Rule 28

Vessels constrained by their draught

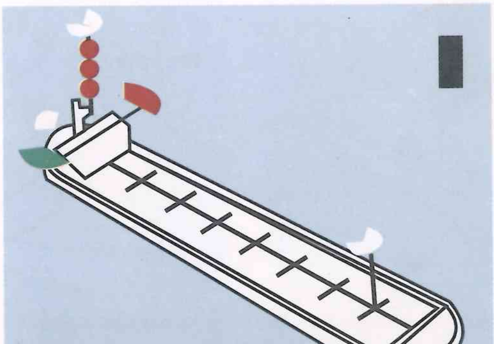
A vessel constrained by her draught may, in addition to the lights prescribed for power-driven vessels in Rule 23, exhibit where they can best be seen three all-round red lights in a vertical line, or a cylinder.

Rule 3(h) states: ***'The term "vessel constrained by her draught" means a power-driven vessel which, because of her draught in relation to the available depth and width of navigable water, is severely restricted in her ability to deviate from the course she is following'.*** Such a vessel may usually be referred to as a vessel **'CBD'**, which would be always be ***'power-driven'.***

Power-driven vessels have to take into account both the depth and the width of available sea room in deciding if they can invoke this **'CBD'** status. Rule 9(c and d), without using this term, do imply certain privileges to such 'CBD' vessels. Rule 18(d) requires all vessels other than hampered vessels to **'avoid impeding the safe passage of a vessel constrained by her draught, exhibiting the signals in Rule 28'** - ***'except where Rules 9, 10 and 13 otherwise require'.***

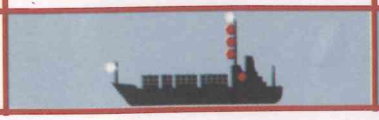
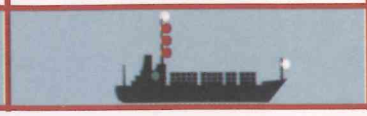
[TASK: REVISE RULE 9, ESPECIALLY PARAGRAPHS 'C' AND 'D'.]

This Rule states the additional lights and day signals that ***'a vessel constrained by her draught may, in addition to the lights prescribed for power-driven vessels in Rule 23, exhibit where they can best be seen'.*** Please note the optional nature of this Rule by the use of the word ***'may'.*** If these lights and shapes are not exhibited, obviously the vessel concerned cannot expect the privileges granted by these Rules. ***'A power-driven vessel'*** exhibiting lights and/or shapes by this Rule must continue to exhibit the normal ***'navigation lights'*** required to be displayed by a ***'power-driven vessel'*** as prescribed in Rule 23.



A power-driven vessel constrained by her draught, may be over 50m in length

A vessel constrained by her draft

Rule & Vessel	Shape	When viewed from			Sound signals in restricted visibility, at intervals of not more than 2 minutes.
		Port	Ahead	Starboard	
Rule 28 **Vessels constrained by her draft**					— • •

Rule 29

Pilot vessels

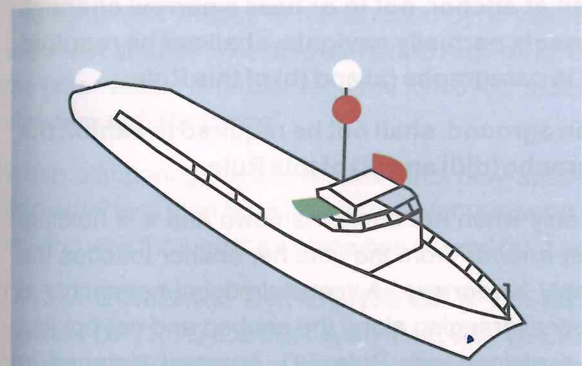
(a) **A vessel engaged on pilotage duty shall exhibit:**

- (i) **at or near the masthead, two all-round lights in a vertical line, the upper being white and the lower red;**
- (ii) **when underway, in addition, sidelights and a sternlight;**
- (iii) **when at anchor, in addition to the lights prescribed in subparagraph (i), the light, lights or shape prescribed in Rule 30 for vessels at anchor.**

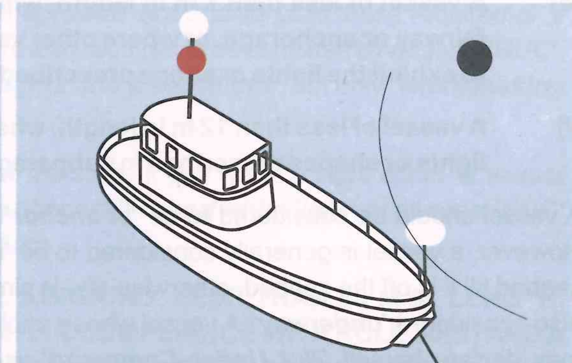
(b) **A pilot vessel when not engaged on pilotage duty shall exhibit the lights or shapes prescribed for a similar vessel of her length.**

Any ***'Vessel engaged on pilotage duty'*** must exhibit only the lights prescribed by this Rule, not otherwise. Such vessels are not required to exhibit any masthead lights. The requirements of this Rule are simple and straightforward. When ***'not engaged on pilotage duty'***, a ***'pilot vessel'*** is not entitled to exhibit the lights and shapes prescribed in this Rule, she must then comply with the other Rules applicable to her depending on her size and type.

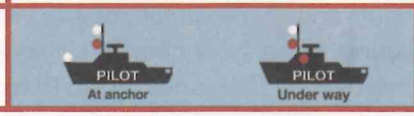
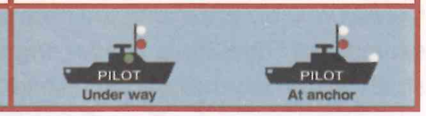
There are no day signals or shapes specified in the Rules for such a vessel, though in practice they normally fly flag 'H' and have the term 'PILOTS', or similar marked on their sides or even on top.



A vessel engaged on pilotage duty, underway. The lights give no indication of the length of the vessel



A vessel engaged on pilotage duty at anchor, less than 50 meters in length

Rule & Vessel	Shape	When viewed from		
		Port	Ahead	Starboard
Rule 29 **Pilot Vessels on Pilotage duty**	 At anchor			

*Note: Sound signals for a **'vessel engaged on pilotage duty'**, **'in or near an area of restricted visibility'** vary depending on her condition. Please refer to Rule 35(k), which further refers to the application of paragraphs 'a', 'b' or 'g' of the same Rule 35.*

Rule 30

Anchored vessels and vessels aground

(a) A vessel at anchor shall exhibit where it can best be seen:

(i) in the fore part, an all-round white light or one ball;

(ii) at or near the stern and at a lower level than the light prescribed in subparagraph (i), an all-round white light.

(b) A vessel of less than 50 m in length may exhibit an all-round white light where it can best be seen instead of the lights prescribed in paragraph (a) of this Rule.

(c) A vessel at anchor may, and a vessel of 100 m and more in length, shall also use the available working or equivalent lights to illuminate her decks.

(d) A vessel aground shall exhibit the lights prescribed in paragraph (a) or (b) of this Rule and in addition, where they can best be seen:

(i) two all-round red lights in a vertical line;

(ii) three balls in a vertical line.

(e) A vessel of less than 7 m in length, when at anchor, not in or near a narrow channel, fairway or anchorage, or where other vessels normally navigate, shall not be required to exhibit the lights or shape prescribed in paragraphs (a) and (b) of this Rule.

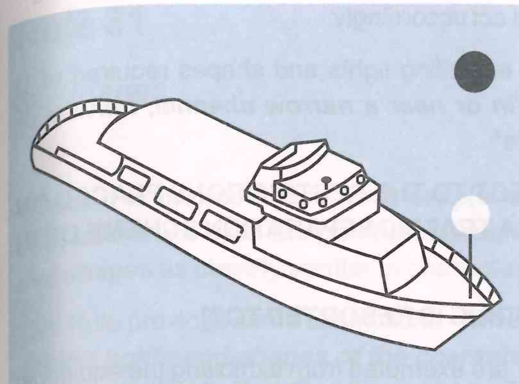
(f) A vessel of less than 12 m in length, when aground, shall not be required to exhibit the lights or shapes prescribed in subparagraphs (d)(i) and (ii) of this Rule.

A vessel should be considered to be ***'at anchor'*** only when her anchor is down and it is holding. However, a vessel is generally considered to be ***'at anchor'*** from the time her anchor touches the seabed till it is off the seabed, otherwise she is simply ***'underway'***. A vessel dredging her anchor is also considered ***'underway'***. A vessel whose anchor is dragging along the seabed and not holding may declare herself ***'Not Under Command'*** as explained with Rule 3(f). A vessel fastened to mooring buoys which themselves are anchored is also considered to be at anchor, so is a vessel whose anchor is fouled with any underwater obstruction. But a vessel ***'made fast to the shore'*** is not considered ***'at anchor'*** even if she has an anchor down for any reason.

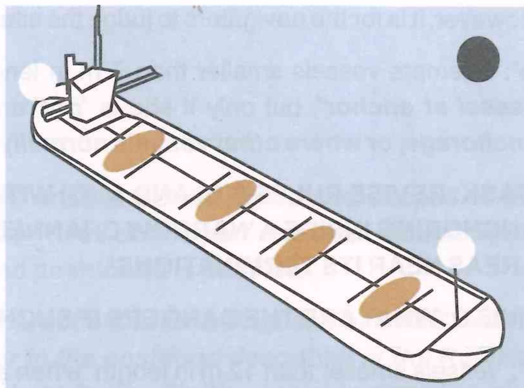
'a to c': These paragraphs state the requirements of lights and shapes to be exhibited by ***'a vessel at anchor'***. Illuminating decks is a requirement for vessels 100 m or more in length, though smaller vessels may exercise this option if they wish to; it is recommended that they should do so.

Certain vessels are exempted from exhibiting lights and shapes prescribed for vessels at anchor, for example by Rule 26, ***'a vessel engaged in fishing'*** when ***'at anchor'***, if still ***'engaged in fishing'***, shall display only the lights and shapes prescribed by Rule 26 and not by this Rule 30.

[TASK: WHICH OTHER RULES STATE THAT VESSELS COVERED BY THEM ARE NOT REQUIRED TO DISPLAY LIGHTS AND/OR SHAPES PRESCRIBED BY THIS RULE WHEN AT ANCHOR?]



A vessel at anchor, less than 50 meters in length



A vessel at anchor with deck illumination, vessel may be more than 50 metres in length, deck illumination a requirement if the vessel is over 100 metres in length

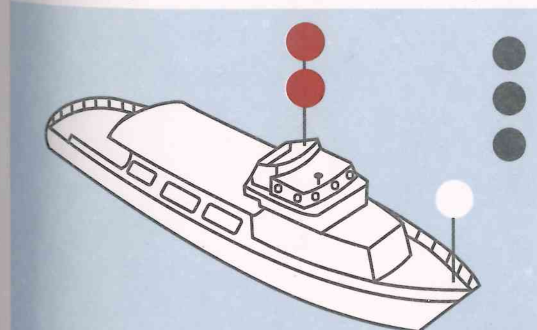
'd': States the requirements of lights and shapes to be exhibited by ***'a vessel aground'***. A vessel is not considered ***'aground'*** if she is intentionally made to push against the bottom or side of a river to hold her position. Such a vessel using her propulsion and steering to maintain her position is otherwise free to move from this holding position is not ***'aground'*** but very much ***'underway'***.

The lights and shapes to be exhibited by ***'a vessel aground'*** are additional to those required of ***'a vessel at anchor'***. The ***'two all-round red lights'*** are also required to be exhibited by a vessel **'NUC'**; the latter vessel is further required to exhibit ***'sidelights and a sternlight'***, but only ***'when making way through the water'***.

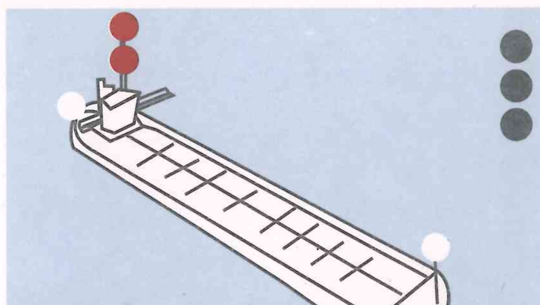
When comparing the above, the lights may appear the same if you were to sight either ***'a vessel aground'*** less than 50 m in length at night showing just one ***'all-round white light'***, or a vessel **'NUC'** making way through the water when viewed from astern.

[TASK: COMPARE THE LIGHTS OF A VESSEL AGROUND, LESS THAN 50 M IN LENGTH, WHICH OPTS TO EXHIBIT A SINGLE WHITE LIGHT IN COMPLIANCE WITH RULE 30(B) AND A VESSEL NUC VIEWED FROM ASTERN EXHIBITING THE LIGHTS PRESCRIBED BY RULE 27(A).]

On sighting a vessel aground the best actions is to turn your vessel back to the reciprocal course immediately. This is an action based on good seamanship point of view, not stated by these Rules.



A vessel aground, less than 50 metres in length



A vessel aground, may be less or more than 50 metres in length

However, it is for the navigators to judge the situation and act accordingly.

'e': Exempts vessels smaller than 7 m in length from exhibiting lights and shapes required of ***'a vessel at anchor'***, but only if she is ***'not'*** anchored ***'in or near a narrow channel, fairway or anchorage, or where other vessels normally navigate'***.

[TASK: REVISE RULES 9(G) AND 10(G) WITH RESPECT TO THE RESTRICTIONS PLACED ON ANCHORING INSIDE A 'NARROW CHANNEL' OR 'IN A TRAFFIC SEPARATION SCHEME OR IN AREAS NEAR ITS TERMINATIONS'.

QUIZ Q: WHAT ARE THE DANGERS IF SUCH ANCHORING IS RESORTED TO?]

'f': Vessels smaller than 12 m in length ***'when aground'*** are exempted from exhibiting the additional lights and shapes required of ***'a vessel aground'*** which are prescribed in subparagraphs 'd-i' and 'd-ii' of this Rule.

On comparing the requirements of paragraphs 'e' and 'f' of this Rule, a vessel between 7 and 12 m in length, if at anchor, ***'shall exhibit'*** the lights and shapes required by this Rule but is exempted from displaying the signals of ***'a vessel aground'***, even if she is aground.

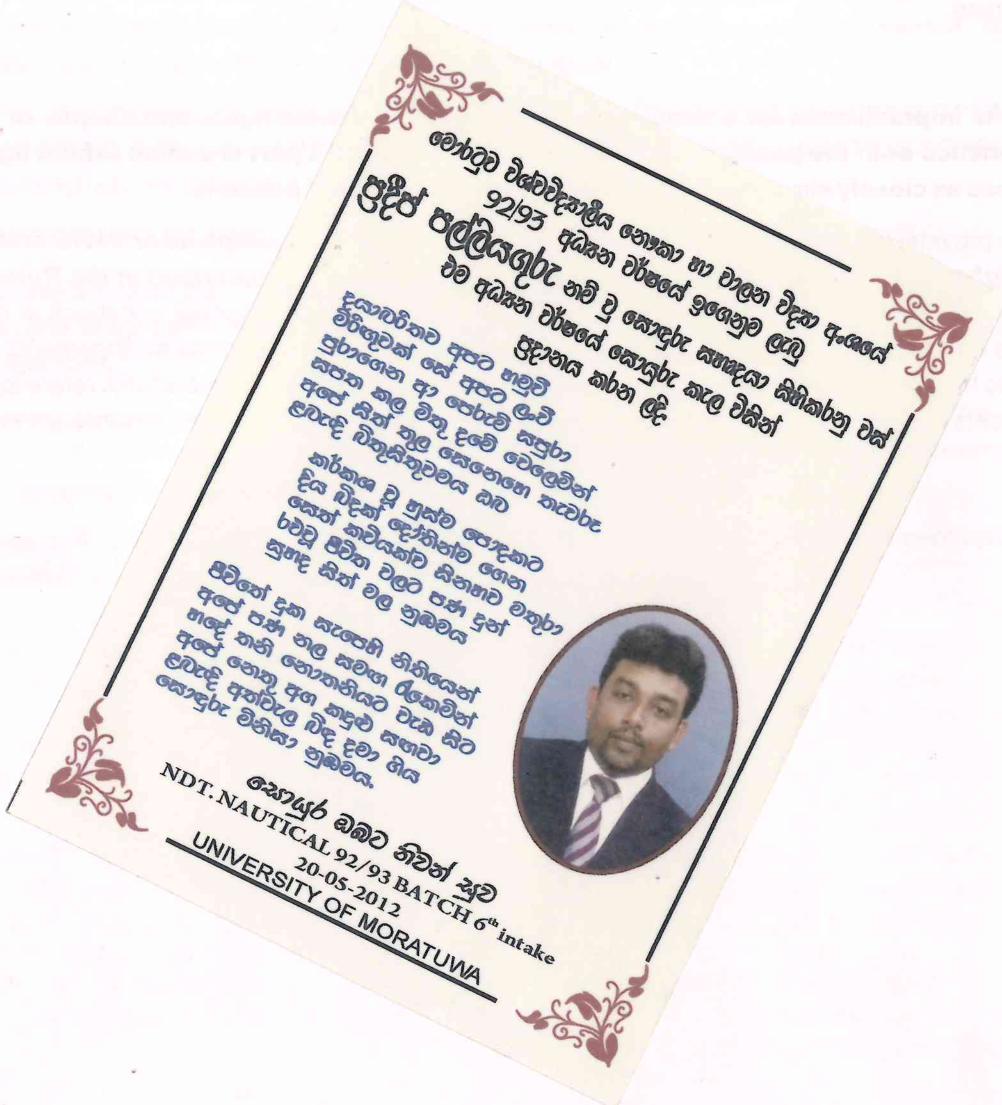
Paragraphs 'e' and 'f' do not necessarily prohibit a vessel from following the requirements of the Rules if she so desires, all that is stated is, ***'shall not be required'***.

Rule 31

Seaplanes

Where it is impracticable for a seaplane or a WIG craft to exhibit lights and shapes of the characteristics or in the positions described in the Rules of this part she shall exhibit lights and shapes as closely similar in characteristics and position as is possible.

This Rule provides some exemptions - ***'where it is impracticable for a seaplane or a WIG craft to exhibit lights and shapes of the characteristics or in the positions described in the Rules of this Part'*** - that is Part C of these Rules. This is perhaps to do with the special construction of ***'a seaplane or a WIG craft'*** and Rule 1(e) allows for this. However, any alternate arrangements are required to be ***'as closely similar in characteristics and position as is possible'***; this refers to the requirements stated in this Part C of these Rules, which automatically refer further to Annex I of these Rules.



PART D - INTRODUCTION TO SOUND AND LIGHT SIGNALS

The requirements of these Rules appear to carry over from the ancient systems of communication at sea that were dependent on sound and light signals alone, radiotelephony or other electronic systems of communication were nonexistent. These traditional methods of communication are the only ones prescribed within these Rules even now, though modern systems feature in the revised Annex IV applicable from December 2009, but nowhere else in these Rules.

Annex III contains the technical details about sound signals and should be read in conjunction with these Rules, especially the requirements on their audible range. The audible range is within a bandwidth of 0.5 to 2.0 nautical miles only depending on the length of a vessel. Annex III, Section 1(c) states, ***'the range of audibility in the table above is for information and is approximately the range at which a whistle may be heard on its forward axis with 90% probability in conditions of still air on board a vessel having average background noise level at the listening posts (taken to be 68 dB in the octave band centred on 250 Hz and 63 dB in the octave band centred on 500 Hz).***

In practice the range at which a whistle may be heard is extremely variable and depends critically on weather conditions; the values given can be regarded as typical but under conditions of strong wind or high ambient noise level at the listening post the range may be much reduced'.

Though Annex III prescribes the approximate range of sound signals explained above, it does not state any range requirements for sound signals from a bell or gong equipment. Only the construction details and intensity parameters are prescribed in Section 2 of Annex III. The intensity requirement is, ***'a bell or gong or other device having similar sound characteristics shall produce a sound pressure level of not less than 110 dB at a distance of 1 meter from it'.***

Noise levels inside and outside the navigating bridge of a ***'power-driven vessel'*** can be substantial because of machinery and external blowers and can thus interfere with the ability to detect external sounds, sometimes even rendering them inaudible. Navigators should be cautious of these facts and not depend upon sound signals alone in totality. They should also take these factors into account when deciding ***'safe speed'***, especially ***'in or near an area of restricted visibility'***. It must also be ensured that seafarers on ***'look-out'*** duties are located in positions where disturbance caused by sounds of their own vessels is minimal, so that they can detect the ***'sound signals'*** from other vessels or even buoys in the vicinity.

Apart from the above, it is important to understand the fact that the human ear cannot determine the direction of sound accurately. Further, sound signals during their transit, travelling through varying densities of medium like uneven fog patches, may be affected by refraction, reflection or even total internal reflection. The apparent direction the sound signals are being received from may give a false indication of the direction of the source which may be quite different from its actual true direction. As such, relying on ***'sound signals'*** alone is rather risky and dangerous.

[TASK: 1: DO YOU RECOLLECT THE REQUIREMENTS OF RULE 6 ON 'SAFE SPEED' AND THE SIX FACTORS APPLICABLE TO ALL VESSELS? IF NOT PLEASE REVISE THEM.

2: WHICH RULE STUDIED EARLIER USES THE TERM 'APPARENTLY' WHEN REFERRING TO SOUND SIGNALS?]

Rule 32

Definitions

(a) The word *whistle* means any sound signalling appliance capable of producing the prescribed blasts and which complies with the specifications in annex III to these Regulations.

(b) The term *short blast* means a blast of about one second's duration.

(c) The term *prolonged blast* means a blast of from four to six seconds' duration.

The term ***'whistle'*** is used for devices that produce sounds, like whistles or horns. The limits of the frequencies at which a vessel's equipment generates sound is dependent on the length of the vessel and is stated in Annex III(b). The signals prescribed in the Rules are specified in terms of short blasts and prolonged blasts as defined in this Rule.

Rule 33

Equipment for sound signals

(a) A vessel of 12 m or more in length shall be provided with a whistle, a vessel of 20 m or more in length shall be provided with a bell in addition to a whistle, and a vessel of 100 m or more in length shall, in addition, be provided with a gong, the tone and sound of which cannot be confused with that of the bell. The whistle, bell and gong shall comply with the specifications in annex III to these Regulations. The bell or gong or both may be replaced by other equipment having the same respective sound characteristics, provided that manual sounding of the required signals shall always be possible.

(b) A vessel of less than 12 m in length shall not be obliged to carry the sound signalling appliances prescribed in paragraph (a) of this Rule but if she does not, she shall be provided with some other means of making an efficient sound signal.

In the introduction to this Part D, the cautions required to be exercised by navigators on board a vessel regarding the direction of propagation and audible range of sound signals have been explained.

Fitment of ***'equipment for sound signals'*** is a must for vessels 12 meters or more in length by this Rule. For vessels less than 12 metres in length, the requirement is optional with the proviso that ***'she shall be provided with some other means of making an efficient sound signal'*** and all equipment ***'shall comply with the specifications in Annex III to these Regulations'***. Any ***'equipment for sound signals'*** should be in compliance with the technical specifications given in Annex III. The frequency and audible range of a whistle is related to the length of a vessel; this allows a wide variety of characteristics; the sound generated also indicates the size of a vessel. Vessels over 200 m in length have a frequency range that provides a relatively deep tone of sound, those below 75 m in length a relatively shrill tone and the others in between these lengths a mid range sound.

'A whistle' cannot be replaced by alternate equipment. Only ***'the bell or gong or both may be replaced by other equipment having the same respective sound characteristics'***. Alternate equipment is not defined or listed, but could be electronic equipment that can normally produce sound of any frequency and amplify it to the required levels; such equipment may be used in lieu of the ***'bell or gong'***. These systems producing synthesised sounds may be more convenient to use and perhaps cheaper too. However, this Rule, while permitting alternate systems, also imposes that ***'manual sounding of the required signals shall always be possible'***. This is to provide a backup against any failures of pure electronic alternates, if opted for. Though the use of powered means is acceptable, real bells and gongs may have to be installed in any case. Annex-III requirements on ***'bell or gong'*** in paragraph 2(b) states ***'but manual operation <u>shall</u> be possible'***.

b: *'Other means of making an efficient sound signal'* prescribed for ***'a vessel of less than 12 m in length'*** could be some form of ***'sound signals'*** generated by using simple equipment that can be heard and understood by other vessels in ample time to fulfil the requirements of these Rules. Equipment fitted on a medium size boat operating in a harbour would not be needed on a 3 metre dinghy operated in a yacht club's moorings. Depending on the circumstances, the requirement could be even met by a lung-powered horn, portable compressed-gas or aerosol air horn, a simple whistle or even a small electric horn.

