never a one-man job. When you hear the fire alarm, gather immediately and carry out the fire fighting as a team.

The Fire triangle (the combustion triangle) is composed of three basic elements: oxygen,

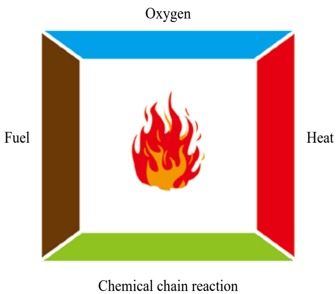
heat and fuel. It is a simple model illustrating the formation of fire.

- For ignition to occur, the following factors are necessarily needed:
  - combustible materials,
  - air (oxygen), and
  - source of heat energy.



- When putting out a fire, it could be done by eliminating one of three factors listed above or cut off their chemical chain reaction. For example, if the compartment is on fire with fuel, the following measures can be taken to put out of fire:
    - Shut off the supply valve of the oil tank.
    - Close the doors, windows and vents of the compartment.
    - Smother the fire with foam by aim the hose of foam fire extinguisher at a vertical surface near the fire.
    - Cover the fire with wet blanket or wet canvas.
    - Cover the fire with sand.

The fire tetrahedron is the latest geometric model – with adding the fourth element, combustion chain reaction, to the basic three elements (oxygen, heat, and fuel). Some newly invented fire extinguishers are able to break the chain reaction and produce inert gases to separate air, e.g. Halon that had been used earlier (now abolished by environmental laws due to the harm it imposed on the ozone layer), and FM200 (heptafluoropropane) that has widely been used recently.



To put out a fire on boat, the best way is to get a few buckets of sea water, smother the fire with wet canvas, or use water type or foam type fire extinguisher. For electrical fire, cut off the electric power supply first and put out the fire by following equipment:

CO_2 fire extinguisher (Carbon dioxide);

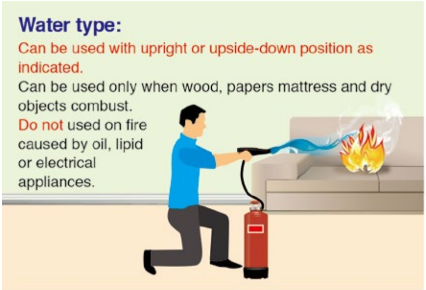
dry powder extinguisher; or

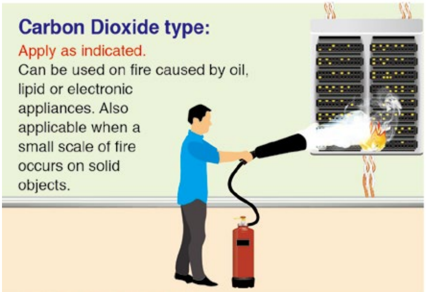
fire blanket.

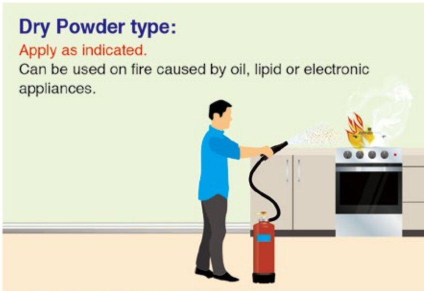
Portable Carbon Dioxide Fire Extinguisher should only be used indoors. If it is used outdoors, the efficiency would be affected as it can easily be dispersed by the wind. If it is used in confined space, persons who work within will be exposed to the risk of hypoxia.

Fire Blanket – mostly seen at galleys, the minimum size is about 1 m x 1 m and the maximum size is about 2 m x 2 m, and it is suitable to extinguish for fire on fryers in kitchen. Air would be isolated from fire after covering with the blanket, and the fire would then be extinguished. The fire blanket can only be removed after the temperature drops.

Types of Portable Fire Extinguishers







Crouch down when putting out fire, and protect your face with the fire extinguisher. If the scene is filled with smoke, open the door for observation. Entry with caution as the smoke represents that the scene is lack of oxygen and the objects are smouldering. If the door is opened swiftly, smouldering objects will be replenished with a large amount of oxygen and will burn in haste, namely flashover*. If the speed of burning is relatively high, fireballs would be formed and pop out through the door, which is similar to an explosion. Therefore, one should be careful and slow when opening doors.

Flashover usually occurs in fire scenes with poor ventilation or in confined space. The temperature of the scene is high, and combustibles decompose and release flammable gases that are not combusted yet. If a large amount of oxygen is replenished in a sudden, all combustibles will ignite and expand, which appears to be fireballs when is seen from a distance. The scene and the vicinity would be in flames and is lethal.

Smoke control doors — Smoke emitted from fire will cause anoxia within the cabin area. Smoke not only contains harmful substances that affect vision and cause suffocation, but it also affects escaping. Smoke control doors can effectively stop the smoke from spreading, therefore each smoke control door on vessels should always keep closing. If being trapped by smoke, bending over to move forward while escaping is more appropriate.

Fire rated door should always keep closing, and should be careful when opening the door.

If being trapped by smoke, bending over to move forward while escaping is more appropriate.

Fire Prevention (Do and Don'ts)

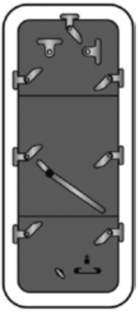
- No smoking on bed.
- No throwing of tinder cigarette ends or matches into waste paper boxes.
- No improper throwing of cigarette ends, and that should be extinguished in ashtrays.
- All scattered miscellaneous objects that are inflammable should be stored properly to prevent fire.
- If damages are spotted on electrical appliances, stop using immediately and repair as soon as possible.
- Lights and electrical appliances should be switched off when not in use. Please don't put objects like towels and clothes near the lights and heaters.
- No spilling or overheating of oils and fats etc. in the kitchen.
- Stoves and ovens should be turned off after cooking.
- Soot ventilation ducts should always be cleaned. Cleaning up the stove and its surroundings after using is more appropriate. All oil stains and grease must be cleared to keep the place clean. Keep the oil basin and bilge dry and without spilled oil.
- When oils and fat oils are on fire, do not use water, and use fire blanket, dry powders, foams or carbon dioxide extinguisher to put the fire out.
- When the airborne dust (e.g. flour) mixed with air, combustion will be triggered when encountering sources of ignition. A rapid combustion of dust is known as dust explosion. Therefore, further precautions should be taken when handling flour in the kitchen.

Emergency fuel supply shut-off valve

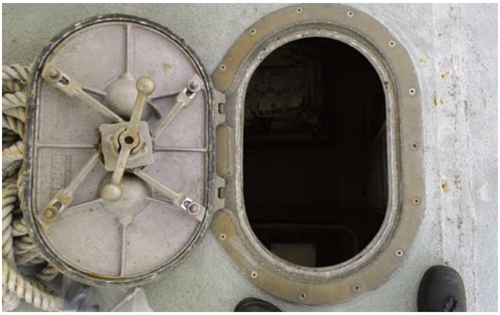
To handle emergencies, fire extinguishing procedures should be practiced on a regular basis in order to allow crew members to be familiarized with various fire extinguishing equipment and operating methods.

Hull damage control

(A) Watertight bulkhead partitions, watertight openings and watertight doors



Watertight door



Watertight hatch

Watertight bulkhead partitions divide the under deck space into several watertight compartments to remain certain buoyancy if water leaks into the ship in accidents. The watertight bulkhead partitions have been installed during the construction of vessel. Further modifications on the partitions including drilling hole on the bulkhead are not allowed afterwards.

Watertight opening and watertight door are located at the check hole of the partitions and the passage through the partitions respectively. Both watertight opening and watertight door are strong enough to cope with the force generated by seawater pressure during accidents. For instance, when a vessel is stranded, the watertight doors between compartments can limit the area of flooding in the event of water leakage caused by the breached hull bottom. This can maintain certain buoyancy and stability of the vessel and prevent the whole vessel from sinking due to a breach in the compartment.

(B) Watertight door operation

- Watertight doors are usually installed among the compartments under the main deck, such as from engine room to auxiliary machinery space, steering gear compartment, void space and fuel tank compartment, etc. All watertight doors should be always kept closed when underway, except the temporary opening for necessary access of crew members.
- Watertight openings, such as the manhole-covers, should always be kept closed except for the operational needs. The covers should be closed appropriately with fastening of all screws/bolts before sailing.
- Ensure there are no damages of door gaskets on the watertight doors from time to time and they can completely seal the closing door. No sundries, such as kitbag and cloths, etc., should be hung on the watertight doors, to avoid disruptions on the operation of the door.

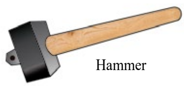
- There should be clear labels and instructions on the operation of watertight doors.
- The watertight doors must not be blocked, obstructed or leading to the doors cannot be closed completely. All pipes and cable wires are laid temporarily passing through the watertight doors between compartments must be all cleared before sailing.
- The opening status sensors and alarms of all watertight doors should be free from interference and remain operational in normal so that the coxswain can has the real-time status of every watertight door on board.
- Watertight doors are heavy, pay attention to safety and mind your hands when operating.

(C) Water ingression in machinery room

- Water level of bilge water will rise due to the flooding in machine room. The bilge alarm will sound and the automatic bilge water pump would already running.
- Find out the source of flooding first. If the flooding is not came from accidents of crushing or stranding of vessels, it could be water leakage from leaking pipes, valves or tanks.
- Activate the emergency bilge water pump (or general service pump, fire pump, etc.) to speed up water pump out and for easier finding the source. If there is leakage of sea water cooling system such as the cooling pipe or joint is broken, try to locate the source and close the sea valves, pumps and other corresponding valves immediately. Stop the engine operation if the safety condition of the vessel is allowed for repairing.
- If the sea water intake pipe breaks or leaks, (e.g. Sea cock), cutting the pipe with tools and punch a plug to clog the breaking pipe to stop water ingress as a temporary measure for the leakage.
- The vessel should keep a number of plugs, wedges, a hammer, pieces of rubber gaskets, hose clamps and cable ties with different size for any unexpected needs. Wedges can be used to deal with the leakage of hull and stern tube, plugs can be used to block the leakage of pipes and valves, rubber gaskets can be used together with the hose clamps or cable ties to tackle the small-scale piping leakage.