Rule 34

Manoeuvring and warning signals

(a) When vessels are in sight of one another, a power-driven vessel underway, when manoeuvring as authorized or required by these Rules, shall indicate that manoeuvre 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".

(b) Any vessel may supplement the whistle signals prescribed in paragraph (a) of this Rule by light signals, repeated as appropriate, whilst the manoeuvre is being carried out:

(i) these light signals shall have the following significance:

- one flash to mean "I am altering my course to starboard";

- two flashes to mean "I am altering my course to port";

- three flashes to mean "I am operating astern propulsion";

(ii) the duration of each flash shall be about one second, the interval between flashes shall be about one second, and the interval between successive signals shall be not less than ten seconds;

(iii) the light used for this signal shall, if fitted, be an all-round white light, visible at a minimum range of 5 miles, and shall comply with the provisions of annex I to these Regulations.

(c) When in sight of one another in a narrow channel or fairway:

(i) a vessel intending to overtake another shall in compliance 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.

(d) 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.

(e) 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) If whistles are fitted on a vessel at a distance apart of more than 100 m, one whistle only shall be used for giving manoeuvring and warning signals.

This Rule prescribes routine and warning communication between vessels; paragraphs 'a, 'c' and 'd' apply only when ***'vessels are in sight of one another'***, as clearly stated, as such, these are dependent on the quality of ***'look-out'***. Paragraphs 'a' and 'b' apply only to power-driven vessels; other paragraphs to all vessels.

[QUIZ QS: DO YOU REMEMBER RULE 5 ON 'LOOK-OUT' AND THE EXPLANATIONS ABOUT LOOK-OUT?

QUIZ QS: WHAT REQUIREMENTS ARE STATED REGARDING 'LOOKOUT' IN THE STCW CODE A-VIII/2 AND HOW MANY TIMES?]

a: The requirements to indicate a ***'manoeuvre by'*** use of sound ***'signals on her whistle'*** apply ***'when vessels are in sight of one another'***, but only to ***'a power-driven vessel underway' - 'when manoeuvring as authorised or required by these Rules'***. This requirement has nothing to do with the range of sound signals; their low range has been discussed in the introduction to this Part 'D'. These sound signals are meant to indicate ***'that manoeuvre'*** to all vessels in the vicinity, so that they can watch out for the manoeuvre and exercise caution if necessary. *'If the vessels are in sight, the signals must be given. The obligation is not conditional upon the signal being audible to the other vessel. It is easy to understand why the rule was drawn in these peremptory terms. It would be very dangerous if the officer in charge were encouraged to speculate as to whether the signal, if given, would be heard; he must give it if in sight. (Ruling in House of Lords, 1921)*

Requirements of this Rule need not apply to ***'any action to avoid collision'*** executed based on radar alone before vessels are ***'in sight of one another'***. However, if vessels are within range so as to be ***'in sight of one another'*** and ***'a power-driven vessel underway'*** relies only on her radar but fails to visually sight the other vessel, ***'nothing in these Rules shall exonerate'*** her if she does ***'not comply with these Rules'***. She and the navigators are more likely to be held at fault for lack of ***'proper look-out'***. *'In sight', in my view, means something which is visible if you take the trouble to keep a look-out, which of course is the position here. In short, the obligation to make sound signals is not excused by the fact that nobody looks to see what there is about. (Mr. Justice Karminski, 1966)*

Excuses for not using the sound signals because the other vessel is too far away to be within audible range or that the use of sound signals could disturb those on board are not reasonable or sufficient reasons for non-compliance with this Rule, the latter would in fact be termed absurd. The Rule uses the word ***'shall'*** and this means the requirements stated have to be followed.

The prescribed sound signals have to be sounded only by ***'a power-driven vessel underway'***, ***'when manoeuvring as authorised or required by these Rules'***. ***'Manoeuvring'*** is the act of taking action. If two ***'power-driven'*** vessels ***'in sight of one another'*** are passing clear and either of them makes a course alteration which is not an ***'action to avoid collision'***, then such action does not fall under the clause ***'required by these Rules'***; for example a routine navigational course alteration. These vessels are not obliged to comply with this Rule in such a situation. Similarly, if a vessel acts at long range before ***'risk of collision'*** is clearly established or begins to exist, then she need not follow this Rule. However, in all such situations also, the vessels concerned should still comply with the requirements of this Rule as explained further.

'Required' is when taking ***'action to avoid collision'*** is as per the requirements stated in these Rules. A ***'power-driven vessel'***, if she is ***'in sight of'*** any other vessel, must comply with this Rule if she takes ***'any action to avoid collision'***, irrespective if done as a ***'give-way vessel'*** or as a ***'stand-on vessel'***. However, ***'authorised'*** appears to have a larger meaning and encompasses manoeuvres done not necessarily for ***'preventing collisions'*** alone but for other reasons which can be linked with ***'authorised'*** or which are not necessarily prohibited by these Rules. For example, Rule 2 clauses ***'ordinary practice of seamen, or by the special circumstances of the case'*** and ***'which may make a departure from these Rules necessary to avoid immediate danger'***. If a navigator executes a manoeuvre basis these considerations which is not necessarily ***'required by these Rules'***, such acts may fall under ***'authorised'*** and would still necessitate compliance with this Rule, provided the ***'power-driven vessel'*** has another vessel ***'in sight'***.

As such the requirements of this Rule should be followed even during routine navigational course alterations, for example: when approaching to anchor in an area where other vessel(s) are present at anchor or otherwise. Even if the approach to the anchoring position is clear and the ***'power-driven vessel'*** is passing at a safe range from all other vessels, then if ***'astern propulsion'*** is operated to reduce speed, she should sound ***'three short blasts'***, though this is not a ***'manoeuvre'*** to ***'avoid collision'*** but gives a clear indication to other vessels in the vicinity about the act. Similarly, when a ***'shall not impede'*** situation is likely to develop, the sound signals should be given as early as possible.

[QUIZ QS. WHICH ALL RULES HAVE THE CLAUSES 'SHALL NOT IMPEDE' AND 'AVOID IMPEDING' IN THEM AND WHAT IS THE DIFFERENCE BETWEEN THESE TWO TERMS?]

The requirements of all the whistle signals stated in this Rule are simple and clear. However, ***'I am operating astern propulsion'***, is many a times not understood clearly. This means a ***'power-driven vessel'*** has reversed her propulsion; it does not mean she is actually moving astern through the water. She may still have a headway, be stopped or may even have developed sternway. As long as her propulsion is working to make her go astern and is ***'authorised or required by these Rules'***, she is required to indicate this by her whistle signals. It is the astern direction movement of any vessel's propulsion machinery, not motion through the water, which is the criterion this Rule is about.

This paragraph is silent on repeating the sound signals. However, the next paragraph 'b' on the optional but additional light signals to supplement this Rule states ***'the interval between successive signals shall be not less than ten seconds'***. It could thus be implied that the light signals may be repeated but the sound signals need not be, though nothing in the Rule restricts the sound signals from being repeated if it is felt necessary.

[QUIZ QS:

1: WHICH RULE RECOMMENDS ALTERATION OF COURSE ALONE TO BE THE MOST EFFECTIVE ACTION TO AVOID A CLOSE-QUARTERS SITUATION?

2: WHY IS THIS ACTION REQUIRED TO BE LARGE ENOUGH?]

b: The light signal requirements are optional; ***'any vessel may supplement the whistle signals prescribed in paragraph (a)'***. '*Any*' implies ***'a power-driven vessel'***. Since the Rule says ***'may supplement'***, this can only be by a ***'power-driven vessel'***, as only she is required to comply with paragraph 'a' of this Rule. The characteristics of the light signals are the same as the sound signals prescribed in paragraph 'a'. Requirements stated in this paragraph 'b' are optional, supplement paragraph 'a' and cannot be implemented in isolation, but always in addition to and in conjunction with the sound signals prescribed in paragraph 'a'.

The sound signals shall be given at least once per manoeuvre, the Rules being silent on their repetition. The light signals may be repeated as felt necessary at intervals exceeding 10 seconds as per subparagraph 'b-ii' of this Rule. There is no requirement that the light and whistle signals have to be synchronized, but on most vessels, where such a signalling light is provided, it usually is synchronised with the sound signals. Usually the light signal is exhibited automatically with the sound signals but can also be operated independently; the latter so that it may be repeated alone if required.

'The light used for this signal shall, if fitted, be an all-round white light, visible at a minimum range of 5 miles'. This optional light should be placed as described in paragraph 12 of annex I. It is required to have a higher visible range than the audible range of the sound signals, it also stands a better chance of being detected as compared to the sound signals; repetition of light signals also increases the probability of them being sighted.

Navigators should keep in mind that the use of the light signal may be avoided where it is felt that their use may confuse other vessels in the vicinity; since their use is optional, there would be no breach of compliance with this Rule. Since it is optional, many power-driven vessels are not even fitted with this signalling light.

Similar requirements of optional light signals exist in paragraph 'd' of this Rule - the ***'doubt'*** signal - but paragraph 'c' on overtaking signals does not refer to any light signals. Paragraph 'e' also does not refer to any light signals since this applies around bends where the other vessels may be obscured, they will anyway not be able to see the light signals originating from another vessel; light does not travel around bends. Paragraph 'd' does not refer to the same light as referred to by this paragraph 'b', nor does it refer to any provisions contained in annex I.

c: These sound signals apply to vessels ***'when in sight of one another'*** when acting in compliance with Rule 9(e) quoted for ready reference.

Rule 9 (e) (i): '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 prescribed in Rule 34(c)(i). The vessel to be overtaken shall, if in agreement, sound the appropriate signal prescribed in Rule 34(c)(ii) and take steps to permit safe passing. If in doubt she may sound the signals prescribed in Rule 34(d).'

Rule 9(e) (ii): 'This Rule does not relieve the overtaking vessel of her obligation under Rule 13.'

As described with Rule 9(e), no sound signal is prescribed when ***'the vessel to be overtaken'*** is not in agreement with the proposal of the one intending to overtake. However, Rule 9(e-i) states ***'if in doubt she may sound the signals prescribed in Rule 34(d)'***, that is ***'at least five short and rapid***

blasts on the whistle'. While Rule 9(e-i) uses ***'may'***, for the same signal and for the same reasons, Rule 34 (d) uses ***'shall'***. Since there is no prescribed signal for a vessel to be overtaken to indicate her disagreement with the proposal made by the overtaking vessel, this doubt signal may be used by her to indicate her disagreement with or rejecting the proposal made by the vessel intending to overtake. The overtaking vessel may keep repeating her intentions until she receives a signal of agreement before attempting to overtake. This Rule applies to all vessels.

> Although not a requirement stated in these Rules, and even contrary to the advice usually given against inter-vessel communication by the use of radiotelephony like VHF for the purpose of ***'any action to avoid collision'***, direct communication between the vessels may prove to be useful as a supplement to these sound signals in situations covered by this particular Rule.

d: Prescribes the ***'doubt'*** signal also frequently referred to as the **'wake-up signal'** of ***'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'***. This Rule applies to all ***'vessels in sight of one another'*** when they ***'are approaching each other and from any cause either vessel <u>fails to understand the intentions or actions of the other</u>, or is in <u>doubt</u> whether sufficient action is being taken by the other to avoid collision'***. This signal should be given as soon as a vessel is in ***'doubt'*** about the action of an approaching vessel, or cannot determine the action or intention of the other vessel, or feels that the other vessel is doing something wrong, or not taking any action, or not taking sufficient ***'action to avoid collision'***.

If a ***'give-way vessel'*** does not appear to be taking ***'positive'*** and ***'substantial action to avoid collision in ample time'***, this signal should be immediately sounded. Unlike in paragraph 'b-ii', this Rule does not state anything about repeating the signal, but if there is no immediate response by the other vessel then this ***'doubt'*** signal should be repeated as necessary to attract the other vessel's attention.

'Such signal may be supplemented by a light signal of at least five short and rapid flashes'. This Rule does not specify which light may be used for this optional ***'light signal'*** to supplement this sound signal and the statement ***'at least five'*** implies that more flashes of the light may be given. This signal may be made by any light, preferably a searchlight or a daylight-signalling lamp, and is likely to be more effective than a whistle, especially at night.

[QUIZ Q: SHOULD A 'STAND-ON VESSEL' USE THESE SIGNALS BEFORE OR WHEN ACTING IN COMPLIANCE WITH RULE 17?]

e: Prescribes the sound signal of ***'one prolonged blast'*** for use by any vessel when ***'nearing a bend or an area of a channel or fairway where other vessels may be obscured by an intervening obstruction'***. It is meant to alert other vessels to watch out for the one approaching; the vessel must then listen for a reply from the other vessel that may be approaching from the other side provided she has heard the signal, which depends on whether she is within the audible range. If the other vessel hears the signal, then ***'such signal shall be answered with a prolonged blast'***. This Rule and other Rules remain silent on the actions required in such circumstances, these seem to have been left for the navigators to decide in the circumstances using ***'ordinary practice of seamen'***.

> This paragraph 'e' implies that another vessel, if one is there, is in close proximity but ***'obscured by an intervening obstruction'***. Though not stated, this requirement would apply in visibility conditions that are good enough in which navigators can be expected to visually see other vessels in the vicinity if they were not ***'obscured'***. ***'In sight of one another'*** is clearly stated as the basic criteria in the application of paragraphs 'a', 'c' and 'd' and is implied in paragraphs 'b' and 'e' of this Rule. A vessel ***'obscured'*** cannot be seen, as such mentioning this would be absurd and the Rules have strictly avoided giving any mathematical figures for visibility or other collision prevention aspects.

f: Sound travels relatively slowly, and sound signals given together or simultaneously by two widely separated whistles from a vessel may be received as two separate signals on another vessel. The strength of the signals as well as the direction of the source will be confusing, which can be misleading even with one whistle, leave alone from multiple whistles.

In line with this requirement paragraph 1(f) of annex III on ***'fitting of more than one whistle'*** also states ***'if whistles are fitted at a distance apart of more than 100 m, it shall be so arranged that they are not sounded simultaneously'***.

Rule 35

Sound signals in restricted visibility

In or near an area of restricted visibility, whether by day or night, the signals prescribed in this Rule shall be used as follows:

(a) A power-driven vessel making way through the water shall sound at intervals of not more than 2 minutes one prolonged blast.

(b) 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.

(c) A vessel not under command, a vessel restricted in her ability to manoeuvre, a vessel constrained by her draught, a sailing vessel, a vessel engaged in fishing and a vessel engaged in towing or pushing another vessel shall, instead of the signals prescribed in paragraphs (a) or (b) of this Rule, sound at intervals of not more than 2 minutes three blasts in succession, namely one prolonged followed by two short blasts.

(d) A vessel engaged in fishing, when at anchor, and a vessel restricted in her ability to manoeuvre when carrying out her work at anchor, shall instead of the signals prescribed in paragraph (g) of this Rule sound the signal prescribed in paragraph (c) of this Rule.

(e) A vessel towed or if more than one vessel is 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.

(f) When a pushing vessel and a vessel being pushed ahead are rigidly connected in a composite unit they shall be regarded as a power-driven vessel and shall give the signals prescribed in paragraphs (a) or (b) of this Rule.

(g) A vessel at anchor shall at intervals of not more than one minute ring the bell rapidly for about 5 seconds. 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 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.

(h) A vessel aground shall give the bell signal and if required the gong signal prescribed in paragraph (g) of this Rule and shall, in addition, give three separate and distinct strokes on the bell immediately before and after the rapid ringing of the bell. A vessel aground may in addition sound an appropriate whistle signal.

(i) A vessel of 12 m or more but less than 20 m in length shall not be obliged to give the bell signals prescribed in paragraphs (g) and (h) of this Rule. However, if she does not, she shall make some other efficient sound signal at intervals of not more than 2 minutes.

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

(k) A pilot vessel when engaged on pilotage duty may in addition to the signals prescribed in paragraphs (a), (b) or (g) of this Rule sound an identity signal consisting of four short blasts.

This Rule 35 prescribes ***'sound signals in restricted visibility'*** which have to be complied with by vessels ***'in or near an area of restricted visibility, whether by day or night'***. This is exactly the same as the second criteria of the application of Rule 19, ***'when navigating in or near an area of restricted visibility'***. These Rules apply even when a vessel is close to ***'an area of restricted visibility'***. These signals are also referred to as ***'fog signals'***; Rule 19(e) uses this term, though by Rule 3(l) ***'restricted visibility'*** can be by conditions other than ***'fog'*** stated as, ***'mist, falling snow, heavy rainstorms, sandstorms or any other similar causes'***. For the purpose of these Rules the term ***'fog signal'*** means the same as the title of this Rule, ***'sound signals in restricted visibility'***. ***'Fog signal'*** in reality is used far more often than the title of this Rule including in the STCW Code.

These Rules do not quantify visibility or the limits when its deterioration makes it ***'restricted'*** enough to activate the sound signals prescribed by this Rule. The approximate audible range of sound signals for the longest vessels is 2 miles - reducing to 0.5 miles for the smallest. If the visibility is greater than the approximate audible range of sound signals, then it may even appear absurd to activate them.

The officer in charge of the navigational watch shall notify the master immediately if restricted visibility is encountered or expected. *(STCW Code A-VIII/2, paragraph 40.1)*. The watchkeeping guidelines are also silent and do not provide any guidance on numerical limits when visibility changes over to ***'restricted'***. Some organisations define minimum visibility limits in their documented management systems; in other cases, masters tend to define this as part of their bridge instructions. This limit should certainly be more than the approximate audible ranges stated in annex III, which anyway can be quite variable. If not defined then the navigators should use their own judgement in deciding on a minimum visibility range at which to activate the sound signals when ***'in or near an area of restricted visibility'***. This will also keep the navigator on the correct side of the Rules in letter and spirit and in compliance with ***'the ordinary practice of seamen'***. As explained before, determination of visibility always is a difficult task.

[QUIZ QS. WHICH RULE STATES THAT RADAR MAY BE USED FOR THE ASSESSMENT OF VISIBILITY? HOW SHOULD THIS BE DONE?]

Rule 32 defines a ***'prolonged blast'*** as one lasting from ***'four to six seconds'***. In this Rule 35, the clause ***'shall sound at intervals of not more than 2 minutes'*** is the stated maximum interval between successive ***'sound signals'*** in most of the paragraphs except 'g' and 'h', where the stated interval is ***'not more than one minute'***. The ***'may in addition'*** requirements of sound signals in paragraphs 'g', 'h' and 'k' are optional and do not define time intervals. Linking them with the primary sound signals prescribed for the respective vessels in this Rule 35, these signals should logically follow the same time intervals as prescribed for the primary signals.

'At intervals of not more than--', imposes a maximum time limit interval between successive sound signals, and it is left to the judgement and discretion of the navigators to decide if - at times - these have to be repeated at lesser intervals. For example, when other vessels are nearby or if it is suspected that any of them may not have an operational radar on board, thus giving them a better chance of hearing the sound signal and determining the apparent bearing of the vessel sounding the signals. However, too high a frequency of repeating the signals will dilute their clarity and may even cause confusion in identifying the type of signal being sounded.

The various sound signals prescribed for different types of vessels in varying conditions are generally self-explanatory.

a and b: describe the two most common ***'sound signals'*** for ***'a power-driven vessel'*** underway. The difference is when ***'making way through the water'*** or ***'underway but stopped and making no way through the water'***. The sound signals are ***'one prolonged blast'*** or ***'two prolonged blasts in succession with an interval of about 2 seconds between them'*** respectively. The two-blast signal should not be given unless it is certain and confirmed that ***'a power-driven vessel'*** has totally stopped and is not ***'making way through the water'***. For both, the time interval requirement is ***'at intervals of not more than 2 minutes'***.

c: Encompasses various vessels that have some impediment which impairs their manoeuvrability or are likely to be less manoeuvrable than ordinary ***'power-driven vessels'***. Though this signal lets the other vessels know about their less manoeuvrable condition, it should be noted that, as per Rule 19, they have no special privileges and all vessels, irrespective of their type, are required to take ***'action to avoid collision'***.

The list of vessels in this paragraph combines various types of vessel that have been covered by separate Rules earlier and includes almost all vessel types which have been given some priority over another in Rule 18. All these have been assigned a common sound signal to ***'sound at intervals of not more than 2 minutes three blasts in succession, namely one prolonged followed by two short blasts'***. This Rule is applicable when the vessels are ***'underway'***, irrespective of whether they are making way through the water or not. Even if their status changes, for example a ***'sailing vessel'*** underway finds her condition changed to a ***'vessel not under command'*** because there is no wind, or she is becalmed, there will be no change in her sound signals.

'A vessel engaged in towing or pushing another vessel' is included in the list of vessels covered by this paragraph. ***'A vessel engaged in a towing operation'*** is not considered a ***'vessel restricted in her ability to manoeuvre'*** unless as per the definition of Rule 3(g)(vi), and repeated again in Rule 27(c) on lights and shapes required on a towing vessel, the activity ***'severely restricts the towing vessel and her tow in their ability to deviate from their course'***. A vessel ***'pushing'*** gets no privilege elsewhere in these Rules. Both these types of vessels are required to comply with the sound signals of this Rule as they are not likely to be as free to manoeuvre as a normal ***'power-driven vessel'***. Do note that, for ***'a vessel engaged in towing or pushing another vessel'***, it's activity is the sole criteria stated in this Rule; it makes no difference if she ***'is restricted in her ability to manoeuvre'*** or not.

However, as per paragraph 'f' of this Rule, ***'when a pushing vessel and a vessel being pushed ahead are rigidly connected in a composite unit they shall be regarded as a power-driven vessel and shall give the signals prescribed in paragraphs (a) or (b) of this Rule'***.

If any of these vessels were to anchor, they would need to change their sound signals to those prescribed in paragraph 'g' for ***'a vessel at anchor'*** except ***'a vessel engaged in fishing, when at anchor, and a vessel restricted in her ability to manoeuvre when carrying out her work at anchor'***. These will continue to comply with the requirements of paragraph 'c' of this Rule as stated in the next paragraph'd'.

d: The requirements have been explained in the previous paragraph. The list of vessels and the explanatory remarks when they are to be considered ***'vessels restricted in their ability to manoeuvre'*** as per Rule 3(g) have to be applied in the activation of the requirements of this Rule too. ***'A vessel engaged in replenishment or transferring persons, provisions or cargo'*** is included under this category only when she is ***'underway'*** as per Rule 3(g)(iii); if at anchor, then she must comply with the requirements stated in paragraph 'g' of this Rule.

In comparison, there are some similarities in these requirements and those of Rule 26(a) on lights and shapes required to be exhibited by a ***'vessel engaged in fishing'***; such vessels, even if anchored, are not required to display the anchor lights or shapes. However, by Rule 27, ***'a vessel engaged in dredging or underwater operations, when restricted in her ability to manoeuvre'*** only ***'when an obstruction exists'***, is not required to display anchor lights or shapes.

e: Prescribes the sound signals for ***'a vessel towed or if more than one vessel is towed the last vessel of the tow, if manned...'***, this requirement is obligatory only if the tow is ***'manned'***. If not ***'manned'***, then the towed vessels are not required to sound these signals. A prudent mariner should normally arrange, if possible, for automatic signals to be given from a towed vessel or the last vessel of any long tow. This may even be considered as a precautionary act required by Rule 2(a), ***'any precaution which may be required by the ordinary practice of seamen, or by the special circumstances of the case'***. However, by the Rule, ***'if manned'*** applies.

Though this signal is independent of the sound signal required to be sounded by a vessel engaged in towing as prescribed in paragraph 'c', ***'when practicable, this signal shall be made immediately after the signal made by the towing vessel'***. The sound signal prescribed is ***'at intervals of not more than 2 minutes sound four blasts in succession, namely one prolonged followed by three short blasts'***.

f: This has been explained with paragraph 'c'. It may be noted that this requirement is the sound signal counterpart of the lights required by Rule 24(b) ***'when a pushing vessel and a vessel being pushed ahead are rigidly connected in a composite unit they shall be regarded as a power-driven vessel'***. This Rule treats these composite units as any other normal ***'power-driven vessel'***. If the two are not ***'rigidly connected in a composite unit'***, the one pushing will sound the sound signals prescribed in paragraph 'c'. ***'A vessel being pushed ahead'*** is not required to sound any signals in either of these two situations.

g: The requirements of the sound signals for vessels at anchor are simple and straightforward. ***'A vessel at anchor <u>shall</u> at intervals of not more than one minute ring the bell rapidly for about 5 seconds. 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 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'***. The optional whistle signal should normally be heard much further away than the bell and gong combination, may give a better indication of the vessels position and should be used whenever necessary, for example when anchored in congested waters or if another vessel appears to be approaching too close or too fast.

This Rule does not prescribe the time duration for the optional whistle signal; it is only stated for the bell and the gong, which have to be sounded ***'at intervals of not more than one minute'*** and are not optional. The introduction to this Rule contains explanatory remarks to assist in deciding the time interval between these optional whistle signals.

Surprisingly, Annex III does not state any minimum audible range requirements for the ***'bell or gong'***, it just states the minimum sound pressure level. Basis the equipment normally seen on board, the audible range of sound signals made by the use of ***'bell or gong'*** are likely to be much lower than the range of the whistle signals.

h: The sound signals for a vessel aground are the same as for a vessel at anchor as ***'prescribed in paragraph (g) of this Rule'*** with an additional requirement of ***'three separate and distinct strokes***

on the bell immediately before and after the rapid ringing of the bell'.

'A vessel aground may in addition sound an appropriate whistle signal'. Similar to as explained with paragraph 'g' for ***'a vessel at anchor'***, this is an optional signal and this Rule also does not define any time intervals. In this case ***'appropriate'*** is also not defined; it is believed the authors of these Rules were unable to agree to a common signal suitable at all times.

In the ***'International Code of Signals'*** the Morse code signal ***'U'*** (two short blasts followed by one prolonged blast) means ***'you are running into danger'***. This signal is used for the purpose of warning other vessels to keep well clear and is also distinctly different than all the other sound signals prescribed in this Rule, as such it is usually recommended as ***'an appropriate whistle signal'*** for ***'a vessel aground'***.

i and j: Provide exemptions to small vessels from the sound signalling requirements prescribed in this Rule. These exemptions are based on the requirements given in Rule 33 on the carriage of sound signalling equipment on vessels below 12 m, 12 to 20 m and over 20 m.

However, both these Rules require ***'some other efficient sound signal at intervals of not more than 2 minutes'***. This alternate sound signal is not defined in the Rules but should be such that it can be heard by other vessels early enough ***'for preventing collisions'***, and preferably have characteristics to indicate that the sound signal has originated from a small vessel. As with most mandatory sound signals, this one also has an upper time limit of 2 minutes between successive signals.

k: ***'When engaged on pilotage duty', 'a pilot vessel'*** is required to comply with ***'signals prescribed in paragraphs (a), (b) or (g) of this Rule'***. That is, ***'a power-driven vessel making way', 'underway but stopped and making no way through the water'*** or ***'a vessel at anchor'*** respectively.

'A pilot vessel may in addition sound an identity signal consisting of four short blasts'. This optional signal would apply to any vessel on pilotage duty in any of the conditions explained. No time durations have been prescribed for this optional signal in the Rule. The sound signal of four short blasts is akin to the ***'International Code of Signals'*** Morse code signal ***'H' - 'I have a pilot on board'***.

This signal of 4 short blasts is close to the doubt signal of 5 or more short blasts prescribed by Rule 34(d), but that is only for use between ***'vessels in sight of one another'***. However, it is possible for both these signals to be heard in the same area. Though the requirements of this Rule 35 apply only ***'in or near an area of restricted visibility'***, and unless the visibility is zero, vessels may get close enough to be able to see the other visually, and, if in doubt about the other, they would comply with Rule 34(d) and sound five or more short blasts. If ever in such a situation, count the blasts carefully to differentiate between them, and remember that four shorts blasts indicates the presence of ***'a pilot vessel'*** in the vicinity.

Rule 36

Signals to attract attention

If necessary to attract the attention of another vessel any vessel may make light or sound signals that cannot be mistaken for any signal authorized elsewhere in these Rules, or may direct the beam of her searchlight in the direction of the danger, in such a way as not to embarrass any vessel. Any light to attract the attention of another vessel shall be such that it cannot be mistaken for any aid to navigation. For the purpose of this Rule the use of high-intensity intermittent or revolving lights, such as strobe lights, shall be avoided.

When reading this Rule it is important to refer to Rule 20(b) which states, ***'the Rules concerning lights shall be complied with from sunset to sunrise, and during such times no other lights shall be exhibited, except such lights as cannot be mistaken for the lights specified in these Rules or do not impair their visibility or distinctive character, or interfere with the keeping of a proper look-out'***. This Rule also states a similar principle ***'may make light or sound signals that cannot be mistaken for any signal authorized elsewhere in these Rules'***.

This Rule should normally apply to ***'vessels in sight of one another'***; the lights would not be visible otherwise. However, this Rule is actually silent on this aspect and does not recommend any sound signals. As explained with Rule 35(h), the sound signal 'U', two short blasts followed by one prolonged blast, meaning ***'you are running into danger'*** is an appropriate signal for the purposes of this Rule too.

The ***'doubt'*** signal to attract attention prescribed in Rule 34(d) is, ***'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'***. However, the requirement of this Rule is for a different purpose; this Rule is to show to another vessel ***'the direction of the danger'*** or to warn another vessel of some danger in her path. When this is required, then obviously it would be ***'necessary to attract the attention of another vessel'***.

The former aspect of this Rule - ***'if necessary to attract the attention of another vessel'*** - may be invoked for other purposes; for example, a sailing vessel may wish to illuminate her sails at night to attract the attention of other vessels to show them that she is under sail.

[QUIZ QS. WHEN SHOULD THE DOUBT SIGNAL STATED IN RULE 34(D) BE ACTIVATED?]

If the beam of a searchlight is directed towards a dangerous area, it should not be directed towards the vessel whose attention is being sought. The navigators on board the vessel will be blinded and unable to see anything.

'Any light to attract the attention of another vessel shall be such that it cannot be mistaken for any aid to navigation' is self-explanatory.

'For the purpose of this Rule the use of high intensity intermittent or revolving lights, such as strobe lights, shall be avoided'. This prohibition aims to stop the use of flash tubes or ***'strobe lights'*** to attract attention. These lights have often been used by commercial fishing vessels and some recreational vessels to warn other vessels to keep away from them. Such use is not legal but sometimes may be resorted to and justified under Rule 2(b) clauses of ***'special circumstances'*** and ***'may make a departure from these Rules necessary to avoid immediate danger'***.

Rule 37

Distress signals

When a vessel is in distress and requires assistance she shall use or exhibit the signals described in annex IV to these Regulations.

Distress signals have nothing to do with ***'preventing collisions at sea'***, but are included in these Rules and listed in annex IV.

Distress signals have been a part of the earlier editions of these Rules; during the last revision, the majority of the participating States felt that retaining distress signals within the framework of the Rules would give the distress signals the widest possible circulation. Navigators should study the same in annex IV; these signals are specifically required to be used by a vessel in distress and requiring assistance. Annex IV has been revised effective December 2009, the last known revision to these Rules at the time of publication of this book.

PART E – EXEMPTIONS

Rule 38

Exemptions

Any vessel (or class of vessels) provided that she complies with the requirements of the International Regulations for Preventing Collisions at Sea, 1960, the keel of which is laid or which is at a corresponding stage of construction before the entry into force of these Regulations may be exempted from compliance therewith as follows:

(a) The installation of lights with ranges prescribed in Rule 22, until four years after the date of entry into force of these Regulations.

(b) The installation of lights with colour specifications as prescribed in section 7 of annex I to these Regulations, until four years after the date of entry into force of these Regulations.

(c) The repositioning of lights as a result of conversion from Imperial to metric units and rounding off measurement figures, permanent exemption.

(d) (i) The repositioning of masthead lights on vessels of less than 150 m in length, resulting from the prescriptions of section 3(a) of annex I to these Regulations, permanent exemption.

(ii) The repositioning of masthead lights on vessels of 150 m or more in length, resulting from the prescriptions of section 3(a) of annex I to these Regulations, until nine years after the date of entry into force of these Regulations.

(e) The repositioning of masthead lights resulting from the prescriptions of section 2(b) of annex I to these Regulations, until nine years after the date of entry into force of these Regulations.

(f) The repositioning of sidelights resulting from the prescriptions of section 2(g) and 3(b) of annex I to these Regulations, until nine years after the date of entry into force of these Regulations.

(g) The requirements for sound signal appliances prescribed in annex III to these Regulations, until nine years after the date of entry into force of these Regulations.

(h) The repositioning of all-round lights resulting from the prescription of section 9(b) of annex I to these Regulations, permanent exemption.

These ***'International Regulations for Preventing Collisions at Sea'*** were adopted by the IMO in October 1972 and became effective from 15th July 1977. The older set of Rules of 1960, effective since 1965, became redundant from this date.

This Rule set time limits for the changeover to the new requirements; paragraphs 'a', 'b', 'd-ii', 'e', 'f' and 'g', describe areas where existing ships had time limits of 4 or 9 years as stated in the relevant paragraphs to comply with these new Rules, ***'after the date of entry into force of these Regulations'***. From 1977 to now the time elapsed is well over these limits.

Paragraphs 'c', 'd-i', and 'h' provide for permanent exemptions. It may be interesting to note that paragraph 'h' was added to this Rule when the Rules were amended in 1981.

The permanent exemption for conversion to metric units refers to old requirements that have been retained in these new Rules but were converted to the metric system of measurement. For example, an old requirement might have called for six feet spacing between lights. The new requirement rounds off the measurement to two meters, a little more than six feet. If the lights are separated by six feet, there is no need to adjust them to meet the new exact metric requirements.

This Rule now mainly serves as a warning to navigators that on any old vessel being served on or encountered at sea, everything may not conform exactly to the present set of requirements.

ANNEX- I

Positioning and technical details of lights and shapes

1 **Definition**

The term *height* above the *hull* means height above the uppermost continuous deck. This height shall be measured from the position vertically beneath the location of the light.

2 **Vertical positioning and spacing of lights**

(a) On a power-driven vessel of 20 m or more in length the masthead lights shall be placed as follows:

(i) the forward masthead light, or if only one masthead light is carried, then that light, at a height above the hull of not less than 6 m, and, if the breadth of the vessel exceeds 6m, then at a height above the hull not less than such breadth, so however that the light need not be placed at a greater height above the hull than 12 m;

(ii) When two masthead lights are carried the after one shall be at least 4.5 m vertically higher than the forward one.

(b) The vertical separation of masthead lights of power-driven vessels shall be such that in all normal conditions of trim the after light will be seen over and separate from the forward light at a distance of 1000 m from the stem when viewed from sea-level.

(c) The masthead light of a power-driven vessel of 12 m but less than 20 m in length shall be placed at a height above the gunwale of not less 2.5 m.

(d) A power-driven vessel of less than 12 m in length may carry the uppermost light at a height of less than 2.5 m above the gunwale. When, however, a masthead light is carried in addition to sidelights and a sternlight or the all-round light prescribed in Rule 23(d)(i) is carried in addition to sidelights, then such masthead light or all-round light shall be carried at least 1 m higher than the sidelights.

(e) One of the two or three masthead lights prescribed for a power-driven vessel when engaged in towing or pushing another vessel shall be placed in the same position as either the forward masthead light or the after masthead light; provided that, if carried on the aftermast, the lowest after masthead light shall be at least 4.5 m vertically higher than the forward masthead light.

(f) **(i)** The masthead light or lights prescribed in Rule 23(a) shall be so placed as to be above and clear of all other lights and obstructions except as described in subparagraph (ii).

(ii) When it is impracticable to carry the all-round lights prescribed by Rule 27(b) (i) or Rule 28 below the masthead lights, they may be carried above the after masthead light(s) or vertically in between the forward masthead light(s) and after masthead light(s), provided that in the latter case the requirement of section 3(c) of this annex shall be complied with.

(g) The sidelights of a power-driven vessel shall be placed at a height above the hull not greater than three quarters of that of the forward masthead light. They shall not be so low as to be interfered with by deck lights.

(h) The sidelights, if in a combined lantern and carried on a power-driven vessel of less than 20 m in length, shall be placed not less than 1 m below the masthead light.

(i) When the Rules prescribe two or three lights to be carried in a vertical line, they shall be spaced as follows:

(i) on a vessel of 20 m in length or more such lights shall be spaced not less than 2 m apart, and the lowest of these lights shall, except where a towing light is required, be placed at a height of not less than 4 m above the hull;

(ii) on a vessel of less than 20 m in length such lights shall be spaced not less than 1 m apart and the lowest of these lights shall, except where a towing light is required, be placed at a height of not less than 2 m above the gunwale;

(iii) When three lights are carried they shall be equally spaced.

(j) The lower of the two all-round lights prescribed for a vessel when engaged in fishing shall be at a height above the sidelights not less than twice the distance between the two vertical lights.

(k) The forward anchor light prescribed in Rule 30(a)(i), when two are carried, shall not be less than 4.5 m above the after one. On a vessel of 50 m or more in length this forward anchor light shall be placed at a height of not less than 6 m above the hull.

3 Horizontal positioning and spacing of lights

(a) When two masthead lights are prescribed for a power-driven vessel, the horizontal distance between them shall not be less than one half of the length of the vessel but need not be more than 100 m. The forward light shall be placed not more than one quarter of the length of the vessel from the stem.

(b) On a power-driven vessel of 20 m or more in length the sidelights shall not be placed in front of the forward masthead lights. They shall be placed at or near the side of the vessel.

(c) When the lights prescribed in Rule 27(b)(i) or Rule 28 are placed vertically between the forward masthead light(s) and the after masthead light(s) these all-round lights shall be placed at a horizontal distance of not less than 2 m from the fore-and-aft centreline of the vessel in the athwartship direction.

(d) When only one masthead light is prescribed for a power-driven vessel, this light shall be exhibited forward of amidships; except that a vessel of less than 20m in length need not exhibit this light forward of amidships but shall exhibit it as far forward as is practicable

4. Details of location of direction-indicating lights for fishing vessels, dredgers and vessels engaged in underwater operations

(a) The light indicating the direction of the outlying gear from a vessel engaged in fishing as prescribed in Rule 26 (c) (ii) shall be placed at a horizontal distance of not less than 2 m and not more than 6 m away from the two all-round red and white lights. This light shall be placed not higher than the all-round white light prescribed in Rule 26 (c) (i) and not lower than the sidelights.

(b) The lights and shapes on a vessel engaged in dredging or underwater operations to

indicate the obstructed side and/or the side on which it is safe to pass, as prescribed in Rule 27(d) (i) and (ii), shall be placed at the maximum practical horizontal distance, but in no case less than 2 m, from the lights or shapes prescribed in Rule 27(b) (i) and (ii). In no case shall the upper of these lights or shapes be at a greater height than the lower of the three lights or shapes prescribed in Rule 27(b) (i) and (ii).

5. Screens for sidelights

The sidelights of vessels of 20 m or more in length shall be fitted with inboard screens painted matt black, and meeting the requirements of section 9 of this annex. On vessels of less than 20 m in length the sidelights, if necessary to meet the requirement of section 9 of this annex, 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.

6. Shapes

(a) Shapes shall be black and of the following sizes:

(i) a ball shall have a diameter of not less than 0.6 m;

(ii) a cone shall have a base diameter of not less than 0.6 m and a height equal to its diameter;

(iii) a cylinder shall have a diameter of at least 0.6 m and a height of twice its diameter;

(iv) a diamond shape shall consist of two cones as defined in (ii) above having a common base.

(b) The vertical distance between shapes shall be at least 1.5 m.

(c) In a vessel of less than 20 m in length shapes of lesser dimensions but commensurate with the size of the vessel may be used and the distance apart may be correspondingly reduced.

7. Color specification of lights

The chromaticity of all navigation light, shall conform to the following standards, which lie within the boundaries of the area of the diagram specified for each colour by the International Commission on Illumination (CIE).

The boundaries of the area for each colour are given by indicating the corner co-ordinates, which are as follow:

(i) White

x	0.525	0.525	0.452	0.310	0.310	0.443
y	0.382	0.440	0.440	0.348	0.283	0.382

(ii) Green

x	0.028	0.009	0.300	0.203
y	0.385	0.723	0.511	0.356

(iii) Red

x	0.680	0.660	0.735	0.721
y	0.320	0.320	0.265	0.259

(iv) Yellow

x 0.612 0.618 0.575 0.575

y 0.382 0.382 0.425 0.406

8 **Intensity of lights**

(a) The minimum luminous intensity of lights shall be calculated by using the formula:

$I = 3.43 \times 10^6 \times T \times D^2 \times K^{-D}$

Where I is luminous intensity in candelas under service conditions,

T is threshold factor 2×10^{-7} lux,

D is range of visibility (luminous range) of the light in nautical miles,

K is atmospheric transmissivity.

For prescribed lights the values of K shall be 0.8, corresponding to a meteorological visibility of approximately 13 nautical miles.

(b) A selection of figures derived from the formula is given in the following table:

Range of visibility (luminous range) of light in nautical miles D	Luminous intensity of light in candelas for K=0.8 I
1	0.9
2	4.3
3	12
4	27
5	52
6	94

NOTE: The maximum luminous intensity of navigation lights should be limited to avoid undue glare. This shall not be achieved by variable control of the luminous intensity.

9. **Horizontal sectors**

(a) (i) In the forward direction, sidelights as fitted on the vessel shall show the minimum required intensities. The intensities shall decrease to reach practical cut-off between 1° and 3° outside the prescribed sectors.

(ii) For sternlights and masthead lights and at 22.5° abaft the beam for sidelights, the minimum required intensities shall be maintained over the arc of the horizon up to 5° within the limits of the sectors prescribed in Rule 21. From 5° within the prescribed sectors the intensity may decrease by 50% up to the prescribed limits; it shall decrease steadily to reach practical cut-off at not more than 5° outside the prescribed sectors.

(b) (i) All-round lights shall be so located as not to be obscured by masts, topmasts or structures within angular sectors of more than 6°, except anchor lights prescribed in Rule 30, which need not be placed at an impracticable height above the hull.

(ii) If it is impracticable to comply with paragraph (b) (i) of this section by exhibiting only one all-round light, two all-round lights shall be used suitably positioned or screened so that they appear, as far as practicable, as one light at a distance of one mile.

10 **Vertical sectors**

(a) The vertical sectors of electric lights as fitted, with the exception of lights on sailing vessels underway, shall ensure that:

(i) at least the required minimum intensity is maintained at all angles from 5° above to 5° below the horizontal;

(ii) at least 60% of the required minimum intensity is maintained from 7.5° above to 7.5° below the horizontal.

(b) In the case of sailing vessels underway the vertical sectors of electric lights as fitted shall ensure that:

(i) at least the required minimum intensity is maintained at all angles from 5° above to 5° below the horizontal;

(ii) at least 50% of the required minimum intensity is maintained from 25° above to 25° below the horizontal.

(c) In the case of lights other than electric these specifications shall be met as closely as possible.

11 **Intensity of non-electric lights**

Non-electric lights shall so far as practicable comply with the minimum intensities, as specified in the table given in section 8 of this annex.

12 **Manoeuvring light**

Notwithstanding the provisions of paragraph 2(f) of this annex, the maneuvering light described in Rule 34(b) shall be placed in the same fore-and-aft vertical plane as the masthead light or lights and, where practicable, at a minimum height of 2 m vertically above the forward masthead light, provided that it shall be carried not less than 2 m vertically above or below the after masthead light. On a vessel where only one masthead light is carried, the manoeuvreing light, if fitted, shall be carried where it can best be seen, not less than 2 m vertically apart from the masthead light.

13 **High-speed craft***

(a) The masthead light of high-speed craft may be placed at a height related to the breadth of the craft lower than that prescribed in paragraph 2 (a)(i) of this annex, provided that the base angle of the isosceles triangles formed by the sidelights and masthead light, when seen in end elevation, is not less than 27°.

(b) On high-speed craft of 50 m or more in length, the vertical separation between foremast and mainmast light of 4.5 m required by paragraph 2 (a) (ii) of this annex may be modified provided that such distance shall not be less than the value determined by the following formula:

$$Y = \frac{(a + 17\Psi)\,C}{1000} + 2$$

Where: y is the height of the mainmast light above the foremast light in metres;

a is the height of the foremast light above the water surface in service condition in metres;

Ψ is the trim in service condition in degrees;

C is the horizontal separation of masthead lights in metres.

* Refer to the International Code of Safety for High-Speed Craft, 1994 and the International Code of Safety for High-Speed Craft, 2000.

14 **Approval**

The construction of lights and shapes and the installation of lights on board the vessel shall be to the satisfaction of the appropriate authority of the State whose flag the vessel is entitled to fly.

ANNEX II

Additional signals for fishing vessels fishing in close proximity

1 **General**

The lights mentioned herein shall, if exhibited in pursuance of Rule 26(d), be placed where they can best be seen. They shall be at least 0.9 m apart but at a lower level than lights prescribed in Rule 26(b) (i) and (c) (i). The lights shall be visible all round the horizon at a distance of at least 1 mile but at a lesser distance than the lights prescribed by these Rules for fishing vessels.

2 **Signals for trawlers**

(a) Vessels of 20 m or more in length when engaged in trawling, whether using demersal or pelagic gear, shall exhibit:

(i) when shooting their nets: two white lights in a vertical line;

(ii) when hauling their nets: one white light over one red light in a vertical line;

(iii) when the net has come fast upon an obstruction: two red lights in a vertical line.

(b) Each vessel of 20 m or more in length engaged in pair trawling shall exhibit:

(i) by night, a searchlight directed forward and in the direction of the other vessel of the pair;

(ii) when shooting or hauling their nets or when their nets have come fast upon an obstruction, the lights prescribed in 2(a) above.

(c) A vessel of less than 20m in length engaged in trawling, whether using demersal or pelagic gear or engaged in pair trawling, may exhibit the lights prescribed in paragraphs (a) or (b) of this section, as appropriate.

3 **Signals for purse seiners**

Vessels engaged in fishing with purse seine gear may exhibit two yellow lights in a vertical line. These lights shall flash alternately every second and with equal light and occultation duration. These lights may be exhibited only when the vessel is hampered by its fishing gear.

ANNEX- III

Technical details of sound signal appliances

1 **Whistles**

(a) *Frequencies and range of audibility*

The fundamental frequency of the signal shall lie within the range 70-700 Hz. The range of audibility of the signal from a whistle shall be determined by those frequencies, which may include the fundamental and/or one or more higher frequencies, which lie within the range 180-700 Hz (± 1%) for a vessel of 20 m or more in length, or 180-2100 Hz (± 1%) for a vessel of less than 20 m in length and which provide the sound pressure levels specified in paragraph 1(c) below.

(b) *Limits of fundamental frequencies*

To ensure a wide variety of whistle characteristics, the fundamental frequency of a whistle shall be between the following limits:

(i) 70-200 Hz, for a vessel 200 m or more in length;

(ii) 130-350 Hz, for a vessel 75 m but less than 200 m in length;

(iii) 250-700 Hz, for vessel less than 75 m in length.

(c) *Sound signal intensity and range of audibility*

A whistle fitted in a vessel shall provide, in the direction of maximum intensity of the whistle and at a distance of 1 m from it, a sound pressure level in at least one 1/3 - octave band within the range of frequencies 180-700 Hz (± 1%) for a vessel of 20 m or more in length, or 180-2100 Hz (± 1%) for a vessel of less than 20 m in length, of not less than the appropriate figure given in the table below.

Length of vessel in metres	1/3 -octave band level at 1 m in dB referred to 2×10^{-5} N /m^2	Audibility range in nautical miles
200 or more	143	2
75 but less than 200	138	1.5
20 but less than 75	130	1
Less than 20	120*	0.5
	111‡	

* When the measured frequencies lie within the range 180-450 Hz

† When the measured frequencies lie within the range 450-800 Hz

‡ When the measured frequencies lie within the range 800-2100 Hz

The range of audibility in the table above is for information and is approximately the range at which a whistle may be heard on its forward axis with 90 % probability in conditions of still air on board a vessel having average background noise level at the listening posts (taken to be 68 dB in the octave band centred on 250 Hz and 63 dB in the octave band centred on 500 Hz).