Plugs

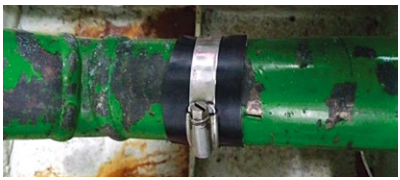
Plug



Hammer

Wedge

Hose clamp



Work seacock handles regularly.
Inspect hoses.
Replace corroded hose clamps.

Use a tapered soft wood plug.
Place a piece of cloth over the end for friction. Drive the plug and cloth into the tail of the seacock. Monitor the repair to make sure it stays put.

- If the breach hole is relatively large, one can first use canvas to block the breach hole and hammer wedges in; or use seating mat, clothes or cloth to block the breach hole and hammer wedges in; or take out the wooden board of chair or seats to block or cover the breach, etc. When such emergency situation is encountered, there is no any standard rule or method for solution. It all depends on one's courage and knowledge to safeguard the vessel from water ingression. The order to abandoning ship has to be given by the captain. Before the order is given, every crew members has to do their best to rescue the vessel.
- If severe accident (e.g. stranding or collision) occur and the ingress is out of control, bear in mind to close all watertight doors before evacuation for avoiding flooding in other compartments.

(D) Measures to Prevent Ingress of Water into Vessels

- Check the bilge alarm and bilge pump regularly. The pump should always be on standby.
- Be familiar with the bilge pump pipeline layout, practise pipeline relocation operation regularly and understand uses of the pumps.
- The sea chest valves and sea cock etc. must be closed and stern packing gland must be tightened for unattended vessels unless exceptional arrangements exist.
- Whenever the pipeline or stern tube is under maintenance, whether or not the job is finished, if the pipeline or stern tube is left attended, even for one minute, the two ends of the pipe must be blocked and a notice must be put at the switches of the pump and the valve to prevent accidental starting of the pump. Besides, the stern packing gland must be tightened to prevent ingress of water.
- Siphon effect may occur on pipes being connected for maintenance and temporary pipes and which can flood the compartment.
- If a vessel is left unattended at the berth, the fresh water supply valve connected to shore must be shut to avoid stagnant water if the pipe/hose leaks.

- All opened hatches, maintenance covers, and manhole covers etc. must be closed securely before voyage.
- Crew members are responsible for inspection to ensure all compartments and cabins are watertight.
- Note if there is any leakage at the cooling system of the machines (especially the air-conditioning system and sea water system). Hoses should be replaced as soon as possible if there are cracks or signs of aging over the surface.
- Ensure all deck scuppers are not blocked for water drain-off. Unless necessary, all weather tight doors and hatches should be closed and always kept at voyage condition.

Refuel Operation

Legislations regarding pollution

- The master and the chief engineer are responsible for taking oil spill preventive measures before refuelling.
- To report maritime oil spill, please call Police on 999, or contact Vessel Traffic Centre ((852) 2233-7801) or Maritime Rescue Coordination Centre ((852) 2233-7999) of the Marine Department.
- Any person who discharge oil (including oily water) or dispose rubbish into the waters of Hong Kong commits an offence and is liable to a fine of $10,000 and to imprisonment for 6 months. Where an offence is committed from any vessel, the owner or master of the vessel shall be guilty of an offence and liable to a fine of $50,000 and to imprisonment for 1 year.
- To complain or report maritime disposal of refuse, please dial the 24-hour Hong Kong government hotline ((852) 1823).
- Discharge of oil decomposed in detergent, soapy water and emulsifier is also illegal.
- Oily bilge water should be kept in a sealed container or a sludge tank if there exists one, and brought back onto the shore and disposed as chemical waste. Cloth used to clean oil and oil absorbent cotton should be brought back onto the shore for disposal as chemical waste. For information about waste treatment contractors, please visit the Environmental Protection Department website: www.epg.gov.hk/epd/cindex.html (as updated).

Environmental Hazard

Flammable

- Cargoes with environmental hazard labels indicates these substances will seriously pollute the ecological environment and affect human health.
- Bring the rubbish as produced on vessel to the shore for disposal.
- Bilge water should not be discharged to ocean unless emergency. Oily bilge water should be kept in a sludge tank if there exists one, and brought back to the shore and treated as chemical waste.

Refueling

Two main requirements:

1. Safety – The biggest risk of refueling is fire outbreaks.
2. Environmental Protection – Not only does fuel leak pollute the environment, tissue paper tainted with oil will also pollute maritime environment if improperly disposed.

Preparation for refueling

- Fire-fighting apparatus should be located at refuelling spot.
- Wear appropriate personal protective equipment. For portable fuel tank, check if the person in charge is capable of moving it safely or requires trolley for assistance.
- Ensure the fuel inlet position in the vessel and that it should not be confused with the fresh water inlet.
- Ensure the fuel supply source matches the engine's specification (diesel/ petrol/ 90/ 93/ 97 (octane number)/ diesel rating (cetane number)). For any questions, please refer to the machine's operator manual.
- Calculate the amount of fuel needed (litre/ tonne) and consider if excess fuel will lead to overflow, and note if the order of refuel may pivot the vessel laterally, affects vessel's stability or bow/stern draft.
- Ensure the correct tank (daily fuel tank/ main fuel tank/ port fuel tank/ starboard fuel tank) is refuelled in required order.

Refuel at Filling Station near Pier or at Oil Barge

1. Tools for preventing of oil pollution (such as oil absorbent cotton, sawdust etc.) should be standby while refuelling.
2. Operators must wear life jacket if there is a risk of man overboard. Operator should wear safety shoes and safety helmet when working on vessel. Safe passage should be provided at suitable position between vessels (such as gangway, gangboard etc.) for crew members to access the vessels.
3. Note that wobbling of vessel will break the fuel fill pipelines.
4. As far as possible, refuel during day time without the use of artificial lighting (electric current flowing in lighting appliances may produce spark, hence increase the risk of fire).

5. Wherever refuel takes place, unrelated personnel should leave the vessel.
6. Before and during refuel, smoking and naked fire operations are prohibited. Engine, mechanical and electrical operations which may produce spark should also be shut down.

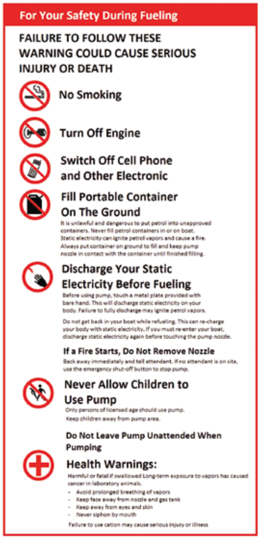
7. Whenever possible, place portable fuel tanks on ground onshore before refuel.
8. Close cabin doors, hatches, portholes and other openings of cabins and compartments to avoid flammable vapours released during refuel entering engine room or compartments.
9. Operating personnel of filling station or oil barge must be present to control the oil pump during refuelling process, unless reliable emergency cut off devices are on hand at the refuelling position, and also keep bilateral communication for immediate reaction in case of emergencies (such as oil overfill and spillage).
10. Calculate the amount of fuel needed and communicate with the operators of the filling station/ oil barge in advance about the procedure and refuel amount.
11. Avoid full refuel of the fuel tank but reserve around 10% space as fuel expands subject to temperature change.
12. During refuel, beware if the sound from ventilation hole of the fuel tank is normal.
13. Refuel nozzles usually have an auto cut off feature which over-reliance should be avoided (especially when refuelling portable fuel tanks).
14. Avoid fastening the refuel nozzle to the fuel inlet with hands-free accessories (or strings), but hold it tightly with hands until refuel is finished. This is to aid immediate reaction in case of accident.
15. The refuel nozzle should contact with the metal frame of the fuel inlet to avoid sparks produced from static electricity. Oil absorbent cotton may be used to surround the fuel inlet during refuel to absorb oil spills. It also helps to absorb minor oil residues from the refuel nozzle when the nozzle is unplugged after refuel.
16. Use oil absorbent cloth or cotton to clean oil leaked to the deck, fuel leaked to engine and bilge should be cleaned immediately.
17. Close the fuel tank cover after refuel and open all cabin doors and other openings of cabins and compartments for ventilation. Treat the oil tainted cloth, oil absorbent cotton, etc. properly by keeping them in sealed containers and bringing them back to the shore to dispose them as chemical waste.
18. Ensure no dangerous vapour in the bilge or engine room before starting the engine. The bilge forced draught fan may not be able to blow away volatilised petrol or diesel vapours completely, so ensure the safety of the environment before starting the engine.

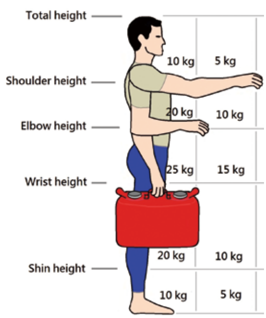
Oil absorbent cotton surrounding the fuel inlet to absorb oil spills

Oil absorbent cotton

Refueling at Roadside Filling Station

- Fuel containers must be approved and suitable for loading fuels, do not use general portable water tank.
- Fuel container must be placed on ground before filling fuel. Risk of static electricity spark will increase if the container is placed on a trolley for refuel. Before refuel, touch a grounding plate with both hands to discharge static electricity from body.
- Use of mobile phones is prohibited. Non-ionizing radiation produced from mobile phones may cause resonance and produce spark if there is metal with matching radio wave wavelength nearby.
- In case of fire, do not pull out the refuel nozzle to prevent spread of fire, but stop the oil pump from pumping oil.
- Filling station may sell fuels other than diesel and petrol, such as LPG and alcohol fuel. Therefore, safety regulations of individual station should be noted and observed.
- The weight of a fully filled portable fuel tank must not exceed 25 kg, or else assisting machines (e.g. trolley) should be used.





Suggested weight an adult man can lift or lay down at different weight zone

Jet Ski

- Jet skis are smaller in size, thus in case of fuel leakage, fuel will quickly flow to the sea and cause pollution.
- Before refuel, moor the jet ski alongside the refuel platform, stabilize the vessel and fasten the jet ski to it.
- If needed, use a funnel to aid refuelling and surround the fuel inlet with oil absorbent cotton to absorb oil spills.
- Before restarting the engine, open the machinery space under the seat for ventilation, inspect and ensure no petrol leakage or accumulated fuel vapour.