In practice the range at which a whistle may be heard is extremely variable and depends critically on weather conditions; the values given can be regarded as typical but under conditions of strong wind or high ambient noise level at the listening post the range may be much reduced.

(d) *Directional properties*

The sound pressure level of a directional whistle shall be not more than 4 dB below the prescribed sound pressure level on the axis at any direction in the horizontal plane within ±45° of the axis. The sound pressure level at any other direction in the horizontal plane shall be not more than 10 dB below the prescribed sound pressure level on the axis, so that the range in any direction will be at least half the range on the forward axis. The sound pressure level shall be measured in that 1/3rd-octave band which determines the audibility range.

(e) *Positioning of whistles*

When a directional whistle is to be used as the only whistle on a vessel, it shall be installed with its maximum intensity directed straight ahead.

A whistle shall be placed as high as practicable on a vessel, in order to reduce interception of the emitted sound by obstructions and also to minimize hearing damage risk to personnel. The sound pressure level of the vessel's own signal at listening posts shall not exceed 110 dB (A) and so far as practicable should not exceed 100 dB (A).

(f) *Fitting of more than one whistle*

If whistles are fitted at a distance apart of more than 100 m, it shall be so arranged that they are not sounded simultaneously.

(g) *Combined whistle systems*

If due to the presence of obstructions the sound field of a single whistle or one of the whistles referred to in paragraph 1 (f) above is likely to have a zone of greatly reduced signal level, it is recommended that a combined whistle system be fitted so as to overcome this reduction. For the purposes of the Rules a combined whistle system is to be regarded as a single whistle. The whistles of a combined system shall be located at a distance apart of not more than 100 m and arranged to be sounded simultaneously. The frequency of any one whistle shall differ from those of the others by at least 10 Hz.

2 Bell or gong

(a) *Intensity of signal*

A bell or gong, or other device having similar sound characteristics shall produce a sound pressure level of not less than 110 dB at a distance of 1 m from it.

(b) *Construction*

Bells and gongs shall be made of corrosion-resistant material and designed to give a clear tone. The diameter of the mouth of the bell shall be not less than 300 mm for vessels of 20 m or more in length. Where practicable, a power-driven bell striker is recommended to ensure constant force but manual operation shall be possible. The mass of the striker shall be not less than 3% of the mass of the bell.

3 Approval

The construction of sound signal appliances, their performance and their installation on board the vessel shall be to the satisfaction of the appropriate authority of the State whose flag the vessel is entitled to fly.

ANNEX- IV

Distress signals (as amended effective 1st December 2009)

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

(a) a gun or other explosive signals 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-colored 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 radiocommunications 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 International Aeronautical and Maritime Search and Rescue Manual, Volume III 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.

IALA - MARITIME BUOYAGE SYSTEM (MBS)

PURPOSE: Buoys are floating aids to navigation. They may be seen in several types of shapes with or without topmarks, having varying colour patterns and some even fitted with white or coloured lights for use at night. Their shape, colour and light patterns all indicate a message towards safe navigation. Buoys are used to mark the approach points of ports, the sides or navigable limits of approach channels, act as dividers in between channels to separate opposite flow of traffic, to mark natural dangers and underwater obstructions like wrecks. Buoys are also used to mark important features of importance in navigation, safe waters, any new dangers and wrecks.

In this chapter a very brief introduction is being provided to the buoyage system, it is recommended that IALA publications, Mariners Handbook and Sailing Directions for the area concerned are studied to obtain in depth knowledge about the MBS and their proper use.

THE HISTORY: A long evolution has led to the present day systems. In 1889 a few countries placed black can buoys on the port side and red conical buoys on the starboard side of their port approach channels to mark the safe navigable limits, the approach direction being considered for the marking. Later red lights and green lights were placed on them respectively. However, in North America the lights were placed in the opposite manner. In 1936 in the Geneva Convention a common system was agreed to but varying interpretations led to the setting up of 9 different systems even in the North European waters soon after the end of World War II in 1945 when new replacement systems were set up to replace those destroyed in the long war.

IALA, International Association of Marine Aids and Lighthouse Authorities, was established in 1957. IALA provides nautical expertise and advice to harmonise aids to navigation worldwide and to ensure that movements of vessels are safe, expeditious and cost effective whilst simultaneously protecting the environment. In 1965 a committee was formed by IALA to study the many existing buoyage systems and provide cost effective solutions to standardise the same.

The IALA process was accelerated by the 11th January 1972 collision and sinking of 'Texaco Caribbean' in the Dover straits followed soon by two other vessels which hit her wreck and sank in the vicinity, details given at the end of Rule 10 on TSS. Though the wreck was marked by buoys, they were not recognized by the other ill fated vessels following the then voluntary TSS off Dover, they struck the submerged wreck apart from many which had near misses with the same.

Over 30 systems were in use as late as 1976 and some in total conflict with each other. It was an impossible task for navigators to be fully familiar with all these systems and this did lead to many accidents too especially when unable to make out that a new uncharted buoy had been placed to mark a recent underwater wreck.

This committee proposed two systems, using red colour to mark the port and starboard sides of the approach channels in different parts of the world naming them as System A and B respectively, green being the colour used for the other side. System A was adopted by Inter-Governmental Maritime Consultative Organization (IMCO) in 1976, now known as IMO. System B Rules were developed only in early 1980. However, even now, if an authority considers that the green colour is not satisfactory due to any exceptional reasons; black colour may be used instead.

The two systems have been combined by IALA into a common set of Rules and the basic essence of marking the port and starboard channels by red remains but these are now called Region A and B respectively to differentiate the areas using the same geographically. These Rules were adopted in

November 1980 in a conference convened by IALA with the support of IMCO and IHO (International Hydrographic Organization).

Adoption of the IALA systems across the world is now almost over. Geographical limits of the areas following A or B systems is well demarcated and readily available in sailing directions, is usually marked on the relevant navigational charts and also on maps published by IALA showing the demarcation of areas.

As per the available information the general demarcation is as follows:

Region A: Europe, Australia, New Zealand, Africa, the Gulf and most of the Asian countries except as listed under Region B.

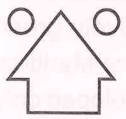
Region B: North, Central & South America, Japan, North & South Korea and the Philippines.

The knowledge of navigators to recognise and act on sighting buoys still remains weak. The submerged wreck of the 'Tricolor', due to her unfortunate collision and sinking on 14th December 2002, was hit by two other vessels on 16th December 2002 and 1st January 2003, even though wreck marking buoys had been immediately placed near the same. Several other vessels had near misses with this wreck too; the case is described with Rule 6 and has similarities with the 11th January 1972 collision and sinking of 'Texaco Caribbean' referred to above.

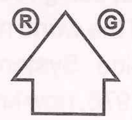
THE SYSTEM:

Six different types of marks are used, namely: Lateral, Cardinal, Isolated Danger, Safe Water, Special and Emergency Wreck Marking Buoys, the last was introduced only in 2006 by IMO on the recommendation of IALA. The marks may be used alone or in any combination. The buoys may be shaped in the form of Can / cylindrical, Conical, Spherical, Pillar or Spar. The first three usually indicate the correct side to pass from except in US waters where similar shaped buoys are frequently used on both sides of a channel, though painted differently in compliance with the Rules applicable to Region B. In addition buoys may be fitted with topmarks and the vast majority now feature radar reflectors incorporated into their design. The usual shapes of buoys are as shown below.

The approach direction to a port, harbour or estuary from seaward is normally taken as the '**local direction of buoyage**'. However, '**general direction of buoyage**' may be adopted by local authorities and may be different than the former. The directions are usually clearly marked on the navigational charts if they have been so declared by the local authorities.



Symbol showing direction of buoyage where not obvious.



Symbol showing direction of buoyage where not obvious, on multicoloured charts (red and green circles coloured as appropriate).

LATERAL MARKS: These are used in conjunction with the conventional direction of buoyage, usually to mark the edges of well defined navigable channels. Modified marks are used to indicate areas where the channels divide and/or indicate the preferred routes to follow.

Lateral Marks are the only marks that differ by region; the other four marks are common to both Region A and Region B.

CARDINAL MARKS: Are used to indicate the position of a hazard and the direction of safe navigable waters around it linked to the true directions of the compass.

ISOLATED DANGER MARKS: Are used to indicate isolated dangers of limited size with safe navigable waters around them, for example a submerged rock or even a small wreck. They are placed over or as close to the danger.

SAFE WATER MARKS: usually indicate the end of a channel and that deep, safe navigable water lies ahead. They also are used as a mid-channel marker buoy and indicate that there is safe navigable deep water around them in all directions.

SPECIAL MARKS: Are not necessarily intended for providing directional guidance to assist navigation but to highlight areas or features referred to in charts and nautical publications. Areas having speed restrictions or mooring locations are marked by such buoys. The best point of passage in a channel may also be marked by such buoys, for example when passing under bridges.

EMERGENCY WRECK MARKS: Is placed as soon as possible close near to a new wreck or newly discovered obstruction considered hazardous to shipping or surface navigation. This was adopted by IMO on 11th December 2006 at the request of IALA and with a view to improve safety of navigation.

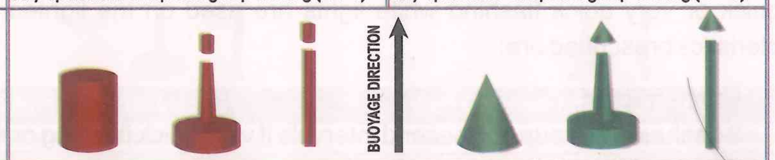
The emergency wreck-marking buoy is designed to provide high visual and radio aid to navigation recognition. It should be placed as close to the wreck as possible, or in a pattern around the wreck, and within any other marks that may be subsequently deployed. The emergency wreck marking buoy should be maintained in position until:

- the wreck is well known and has been promulgated in nautical publications;
- the wreck has been fully surveyed and exact details such as position and least depth above the wreck are known; and
- a permanent form of marking of the wreck has been carried out.

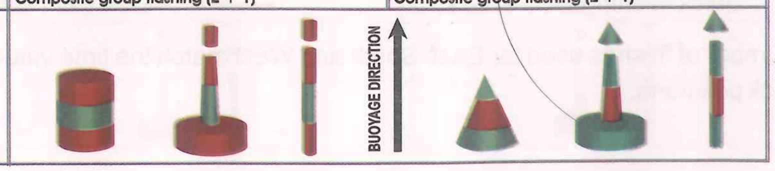
Principal features of each system and type of the above is shown in the below diagrams and charts.

LATERAL MARKS: REGION A

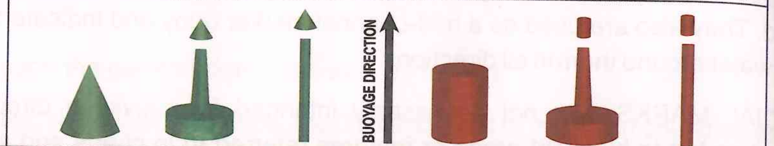
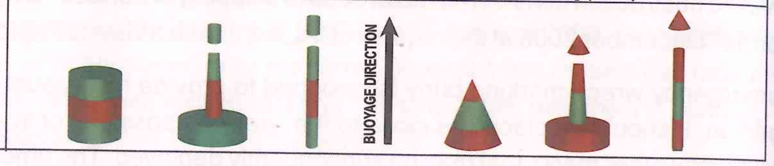
	Port Hand Marks	Starboard Hand Marks
Colour	Red	Green
Buoy Shape	Cylindrical (can), pillar or spar	Conical, pillar or spar
Topmark (if any)	Single red cylinder (can)	Single green cone, point upward
Light Colour (when fitted)	Red	Green
Light Rhythm (when fitted)	Any apart from composite group flashing (2 + 1)	Any apart from composite group flashing (2 + 1)



	Preferred Channel to Starboard	Preferred Channel to Port
Colour	Red with one broad green horizontal band	Green with one broad red horizontal band
Buoy Shape	Cylindrical (can), pillar or spar	Conical, pillar or spar
Topmark (if any)	Single red cylinder (can)	Single green cone, point upward
Light Colour (when fitted)	Red	Green
Light Rhythm (when fitted)	Composite group flashing (2 + 1)	Composite group flashing (2 + 1)



LATERAL MARKS: REGION B

	Port Hand Marks	Starboard Hand Marks
Colour	Green	Red
Buoy Shape	Cylindrical (can), pillar or spar	Conical, pillar or spar
Topmark (if any)	Single green cylinder (can)	Single red cone, point upward
Light Colour (when fitted)	Green	Red
Light Rhythm (when fitted)	Any apart from composite group flashing (2 + 1)	Any apart from composite group flashing (2 + 1)
		
	Preferred Channel to Starboard	**Preferred Channel to Port**
Colour	Green with one broad green horizontal band	Red with one broad green horizontal band
Buoy Shape	Cylindrical (can), pillar or spar	Conical, pillar or spar
Topmark (if any)	Single green cylinder (can)	Single red cone, point upward
Light Colour (when fitted)	Green	Red
Light Rhythm (when fitted)	Composite group flashing (2 + 1)	Composite group flashing (2 + 1)
		

CARDINAL MARKS: REGION A & REGION B

Are used to signify a danger and show the direction of safety as a compass direction relative to the mark. They are after the quadrant in which they are placed. This system makes them free from direction of approach of a vessel. These are usually used to show:

- ➢ The deepest water on an area on the named side of the mark;
- ➢ The safe side on which to pass a danger; and
- ➢ Draw attention to a feature in a channel such as a bend, junction, bifurcation or end of a shoal.

They do not have a distinctive shape prescribed for them, but buoys used as Cardinal marks are usually either pillar or spar shaped.

Only quick or very quick flashing white lights are used on the lighted cardinal marks. The light characteristics prescribed are:

N Uninterrupted,

E 3 flashes in a group at 5 second intervals if very quick flashing or 10 second intervals if quick flashing,

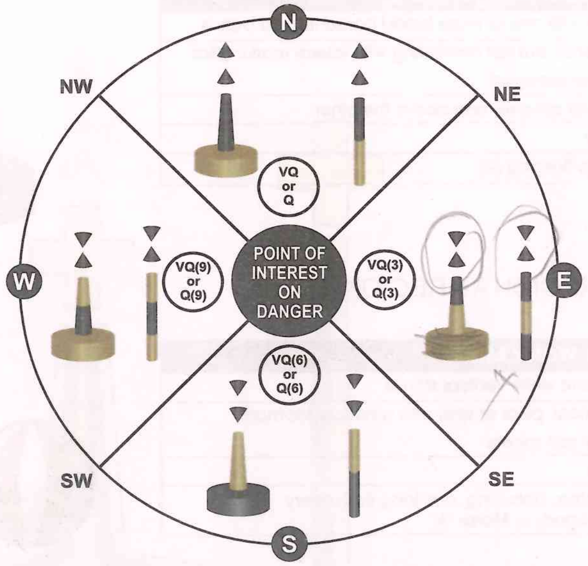
S 6 flashes in a group followed by a long flash, the latter not less than 2 seconds duration. At 10 second intervals if very quick flashing or 15 second intervals if quick flashing,

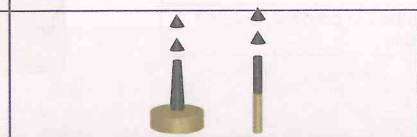
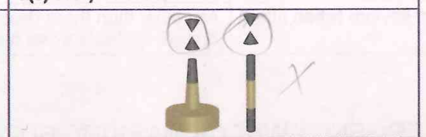
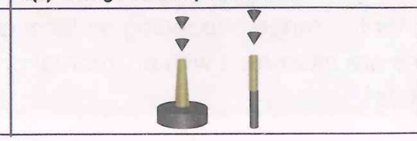
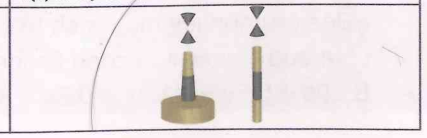
W 9 flashes in a group, at 10 second intervals if very quick flashing or 15 second intervals if quick flashing.

The number of flashes used for East, South and West match the time values used in a clock, 3, 6 and 9 o'clock positions.

Quick flashing means a rate between 50 and 79 flashes/minute, usually 50 or 60. Very quick flashing means a rate between 80 and 159 flashes/minute, usually 100 or 120.

A vessel is safe if the navigators take her N off a North mark, E of an East mark, S of a South mark and W of a West mark.



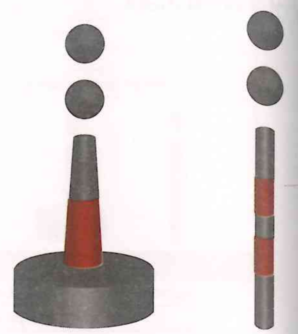
	North Cardinal mark	East Cardinal Mark
Colour	Black above yellow	Black with a single broad horizontal yellow band
Buoy Shape	Pillar or spar	Pillar or spar
Topmark	2 black cones, one above the other, pointing upward	2 black cones, one above the other, base to base
Light Colour (when fitted)	VQ or Q	White
Light Rhythm (when fitted)		VQ(3) every 5 seconds or Q(3) every 10 seconds
		
	South Cardinal Mark	**West Cardinal Mark**
Colour	Yellow above black	Yellow with a single broad horizontal yellow band
Buoy Shape	Pillar or spar	Pillar or spar
Topmark	2 black cones, one above the other, points downward	2 black cones, one above the other, point to point
Light Colour (when fitted)	White	White
Light Rhythm (when fitted)	VQ(6) + Long flash every 10 seconds or Q(6) + Long flash every 15 seconds	VQ(9) every 10 seconds or Q(9) every 15 seconds
		

ISOLATED DANGER MARKS: REGION A & REGION B

The double sphere topmark is an important feature and needs to be visible by day. The topmarks should be as large as possible with the spheres clearly separated.

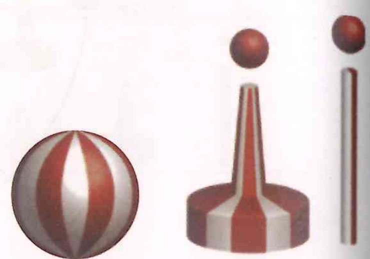
ISOLATED DANGER MARKS: REGION A & REGION B

	Isolated Danger Mark
Colour	Black with one or more broad borizontal red bands
Buoy Shape	Optional, but not conflicting with lateral marks; pilar or spar preferred
Topmark	2 black spheres, one above the other
Light Colour (when fitted)	White
Light Rhythm (when fitted)	Group flashing (2)



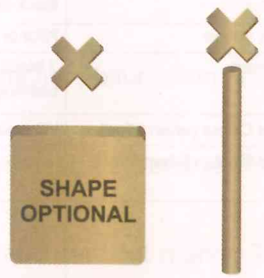
SAFE WATER MARKS: REGION A & REGION B

	Safe Water Mark
Colour	Red and white vertical stripes
Buoy Shape	Spherical; pillar or spar with spherical topmark
Topmark (if any)	Single red sphere
Light Colour (when fitted)	White
Light Rhythm (when fitted)	Isophase, occulting, one long flash every 10 seconds or Morse "A"



SPECIAL MARKS: REGION A & REGION B

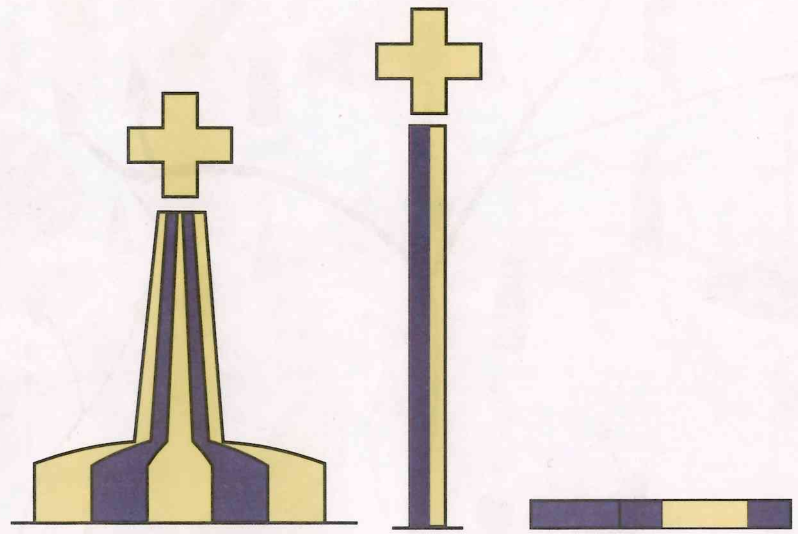
	Special Mark
Colour	Yellow
Buoy Shape	Optional but not conflicting with navigational marks
Topmark (if any)	Single yellow "X" shape (St Andrew's Cross)
Light Colour (when fitted)	Yellow
Light Rhythm (when fitted)	Any other than those described in cardinal, isolated danger and safe water marks



EMERGENCY WRECK MARKING BUOY

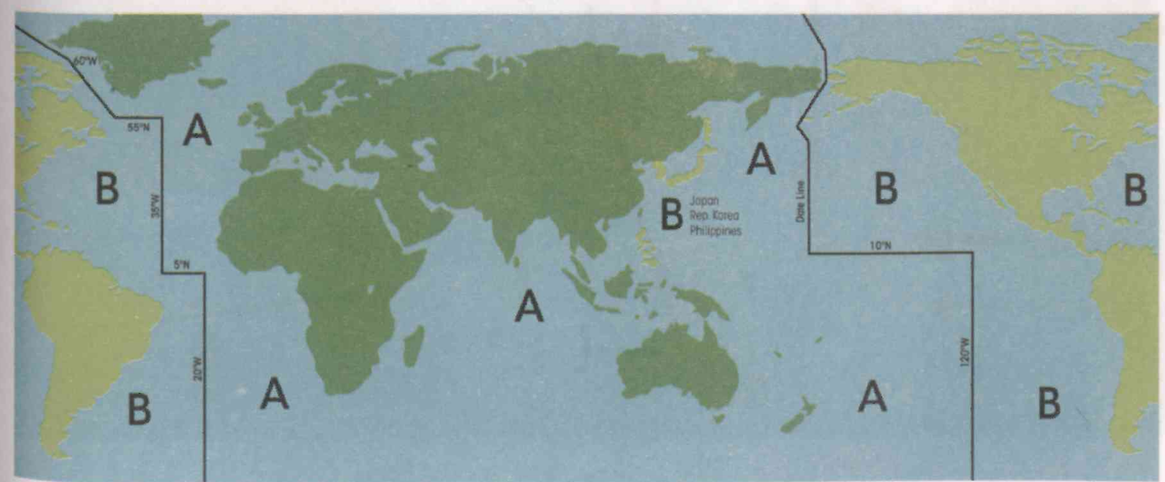
- A buoy used for this purpose is required to have the following characteristics as per the IMO SN.1/Circ.259 of 11 December 2006:
- A pillar or spar buoy, with size dependant on location.
- Coloured in equal number and dimensions of blue and yellow vertical stripes (minimum of 4 stripes and maximum of 8 stripes).
- Fitted with an alternating blue* and yellow flashing light with a nominal range of 4 nautical miles (authorities may wish to alter the range depending on local conditions) where the blue and yellow 1 second flashes are alternated with an interval of 0.5 seconds.
- B1.0s + 0.5s + Y1.0s + 0.5s = 3.0s

- If multiple buoys are deployed then the lights should be synchronized.
- Consideration should be given to the use of a racon Morse Code "D" and/or AIS transponder.
- The top mark, if fitted, is to be a standing/upright yellow cross.



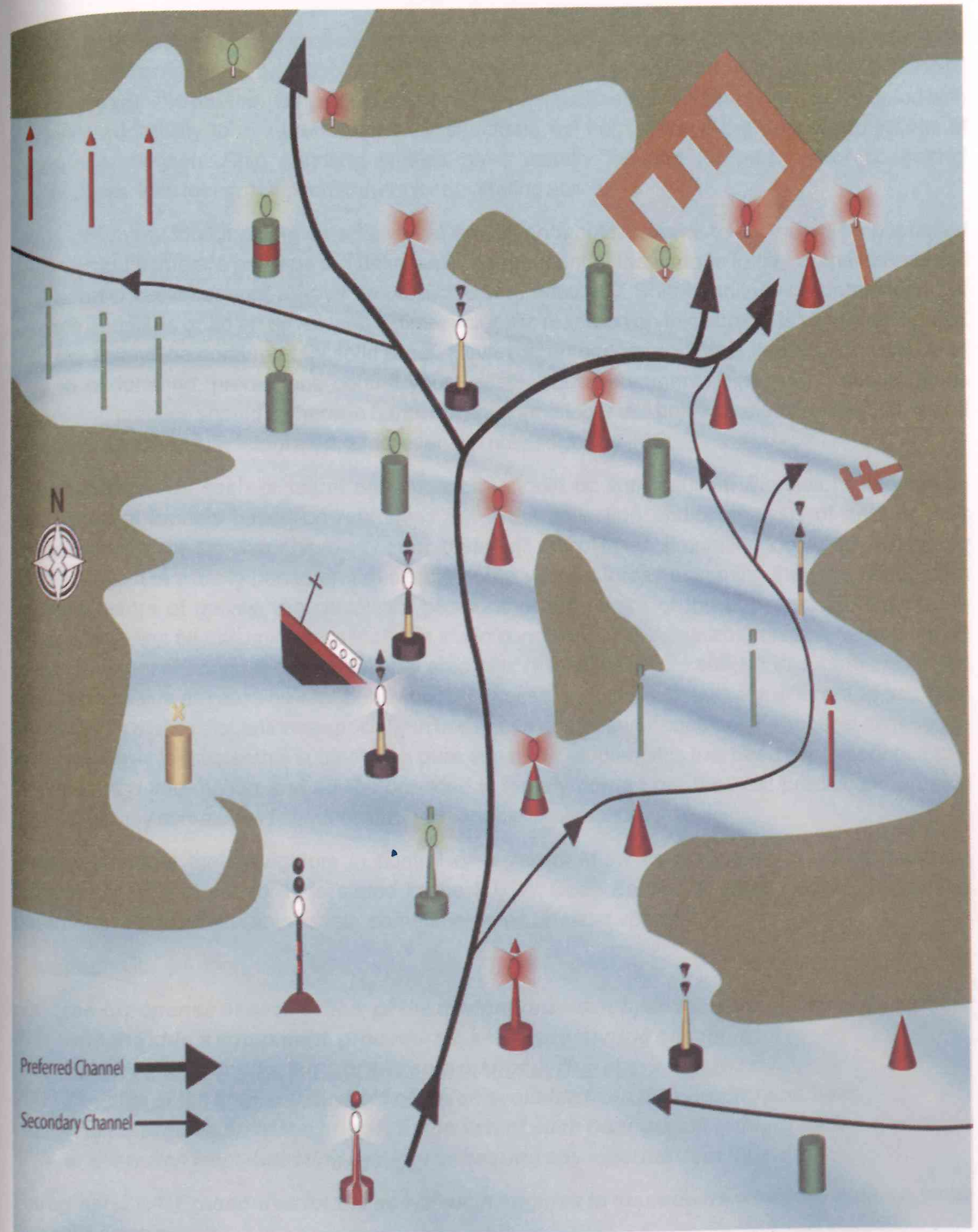
The world is divided into buoyage regions A and B as shown in the map below. The buoyage direction in the two regions is as shown in the examples further below.

IALA buoyage region A & B:



IALA Buoyage System: REGION A:

IALA Buoyage System: REGION B:



BASIC SHIP HANDLING - FOR PREVENTING RISK OF COLLISION

Only the very basics from the vast subject of ship handling are explained in this chapter which should be helpful in navigational activities but more so when executing ***'any action to prevent collision'***. Familiarity with the manoeuvring capabilities of a vessel, basic ship handling principles coupled with the skills and ability to use them in real life situations will help achieve the desired objectives of collision prevention. Ship handling studies have usually focused for port and/or congested manoeuvres, little thought is given to them for navigating at sea.

There are many forces acting on a vessel at any given moment, some cannot even be quantified properly and some are perhaps still unknown. The resultant of the various forces or their combined effects on a vessel cannot always be predicted with accuracy. Ship handling is a combination of science and skills or an art developed in time, scientific research on this subject is yet imperfect and may not always be confirmed by solid proof. However, an understanding of these basics will be of help to understand, predict and control your vessel. These comments may sound absurd since theory and practice should go hand in hand, but ship handling is still being studied and the theory and practice are not yet fully integrated, a fact even acknowledged by IMO.

Ship behaviour as seen or learnt on simulators should be with caution. Simulators operate on mathematical models based on real ships but if the collection and/or analysis of data or their applications on the simulator have any error, these will reflect in the simulation too. Academic theory of this subject is usually based on the effects of the various forces assuming they are acting on a vessel's centre of gravity, the calculated positions of the centre of the buoyancy, floatation, the vessels stability; all assuming a vessel is in static conditions. These parameters are dependent on the underwater shape and cross sectional area of a vessel; which are subject to dynamic changes when a vessel is at sea. The real behaviour of a vessel may be substantially different at sea than predicted by static calculations especially in heavy sea and/or swell conditions. Practical experience is the best way to master this subject than pure academic studies; this has been my experience too. However, the information and advice provided is largely correct but the best predictions on ship behaviour may sometimes fail without any reasonable explanations.

The requirement that navigators in control of a vessel know its manoeuvring and/or handling characteristics and capability is stated in the STCW Code Section A-VIII/2, quoted below. The parameters vary on different vessels, sometimes even on sister vessels.

Paragraph 17:

.7: ***the experience of each officer of the navigational watch, and the familiarity of that officer with the ship's equipment, procedures, and <u>manoeuvring capability</u>.***
.10: ***<u>Rudder and propeller control and ship manoeuvring characteristics</u>.***
.11: ***<u>The size of the ship</u> and the field of vision available from the conning position.***
.12: ***The configuration of the bridge, to the extent such configuration might inhibit a member of the watch from detecting by sight or hearing any external development.***

Paragraph 22.4: ***Procedures for the use of main engines to manoeuvre when the main engines are on bridge control.***

Paragraph 30: ***Officers of the navigational watch <u>shall know the handling characteristics of</u>***

<u>their ship, including its stopping distances, and should appreciate that other ships may have different handling characteristics</u>.

Paragraph 49: ***The master and the pilot shall exchange information regarding navigation procedures, local conditions and <u>the ship's characteristics</u>.***

A vessel or a ship floats in water because its underwater volume displaces water equivalent to its weight or mass, and the equivalent upward force of buoyancy keeps the vessel afloat.

[TASK: REVISE ARCHIMEDES PRINCIPLE.

QUIZ Qs: IS ARCHIMEDES PRINCIPLE APPLICABLE WHEN A BALOON FLOATS AND GOES UP IN AIR?]

The hull of a vessel is designed to ease her movement ahead through the water and the flow of the water astern. The designs vary from warships, passenger and container vessels with fine contours and pointed bow profiles designed for faster speed, to the large bulk carriers and tankers with a rather blunt face. A vessel's block coefficient, or Cb, should give a fair idea of the type of her underwater construction.

[QUIZ QS. FIND OUT WHAT EXACTLY IS BLOCK COEFFICIENT?

TASK: REVISE NEWTON'S THREE LAWS OF MOTION AND MOMENTUM.

QUIZ QS. CALCULATE AND COMPARE THE MOMENTUM GENERATED BY A CONTAINER VESSEL OF 12'000 MT DISPLACEMENT MOVING AT 24 KNOTS AND A LARGE BULK CARRIER 3'35'000 MT DISPLACEMENT MOVING AT 12 KNOTS?]

The momentum of a vessel is not just in the fore-and-aft direction but also the angular momentums when rolling, pitching or swinging, as such the combined effects would be of 'Longitudinal', 'Lateral', 'Rotational or 'Angular' momentum, individually or in any combination.

Other than momentum, is the inertia a vessel has when stopped. To make a vessel move the force exerted should be large enough to overcome inertia and result in the vessel achieving motion through water.

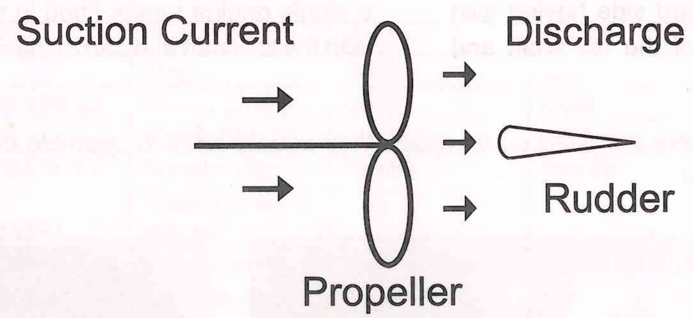
MOVEMENT THROUGH WATER: Unlike a vehicle on the road there is no road for a vessel. A vessel not only floats in water but also uses the same medium to propel her through it. A vessel has no brakes; she can only change the force or direction of her propulsion system. A vessel does not turn as easily as vehicles on land, the time and distance taken for any movement or stopping takes much longer and these aspects make ship handling very different from handling various modes of transport on land. Though Newton's laws of motion apply to all movements, they do so in conjunction with the laws of floatation and fluid hydrodynamics. The following explanations cover motorised vessels only.

PROPULSION AND PROPELLORS: The development of engines also led to their being fitted on board to provide propulsion power. Starting with steam engines, modern vessels now come fitted with various types of engines or power plants, the diesel engine being the most common but steam turbine engines are still used on LNG vessels. Some of the latter have diesel/LNG powered generators and electric propulsion systems; nuclear power is usually restricted to Naval vessels.

Propulsion systems started with paddle wheels fitted on the side, but some time since the 1860's the screw type fixed pitch propeller was developed and remains most popular even now with many

models. The number of blades in a propeller, their size, pitch and diameter are all based on expected usage. If a vessel is fitted with two propellers, one on each side, she would be highly manoeuvrable and the two usually rotate in opposite directions cancelling each others transverse thrust effects, explained later. A single screw propeller is fairly efficient and is mostly right handed, this means it turns clockwise when viewed from right astern of the vessel looking forward, this nomenclature is used to describe a propeller whether it is right or left handed.

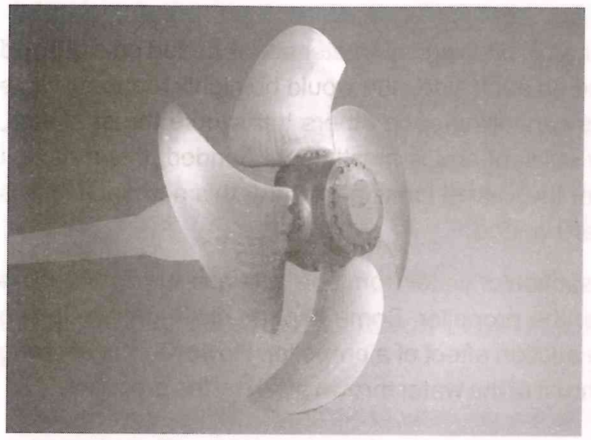
Propulsion is provided by the combined total of suction of water from one side and the thrust of the water to the other side created by the rotation of the propeller. Some experts claim that up to two thirds of the propulsion force generated is by the suction effect of a propeller. However, the steering provided by the rudder is dependent only on the thrust of the water thrown away by the propeller.



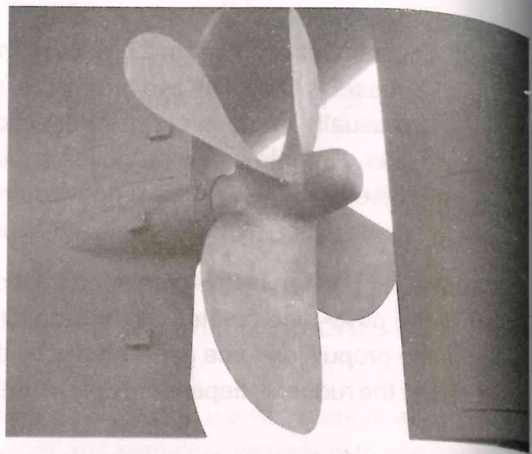
However other types of propulsion systems do exist like the variable or controllable pitch propellers where the pitch angle of the blades can be controlled, but the engine keeps running in one direction only at a constant RPM. With the reversible pitch propellers use of non reversible machinery like gas turbine engines is possible. Some of the new craft of smaller size are being fitted with water jet propulsion systems, there is no propeller, and water is sucked from the bottom of the hull from the forward side and thrown back astern across a rudder. Some of these vessels have twin outlets and thus dispense with a rudder too. Even single propellers have many designs but that is outside the scope of the basic level of explanations included in this book.

Some tugs and ferries also use Voith Schneider propulsion systems (VSP), also known as a cycloidal drive. In this specialised system, changing the power and direction of thrust through 360^{o} is very fast and as such a rudder is also not required. Another type of propulsion where the rudder and traditional propeller shaft are dispensed with is known as the azimuth or azipod thruster, swivelling pods contain a powerful electric or hydraulic motor and propeller combination; these can rotate the full 360^{o} without any limitations. These systems are now common but there may be even other systems in existence now or may develop in future, you need to be fully familiar with the system on your own vessel.

Engine power is now expressed in Kilowatts, earlier it was BHP (Brake horse Power). Actual power delivered at the propeller shaft is termed SHP (Shaft Horse Power).



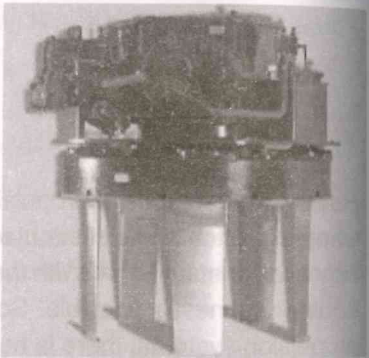
A 4 blade, fixed pitch left handed propeller of a ferry fitted on her starboard side having twin engines, propeller, part of the tail shaft and starboard rudder is visible.



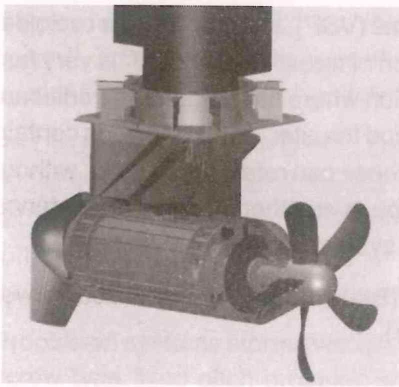
A 4 blade, fixed pitch right handed propeller of a single engine tanker fitted in the centre line with the tail shaft and part of the rudder visible.

Note: Where twin propellers are fitted on a vessel, they usually work in opposite directions to eliminate transverse thrust.

A fast marine propeller in action.



A typical Voith Schneider propeller, usually on tugs and smaller vessels



azimuth or azipod thrusters, the one on the right is being fitted on a new building passenger ferry.

[QUIZ Q: WHAT IS THE CONVERSION FACTOR FROM KILOWATTS TO BHP AND VICE-VERSA?]

PROPULSION SYSTEMS: Each type of power plant / propeller combination has its advantages and disadvantages as shown in the chart below, data is indicative only.

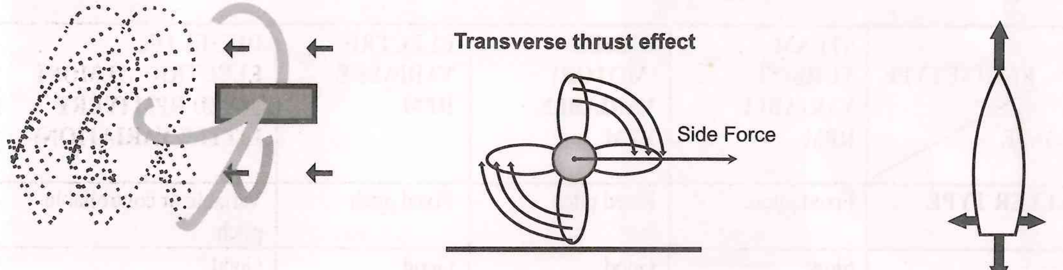
ENGINETYPE / RESPONSE	STEAM TURBINE VARIABLE RPM	DIESEL (MOTOR) VARIABLE RPM	ELECTRIC VARIABLE RPM	DIESEL OR ELECTRIC ALMOST FIXED RPM (VERY LITTLE VARIATION)
PROPELLER TYPE	Fixed pitch	Fixed pitch	Fixed pitch	Variable or controllable pitch
START	Slow	Good	Good	Good
STOP	Slow	Good	Good	Good, some residual speed may remain
ACCELERATE	Slow	Good	Good	Good
SLOWING	Slow	Good	Good	Good
FULL POWER AHEAD	Slow to develop but reliable	Good	Good	Good
GRADUAL CHANGES IN SPEED (INTERMEDIATE)	Not normally unless specially arranged	Possible	Possible	Possible
STERN POWER EFFICIENCY (APPROXIMATE % OF AHEAD POWER)	Separate turbine for astern since turbines are not reversible. Poor – around 40 %	Fair – 50 TO 75 %	Good - Up to 85 %	Good - Up to 80 %
STEERING	Good	Good	Good	Poor when pitch set to zero as cuts off all water flow across the rudder.
PRECAUTIONS	Necessary and anticipation is necessary	For crash stops, number of stops and starts	Nil	For stopping and crash stops

TRANSVERSE THRUST BY PROPELLERS: The water discharge from the propeller is helical in pattern as shown in the following diagram and not uniform resulting in uneven distribution of the thrust force. In a conventional right handed propeller, the thrust delivered from the starboard side is stronger resulting in an uneven couple, and when going ahead the stern is pushed sideways to the starboard side, or the bow cants (turns) to port. The reverse happens when the propeller direction is reversed.

Another reason for this is that the sideway force created by a propeller blade, should ideally cancel the sideway force created by the one opposite, but since water pressure is lower on top, the sideways force created by the lower blades is higher being in higher pressure of water, adding to the couple.

For the purpose of understanding this phenomenon, assume a propeller blade is walking along the bottom of the sea, but with very low efficiency like a person trying to walk in a swimming pool standing in neck deep water, this is to emphasise that the side force due to transverse thrust is rather weak. If the direction of rotation of a propeller is reversed, the direction of the residual force also reverses. The following diagrams describe the transverse thrust effect using this example. The efficiency of any force turning the vessel depends on the point of application of the force and the position of the pivot point at that time. Pivot point is described later.

PROPELLER FORCES



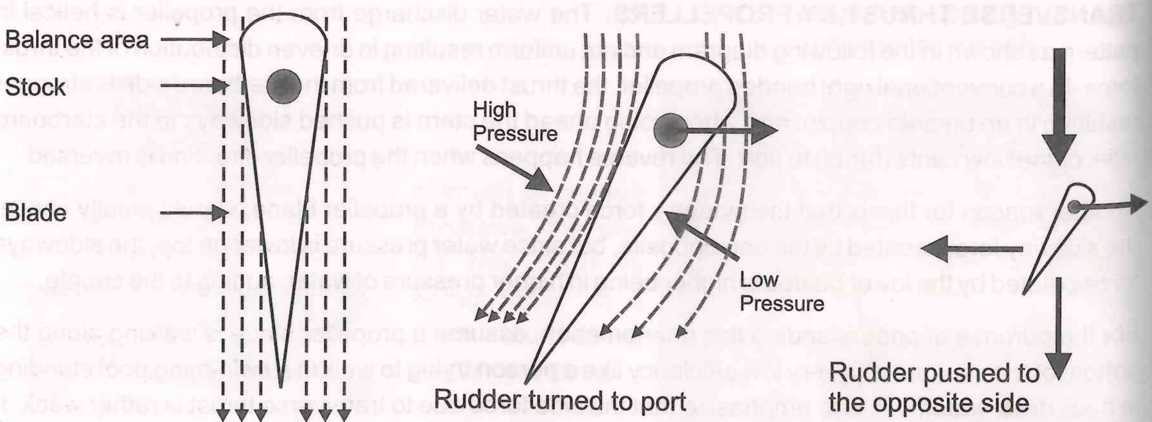
Helical discharge from a Propeller

Visualize the lower blades walking along the bottom. The stern moves in the same direction as the rotation of the propeller.

Longitudinal and transverse thrust

RUDDERS: Various methods have been used through time to turn a vessel. The most common now is the rudder. Movement of a vessel is achieved by the propulsion system fitted on board pushing water towards one side and the vessel moving towards the other. For ahead movement water is thrust astern and the vessel moves forward, this action being reversible on most of the vessels. Other than in Voith Schneider propulsion systems, most others have a rudder placed aft of the propulsion system to enable turn the vessel and is effective when there is a flow of water across it. There are many kinds of rudders in use, the modern ones have an aerodynamic shape, and these may be balanced, semi-balanced or at times even un-balanced. When turned they deflect the flow of water in a direction away from the right astern direction to enable the ships stern to turn.

The flow of water from the propeller on hitting a rudder which is turned gets deflected and can be considered divided into two components, a fore-and-aft one and one perpendicular to the vessels fore-and-aft line, this latter provided the turning force at the rudder stock. If a rudder is turned more than about 45° the smooth water flow will start to eddy and the rudder will stall, loosing its effectiveness. In practice, 35° rudder angle has been found to give the maximum turning effect on conventional vessels.



Rudder turned to port

Rudder pushed to the opposite side

Rudder amidships

Rudder turned to port deflects the water current. The deflected water stream may be considered divided into two components. The fore and aft one makes the vessel to move ahead, the side component causes the rudder stalk to move to the opposite side.

[QUIZ QS? WHICH NEWTON'S LAW IS APPLICABLE WHEN A RUDDER TURNS A VESSEL?]

There is another force created by the rudder when turned, a drag force which causes a reduction in speed of the vessel. This can be large and dangerous if the rudder was to be made too long and is higher at very large angles when the drag force could be larger than the sideways force. In order to keep the drag force under control the size of rudder is limited to be within 1.2 to 2.0 % of the length of a vessel

RUDDER PROPERTIES.

- Takes time to turn.
- Effective as long as there is a thrust of water across it. If the propeller stops the flow of water reduces and rudders become less efficient even if the vessel has headway.
- In case of a variable or controllable pitch propeller, reducing the pitch to zero cuts off the flow of water across the rudder even if a vessel has headway. The rudder becomes totally ineffective.
- Rudder effect is close to nil when propulsion is reversed, the reverse flow does not impact the rudder surface.

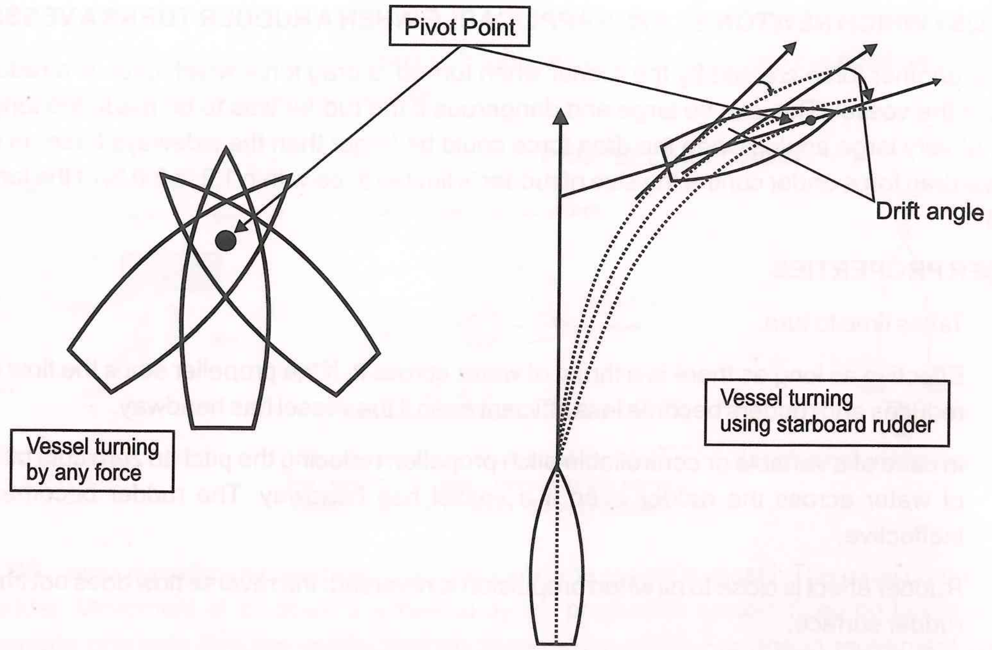
A turned rudder causes the stern of the vessel to turn along the rudder stalk axis. A vessel would turn around its pivot point; this is explained a little later.