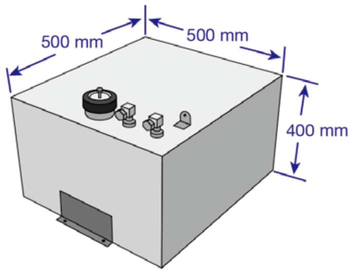
Fuel Tank Volume Measurement and Calculation:

Sounding method Fuel Tank Volume Measurement

Most fuel tanks on vessels are made of metals, with filling/supply pipelines, manhole/inspection cover, vent pipe and sounding hole on deck, the vent pipe opening is covered with brass mesh to avoid tinder from entering the tank in case of accident.

As the design of fuel tank has to accommodate the vessel's curved hull surfaces, therefore it is rarely made as cubes, but usually trapezoidal prism, cuboid or cylinder. The following is an example of volume calculation (refers to the figure on the right):

Suppose the dimension refers to the measurement of inner layer:



Volume = Length x Width x Height

Volume = 0.5 m × 0.5 m × 0.4 m

Volume = 0.1 m^3

As 1.0 m^3 = 1,000 Litre = 1 Cubic Metre

Therefore 0.1 m^3 = 100 Litre (Maximum volume of fuel tank shown on the right)

Density, ρ — refers to the mass per unit volume (kg/m^3).

$$\rho = \frac{m}{V} \quad (m) = \text{Mass; } (V) = \text{Volume}$$

The density of water is 1000 kg/m^3 or 1 gram (g) per 1 cubic centimeter (cc), so 1,000 litres of water = 1,000 kilograms (kg)

Specific gravity — generally compared the density with pure water. It does not have a unit as it is a ratio. If the specific gravity of a substance is greater than 1.0, that is the density is higher than water, the substance will sinking in water; if the specific gravity of a substance is less than 1.0, that is the density is less than water, the substance will floating on water. If the specific gravity is 1.0, the substance is probably water. 1 cubic metre of water equals to 1,000 litres of water. The weight is 1,000 kilograms.

Example:

(refers to figures on the right)

1 tonne = 1,000 kg

Type of fuel	Density
Diesel	0.84 g/cm^3
Petrol	0.73 g/cm^3

What is the weight of 2,000 litres of diesel?

Weight of diesel = volume x specific gravity

Specific gravity of diesel = 0.84

2,000 x 0.84 = 1,680 kg = 1.68 tonne

What is the weight of 500 litres of petrol?

Weight of petrol = volume x specific gravity

Specific gravity of petrol = 0.73

Weight of petrol = 500 x 0.73 = 365 kg

Flash Point

The flash point of a flammable material is the lowest temperature the material evaporates into flammable vapours.

On the right is the flash point data of a certain finished oil product in the market. The flash point of different brands' oil products may differ by a few degree Celsius, but they are still flammable. Petrol is especially dangerous as it emits flammable vapours under room temperature which will ignite by spark.

Flash Point (Petrol) = -43°C

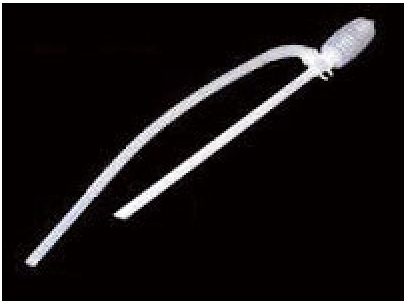
Flash Point (Diesel) = +63°C

Fuel Tank Sounding Method

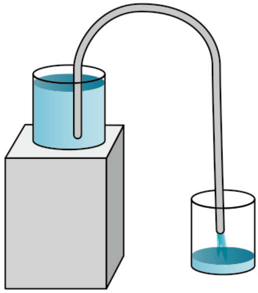
Insert a scale bar or scale ruler from the top of the fuel tank and retrieve it to observe the height of fuel level (h), thus calculate the fuel level. Besides, the fuel level of the tank can be obtained by comparing the height of fuel level with the sounding table provided by the vessel manufacturer.

Other Matters:

Never draw air from hose of fuel line by sucking with mouth — fuel can be extracted from the fuel tank by applying of Siphon effect. Accidental swallow or ingestion of fuel can be fatal as fuel will enter blood by absorption of the gastrointestinal tract. Use tools that meet the standard such as hand operated siphon pump to extract oil with Siphon effect if needed.



Hand operated siphon pump



Siphon effect

Unleaded Petrol

Petrol with high octane number reduces the chance of petrol engine knocking. A few decades ago, octane number is increased by adding antiknock agents such as tetraethyl-lead, MTBE, DMC, MMT etc.

Lead is a poisonous material which can be absorbed by human easily and causes serious public health problem, thus petrol with lead containing fuel additives is banned by numerous countries many years ago and those additives are replaced by unleaded fuel additives, forming unleaded petrol.

Ultra-low Sulphur Diesel

Ultra-low sulphur diesel contains less than 0.005% of sulphur which is one-tenth of regular diesel. Vessels using ultra low sulphur diesel helps to reduce suspended particulates and sulphur oxides (SOx) emission.

Sulphur in Diesel

Sulphur is a chemical element and is found in crude oil which can be seen in general oil products (such as diesel). Low sulphur diesel means diesel with average sulphur concentration of less than 150 PPM (150 over a million). Emission of sulphur oxides originates from sulphur impurities in the fuel. The amount of pollutants released is in proportion to the amount of fuel burnt and the percentage of sulphur contained in fuel. Thus, the sulphur contained in diesel is a major cause of air pollution and engine damage.

Air Pollution

Sulphur diesel emits pollutants, such as sulphur dioxide, carbon monoxide, nitrogen oxides, volatile organic compounds and other fine suspended particulates matter, which contributes to the formation of other pollutions such as ground level ozone. These pollutants cause visibility impairment, respiratory symptoms, damage to cardiopulmonary function and viral diseases such as asthma. The acidic chemicals in pollutants deposit to the atmosphere of the Earth's surface and this process is called acid deposition. The major causes of acid deposition are nitrogen oxides and sulphur dioxide gases. Toxic metals such as mercury and aluminium can be released into the environment through soil acidification and then stay in the drinking water, crops and animal cells. Although some toxic metals do not directly affect animals, they will harm human health when the poultry and livestock are consumed by human.

Engine Damage by Sulphides

During combustion, sulphur in fuel combines with moisture in air to produce sulphuric acid. The acid accumulates in the engine lubricating system or suspends in the fuel to damage the cylinder, piston ring, exhaust valve, duct etc. Sulphur dioxide also damages the catalyst and causes the smell of the exhaust.

Advantage of using Ultra-Low Sulphur Diesel

- Protects the environment
- Reduces exhaust emission, black smoke and noise
- Reduces nasty smell and sulphur dioxide emission

Benefits to the Engine

- Can be introduced without any engine adjustment
- Decreases piston corrosion and cylinder wear, thus reduces maintenance costs
- Extends oil lubricant's service life

Engine Operation Safety

Apart from the propeller engine (main engine) and electric generator, steering gears (auxiliary machineries), crew members have to operate deck cranes, anchor winches, thrusters and other auxiliary mechanical devices on larger vessels.

Deck crane

Deck crane are equipped on larger pleasure vessels to hoist supplementary boats or jet skis etc. Deck crane may equip small internal combustion engine which drive the winch through the gearbox; it may also be driven by electric motor or electro-hydraulics. Before use, note the WLL (work load limit) or SWL (safe working load) of the deck crane.

In general, the deck crane of a pleasure vessel hoists the same boat every time which causes no problem. If it is used to hoist other things, proper calculations must be done before operation. For example, a 3-meter-long landing boat weighs about 100 kg and the crane has similar lifting capacity while a 3-meter-long jet ski can weigh up to 300 kg which exceeds two times of the capacity. Do not overload when hoisting to avoid danger.

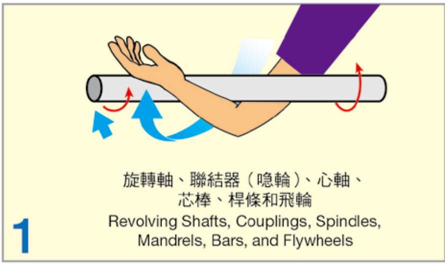
- Before taken into use of the lifting appliance and lifting gears on local vessel, they should be examined and tested, or regular thoughtful examined by competent examiner, and the certificates issued by the competent examiner is kept on board.
- Crane installed on local vessels can only be operated by trained person with valid certificate from relevant training course.
- Before working, choose the suitable crane (with proper work load limit and safe working load) and check the condition of lifting appliances and knots to assess the risk.
- Ensure the hoisting operation cause no risk of overloading.
- Note the state of the sea is suitable for hoisting operation. A vessel undergoing hoisting operation at a calm pier may be affected by sudden wake of other vessels, it could leading to the operator may be injured by swinging hanging object or fall into the sea. It can affect the stability of the vessel or even cause the vessel capsized.
- Lifting appliances, cranes, lifting gears, etc. must have clear labels and marked with safe working load.
- Before operation, check if the lifting appliances, lifting gears, etc. have been thoughtful examined by competent examiner of inspected by competent person and the certificate of examination of the crane is valid.
- Check and fix the tension angle and weight distribution, also keep at least one tail rope to prevent/ control the hoisted item from swinging.

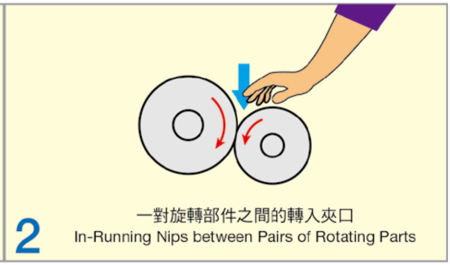
Anchor windlass

Anchor winches are usually equipped at the bow to release and pick up of anchor. Anchor winches can be powered by small internal combustion engine, electric-hydraulic drive or electric motor; Anchor winch of small vessels can also be operated manually.