When a vessel has considerable sternway with the propeller running in the astern direction, a turned rudder restricts suction of water into the propeller causing a couple, this appears as if the rudder has a slight steering effect. However, this varies from vessel to vessel, the effect is very weak and usually felt at high astern speeds, as such should not be relied upon.

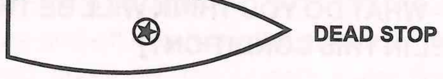
[TASK: MAKE A DIAGRAM OF FORCES WITH THE PROPELLER GOING ASTERN, THE SUCTION OF THE WATER RESTRICTED ON ONE SIDE – WHAT DO YOU THINK WILL BE THE TURNING COUPLE EXERTED ON THE HULL OF A VESSEL IN THIS CONDITION?]

THRUSTERS: On some ships, bow, and sometimes even stern thrusters are fitted, more than one at times depending on the need. These are underwater tunnels perpendicular to the vessels fore-and-aft line and can be used to move the bow / stern vessel sideways. These are designed for mooring / harbour operations and loose their efficiency and effectiveness if a vessel is at speeds usually over 5 knots. Thrusters are not meant for or designed to turn a vessel proceeding high speeds.

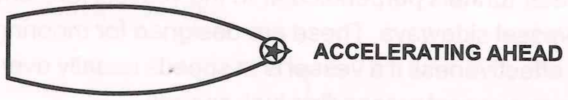
PIVOT POINT: Vessels do not turn around their longitudinal centre of gravity or centre of floatation but on the Pivot Point. Pivot point can be described as the point around which something turns or rotates. It may be compared to the pointed fulcrum on which a bar lying horizontally would oscillate. On a vessel this lies is the point on the fore-and-aft centre line of a vessel and is the point around which the vessel appears to turn whenever any turning force is acting on the vessel. Pivot point is also described as the point on the fore-and-aft centre line of a vessel where the drift angle between the fore-and-aft line and the tangent to the circular movement is zero. Drift angle is the angle the tangent of the circular path of any point makes with the vessels fore-and-aft line when in a circular turning motion. The following diagrams show this, as a vessel turns every point has a drift angle with the fore-and-aft line except at the pivot point.



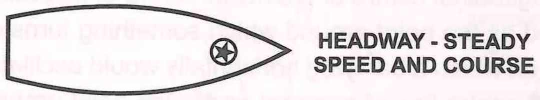
The position of pivot point is linked with the momentum of a vessel and her speed. It reflects the status between the force a vessel exerts in moving and the resistance to the same by the water mass and even air. Because the forces are not always in equilibrium they cause the pivot point to shift, the shifting nature of the pivot point on a vessel as shown in the following diagrams, the positions are approximate and a slight variation will be there on different vessels and will also be subject to whether the vessel is operating in deep or shallow waters.



Pivot Point is approximately at the centre of the vessel.



Pivot Point moves ahead, the higher the rate of acceleration the further it goes, even outside the vessel.



At steady speed the Pivot Point is approximately 1/3[rd] to 1/4[th] of the vessels length from forward, the speed should be steady, the quantum of speed does not matter.

Note : When moving astern the positions of the Pivot Point are a reverse mirror image of the forward movements shown above.

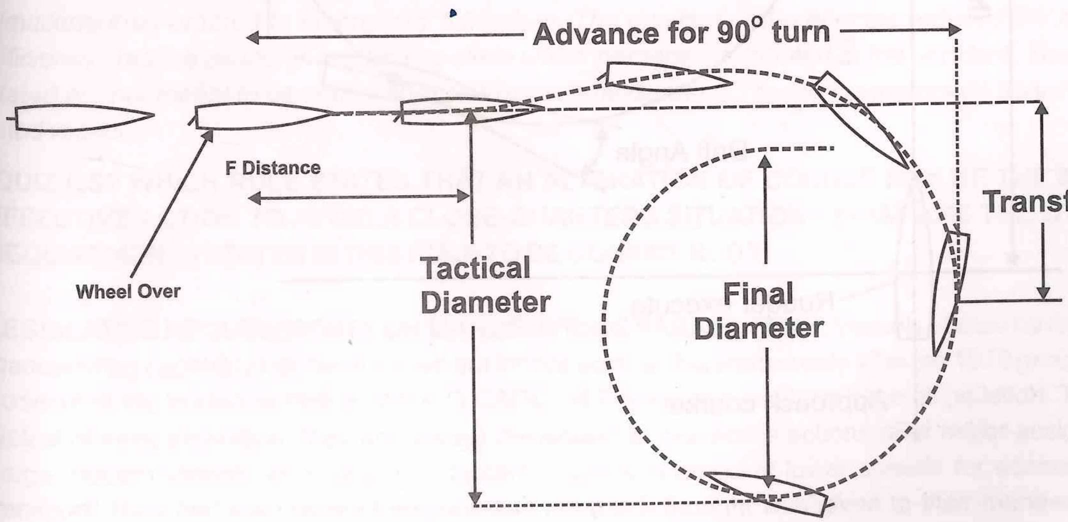
[TASK: BASIS THE ABOVE DRAW A DIAGRAM SHOWING THE PIVOT POINT POSITIONS WITH A VESSEL MOVING ASTERN IN DIFFERENT CONDITIONS].

The actual position of the Pivot Point may vary and depend on a vessel's hull form, her block coefficient, trim, depth of water etc. The approximate positions shown are sufficient to understand its shifting nature. The change in the length of the lever from the point of application of any turning force to the pivot point changes the moment of a turning force at the pivot affects and has a direct impact on the efficiency and effectiveness of turning. The larger the length of the lever; the more effective will be the force turning a vessel. For example in the middle picture, accelerating ahead, the rudder fitted astern will be most effective and the bow thruster the least.

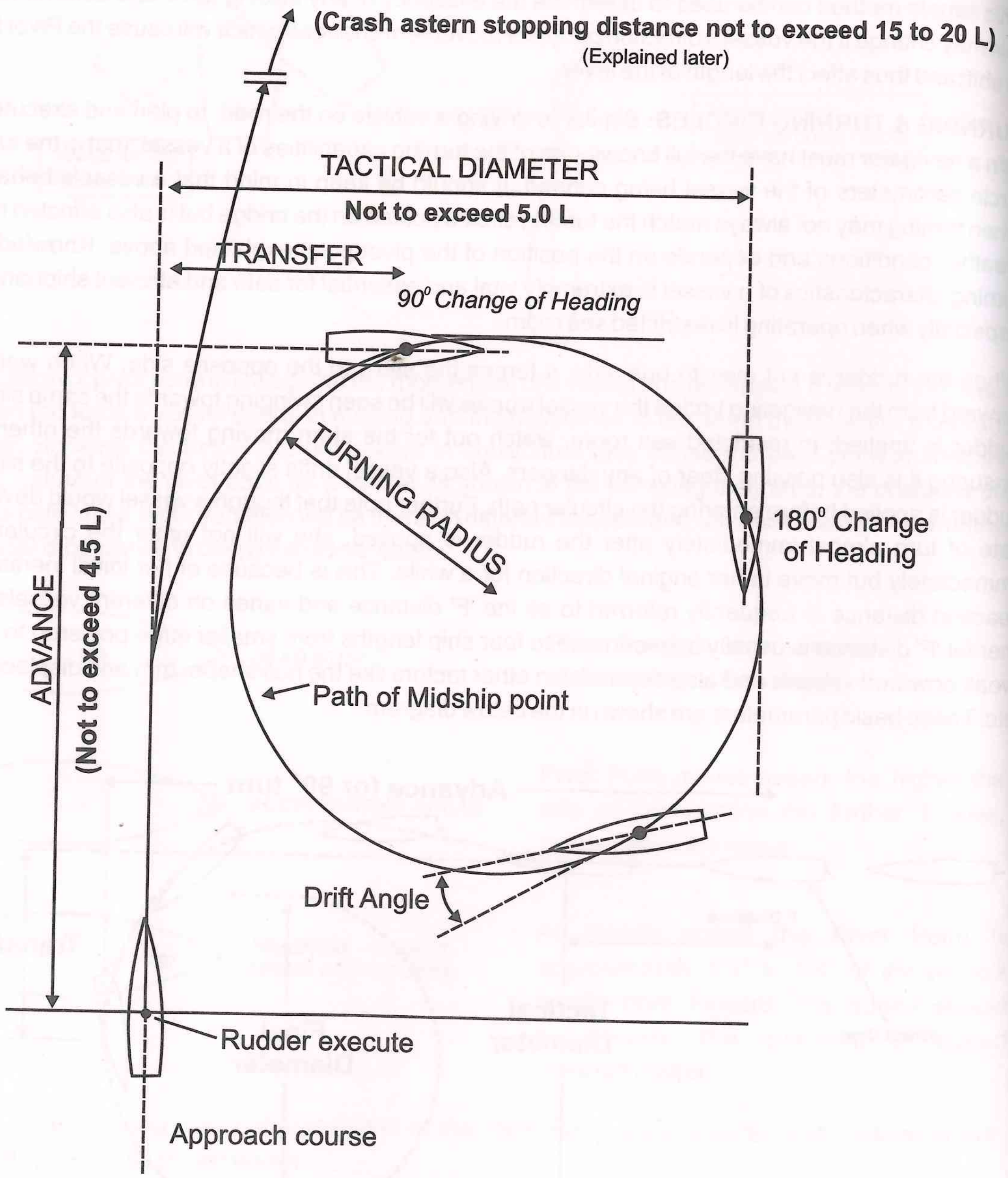
This simple method can be used to determine the efficiency of any turning force and determine how this may change if the vessel's direction or rate of movement changes which will cause the Pivot Point to shift and thus effect the length of the lever.

TURNING & TURNING CIRCLES: Similar to driving a vehicle on the road, to plan and execute any turn a navigator must have the full knowledge of the turning capabilities of a vessel, that is the turning circle parameters of the vessel being conned. It should be keep in mind that a vessels behaviour when turning may not always match the turning circles posted on the bridge but is also effected by the weather conditions and depends on the position of the pivot point explained above. Knowledge of turning characteristics of a vessel is extremely vital and essential for safe and efficient shiphandling, especially when operating in restricted sea room.

When the rudder is put over to one side, it forces the stern to the opposite side. When watching forward from the navigating bridge the vessel's bows will be seen swinging towards the same side the rudder is applied; in restricted sea room, watch out for the stern moving towards the other side, ensuring it is also passing clear of any dangers. Also a vessel drifts slightly opposite to the side the rudder is applied before entering the circular path. Further note that though a vessel would develop a rate of turn almost immediately after the rudder is applied, she will not enter the circular path immediately but move in her original direction for a while. This is because of her initial inertia. This reaction distance is frequently referred to as the 'F' distance and varies on different vessels. This inertial 'F' distance is usually between one to four ship lengths from smaller large powered to larger weak powered vessels and also depends on other factors like the hull shape, trim and displacement etc. These basic parameters are shown in the below diagram.



The below turning circle diagram is based on the MSC/Circular 1053 of 16th December 2002, which is linked with the earlier IMO resolution MSC.137(76) of 4th December 2002 on ***'standards for ship manoeuvrability'***. As can be seen, after 'Rudder Execute' the vessel has been shown to continue on an almost straight path for considerable distance, this is the 'F' distance explained above, the rudder applied in the below would be to starboard.



The above explained turns may also be referred to as 'CONSTANT RUDDER TURNS' since the rudder angle remains constant throughout, whatever the angle used. At hard over wheel the figures of advance and transfer, etc. would be the least and will increase in quantum proportional to the decrease in the rudder angle.

The turning circle parameters in deep water vary with rudder angle used and a vessel's displacement. However, and this may appear strange, **<u>but is very important</u>**: in deep waters and calm seas, for the same rudder angle used, the parameters of advance, transfer and tactical diameter remain <u>almost</u> the same at different engine speeds. In other words, if a vessel is at a steady propulsion power / speed, whatever be the quantum, for any given rudder angle, her turning circle parameters would be <u>about the same if the propulsion power remains steady during the turn</u>. Only the time factor will vary, the lower the speed, the longer the time to complete a similar turn.

The slight difference as seen in the manoeuvring characteristics of a VLCC I served on in 2001 as master was just 4m in the advance figures of 964 and 960 m at full and half ahead respectively, and 7m in the transfer (90° turn) figures of 497 and 490 m.

[TASK: STUDY THE MANOEUVRING CHARACTERISTICS OF THE VESSELS YOU SAIL ON AND KEEP A RECORD, COMPARE THE FIGURES OF VARIOUS VESSELS.]

During a turning manoeuvre with the rudder angle steady, if the propulsion power is reduced, say from full to slow, the negative acceleration will cause the pivot point to move aft reducing the lever between the same and the rudder, and the thrust of water on the rudder would also decrease. These combined reduce the rate of turn leading to a larger turning circle. Reducing speed during a turn is thus extremely dangerous as the increased turning circle will take a vessel closer to a vessel or object being avoided. When turning a vessel for ***'any action to avoid collision'***, the propulsion speed should never be reduced, on the contrary, if circumstances permit, an increase in propulsion power will lead to a shorter and faster turn, a technique usually employed by Pilots. The forward acceleration moves the pivot point forward increasing the turning lever.

It is been said that had the navigators on board the ill fated Titanic not reversed the engines when turning the vessel away from the iceberg they may have succeeded in avoiding the same. It is a fact that immediately after the iceberg was sighted, hard over wheel was applied and the engines simultaneously ordered to emergency full astern. The reversal of the engines reduced the rudder efficiency creating an increased turning circle which perhaps contributed to the accident. The facts stated are not meant to be critical of or to express any disrespect to the navigators on board the ill fated vessel.

[QUIZ QS? WHICH RULE STATES THAT AN ALTERATION OF COURSE MAY BE THE MOST EFFECTIVE ACTION TO AVOID A CLOSE-QUARTERS SITUATION? WHAT ARE THE OTHER REQUIREMENTS STATED IN THIS RULE TO BE CONSIDERED?]

LEGISLATIVE REQUIREMENTS ON MANOEUVRING PARAMETERS: Vessels should have good manoeuvring capability has been known but formal work on this started only after the 1978 grounding accident of the loaded oil tanker AMOCO CADIZ off France and resulting large oil pollution. This is typical of most legislation; they are always developed as corrective actions after major accidents. Large modern vessels were designed to carry maximum cargo at lower speeds for economy of transport. They had low powered engines and not much thought was given to their manoeuvring capabilities. Research in the 1980's analysed that unsatisfactory manoeuvring characteristics were the cause of over 70% collisions, shore contact and grounding accidents involving merchant vessels. Classification societies and ship building yards used their own standards for these aspects since no formal standards or requirements existed. IMO is known to have discussed this issue for the first time in 1968. MSC/Circ.389 titled ***'Interim Guidelines for Estimating Manoeuvring Performance in Ship Design'*** was issued only on 10th January 1985. In November 1993 IMO adopted resolution A.751(18) on ***'Interim Standards for Ship Manoeuvrability'***.

The last resolution on this subject is **MSC.137(76)** ***'standards for ship manoeuvrability'*** **adopted by IMO on 4th December 2002 which states:** ***'The standards should be applied to ships of all rudder and propulsion types, of 100m in length and over, and chemical tankers and gas carriers, regardless of the length, which are constructed on or after 1 July 1994'***. This was followed by MSC/Circular 1053 of 16th December 2002 containing ***'appropriate explanatory notes for the uniform interpretation, application and consistent evaluation of the manoeuvring performance of ships'***, this superseded the earlier MSC/Circ.644 of 6th June 1994.

The two most important manoeuvring requirements stated in section 5.3 of the above referred IMO resolution **MSC.137(76)** are:

The manoeuvrability of the ship is considered satisfactory if the following criteria are complied with:

5.3.1 Turning ability: The advance should not exceed 4.5 ship lengths (L) and the tactical diameter should not exceed 5 ship lengths in the turning circle manoeuvre.

5.3.4 Stopping ability: The track reach in the full astern stopping test should not exceed 15 ship lengths. However, this value may be modified by the Administration where ships of large displacement make this criterion impracticable, but should in no case exceed 20 ship lengths. This means that the vessel stops ***'to dead in water'***. This aspect is explained further below where emergency reversal of propulsion / engines is explained.

When conducting tests to verify compliance with the above the approach speed specified is to be at least 90 % of the ships speed corresponding to 85 per cent of the maximum engine output and using ***'35° rudder angle or the maximum rudder angle permissible at the test speed, following a steady approach with zero yaw rate'***.

[TASK: COMPARE THE MAXIMUM ALLOWED TURNING ABILITY AT MAXIMUM ALLOWED RUDDER AND FULL ASTERN STOPPING DATA FOR VESSELS HAVING A LENGTH OF 100, 200, 300 AND 400 METRES, CONVERT THE FIGURES INTO NAUTICAL MILES WHEN COMPARING.]

It is important to link these requirements with those of Rule 8(c), ***'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'***. The reasonable logic of the requirement from this Rule recommending ***'alteration of course alone'*** is quite clear. A vessel needs a rather small area to turn than to be stopped with emergency astern propulsion when at full speed. As has been emphasized earlier, turning a vessel for ***'any action to avoid collision'***, if sea room permits, is the most effective action.

In an emergency hard over wheel should always be used, this neither has any detrimental effects on the propulsion or steering systems nor on a vessels stability, such assumptions are dangerous myths. However, if the requirements of Rule-8(a) ***'any action to avoid collision shall be taken in accordance with the Rules of this Part 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'***, are practiced, there may never be a need for such a drastic action. There are many reported incidents when the navigator in charge hesitated in using maximum rudder to turn the vessel away resulting in a large turning circle and a collision, please see the details of the collision between the VLCC 'Samco Europe' and the container vessel 'MSC Prestige' given with Rule 10, hard over wheel was applied far too late. The vessels were new, built in 2007 and 2006 and measured 333 and 293 metres in length respectively. Their advance for a 90 degree turn using hard over wheel as per their manoeuvring characteristics is stated as 844.5 and 895 m respectively. The total is 1739.5 m or 0.94 nautical miles. Allowing a safe margin for interaction, even if hard over wheel had been applied when they were just over one mile away, the severe collision may have been avoided.

Usually there are no technical limitations if hard over wheel is applied. However, in case there are any, for example a shaft generator coupled to the propeller shaft and or a problem with an increase of load on engines and there is no governor fitted, such factors will vary on different vessels. Systems fitted on board should be studied, understood and any limitations known to the navigators in order to enable plan and execute their actions correctly. It is good to remember that turning a vessel is reasonably fast and does not need a large sea room, it is also important to study and be aware of the manoeuvring characteristics of the vessel under your control, the requirements given in the STCW Code on this aspect are stated in the beginning of this chapter

REVERSING PROPULSION OR ENGINES FOR AN EMERGENCY CRASH STOP: Some of the important requirements from the STCW Code Section A-VIII/2 regarding propulsion machinery have been quoted with the explanations of Rule 19(b).

[TASK: PLEASE REVISE AND REFRESH THE SAME BEFORE READING THIS SECTION FURTHER.]

These Rules ***'for preventing collisions'*** and the watchkeeping requirements from the STCW Convention clearly state that the propulsion machinery shall be available for use when required, in reality reluctance to use propulsion systems or engines even when this is perhaps the only choice left has led to many accidents, both collisions and standings (groundings).

If propulsion is stopped, a vessel will continue to travel a considerable distance before stopping, the distance depends on her displacement, hull form, weather, UKC etc. Heavier vessels tend to go longer before stopping. In order to reduce speed rapidly and/or stop a vessel, astern propulsion is required. Activating astern propulsion may even take a few minutes on some vessels. To achieve a rapid speed reduction, the propulsion power or propeller RPM must be reduced substantially, say from full to dead slow ahead.

Before resorting to a crash stop manoeuvre, navigators should consider the merits of Rule 8, relevant paragraphs quoted below for ready reference, which remain applicable at all times whenever ***'any action to avoid collision'*** is executed, irrespective of the Rule applicable to the situation.

8(b) ***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.***

8(c) ***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.***

A large course alteration can usually be executed rapidly and would be ***'readily apparent to another vessel observing visually or by radar'***. When turning, a vessel has a natural loss of speed when its larger hull profile is retarded by the water resistance. Though turning is the most preferred and the ***'most effective action to avoid a close-quarters situation'***, as explained with Rule's 8 and 19 if and when circumstances do not allow this, ***'a vessel shall slacken her speed or take all way off by stopping or reversing her means of propulsion'***. There should be no hesitation to use engines in such cases. A vessels speed will initially start decreasing rapidly on stopping the propulsion but the rate of drop of speed will decrease as the water resistance decreases. The hull resistance being directly proportional to the square of the speed.

The following extract from the IMO circular 'MSC/Circ.1053' of 16th December 2002 explains a crash stop manoeuvre: ***'The behaviour of a ship during a stopping manoeuvre is extremely complicated. For any ship the longest stopping distance can be assumed to result when the ship travels in a straight line along the original course, after the astern order is given. In reality the ship will either veer off to port or starboard and travel along a curved track, resulting in a shorter track reach, due to increased hull drag'.***

The IMO requirements on this test are based on the following:

i. ***The resistance of the hull is proportional to the square of the ship speed.***

ii. ***The astern thrust is constant throughout the stopping manoeuvre and equal to the astern thrust generated by the propeller when the ship eventually stops dead in the water; and***

iii. ***The propeller is reversed as rapidly as possible after the astern order is given.***

For purpose of calculations IMO has used an assumed figure of one minute delay for the propeller to reverse, none of the regulations state any maximum time requirement, in reality it may take longer.

Astern propulsion on a vessel fitted with a steam turbine engines is slow and weak. A steam turbine by design can move in only one direction and to provide astern propulsion a separate smaller lower powered turbine unit is installed. Astern power on vessels fitted with such systems is rather weak and may take long to activate since a steam turbine cannot even be started instantly if has not been kept heated and in readiness.

Diesel engines are reversible and are the most common on merchant vessels. However, they have their own technical limitations for instant reversal when operating in one direction. Every new vessel may not go through crash stop trials, in a series of sister vessels only the first one is usually subjected to the crash stop test when at full sea speed the engines are reversed from full speed ahead to maximum speed astern. The stopping distance depends on the astern power developed and various other factors.

If engines have to be reversed on a vessel proceeding at sea operating her engines at full sea speed, the following sequence would normally take place. A common technical restriction in most reversible diesel engines is that the engines must be at stop before being reversed; this is similar to engaging the reverse gear on a car. In effect the propeller shaft must stop or be at very low ahead revolutions before the engine can be operated in the reverse direction, the propeller shaft is usually directly connected to the engine.

Even after the air and fuel to an engine is cut off, a propeller keeps rotating for considerable time due to the flow of water across it with the vessels movement through water due to her momentum, the rotating propeller keeps the engine moving too. To stop the engine faster, compressed air is released into the cylinders when the piston is down (bottom dead centre) of the engine to act as a brake. However, this can only be done after the engine speed (RPM) has dropped by a certain amount, varying from model to model. Only after the engine actually moves in the reverse direction by an air kick can it be fired on air & fuel to develop full astern power.

Compressed air available for braking is limited. The release of braking air into a hot engine causes severe thermal shocks and the sudden reversal of the engines causes stress on all components and may even inflict permanent damage to some of them. Since it is meant only for use in a severe emergency, this manoeuvre is not tested on board as a routine. The risk of a last minute machinery component failure due to the stresses and shocks should always be kept in mind by the navigators when considering this option.

Modern automated controls of the main engine have automatic pre programmed load up/down parameters for normal increase and decrease of RPM from harbour manoeuvring to sea speed and vice versa. These have to be bypassed in carrying out the crash stop/astern manoeuvre, achieved manually or automatically as per the design installed. In most modern systems, bringing the telegraph to a position half ahead or lower bypasses the automatic load up/down programmes, ie if the telegraph is put to stop the air and fuel supply to the engines is immediately cut off. It is important that both the navigators and engineers on board a vessel are well familiar with the design and operating of the systems installed should it ever be required to carry out this manoeuvre.