Dangerous Parts of Machines

- The danger of machinery comes from the machine itself or operating components. If a human is in contact with such parts without any protection measures could lead to accident.
- Protective guard/screen should be installed around the rotating parts, moving parts, hot surfaces of engines or auxiliary machineries, such as engine‘s flywheels, driving belts, transmission shafts, couplings, etc. (see figure 1 below)



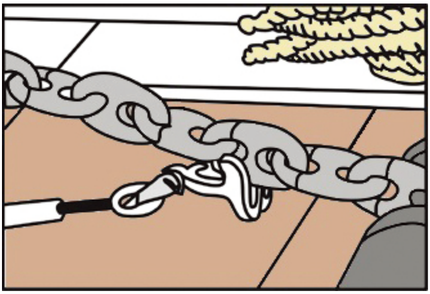


- In and out position of winch’s rope/chain, position of driving belt and diesel engine’s timing gear, etc. (see figure 2 above).
- Beware of the path of anchor chain, vessels mostly let go the anchor with chain, the operator should be mindful if his/her feet have enough personal protection equipment when operating the anchor winch if he/she is in bare feet, sandals or boat shoes and assess the risk.
- Beware of clothes and accessories, including ties, scarfs, necklaces, watches and cotton gloves (or labour gloves), could cause risks to entangle into rotating parts of the machine. Wear suitable personal protective equipment to avoid injury when operating of manual or electric winch on vessel.
- Before operating the anchor winch, check different parts of the machine, such as if the emergency stop switch, stopper, brake, riding pawl, etc. function properly and if the oil level and quality in gearbox is appropriate. If the machine is powered by small internal combustion engine, check the clutch, brake, internal combustion engine etc. function properly. If it is a hydraulic anchor winch, check the oil level and quality of hydraulic oil, ensure no leakage at all control valves and pipelines, test the function of the hydraulic pump and note the pressure reading of the hydraulic pressure gauge.
- Operate the windlass carefully when letting go the anchor and wash away all sand and mud on the anchor chain when picking up the anchor before storing the anchor chain into the chain locker.

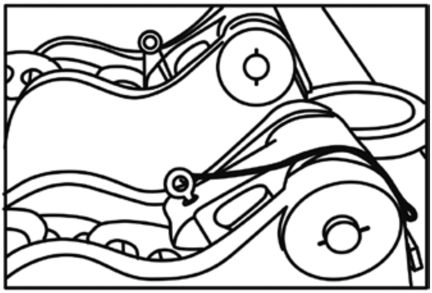
Rope winch — the pawl limits the gear to rotate in single direction only (anti-clockwise)

Procedures for letting go the anchor

- Sail the vessel to the anchorage position.
- Open the riding pawl.
- Separate from the gipsy wheel/ release the devil claw chain stopper/ release the safety pawl.
- Pull the anchor chain by controlling in pick up action of the windlass and release the chain stopper.
- Pick up the anchor/ let go the anchor.
- The lowering speed of anchor chain can be controlled by the brake of the windlass when letting go the anchor.
- Fix the brake band of windlass after releasing appropriate length of chain.
- Check regularly for the wear and tear, adjust and rectify defects of components of the anchor windlass. The anchor and anchor chain may be lost if there is failure of the windlass.
- Pick up of the anchor chain without opening the riding pawl may damage the pawl. Rotating the anchor winch without releasing the brake band may damage the brake components.



Devil's claw

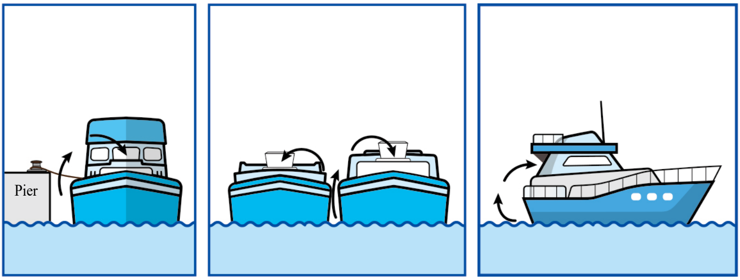


Riding pawl

- Regular maintenance is required for anchor windlass. Switch off the power source of windlass before maintenance and a warning sign should be hung at the main switch to avoid accidents.
- Check the oil level and quality of anchor winch's and gearbox, replace regularly. Rectify and repair immediately if any leakage.
- The pawl inside the winch limits the gear to rotate in single direction. It should be regularly dismantled for cleaning and greased with the specified lubricant to maintain the operation in good working order.

Carbon Monoxide

- The combustion of engine causes chemical reaction between the fuel and oxygen in the air which normally produces heat and carbon dioxide, thus emits mainly carbon dioxide and a small amount of other pollutants such as photochemical smog, carbon particulates, nitrogen oxides, carbon monoxide etc. If an engine works in an anoxic condition, such as insufficient ventilation in engine room, clogging of engine air inlet or long-term operation in low speed etc., the carbon monoxide concentration in emission will soar.
- If the carbon monoxide concentration in air reaches 35 ppm, it affects human health, causes hypoxia and can be fatal.
- When the engine operating, ensure there is sufficient ventilation in the engine room and no leakage from the exhaust pipe. Also, when vessels moor alongside with another vessel or the pier, check the exhaust gas is discharged smoothly and the exhaust gas will not blow back into the cabin or affect other vessels.



(22) Use LPG Safely on Vessel

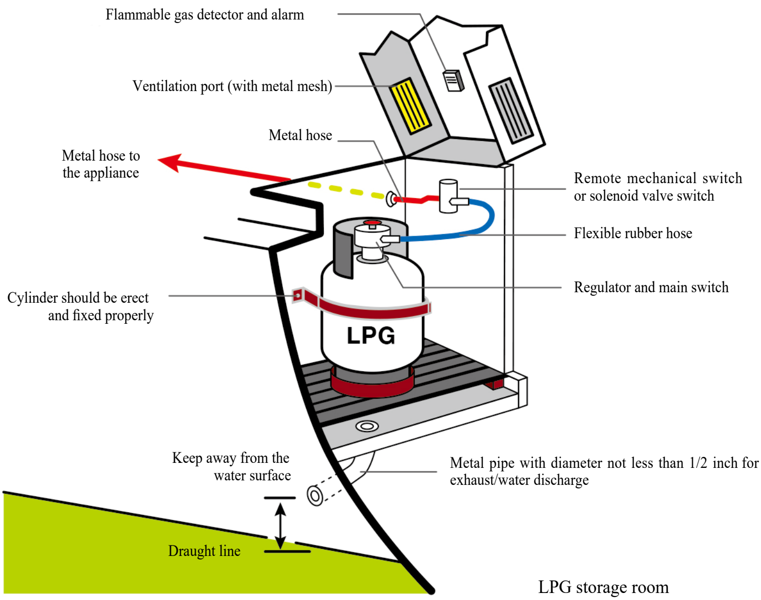
Liquefied Petroleum Gas (LPG) on vessel is contained in steel cylinder with pressure of 80 per square inch (psi*). Before LPG is delivered to the cooking or heating devices via hoses, the LPG pressure will be lowered by pressure regulator to less than 0.5 per square inch. For cassette cookers without regulators, the spiral switch/ valve by the cylinder connection can be turned to adjust the pressure of LPG outlet.

As LPG is heavier than air, it sinks to the deck or lower places if there is a leakage and may accumulate at the bilge. LPG is highly flammable and becomes a highly explosive gas mixture when mixed with air which can be ignited by just a slight spark of a lit cigarette or electrical appliances.

Even there is only a little amount of LPG, if it is mixed with air in a confined area to a certain proportion and ignited by spark, it will cause strong explosion. Therefore all preventive measures should be taken to avoid LPG leak into compartments of the vessel.

The ideal way is to install LPG equipment system on the deck such that any leaked LPG will flow out of the vessel safely due to gravity or blow away by wind. It must be extremely careful when installing, using and maintaining of LPG equipment to avoid any leakage, be alert to LPG accumulation tendency in the cabin and be familiar with the handling approaches.

* psi (pound per square inch); 1 bar = 14.504 psi



LPG storage room

LPG Appliances on Vessel

The ideal position for various kinds of vessels to store LPG cylinders is the ventilation cabin near stern deck. There is an exhaust port at the bottom of cylinders, so cylinders must be stored away from all cabin openings, ventilation windows and ventilation ports / air inlets. In case LPG leaks from the exhaust port, it will be safely discharged out of the vessel.

If the LPG cylinders cannot be stored on deck, the best approach is to store them in a special air-tight cabin under the deck where there are exhaust ports by the floor for direct gas discharging out of the vessel. Both empty and filled LPG cylinder should be erect and stay away from heat sources such as direct sunlight, engine, exhaust pipe, etc. A maximum of 50 kg of LPG is allowed to be loaded on a vessel.

LPG hoses, accessories and devices should meet the safety standard approved by LPG company authorised distributors and the Electrical and Mechanical Services Department (EMSD). Please consult distributors and the EMSD for any enquiry.

Long LPG hoses should be made of metal and fixed at a damage-free location. Flexible rubber hoses could be damaged or broken due to wear and tear and the damaged part could be hidden by panels or similar objects and remains unnoticed. Therefore, it should minimize the length of the flexible rubber hose between two joints and it should be kept visible for immediate notice of any hardening or deterioration. Rubber hoses should be replaced regularly due to plastic ageing. Always keep the flexible rubber hoses clean. The hoses melt if they are in contact with oil and that long-term exposure to heat could accelerates the ageing and cracking of hoses.

Hose clamp should be used to fix the flexible rubber hose to its accessories, but it may puncture the hose if too tight.

Ensure LPG cylinders, devices and supply hoses not affected by the rolling of vessel.

Use of Gas Appliances

The model of gas appliances (such as cooking appliance and heater) must be approved by the EMSD Gas Authority and the appliance should have the "GU" label. Existing gas appliances should be equipped with automatic cut-off device to stop supply of LPG if the flame suddenly goes off.

Ensure all switches of the LPG appliance are turned off before turning on the regulator or switch of the LPG cylinder.

Unless the gas appliance is equipped with a fully automatic and reliable ignition device, the LPG appliance's switch should be turned on only when a burning match or tinder is put near the LPG stove.

Check all appliance valves are closed properly before leaving the vessel, turn off the regulator or main switch of the LPG cylinder. If the vessel is left unattended for a few days, isolate the LPG cylinders from the supply system to ensure safety. Seal the gas outlet of the separated LPG cylinders properly with caps to prevent dust or moisture enter the cylinders.

If there is still a little LPG left in a finished LPG cylinder, do not store it under the deck but treat it as a filled cylinder and seal the gas outlet properly with a cap.

Maintenance of LPG Equipment

Check the anti-leakage rubber ring (O-ring) of the LPG cylinder connector and keep it clean and without blockage. When not in use, cover the cylinder with a cap. If the LPG cylinder has a regulator, check any damage on the anti-leakage rubber ring. If in doubt, ask the supplier for replacement.

Furthermore, check for any damage or deterioration of the rubber hose. Rubber hardens or breaks if heated while softens, decomposes and becomes viscous if it is in contact with oil.

If leakage of LPG is suspected from the hoses or connector, test it by spraying soapy water (or detergent) on it. Bubbles appear at the leak. Do not test it with open fire.

Check the LPG system regularly. For any questions about the LPG equipment, enquire the LPG equipment supplier.

How to check and handle leakage of LPG

When returning to the vessel, especially when its service is suspended for a while, one should look around to check if there is any smell of LPG (or activate flammable gas sensor and alarm). Do not forget to check the bilge as LPG is heavier than air.

If smells LPG is noted, he/she should inform everyone on board to be vigilant and execute precautionary measures. Then, take away the regulator on the LPG cylinders, and move all cylinders to the open deck.

Do not operate with open fire, smoke, or switch on or off any electrical appliances until the compartments are completely and effectively ventilated. Any metal collisions are dangerous. Do not start any machines to prevent sparks from friction.

Normal ventilation methods include using the ventilators on the deck, ventilation windows, porthole windows and doors. These methods have little to no effect on heavier gases in the bilge. To clear those gases, use a hood made by canvas, or strongly slap cardboards, blankets, large towels or moderate-sized canvas or similar materials to form an airflow directed to the bilge inside the compartment. This helps to disperse LPG in the air and cause it to leave the vessel through windows and doors opened. Do not use electrical fans, as weak spark from any electrical appliance switches or engines can cause explosion.

Hang a jib sheet above the hatch of the vessel’s bow as a hood

Whatever method you use, the dispersal of LPG should continue until the smell of LPG vanishes completely and ventilation should be well kept during the process. LPG is not a toxic gas, but breathing in too much LPG leads to impaired sensation retardation including sense of smell. A person can hardly notice the special smell of LPG once he inhales too much of LPG.

After clearing LPG on vessel, you should look for the leak which is possibly the switch of an appliance that is not turned off properly. Perform a thorough inspection on the LPG tubing system before using LPG again. Seek help from the LPG equipment supplier if you have any questions.

(23) Part B — Q&A

Q: What are the advantages of petrol engine?

A: Respond is faster and engine body weight is lighter than diesel engine (compare based on the same power output).

Q: In a 2-stroke engine, what is the relationship of rotational speeds between the camshaft and crankshaft?

A: Rotational speed of Camshaft equals to rotational speed of crankshaft.

Q: With valves on cylinder head and side camshaft installed inside the engine, where is the location of the tappet?

A: Between the cam and rocket arm.

Q: The compression of diesel engine is higher than that of the petrol engine, why?

A: Diesel required higher temperature for ignition.

Q: Compare with the two-stroke engine, what is the advantage of a 4-stroke engine?

A: Less vibration.

Q: In a 4-stroke engine, what is the relationship of rotational speeds between the camshaft and crankshaft?

A: Rotational speed of Camshaft is half of the rotational speed of crankshaft.

Q: What does "stroke" of a reciprocating internal combustion engine mean?

A: The distance of piston from top dead centre to bottom dead centre, or vice versa.

Q: Which type of internal combustion engine does diesel engine belong to?

A: Compression ignition internal combustion engine.

Q: Which type of internal combustion engine does outboard petrol engine belong to?

A: Spark ignition internal combustion engine.

Q: What is the main function of a crankshaft?

A: To transform linear reciprocating movement to circular movement.

Q: What is the main function of a gasket?

A: To act a mating surface for sealing the engine.

Q: In terms of a typical 4-stroke engine with a compression rate of 8:1, what is the pressure inside the cylinder during an “induction stroke”?

A: Lower than atmospheric pressure.

Q: In terms of a typical 2-stroke engine with a compression rate of 10:1, what is the pressure inside the cylinder during an “exhaust stroke”?

A: Higher than atmospheric pressure.

Q: The 2-stroke engine inside a single cylinder is running at 3,000 revolutions per minute (r.p.m.). Please calculate the number of power stroke per minute.

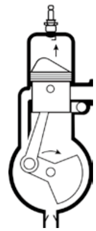
A: 3,000.

Q: The 4-stroke engine inside a single cylinder is running at 2,000 r.p.m.. Please calculate the number of power stroke per minute.

A: 1,000.

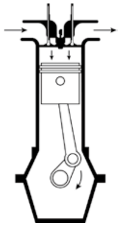
Q: Which kind of stroke is conducted in the internal combustion engine as shown in the right figure?

A: Compression stroke.



Q: Which kind of stroke is conducting in the internal combustion engine as shown in the right figure?

A: Power stroke.



Q: Why is the piston crown of a simple 2-stroke engine designed to a certain shape?Enhance on

A: purging of exhaust gas.

Q: What is the purpose of sealing the crank case of an outboard two-stroke petrol engine?To

A: prevent leakage of air and fuel air mixture.

Q: List one of the functions of the piston ring installed on a piston.

A: Regulating engine oil consumption by scraping oil from the cylinder walls back to the sump.

Q: Which system does not require an installation of filter?

A: The ignition system.

Q: What is the purpose of the safety valve of air receiver?

A: Discharge excessive pressure.

Q: What is a dry cylinder liner?

A: No direct contact between the cylinder liner and cooling water.

Q: Which installation is used to reduce the change in engine speed between the two power strokes?

A: Fly wheel.

Q: What is the purpose of opening of air intake valve and exhaust valve of the diesel engine with some time overlapping?

A: To improve the effect of scavenging.

Q: What is the purpose of choke when starting the petrol engine?

A: Enrich the fuel air mixture.

Q: What is the purpose of throttle valve when starting the petrol engine?

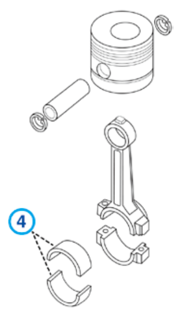
A: To control the intake quantity of fuel air mixture.

Q: To avoid mounting from experiencing severe vibration stress, what should be equipped with the diesel engine?

A: Flywheel with heavier weight.

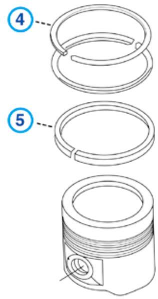
Q: What is the name of the component marked as ④ in the figure?Big

A: end bearing.



Q: What are the respective names of the components marked as ④ and ⑤ in the figure?

A: ④ is compression ring; ⑤ is oil ring.



Q: What is the purpose of the Venturi pipe inside a carburettor?

A: Increase air speed and reduce air pressure.

Q: Before entering the cylinder of the engine, the atomization of petrol air mixture is completed inside ____________________.

A: Intake manifold.

Q: How would a idle jet of a carburettor affect the engine?

A: Steady idling.

Q: What is the purpose of the carburettor of a small-sized outboard two-stroke engine?

A: Mixing air and petrol.

Q: What is the speed of the distributor of a four-stroke petrol engine?

A: Half the speed of the engine revolution.

Q: The contact breaker inside the petrol engine system is installed in the _______________ system.

A: Ignition.

Q: What is the purpose of the contact breaker inside the ignition system of the petrol engine?To control

A: the ignition of spark plug.

Q: When the contact breaker inside the ignition system of the petrol engine is ______________, the spark plug will produce sparks.

A: Separating

Q: Which component could directly ignite the petrol air mixture inside the cylinder?

A: Spark plug.

Q: What is the purpose of the coil inside the ignition system of a petrol engine?

A: Produce high voltage by secondary induction circuit.

Q: Which component does not belong to the distributor of the ignition system inside the petrol engine?

A: Spark plug.

Q: What components are included in the distributor of the ignition system inside the petrol engine?

A: (i) Capacitor, (ii) Drive shaft, (iii) Contact breaker

Q: Why is "firing order" required in the internal combustion engine with multiple cylinders?

A: Reduce the vibration of the engine, and force balancing of the pistons motion.

Q: What is the correct description of a "hot-type spark plug"?

A: "Hot-type spark plug" has long insulator nose and long cooling path. The temperature of the end of spark plug is relatively high.

Q: What is the correct description of a "cold-type spark plug"?

A: "Cold-type spark plug" has short insulator nose and short cooling path. The temperature of the end of spark plug is relatively low.

Q: What does "hot-type spark plug" and "cold-type spark plug" represent respectively?

A: Hot-type spark plug is that the plug end is easily to be heated, and cold-type spark plug is that the plug end is not as easy to be heated as the hot-type spark plug.

Q: If an engine mistakenly uses a set of spark plugs that is of unsuitable heat range, causing the spark plugs to be kept in a working temperature that is too low, what would be the consequences?

A: With insufficient heat, there will be carbon accumulated between electrodes. The accumulated carbon will cause electrical short-circuit, which in turn causes difficulties in producing spark.

Q: If an engine mistakenly uses a set of spark plugs that is of unsuitable heat range, causing it to be kept in a working temperature that is too high, what would be the consequences?

A: Occurrence of pre-ignition which in turn causes dissolution of electrode of the spark plug.

Q: What are the advantages of the atomization of diesel by fuel injector?

A: (i) Fuel is broken into tiny droplets, penetrate far enough into the combustion space and intimately mix with swirled oxygen in the air flow; (ii) increase surface areas of fuel burning;(iii) easy ignition of fuel.

Q: How to control the power output of the diesel engine?

A: Adjust the fuel injection volume.

Q: What are the main purposes of the fuel injection system of a diesel engine?

A: (i) Supply fuel in a timed manner; (ii) supply of fixed-amount fuel; (iii) atomization of fuel.

Q: The purpose of a high-pressure fuel pump of a diesel engine is to supply fuel __________ to the fuel injector.

A: in a timed man ner.

Q: What is the purpose of the cooling system of the internal combustion engine?

A: Keep the engine in high temperature that is mechanically possible to enhance the combustion rate.

Q: What is the reason to equip a fresh water circulating system for cooling sea water in the engine?

A: Reduce corrosion.

Q: What is the advantage of direct cooling engine when compared with indirect cooling engine?

A: Simpler cooling system.

Q: What is the correct description of the cooling of an outboard engine?

A: Cooling water is discharged at about midsection of the unit.

Q: What is the disadvantage of using direct cooling system in an internal combustion engine?Easy

A: accumulation of water deposit at cooling water jacket.

Q: With fresh water cooling system used in a diesel engine, what component should be used to transport heat to the sea water?

A: A heat exchanger.

Q: Which part of the main engine is installed with a heat exchanger?

A: Engine oil cooling system of a diesel engine, gear oil cooling system of a gear box and cooling system of jacket cooling water.