The vessels hull profile is designed for forward movement; at the aft end the design is to allow free flow of water into the propeller which is thrust astern by it, the propeller blades are designed for this. The resistance to the water thrust by the propeller is the water astern of a vessel and her rudder, the latter is anyway designed to offer least resistance when in the neutral or amidships position. When the propeller is rotating in the reverse direction or providing astern propulsion, the efficiency of its blades is lower. Further, a vessels hull offers resistance to and deflects the water thrust towards the hull by the propeller. These factors cause the efficiency and effectiveness of the propeller to drop when moving astern in comparison to when moving ahead at the same RPM.

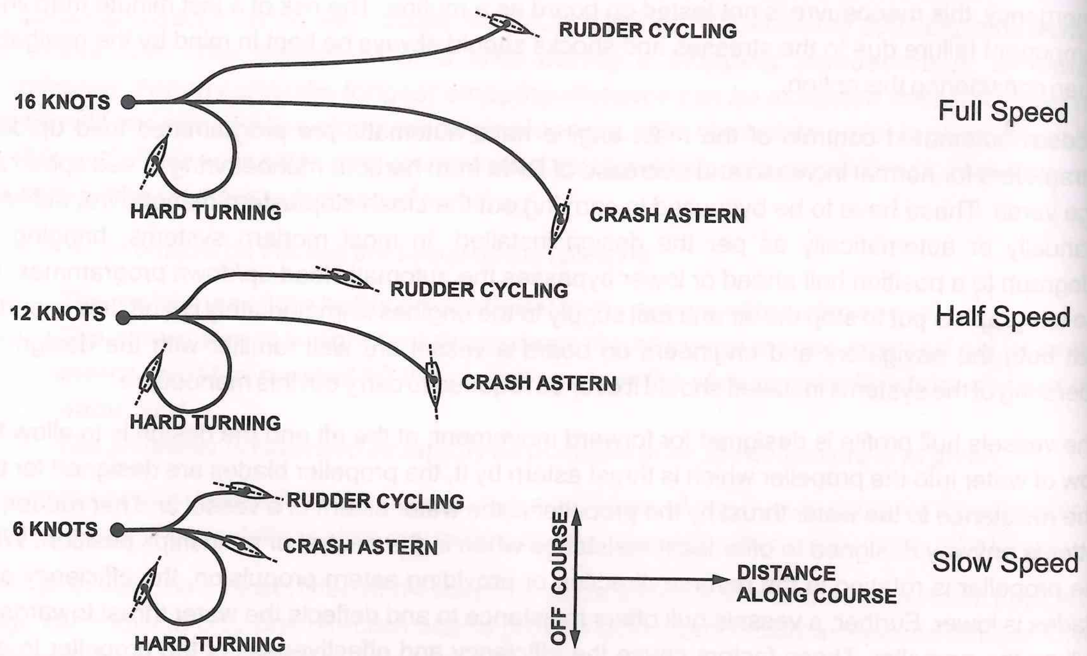
In case of controllable/variable pitch propellers, it is the pitch of the propeller which is reversed, to avoid severe stresses and permanent damage there are some restrictions on such systems too and a sudden reversal may not be possible when moving at full speed, which is at maximum pitch for the forward propulsion. The propeller pitch may have to be reduced slowly to allow a certain drop in speed before the pitch angle can be reversed. At zero pitch the flow of water through the propeller will be almost nil even when the vessel is moving ahead due to its momentum and in this condition the rudder becomes totally ineffective.

Reversing propulsion takes time and is less efficient too. The standards set by IMO allow a vessel 15 ship lengths to stop dead in the water which may be extended up to 20 ship lengths for larger ships. In comparison the maximum advance for a 90° turn should not exceed 4.5 ship lengths.

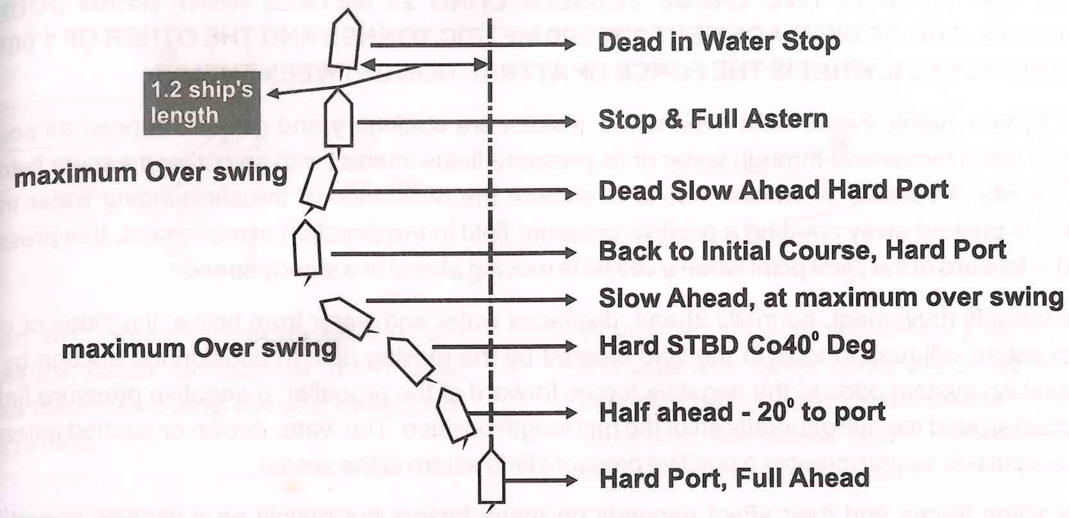
In addition, when astern propulsion is in operation the flow of water across the rudder to allow steering is not there. A vessel will follow a path dictated by her characteristics and the prevailing conditions.

[QUIZ: ON A RIGHT HANDED SINGLE PROPELLER VESSEL, HOW WILL THE TRANSVERSE THRUST TURN A VESSEL WHEN THE PROPELLER IS OPERATED TO GIVE ASTERN PROPULSION?]

The following diagram shows a comparison between hard over turning, crash stop and zig-zag turns to stop a vessel. As can be seen, turning is far more efficient and effective; it is fast, takes less space or sea room and does not strain the propulsion or steering machinery as compared to a sudden emergency reversal of propulsion. One of the popular versions of a zig-zag turn is shown further, there are several versions and this manoeuvre may be considered in lieu of a crash stop manoeuvre. The comparison diagram shown below is of a 300 m long oil tanker of 1'93'000 MT DWT.



ZIG-ZAG OR LOW FREQUENCY RUDDER CYCLING FOR EMERGENCY STOPPING: One of the versions of this manoeuvre is shown below and is basically self explanatory. The vessels fore and aft hull profile is pushed against the water mass by swinging the vessel, this retards the speed. Propulsion power is reduced in stages and then maximum astern power applied. There are several versions of using this manoeuvre and may be a better choice when compared to an emergency crash stop manoeuvre explained above. Since propulsion is reduced in stages and then reversed, it has lesser strain on the propulsion machinery. However, as can be seen, turning is still a better choice as requires least sea room.



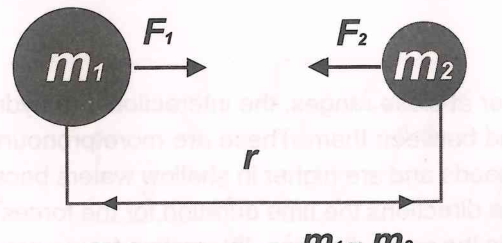
INTERACTION FORCES: Any vessels manoeuvring behaviour is subject to the universal law of gravitation and the hydrodynamic forces. The many interactive forces affecting vessels behaviour are due to a combination of these two main components.

The former is Newton's law of universal gravitation, first published on 5th July1687, the physical law is about the gravitational attraction between bodies having a mass. In modern language the law states: ***Every point mass attracts every other point mass by a force pointing along the line intersecting both points. The force is proportional to the product of the two masses and inversely proportional to the square of the distance between the point masses.***

where:

- F is the magnitude of the gravitational force between the two point masses,
- G is the gravitational constant,
- m_1 is the mass of the first point mass,
- m_2 is the mass of the second point mass, and
- r is the distance between the two point masses.

Assuming SI units, F is measured in newtons (N), m_1 and m_2 in kilograms (kg), r in metres (m), and the constant G is approximately equal to $6.67 \times 10^{-11}\ \mathrm{N\,m^2\,kg^{-2}}$.



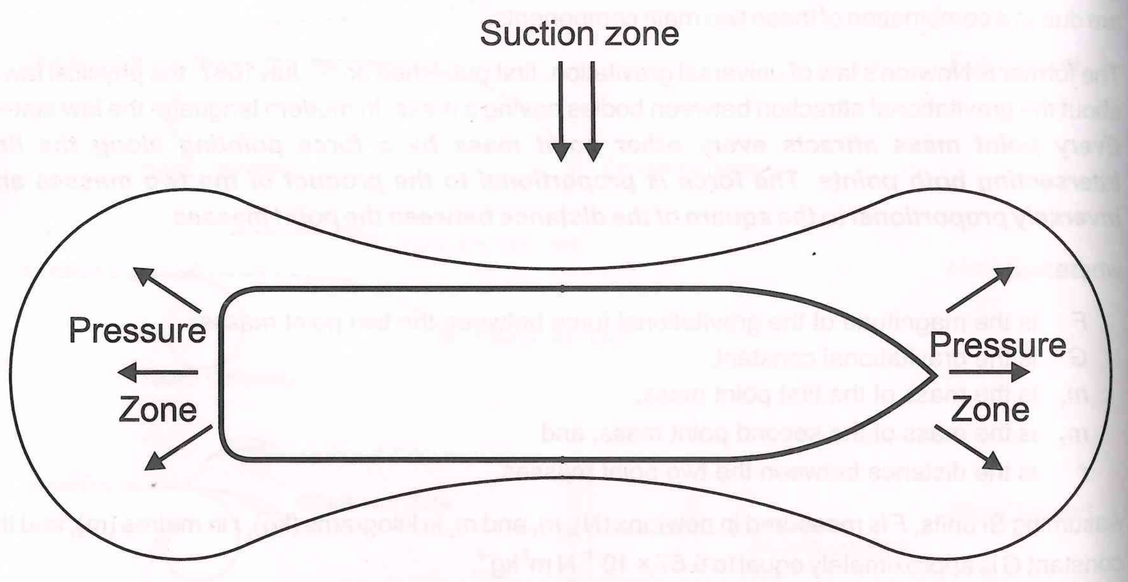
$$F_1 = F_2 = G\frac{m_1 \times m_2}{r^2}$$

[QUIZ QS? ASSUME TWO LARGE VESSELS LYING 25 METRES AWAY WHEN DOUBLE BANKING, ONE OF DISPLACEMENT 3'35'000 METRIC TONNES AND THE OTHER OF 1'00'000 METRIC TONNES, WHAT IS THE FORCE OF ATTRACTION BETWEEN THEM?]

The hydrodynamic forces exist even when vessels are stationary and get pronounced as soon a vessel has a movement through water or its pressure fields interact with any other pressure fields in the vicinity. A vessels movement has to overcome the resistance of the surrounding water mass which is pushed away creating a positive pressure field in the direction of movement, this pressure field is forward of the pivot point when a vessel is moving ahead at a steady speed.

The vessels movement, normally ahead, displaces water and water from below, the sides or even from astern will rush in to fill in the void created by the moving hull. In addition the suction by the propulsion system adds to the negative forces forward of the propeller, a negative pressure field is created around the hull generally aft of the mid length position. The water thrown or pushed astern by the propulsion system creates a positive pressure field astern of the vessel.

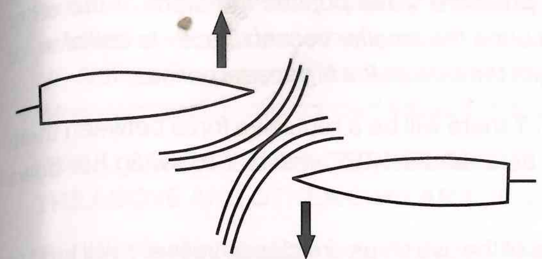
Interaction forces and their affect depends on many factors but mainly on a vessels speed, the distance between the vessels or the coast, the slope of the coast, if a narrow channel, its depth and width and any breaks in the channel, the UKC and the vessels design, her block coefficient and trim.

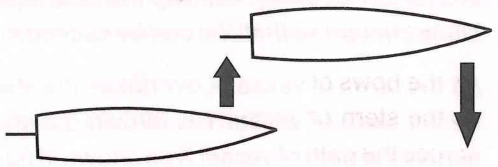


The pressure fields created when a conventional vessel is moving through the water.

As vessels pass each other at close ranges, the interaction and hydrodynamic forces of attraction and repulsion get activated between them. These are more pronounced when the vessels are on parallel courses at high speeds and are higher in shallow waters because there is less space. With vessels moving in opposite directions the time duration for the forces to effect a vessel is less than when vessels are moving in the same direction. Interaction forces are higher in restricted waters but even in open waters too they have been seen to act at ranges of over 300 metres.

The following diagrams show the interaction effects when two vessels pass too close to each other.





When two vessels meet as shown, the pressure fields forward of the vessel make the bows swing out and away from each other.

When two vessels are passing as shown the pressure fields make the bows of the one overtaking swing towards the stern of the other, the vessel being overtaken will develop an opposite sheer.

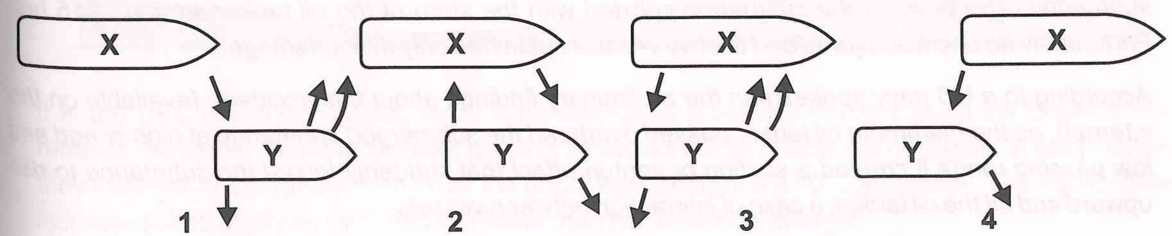
[TASK: IN THE ABOVE DIAGRAM SHOWING ONE VESSEL OVERTAKING ANOTHER DRAW THE PRESSURE FIELDS BASIS THE ABOVE EXPLANATIONS TO EXPLAIN THE INTERACTION EFFECT.

WHAT WILL BE THE PRESSURE FIELDS AND THEIR EFFECT ON THESE VESSELS WHEN THE TWO ARE CLOSE TO AND PARALLEL TO EACH OTHER?]

Similar to interaction between vessels, even when vessels pass close to a shore bank, or too near the side of a narrow channel, the pressure fields do not have sea room to travel and dissipate but rebound from the sides of the bank or narrow channel. The rebound pressure waves can cause vessels to suddenly turn (sheer) and that too very rapidly that they may not remain controllable even with full use of engines and rudder. These are generally referred to as banking effects with many subdivisions and form part of higher studies on ship handling.

Vessels should pass each other at maximum possible range when at sea to avoid the interaction dangers. When navigating in restricted areas close to the shore banks or in narrow channels where other vessels have to be passed at close range, keeping the speed low at interaction points with timely and bold use of engines and rudder assist in keeping vessels under control and to counteract interaction effects.

In the below figure, the larger vessel 'X' is overtaking the smaller vessel 'Y'. The 4 diagrams with explanations as seen from left to right numbered 1 to 4 show the pressure fields/interaction effects.



The pressure wave from a large overtaking vessel can easily cause a smaller one to swing uncontrollably. As the large vessel approaches, its pressure wave pushes the stern of the other vessel further away, causing the bow to swing in and bring the smaller vessel directly to collision, or close enough so that she can be sucked in to collide with the side as the big vessel passes.

As the bows of vessel X overtakes the stern of vessel Y there will be a repulsive force between them so the stern of vessel Y is thrown out and there will be a tendency for vessel Y to swing her bows across the path of vessel X as shown in fig. 1.

Later the turning moment is reversed, and as the bows of the two ships are closer, vessel Y will tend to swing outward as shown in fig. 2.

When the sterns of the two vessels come together there will be a repulsive force between them so that once again there will be a tendency for the bows of vessel Y to swing inwards as shown in fig. 3.

Finally as the stern of vessel A passes the stern of vessel Y the turning moment on vessel Y will again be reversed as shown in fig. 4.

Interaction between vessels is said to have led to the unfortunate collision between the passenger vessel Queen Mary, engaged in carrying troops, and the light naval cruiser HMS Curacao having a displacement of about 4'200 mt which was escorting her off the coast of Ireland in 1942 even though the water depths in the area were over 100 metres.

The Queen Mary was zig-zagging to deter German U-Boats and aircraft with the HMS Curacoa sweeping the waters ahead. Queen Mary caught up with her escort which slowed suddenly when one of the persons on look-out duty reported a probable sighting of a periscope, raising the threat about the presence of a German U Boat. Queen Mary found herself swinging fast and towards the cruiser on a collision course. Queen Mary, some twenty times the size of Curacoa and steaming at 28.5 knots sliced the Cruiser neatly in two. She could not even stop to assist as her orders were to keep proceeding at full speed till her safe arrival at the destination port no matter what. HMS Curacao sank with severe loss of life.

*A first hand report from men on board a naval destroyer which rescued some of the seafarers from the ill fated HMS Curacao states, **'the sea was soon covered in oil and hundreds of heads with oily faces and panicky white eyes in the water, many just choking with fuel oil in their lungs and others dying from drowning'**. Only 97 people out of 650 on board were rescued, of these another 5 died later because of fuel which had gone in and damaged their lungs.*

In another case, on 8th January 2007 the U.S. nuclear-powered fast-attack submarine USS 'Newport News' having a displacement of about 6'900 mt was manoeuvring under water near the Straits of Hormuz. A Japanese owned but Panama flag fully loaded oil tanker 'Mogamigawa', 317 m long, having a displacement of around 3'00'000 mt, with a draught of about 20 m passed over the submarine. The bows of the submarine collided with the stern of the oil tanker around 2215 hrs. Fortunately no one was injured and the two vessels sustained only minor damages.

According to a US navy spokesman the preliminary findings about this accident, (available on the internet), as the mammoth oil tanker passed overhead the submerged submarine at high speed and low passing range it created a suction or venturi effect that suddenly forced the submarine to rise upward and hit the oil tanker, a case of interaction between vessels.

The navigators of the oil tanker could not have known about the presence of a submerged submarine

*and the submarine staff probably underestimated the draught of the loaded oil tanker. Submerged submarines stay out of other vessels, an **'ordinary practice of seamen'**. On 2nd October 2007 the US Navy agreed to pay the Japanese Company Kawasaki Kisen Kaisha Ltd, (K Line) which owns 'Mogamigawa' an undisclosed amount in compensation for the collision.*

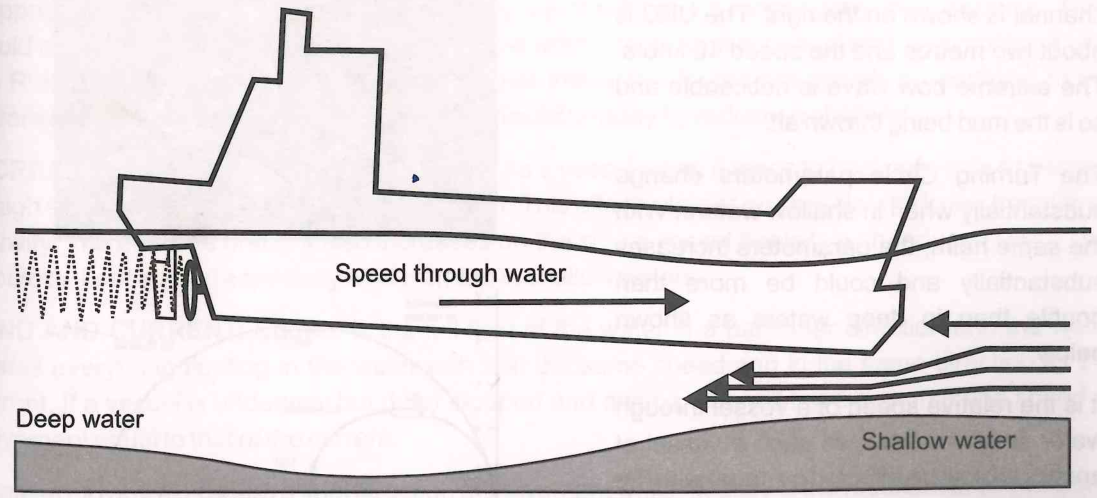
[TASK: SEARCH THE INTERNET ABOUT THIS ACCIDENT TO LEARN MORE DETAILS ABOUT THE ABOVE AND OTHER SIMILAR ACCIDENTS.]

The effects of interaction, bow cushion and bank suction must be taken into account when overtaking in a narrow channel. Overtaking vessels should not attempt to pass too close in open waters either when there is plenty of sea room to manoeuvre. In narrow channels it would be dangerous to overtake another vessel which itself is moving at a high speed.

SQUAT: A vessel moving through the water displaces the water, a vacuum is created in the space from where the hull moves away, the vacuum created in the water is immediately filled in by water from all sides, especially from below; in deep waters the pressure fields created are as described earlier.

However, when the under keel (UKC) or side clearances are low, the water displaced by a moving vessel is not immediately filled in and creates a negative pressure field below the vessel. To compensate for this imbalance of pressures, the surrounding water mass with the vessel afloat in it move down towards the sea bottom leading to a further reduction in the under keel clearance. This phenomenon is called squat or more technically vertical squat.

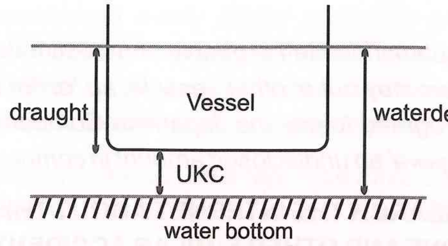
[TASK: REVISE BERNOUILLI'S LAW AND ITS APPLICATIONS. DOES IT APPLY IN THIS CASE?]



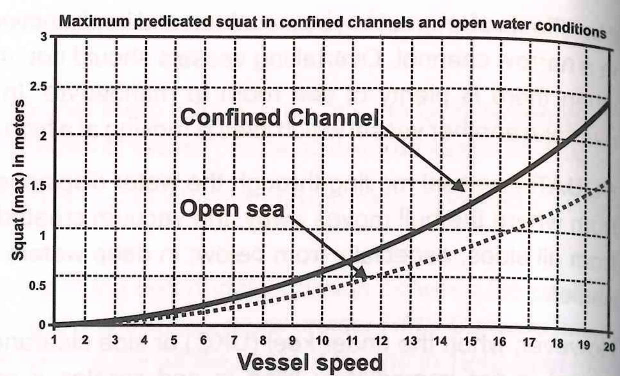
It is the UKC which decreases, there is no change in a vessels draught since the displacement remains the same. Squat would take place in all waters but its effects are negligible in deep waters, they increase in a parabolic fashion as the under keel clearance (UKC) decreases. The squat effects increase substantially as UKC reduces lower than half a vessels draught.

Squat is:

1. Inversely proportional to the UKC, and
2. Directly proportional to the square of the speed.



The adjoining graph gives an indication of expected squat for a small vessel being propelled at constant propulsion power.

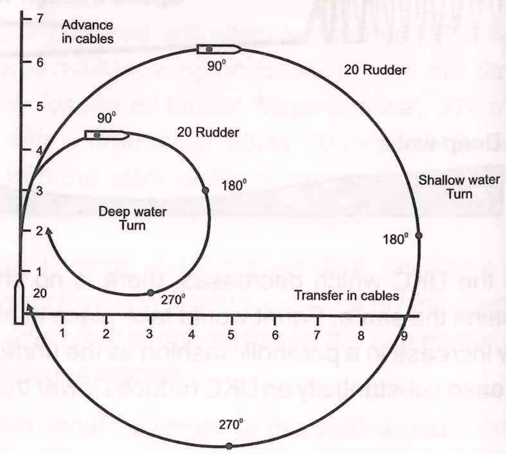


Squat has severe detrimental effects on a vessel's manoeuvring characteristics and on ship handling. When affected by squat a vessel will not behave like she does in deep water or as explained so far. If inside a narrow channel with restricted width then squat effects increase even more.

The change in longitudinal resistance affects the position of longitudinal equilibrium which in turn pushes the Pivot Point aft. This reduces the length of the lever between the Pivot Point and the Rudder and thus the rudder effectiveness and in general all other manoeuvring parameters or characteristics.