Q: What is the correct description of a fresh water cooled engine in closed system?

A: Only fresh water would be circulated in the engine.

Q: What is the purpose of a clutch?

A: To engage or disengage the driving shaft of the engine and propeller shaft.

Q: What is the purpose of installing a gear box in the transmission line of an inboard engine?

A: Greater torque and slower rotational speed for propeller shaft.

Q: What are the usages of the gear box?

A: Drive ahead and astern.

Q: Which two components are normally installed with a clutch?

A: Engine and transmission gear box.

Q: What is the purpose of installing a clutch on an engine?

A: To drive gears and separate transmission gear and propeller shaft from engine.

Q: Conical clutch are installed in the gear box of small to medium-sized engines, what is the advantage of the design of this kind of clutch?

A: Increase connectivity.

Q: What is an exhaust duct (manifold)?

A: A main exhaust pipe to connect the exhaust gas from engine.

Q: What is the main disadvantage of a wet exhaust system?

A: Reflux water into cylinder.

Q: What is the main purpose of the gap between air intake valve and exhaust valve?

A: To tightly close the valves.

Q: What is the purpose of a thrust bearing?

A: To push the vessel.

Q: The driving force produced by the propeller shaft driven by the main engine is transmitted to the hull through a ____________.

A: Thrust bearing

Q: Thrust bearing should be installed somewhere on the inboard engine shaft, to________________________.

A: Protect crank shaft from the thrust of the propeller shaft.

Q: The pressurized engine oil inside the lubrication system will __________________ and reach crankpin and crankshaft bearing.

A: Pass through the oil passage inside the crank shaft.

Q: To lubricate the cylinder wall of a 2-stroke outboard engine, use______________.

A: The mixture of lubricant and petrol which is drew into the crank case.

Q: The oil sump inside the engine is mainly used to _______________.

A: Store engine oil

Q: Which kind of lubrication is used on the big end bearing of a small-sized 2-stroke outboard engine?

A: By the mixture of lubricant and petrol which is drew into the crank case.

Q: The oil pump of a common 4-stroke diesel engine with six cylinders is a gear pump, and the power source for driving the gear pump is ____________.

A: Cam shaft and crank shaft

Q: The engine oil gear pump of a common 4-stroke diesel engine with six cylinders is directly driven by a cam shaft, what is the speed of it?

A: Only half the speed of the main engine.

Q: What would happen if air is entered into a fuel injector of a diesel engine?

A: The high compressibility in air would cause malfunctions when operating.

Q: What measures must be taken when air is suspected to be inside the diesel system?

A: Eliminate air by priming of fuel line.

Q: What is the determining factor of the fuel injection pressure of a diesel engine?

A: The spring pressure of the needle valve of the injector.

Q: Regular inspection should be conducted on the high pressure oil pipes, what is the danger when there is leakage of high pressure fuel?

A: Fire hazard.

Q: What is the gross volume of a fuel container of 10 m length, 5 m width and 8 m height?
A: 400 cubic metres.

Q: What is the gross volume of a rectangular fuel container of 5 m length, 6 m width and 5 m depth and half filled with fuel?

A: 75 cubic meters.

Q: The dipstick is now measured at 0.4 m in a fuel container of 1 m depth, 2 m width and 1 m length, how much fuel does it need to fill up the whole container?
(1 cubic meters = 1,000 litres)

A: 1,200 litres.

Q: The dipstick is now measured at 0.6 m in a fuel container of 1 m depth, 2 m width and 1 m length, how much fuel does it need to fill up the whole container?
(1 cubic meters = 1,000 litres)

A: 800 litres.

Q: A rectangular fuel container of 6 m height, 2 m width and 3 m length, the total amount of fuel in the container when the dipstick is measured at 4 m is _______________ cubic meters.

A: 24

Q: A rectangular fuel container of 6 m height, 2 m width and 3 m length, the total amount of fuel in the container when the dipstick is measured at 5 m is _______________ cubic meters.

A: 30

Q: A rectangular fuel container of 5 m height, 2 m width and 2 m length, the total amount of fuel in the container when the dipstick is measured at 4 m is _______________ cubic meters.

A: 16

Q: What is the approximate flashing point of diesel?

A: + 63°C.

Q: What is the approximate flashing point of petrol?

A: -40°C.

Q: What is the meaning of fuel flashing point?

A: It is the lowest temperature at which a liquid fuel will give off sufficient vapour to ignite in air when expose to flame.

Q: What is the usage of this meter on the control panel which located next to the main engine?

A: Indicate the engine oil pressure.

Q: When the vessel is underway, a rope is found floating under the bow, what should be done to the gear box control?

A: Change to neutral mode.

Q: What is shown on the control panel right after the main diesel engine is started?

A: The engine oil pressure gauge shows the rated pressure.

Q: What is the reason of the malfunction of clutch?

A: Inappropriate adjustment of soft control cable; deterioration of clutch disc leads to the clutch slip.

Q: What is the purpose of the static pressure oil tank of the oil lubricated propeller shaft?

A: It can reduce the water pressure experienced by the stern tube shaft seal.

Q: When operating a hydraulic steering system, it is expected that the readings from pressure gauges are __________ .

A: Normal and stable pressure readings.

Q: What is the reason of air lock of steering gear?

A: There is leakage at the pipeline connectors and/or insufficient amount of oil.

Q: What should we pay attention to when inspecting the steering system?

A: (i) Rudder angle indicator, (ii) pressure gauge, (iii) oil level gauge

Q: What is the correct statement of hydraulic steering gear?

A: Safety valve must be installed.

Q: What kind of problem would be caused if air inside the hydraulic steering system?

A: Slow motion and instable pressure.

Q: What is the main reason if the angle of the rudder is different from the angle shown on the rudder angle indicator?

A: Twisted rudder post and/or damaged rudder angle indicator.

Q: What is the first two steps of starting a simple small-sized outboard petrol engine?

A: Lower the engine into the locking position, and check if the gear is at neutral mode.

Q: If the charging indicator light is still on and the ammeter indicated at 0 reading after the engine was started, what should first be inspected?

A: Check if the electric generator is in normal operation.

Q: When electricity is used to start the engine, the starting button________________.

A: Should be released if the engine does not start after pressing it for a few seconds.

Q: Engine running at an idle speed for a long period of time will cause excessive abrasion, it is because _____________________.

A: The circulation of cooling water is poor.

Q: After starting the outboard engine, why should it be run at an idle speed for a while?

A: To allow the transportation of engine oil to the rotating parts.

Q: The fastest and correct way to stop the outboard engine is ______________.

A: Turn off the ignition system.

Q: Under normal circumstance, which method should be adopted to stop the diesel engine?

A: Cut the fuel supply.

Q: What should be done after driving the vessel in full speed for a while and before turning off the main engine?

A: Run the engine at an idle speed for a while.

Q: Using a compression release mechanism (exhaust valve lifting lever) to shut down the diesel engine in a small-sized diesel engine is not suggested. What problem will it cause?

A: The unburnt fuel going into the exhaust system will have the potential to cause fire.

Q: An engine-driven vessel with 50 horsepower (37.3 W) diesel main engine installed. The vessel uses a 12 V direct current system.

If you hear a "click" sound and found the panel lights become dimmed when you start the engine with electric start, it is probably _______________.

A: Battery fault.

Q: If the vessel grounds, which of the following measures is the most appropriate to take?

A: (i) Stop all engines; (ii) Check if there is any damage at machinery space, main engine, tail shaft; (iii) Pump away all accumulated water at the bilge.

Q: If the machinery space is flooded with sea water suddenly, and the situation cannot be controlled, what is the ultimate action to be taken?

A: Close all watertight doors at the machinery space, and cut off fuel supply and switch off the electric circuit from outside of the machinery space.

Q: The emergency exit of the engine room must:

A: (i) be able to open from both inside and outside; (ii) have clear instructions; (iii) be free of obstructions.

Q: What should be done before entering the engine room?

A: Turn on the lighting and ventilation.

Q: The anchorage of your vessel is next to the beach and there are diving activities nearby. You are going to leave and preparing to start the main engine now.

Before pressing the start button, what precautionary measure should be taken?

A: Ensure there is no one in the water near the vessel.

Q: If there is not much fuels left on the vessel, which of the following way below can help save the fuel for longer running time?

A: Adjust to reduce the throttle opening

Q: With proper matching between the hull and propeller and appropriate operation of the engine, your engine could be _________________.

A: Running with full power and speed

Q: Why the engine is normally installed on rubber engine mounts?

A: To reduce the vibration transmitted to the hull shell.

Q: What is indicated of a fully opened thermostat of a water-cooled engine?

A: The temperature of the cooling water is higher.

Q: When the engine was just started, the thermostat is ______.

A: In closed mode, the warming up of the engine can be faster.

Q: Why is the thermostat of indirect cooling marine engines not suitable for direct cooling marine engines?

A: Their operating/running temperature setting is too high.

Q: What cools down the exhaust gas of inboard engine?

A: Circulating seawater.

Q: Which component does the cooling sea water of an inboard engine will circulate through for cool down before discharge?

A: Exhaust pipe.

Q: What does the oil pressure warning light of engine oil indicate?

A: Low oil pressure.

Q: What are the causes of the low engine oil pressure of diesel engine?

A:
(i) Worn bearing;
(ii) Damaged oil pump;
(iii) Insufficient engine oil;
(iv) Clogged engine oil filter;
(v) Damaged engine oil safety valve.

Q: When the engine oil pressure reduces to zero, what action should you take immediately?

A: Stop the engine.

Q: When the engine oil pressure alarm starts to ring, what action should you take immediately?

A: Reduce engine speed.

Q: What is not the causes to the damage of bearings?

A: High operating speed.

Q: The viscosity of engine oil is mainly affected by ________.

A: Temperature

Q: What are the advantages of a gear pump?

A: (i) Applicable to liquids with higher viscosity; (ii) Applicable to pressure system.

Q: What is the most probable cause of a relatively high level of engine oil pressure?

A: Inappropriate adjustment of the pressure relief valve.

Q: What causes the overheat of an exhaust pipe?

A: Delayed ignition.

Q: Which component is not included in the exhaust system?

A: Wastegate.

Q: What is the purpose of installing thermal resistant material on an exhaust pipe?

A: (i) Reduce the heat dissipation from the exhaust pipe

(ii) Reduce the temperature in engine room

(iii) Avoid fire hazard caused by the contact of a heated exhaust pipe with any kind of oil

(iv) Reduce the safety hazard of burning to any person from the heated exhaust pipe

Q: What problems would be caused if the wire is too close to the main engine exhaust pipe?

A: The protective insulating cover layer of the wire would become carbonize and peel off because of the high temperature.

Q: In a wet exhaust system, what problems would be caused if the water jacket is cracked due to metal fatigue?

A: The cooling water can backflow to the cylinder and cause severe damage.

Q: What is the sign of an inlet manifold leakage in a petrol engine?

A: There are white residues on the spark plug.

Q: What problems would be caused if the spaces of the intake valve and exhaust valve of the petrol engine is insufficient?

A: Loss of pressure.

Q: What are the major characteristics of reciprocating pumps?

A: (i) Self-priming; (ii) High pressure head.

Q: Why oil bilge water should not be accumulated in engine room?

A: Increase risk of fire and spreading of fire.

Q: Why a man-powered bilge pump is needed on a vessel that has been installed with an electric bilge pump?

A: It is a contingency measure against loss of electricity.

Q: What is the material used to make the suction pipe of a bilge pump?

A: Thick and hard material.

Q: What is the most common cause for the failure of a centrifugal pump?

A: Accumulation of air in the pump body.

Q: Vessels of ____ meters or more in length must be equipped with a bilge pump of adequate displacement.

A: Eight.

Q: Which kind of electric motor should be used for the fan installed in the battery room to prevent the accumulation of hydrogen?

A: Explosion proof type.

Q: Which type of engine requires a particularly good ventilation system in the engine room?

A: Air-cooled engine.

Q: Why should jet ski be equipped with manufacturer-recognised or appropriate engine cut off device?

A: The engine can be immediately stopped when the jet ski is out of control.

Q: What kind of fire fight apparatus must jet ski is equipped with?

A: Jet ski is not required to be equipped with fire fight apparatus.

Q: A 12-volt lead-acid battery is made up of ___.

A: Six units of 2 V (Volts) cell in series.

Q: What should be noted to ensure storage batteries are working normal?

A: Maintain proper cooling, ventilation, with proper specific gravity and liquid level of electrolyte.

Q: If a lead-acid battery is fully charged, what is the approximate electrolyte specific gravity?

A: 1.27.

Q: If the lead-acid battery is over-heated while charging, what should you do?

A: Reduce the charging current.

Q: A 24-volt direct current electrical system is made up of ___.

A: Two units of 24 volts battery in parallel.

Q: What determines the battery capacity?

A: The surface area of the electrodes immersed in electrolyte.

Q: Storage batteries should be fixed firmly in its place to ___.

A: Prevent damage during rough seas.

Q: The battery connector of the starter should be tightened and kept in clean condition in order to ________.

A: allow a large current to pass through when engine starting

Q: Distilled water is usually used to replenish the electrolyte of Lead-acid battery, why?

A: Because only water is consumed.

Q: What is the safety knowledge on electrical system?

A: Do not touch any conducting materials; understand electrical system equipment; display warning signs during maintenance.

Q: When a generator is running, what should be noted in general?

A: Examine the condition of loading and commutator; examine the operating condition of lubrication system and governor of prime mover; examine the temperature and vibrating condition of the bearing.

Q: When an engine is operating, what should be noted in general?

A: The engine should be kept clean and dry; bearing should be kept lubricated; governor should be kept in good condition.

Q: When a generator is running, what causes an extremely low voltage?

A: An overloading or extremely low rotational speed.

Q: In case of over speeding of electric generator powered by the diesel engine, what actions should be taken immediately?

A: Adjust the governor to reduce the engine speed.

Q: What is the use of rectifier on the circuit?

A: To convert alternating current (AC) into direct current (DC).

Q: Which device controls the output voltage of a DC generator?

A: Regulator.

Q: If the two indicator lamps earth fault detector system - has been correctly insulated with the earth wire, how would these two lamps display?

A: The brightness of the two lamps would be the same and illuminate with half-light.

Q: If earthing occurs in one of the power cords on the two indicator lamps earth fault detector system, how would these two lamps display?

A: One lamp is darkened and the other one is illuminated.

Q: When the motor stops running suddenly, what measures should be taken immediately?

A: Switch off the power supply and make sure the motor is isolated from the power supply.

Q: In a single phase 220 V electric system with alternating current, what is the rated voltage of the indicator light used in the earth fault detector?

A: 220 V.

Q: Which device can divert direct current into alternating current in the engine room onboard?

A: Inverter.

Q: The fuse in an electrical system is to ____________.

A: Prevent the destruction to the electrical system in case of short circuit fault

Q: What is the unit used in the rating of a fuse?

A: Ampere (A).

Q: A yacht is berthed at the pier. Before connecting to the shore power supply, you should first __________________.

A: Switch off the main circuit breakers of the electric power supply panel of pier and the vessel's electricity distribution system.

Q: What causes electric shock?

A: Alternating current or direct current with a voltage higher than 50 V.

Q: What should be done first if an injured person is found who's suffered from electric shock but still has pulses and breaths?

A: Lay the injured person down in a recovery position and call for medical personnel.

Q: What are the potential dangers of electricity?

A: Contact of live part rendering electric shock and burnt; fire risk incurred by electric fault; and it is a source of ignition in flammable or explosive environment.

Q: If someone encounters electric shock in the engine room and is still shocked by electricity in some body parts, what should you do before rescuing the injured person?

A: Shut down the electricity supply.

Q: What is the common fault of a magneto?

A: The damage of the insulator between the coils.

Q: If the lubricant/petrol mixture used by outboard petrol engine contains too much lubricant, what consequence would be caused?

A: Dirt is appeared at spark plug and lack of spark.

Q: What is the problem if a petrol engine is unable to start and fuel accumulates in cylinder?

A: Temporary error of spark plug.

Q: What is the potential cause of the sudden stop of engine and unable to run afterwards?

A: Propeller is twined by other objects.

Q: What should be inspected first when the petrol engine cannot be started?

A: Check if fuel tank is empty and the spark plug has sparks.

Q: Why cause the need on action of the choke flap at idling after the engine is warmed up?

A: Lean petrol / air mixture from the idling jet of carburettor.

Q: What is not the difficulty of starting the diesel engine?

A: There is not enough engine oil in the oil sump.

Q: What are the possible reasons if failed to start the engine?

A: Current isolator is not connected; commutator brush is abraded; starting pinion is jammed.

Q: What are possible reasons if the engine is suddenly stalled while running?

A: Fuel strainer is blocked; water or air found in fuel system; piston is jammed.

Q: What are the effects on the petrol engine if the fuel air mixture is ignited ahead of time by the sparks?

A: Loss of horsepower; Damage of cylinder liner and cylinder head; Possible damage of piston or connecting rod.

Q: What are the most probable reasons for the rapid change to intermittent ignition of all cylinders of a loaded petrol engine?

A: The clearance of contact breaker is diminishing and a dirty contact surface.

Q: What is the phenomenon called when the petrol inside the engine is ignited too soon?

A: Engine knock.

Q: What is the reason if you cannot increase the speed of the vessel's petrol engine?

A: It has dirt on nozzle of carburettor.

Q: What problem will be caused if the injection time of the diesel engine is too early?

A: Knock from the engine.

Q: If the fuel injection is delayed in the engine cycle, how does it affect the diesel engine?

A: Emits black exhaust; losing horsepower; incomplete combustion.

Q: If the petrol engine functions well at low speed and medium speed, but it cannot accelerate, what might be the reasons?

A: The main nozzle of the carburettor is clogged.

Q: What might be the problem causing the engine to slow down, speed up, then stop?

A: The fuel system.

Q: What might be the main reason causing the engine that used to run smoothly to excess vibration?

A: Propeller blades bend.

Q: If oil stain is found in the spark plug that was removed from the engine, what does it indicate?

A: Fuel air mixture is too rich.

Q: When spark plug is removed from the engine, it is found to be black and layered with carbon stain, what does it indicate?

A: Fuel air mixture is too rich.

Q: Black smoke is emitting from the diesel exhaust, what is the least possible reason for it?

A: Engine oil is combusted.

Q: If black smoke is emitting from a diesel engine exhaust, what may be the reasons?

A: Blockage of the air filter; faulty injectors.

Q: White smoke is emitting from the diesel exhaust, what is the reason?

A: Fuel in tank is mixed with water.

Q: If the engine oil from the internal combustion engine is over-consumed in combustion, the most apparent sign is that the colour of exhaust will appear to be _____________.

A: Blue

Q: What are the symptoms of fuel injector leakage?

A: Power decrease; black smoke; vibration; increased fuel consumption

Q: What cause carbon deposits on the nozzle of a fuel injector?

A: Leaking needle valve of fuel nozzle.

Q: What are the reasons causing the sparks in the diesel engine's exhaust ?

A: Excessive carbon deposits in the combustion chamber or exhaust pipe; injection time is too late; the exhaust valve is not fully closed; oil leakage in the injector.

Q: What is the cause of the discharge of black exhaust gas from the vessel’s diesel engine?

A: Blockage of the air filter; Overloading of the engine; Leakage of the exhaust valve.

Q: What is the most likely cause of the wearing of the cylinder liner?

A: The engine is operated in low cooling water temperature.

Q: What causes overheating of jacket water in a fresh water cooling system installed with a header tank?

A: The heat exchanger is dirty or the thermostate is stuck in the closed position.

Q: What is the possible cause of abnormal high fresh water consumption in a fresh water jacket cooling system?

A: Leakage due to a defective cylinder head gasket.

Q: What are the consequences of high cooling water temperature?

A: Accelerate wear and tear of the engine parts.

Q: What should be inspected when the sea water cooling system of the diesel engine break down?

A:
(i) Check whether the sea water strainer is blocked;
(ii) Check whether the belt of the sea water pump is loosened;
(iii) Check whether the sea water pump casing is overheated.

Q: What action should be taken if the cooling water temperature alarm goes off while the diesel engine is running?

A: Slow down the speed.

Q: What is the consequence of operating the outbound engine above the water surface?

A: The cooling water pump will be damaged.

Q: What is the impact on the engine if the air cooler of the turbo blower is blocked such that hot air is transmitted to the diesel engine?

A: Overheating.

Q: What is an indication of delayed fuel injection of diesel engine?

A: High exhaust temperature.

Q: What will happen if the exhaust gas valve is opened too early?

A: Loss of pressure leading to power loss.

Q: What will cause a loss of compression of a compression ignition engine?

A: Serious leakage of compression chamber, such as inlet and/or exhaust valve jammed in open position.

Q: If the clutch of the engine is not adjusted, what problem will occur?

A: Slippage

Q: Some outboard engines use dog clutch. The slipping of this kind of clutch is because of ___________ .

A: the damage of rolling head

Q: When an outboard engine is not in use, it should be elevated to _____________.

A: no higher than 90 degrees

Q: A vessel with petrol engine should carry along a set of spare __________ .

A: spark plug

Q: What should be done when an outboard petrol engine is to be suspended for a long period?Turn off

A: the ignition system and cut off the fuel supply.

Q: When an outboard engine operates in shallow water, the most important safety measure is ____________________.

A: to adjust the tilting mechanism to an appropriate tilted angle

Q: Why should the outboard engine be lifted above water surface when the vessel is berthed or moored?

A: To drain the sea water out of the cooling system.

Q: What is the most important preventive measure before repairing an engine on board?

A: Remove the starting power cord and isolate the batteries.

Q: An aluminium alloy vessel of 4.5 m long uses an electric outboard engine. The outboard engine is powered by an external 48 V (Volt) 200 Ah battery to provide 4 kW (kilowatt) drive power. Since the propeller was damaged, the vessel has been anchored for the replacement of propeller. Before that, we must ________________.

A: Isolate the power cord of the outboard engine and the electricity supply from battery.

Q: The amount of black smoke comes from the exhaust gas produced by the petrol engine is less. Why?

A: Petrol is easier to burn completely; consist of lower carbon content; petrol is easier to ignite.

Q: Under which of the following circumstances should the toothed timing belt of the valve be replaced?

A: (i) Cracks found on the back or the tooth bottom of the belt; (ii) serious abrasions of the tooth bottom of the timing belt; (iii) sign of abrasion at the edge or on the surface of the belt.

Q: The cooling system of the engine should be cleaned regularly in order to __________.

A: Remove rust and accumulated scale

Q: What is the function of lubricant?

A: Reduce the friction of moving parts; take away the heat generated by the friction of the moving parts; separate the moving parts.

Q: Why does lubrication system of engine differ from that of gear box?

A: The requirements of lubrication oils for engine are different from that of gear box because they are operating under different environments.

Q: What are the consequences of over lubricated cylinder of a diesel engine?

A: Excessive formation of carbon deposit on moving components such as piston rings.

Q: What is the severest outcome if the lubricant inside the oil sump or gear box contains water?

A: Damage of bearing.

Q: Why should the engine oil inside the engines with pressurized lubrication be renewed frequently?

A: Acidic substances formed after lubricating oil contacts with hot metal parts, and combustion products and worn debris fall into oil sump will change the viscosity of oil.

Q: What are the immediate effects on a diesel engine using polluted or non-filtered fuel?

A: Malfunction of the engine fuel injector.

Q: Fuel for compressed ignition engines must be filtered to_______________.

A: prevent damaging the fuel pump

Q: What is the severest outcome if the fuel of a petrol engine is dirty?

A: Blockage of the nozzle of carburettor.

Q: A vessel is equipped with a motor landing craft. The landing craft of 2.5 meters long is powered by a 4 HP/3 kW outboard engine with a total weight of about 90 kg (kilograms). The vessel is equipped with an electro-hydraulic davit to assist with daily lifting. A friend has asked you to help lifting a jet ski for inspection and maintenance at the bottom temporarily. Before lifting, you should first _________________.

A: pay attention to the safe working loading of the davit and the weight of the jet ski

Q: What is the most appropriate action to be taken when the lubricant level is low in the oil conservator of a hydraulic winch?

A: Stop the winch immediately, and inspect the surrounding the winch and all hoses for signs of leakages.

Q: Petrol is a volatile fuel, meaning _______________.

A: it is susceptible to vaporization and ignition by sparks.

Q: Where are the emergency stop switch of the main engine and the emergency fuel stop valve controller installed?

A: Designated space outside the engine room.

Q: If engine oil is leaked into the bilge when it is released from the oil sump, what action should be taken?

A: Wipe clean with a cloth, and then put the used cloth into a box that can be sealed.

Q: Why water must not be used to extinguish oil fire?

A: Water injection would cause spreading and expansion of fire.

Q: What causes a fire?

A: Fuel; air; fuel and air are at a proper ignition temperature.

Q: The principle of using dry powder to extinguish a fire is to __________.

A: Eliminate oxygen and generate carbon dioxide

Q: The rules for fire-extinguishing are __________.

A: Reducing heat; cutting off air supply

Q: Fire detectors used in general engine rooms include _________.

A: Fixed-temperature heat detector and visible smoke detector

Q: For a typical modern 9-litre foam type extinguishers, the driving force for discharging foam comes from __________.

A: the compressed carbon dioxide contained in the extinguishers.

Q: When carbon dioxide (CO_2) is used as a fire distinguishing agent, what measure should be taken?

A: Aim the nozzle at the surrounding areas of the fire.

Q: Which type of fire extinguishers is not suitable to use in confined spaces with workers inside?

A: Carbon dioxide (CO_2) fire extinguisher.

Q: Carbon dioxide is an outstanding fire distinguishing agent. However, what is its disadvantage when using it inside the engine room?

A: The cooling effect of carbon dioxide is not significant.

Q: How do we know if the carbon dioxide (CO_2) fire extinguisher on board requires a refill?

A: A fire extinguisher requires a refill when the actual weight is less than that marked on the cartridge.

Q: What is the serious outcome of using carbon dioxide (CO_2) to extinguish fire in confined space?

A: Occupants unaware of the situation will be suffocated to death.

Q: By which reaction can the foam extinguish fire?

A: By isolating oxygen in the atmosphere from contacting with the fire.

Q: To extinguish fire triggered by acetone or alcohol, which type of fire extinguishers is the most appropriate?

A: Carbon dioxide or dry powder.

Q: To put off fire triggered by electrical entities, which type of fire extinguishers is the most suitable?

A: Carbon dioxide or dry powder.

Q: If the fire inside the hold becomes uncontrollable, what should be done next?

A: Close all air vents

Q: After closing all air vents, what should be done next?

A: Pour water on the deck.

Q: What is the conduction method of transferring heat to another hold through the bulkhead?

A: Direct conduction.

Q: How many general conduction methods are there for fire?

A: Four. They are radiation, conduction, convection, and direct burning respectively.

Q: If the television on the vessel is on fire, and there is no suitable fire extinguish nearby, what should be done to suppress the spread of fire?

A: Immediately cut off the electricity.

Q: Which kind of substance cannot be used to extinguish an oil fire?

A: Water (in the form of a jet or a spray).

Q: What kinds of material on fire can a water type fire extinguisher be used for fire extinguishing?

A: Paper, cloth and wooden furniture items.

Q: When using a foam type fire extinguisher to extinguish oil fire of an oil pan, the nozzle should ___________________.

A: be aimed at the surrounding boards of the fire for spreading the foam

Q: Under what situation is the fire considered to be under control?

A: When it stops spreading.

Q: We should first ___________ if electrical appliances are on fire.

A: separate the affected equipment or cables from the electricity supply

Q: Which fire-fighting method is not applicable in fire caused by fuel oil?

A: Injecting water to the fire.

Q: What is the primary principle of safe storage of LPG?

A: LPG cylinders should be stored in lockers where natural ventilation could expel any leakage of LPG away from the vessel by gravity.

Q: LPG ______________.

A: (i) is a highly inflammable fuel under high pressure;

(ii) can cause suffocation;

(iii) is heavier than air;

(iv) should be handled as dangerous goods

Q: The common way of fuel supply for outboard petrol engine is __________.

A: sucking fuels from the removable fuel tank through the fuel pump of the engine

Q: Which of the following actions is incorrect when the vessel installed with an inboard petrol engine is bunkering?

A: Open all the doors, hatches and side scuttles.

Q: Why should we keep contacting between the fuel nozzle and the metal part of the hull while a vessel is bunkering?

A: To prevent sparks caused by static electricity.

Q: What are the preventive measures when a vessel is bunkering?

A: (i) Close all the doors and windows nearby;

(ii) No smoking;

(iii) Ensure that there is no naked flame

Q: What equipment should be prepared for emergency use and what preventive steps should be taken before bunkering?

A: Prepare foam type fire extinguisher and wood chaff, and close all the scuppers on the deck.

Q: What actions should be taken before/ during bunkering?

A: Secure the vessel after transporting the passengers to the shore. Hold the fuel nozzle tightly and keep it to contact with the oil filler neck.

Appendix 1 (Extract from Chapter 4 of the Examination Rules for Pleasure Vessel Operator Certificate of Competency)

Eyesight Standards For Pleasure Vessel Operators

1. The eyesight standards for pleasure vessel operators are as follows:

		Eyesight Standards
Distant Vision with or without visual aid	Better eye	6/9
	Other eye	6/12
Near, Intermediate and colour vision, both eyes together, aided or unaided		Vision required for ship's navigation (e.g. chart and nautical publication reference, use of bridge instrumentation and equipment, identification of navigation aids)

2. Colour vision will be tested by Ishihara plates or equivalent.

3. All applicants for Pleasure Vessel Operator's Certificate of any grade (including new issue and extension) are required to provide a certificate (Marine Department Form M.O. 687 – see Appendix I) issued by a registered medical practitioner or registered optometrist (either Part I or Part II optometrist) attesting that the applicant has attained the standards in paragraph 4.1 above within the 24 months (12 months in respect of an applicant 65 years of age and over) preceding the application will be accepted, the certificate shall remain valid at the time of examination (not applicable to extension).

4. Any applicant or candidate who fails in colour vision test can only operate a pleasure vessel for the period between sunrise and sunset, in such case his/her Pleasure Vessel Operator Certificate will be endorsed as "Day time operation only and required to have another person who has reached the eyesight standard for pleasure vessel operator to assist him/her to perform lookout duty on board".

5. Any applicant or candidate who requires visual aids for passing the eyesight test in paragraph 4.1 above, his/her Pleasure Vessel Operator's Certificate will be endorsed as "with visual aids".

6. If the examiner is in doubt of the eyesight standard of an applicant, he/she may request the applicant to produce an eyesight test certificate signed by another registered practitioner or registered optometrist (either Part I or Part II optometrist) on the expenses of the applicant or refer the applicant to the Hong Kong Eye Hospital for examination.