A dredger moving through a shallow channel is shown on the right. The UKC is about two metres and the speed 10 knots. The extreme bow wave is noticeable and so is the mud being thrown aft.

The Turning Circle parameters change substantially when in shallow waters. With the same helm, the parameters increases substantially and could be more than double than in deep waters as shown below.



It is the relative speed of a vessel through water which matters; as such a vessel at anchor too will be affected by squat with the flow of tidal stream. The lower the UKC and the higher the speed of relative flow of water, the more the drag on the vessels hull, this should be kept in mind at anchorage as a vessel may drag anchor

due to these squat affects even in otherwise fair weather, especially on a falling tide as the UKC drops.

One or more of the following symptoms indicate a vessel is in shallow water conditions and experiencing squat.

1. Wave making resistance increases at the forward end of the ship.
2. Ship becomes more sluggish to manoeuvre.
3. Draught indicators on the bridge or echo sounder traces will indicate changes in end draughts or UKC respectively.
4. RPM indicator of main engine will show a decrease. If the ship is in "open water" conditions, i.e. without breadth restrictions, this decrease in RPM can still be about 20% of the service RPM.
5. There will be a drop in speed of the ship. If the ship is in open water conditions, it may amount to about 30%. If the ship is in a confined channel, it may be a drop of up to 60% of the corresponding speed in deep waters.
6. The ship may start to vibrate suddenly because of entrained water effect causing the natural hull frequency to become resonant with another frequency.
7. Pitching and rolling motions decrease.
8. Turning diameter becomes larger, twice or even higher than the deep water turning diameter.
9. Takes a longer time to stop naturally or in a crash stop manoeuvre.

[QUIZ QS? DO YOU REMEMBER WHICH RULE IS ON *'SAFE SPEED'*? DOES IT INDIRECTLY REFER TO THIS PHENOMENON OF SQUAT?]

'Safe speed' requirements apply to all vessels when navigating and at all times. This has to be kept in mind by navigators especially on large, heavily loaded vessels operating in shallow waters with low UKC. Due to their momentum such vessels carry themselves for considerable distances after being stopped in deep waters, and when affected by squat will have a longer carry over distance. They would need to maintain a lower speed in shallow waters to be kept in control and in compliance with the Rule on ***'safe speed'***. Since squat and other interactive forces are directly proportional to the square of a vessels speed, they can be reduced substantially by reduction of speed.

INCREASE IN DRAUGHT WHEN TURNING: As a vessel turns, it tends to heel outwards especially at high speeds and with the rudder on hard over. This effect is larger on vessels with lower transverse stability. The effective draught also increases on the side a vessel heels to with reduced UKC. This should be kept in mind especially when turning in shallow waters.

WIND AND CURRENT: Current is the full flow of the water in a particular direction and the water carries everything floating in the water with it at the same speed and in the same direction as the current. If a vessel is underway but dead stopped and drifting, she will have a course and speed of movement equal to that of the current.

A vessel moving at sea has a final direction of movement which usually is the resultant of two vectors, the vessels course steered and her speed through water being one vector and the other the vector of the direction and strength of current. This will normally be covered in chart work.

Wind generally has a lesser effect on a vessel as compared to current as it exerts a push only on the exposed surface of a vessel above the water line. However, vessels with a large freeboard like car carriers, passenger vessels, gas ships, and oil tankers or bulk carriers in ballast all have relatively smaller draught but a larger above water profile which can be severely affected by the wind. Wind effect is called leeway.

Air-cushion vessels when operating in non-displacement mode have almost nil draught and are prone to large wind effects. They could have a leeway or a drift angle of as much as 45° and their heading as seen or indicated by their navigation lights could give a false indication of their direction of travel which can be very different than as indicated by their heading. Apart from their high speeds it is also for this reason that they are required by Rule 23(b) to exhibit an all-round flashing yellow light which is in addition to the lights prescribed for power-driven vessels underway.

To conclude, there are three basic categories of forces acting on any vessel, the controllable, the semi-controllable and the uncontrollable. All these should be taken in to account in not only planning and deciding actions but in deciding the safe passing distance.

[TASK: HAVING READ THE ABOVE, DIVIDE ALL THE FORCES INTO THE THREE CATEGORIES.]

Captain Jayant K. Sahu, who has earned the respect of the industry having regularly served as Master on the worlds largest tanker the 'Jahre Viking' from 1991 till 2007, the last 2 when she had been converted to a FSO. In 1998 he was specially invited to review a BTM course being conducted by the author since he had attended several such courses around the world.

His simple comment on ship handling was, 'make full and bold use of engines, rudder and all machinery, without any reluctance or hesitation, do not worry, they are designed to take the load and the related stress'.

[TASK: FURTHER STUDY RECOMMENDED ON THE SUBJECTS OF BOW CUSHION, BANK SUCTION EFFECTS AND INCREASE IN DRAFT WHEN TURNING]

TREND ANALYSIS OF MARITIME COLLISIONS

The trend of navigational accidents, including collisions, had shown a steady decrease since 1978 reaching the minimum levels around 2003. Thereafter collisions have gone up and have continued to show an increasing trend. The statistics shown further are self explanatory. This and the following chapter contain a gist of several recommendations to prevent accidents made by several organisations which investigate maritime accidents. This book is also an attempt to enhance maritime safety by explaining the International Regulations for Preventing Collisions at Sea to achieve a better understanding of their best practical application linked to other navigational watchkeeping activities, basic ship handling and risk management concepts.

A tanker industry report released in the last week of December 2010 states that collisions have increased to 31% of the total incidents reported in 2010 as compared to 26% in 2009.

The following extracts are from a recent study conducted by ***'The Swedish Club'*** titled ***'Loss prevention project – Collisions and contact study'***. It is self explanatory and the information is provided with the kind courtesy of **'The Swedish Club'**.

'Nine claims selected from 2005 and 2006 having a claim value of over or equal to US$ 5'000/- have been considered excluding deductibles. The investigation is limited towards bridge, navigation, and manoeuvring activities, port approaches and berthing to quay / lock.

Approximately 50% of all accidents at sea can be related to navigation bridge system failures causing collision, grounding or contact damages.

It has been an increase in the frequency of serious maritime accidents since the start of the new century, coinciding with a stronger emphasis on safety is a result of a positive trend with few accidents from the late 1980's is beginning to change.

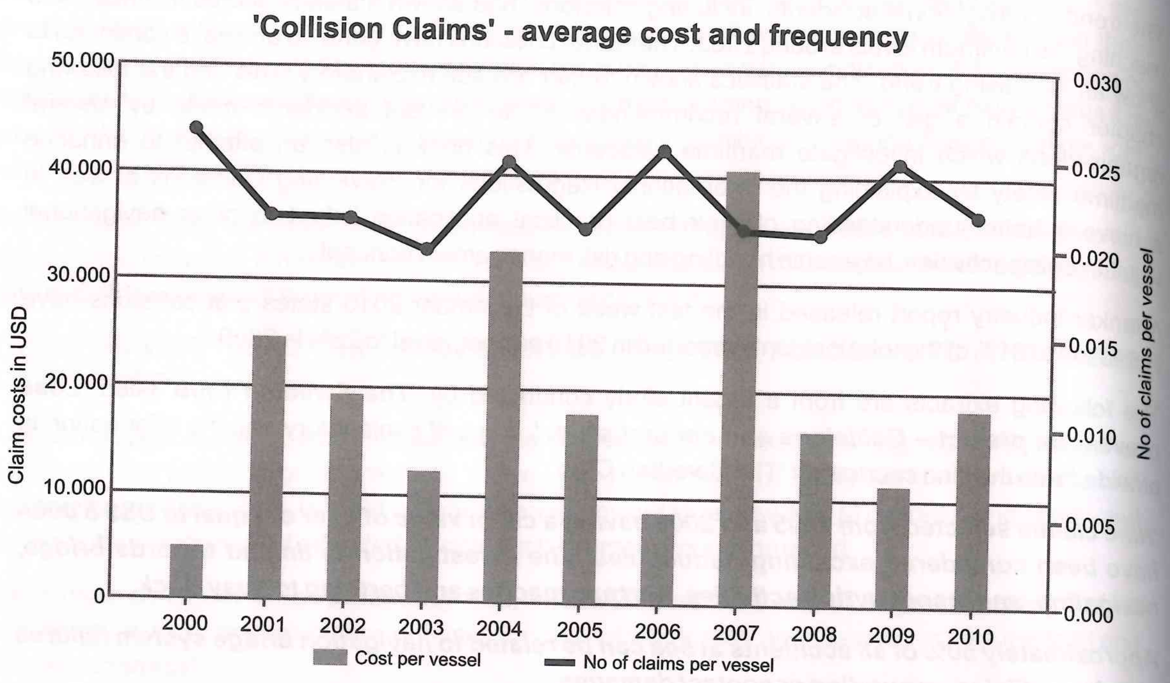
This unwelcome reversal of the trend could most plausibly be attributed to a 'loss of competence' among crews, linked with stress, fatigue and inexperience, but not necessarily attributable to fewer crew members per ship.

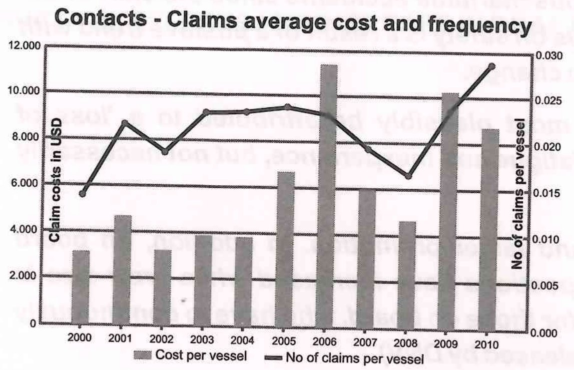
There are more new recruits, less retention and faster promotion. In addition, on board workloads with respect to paperwork and inspections have increased while crew size is stable. The loss of experience is a stress factor for those on board, who have to continuously train newer crew members. (Based on the data released by DNV).

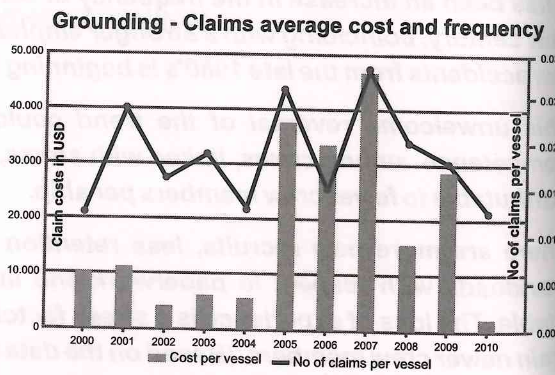
With the above factors given, correct procedures must be imperative to maintain an improved level of nautical safety and put stress off the crew involved. This procedure should not be limited only to pure operation of the vessel, it should also include proper training on board as well as ashore eg., simulators, leadership and other training facilities'.

This report concludes that ***'standard operating procedures for daily bridge work means that the vessel should maintain good routines in order to keep a high level of seamanship, eg., adherence of collision (prevention)regulations, route planning, internal/external communication and weather routing. Breach of the international collision (prevention) regulations acts as a main contribution to collision in the cases studied.***

The following data and statistics are courtesy **'The Swedish Club'** to show the trend of accidents.







A previous study by **'The Swedish Club'** had the following statistics:

- 2 of 24 collisions occurred in daylight and in good visibility.
- 8 of 24 collisions occurred in poor or very poor visibility.
- 11 of 24 collisions occurred during the dark hours but in good visibility.
- 20 of 24 collisions occurred in light or moderate winds (Beaufort Force 4 or less).
- 19 of 24 collisions occurred in congested areas such as straits, harbours, channels or rivers
- 9 of 24 collisions occurred with Pilot on board.

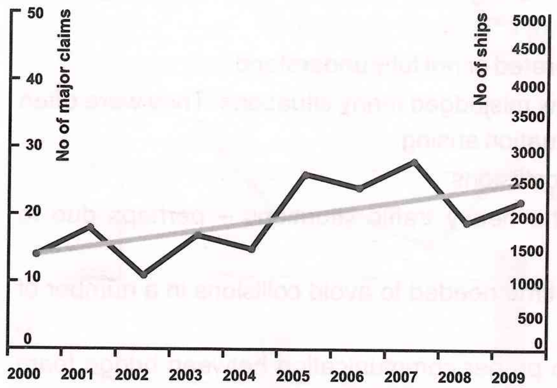
This reasons for the accidents were attributed to the following factors in the same study:

- Darkness and/or poor visibility left the crew to rely on information from the navigational instruments alone.
- In many cases, this information was misinterpreted or not fully understood.
- During darkness and/or poor visibility the crew misjudged many situations. They were often caught by surprise by a sudden dangerous situation arising.
- Bad weather is not a common cause of these collisions.
- Speed was not reduced and adapted to the heavy traffic situations – perhaps due to commercial pressure.
- Reduced speed would have given the extra time needed to avoid collisions in a number of these cases.
- Heavy traffic requires additional attention to proper communication between bridge team members, pilots as well as surrounding vessels.
- In several cases, the collision might have been avoided if the master had communicated better, or at all, with other parties
- In at least three cases there were language issues complicating master/pilot communication.
- In other cases the collision might have been avoided if there had been more prudent planning of the passage.
- Sometimes when the pilot is onboard; the bridge team tends to relax – a well functioning co-pilot system might prevent this from happening.

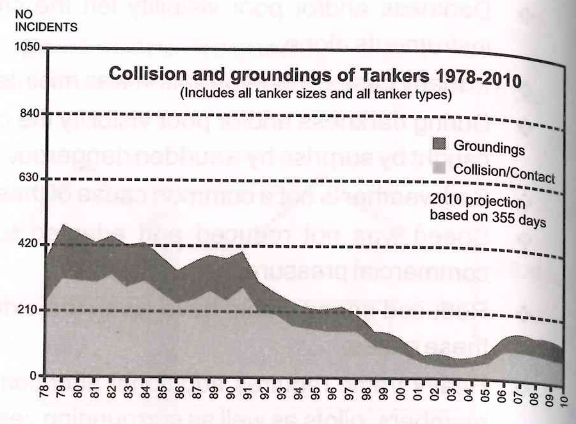
The major areas of failures were determined to be as follows.

- Misjudgement and lack of situational awareness.
- False sense of security, reduced vigilance and narrowing margins.
- Failure to use and interpret available resources such as radar, AIS, GPS and ARPA etc.
- Lack of briefings, planning and communication.
- Non-adherence to Standard Operating Procedures (SOP's).
- Lack of adherence to the Collision Prevention Rules.
- Insufficient preparation.
- Failure to properly follow BRM/MRM principles of good planning combined with adequate safety margins. That is:
  - ☐ Take into account unforeseen events which may develop into a serious and difficult situations.
  - ☐ Effective communication between all bridge team members, timely and accurate communication is a key element.
  - ☐ Navigation during pilotage is a shared task.
- Routine is dangerous, that is:
  - ☐ Procedures are necessary and must always be followed to the fullest extent possible, no matter how familiar the operation.

In addition to the previous information, similar statistics have been provided by a leading P & I Club based in UK and also released by the tanker industry recently show a rising trend of Maritime Collisions as shown below:



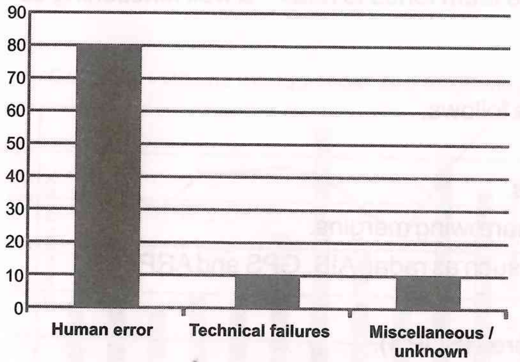
UK based P & I Club Statistics



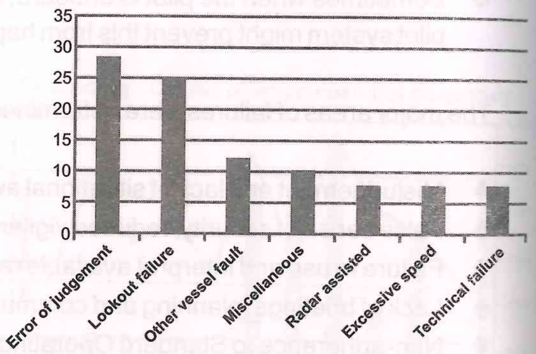
Tanker Statistics

The analysis by the above UK based P & I Club showed the reasons of Maritime Collisions as follows (all figures in percentage)

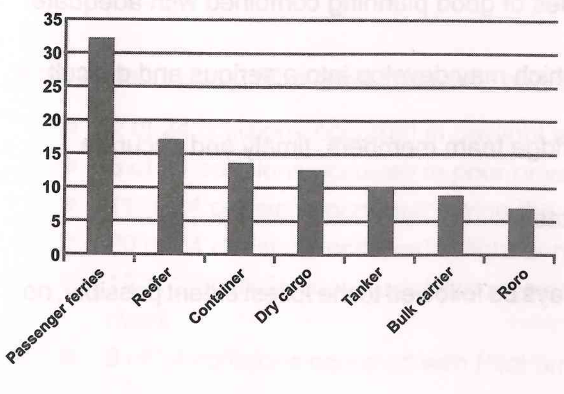
PRIMARY CAUSES



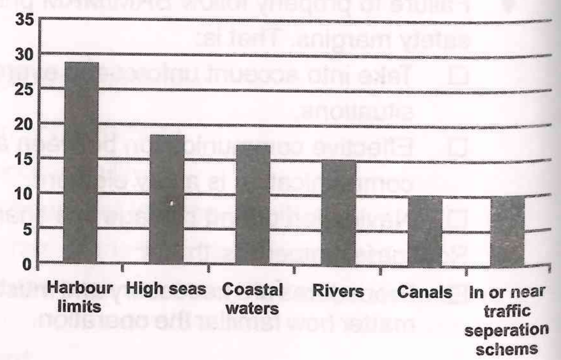
REASONS



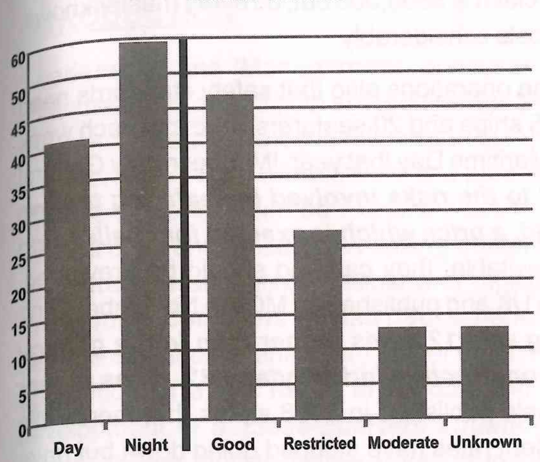
TYPES OF VESSELS



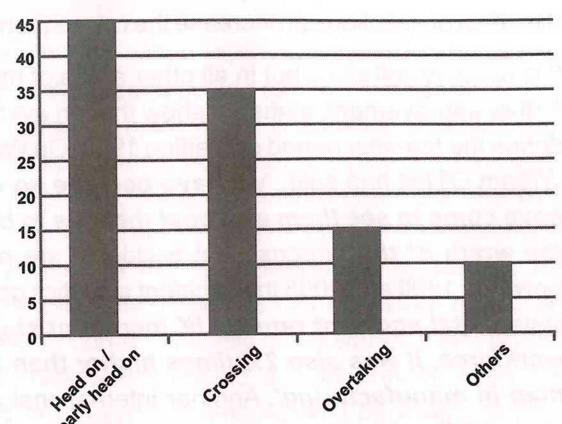
LOCATION OF COLLISIONS



TIME AND VISIBILITY



SITUATIONS WHEN IN SIGHT OF ONE ANOTHER



The following are the reports of a few other organisations providing reasons of failures leading to navigational (Collision) accidents.

Nautical institute survey results released in July 2003 state the reasons of failures as:

- Ignorance or disregard of the rules,
- Reluctance to slow down or deviate from track,
- Poor lookout,
- Poor traffic awareness,
- Lack of experience, and
- Wrong action taken by other vessel

The most objective evidence is from The Nautical Institute's confidential Marine Accident Reporting Scheme (MARS). This scheme, which has been running for years, demonstrates that seventy four percent of all incidents or near incidents reported relate to uncertainty, violations and total disregard of the ***'International Regulations for Preventing Collisions at Sea'***.

GARD P & I Club had published the following in October 2004 as reasons for navigational accidents and it appears valid even now:

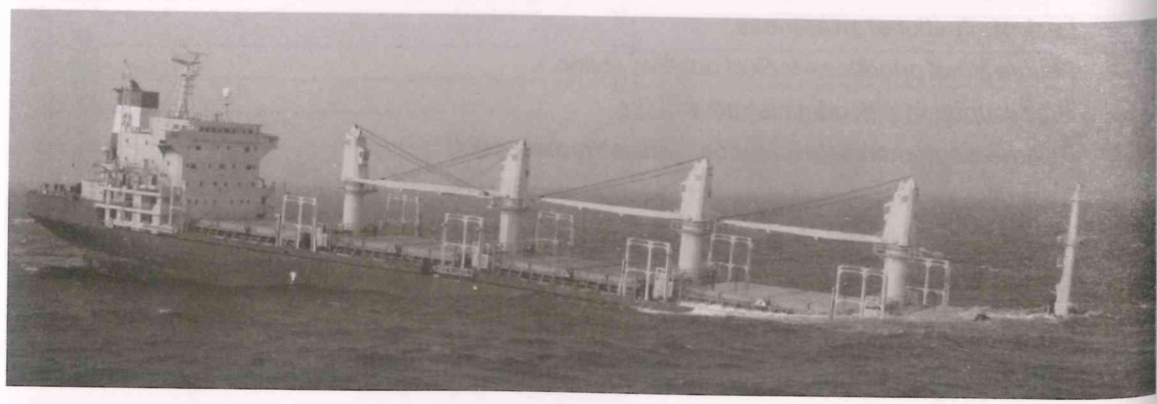
- *Insufficient watch-keeping.*
- *Lack of situational awareness.*
- *Failure to set priorities – lack of positive action.*
- *Preoccupation with administrative tasks.*
- *Failure to communicate intentions (officer/master/pilot).*
- *Lack of assertiveness – failure to challenge incorrect decisions (officer/master/pilot).*
- *Failure to comply with standard procedures and international regulations.*
- *Failure to utilise available data and resources.*
- *Lack of training – "human-technology" interface.*

The UK P&I Club, in their Analysis of Major Claims ten year trends, confirm that deck officer and pilot error account for 83% of major collisions. The average claim is $500,000 but, as every master knows, the effect of pollution can increase the consequential costs considerably.

It is not only collisions but in all other areas of maritime operations also that safety standards need further improvement, statistics show that on average 5 ships and 20 seafarers were lost each week during the ten-year period preceding 1994. On World Maritime Day that year, IMO Secretary General William O'Neil had said, ***'we have become so used to the risks involved in seafaring that we have come to see them as a cost that has to be paid, a price which is exacted for challenging the wrath of the oceans'***. But accidents are not inevitable; they can and should be prevented. Between 1996 and 2005 the accident statistics done in UK and published by MCA in November 2007 state, ***'fatal accident rate in UK merchant shipping was 12 times higher than in the general workforce, it was also 2½ times higher than the construction industry and 8½ times higher than in manufacturing'***. Another international analysis published in 2008 states that mercantile marine is the only industry internationally where accident rates have stopped going down but have started showing a reverse increasing trend, rather unfortunate since all efforts are to reduce this.

19th August 2009, a loaded oil tanker on fire after collision with a bulk carrier in Malacca Straits in good visibility / weather. Nine crew members died in the blaze.

02nd May 2010, a 27,000 dwt bulk carrier afloat after collision with a 178,739 dwt bulk carrier, the latter sank. The collision took place off Yantai, China in restricted visibility.



LEADERSHIP AND MANAGEMENT IN PREVENTING COLLISIONS

INTRODUCTION

'Leadership' and **'Management'** principles are enshrined within various legislations governing maritime activities and both are required for ***'proper and effective action to avoid collision'***. These concepts have always been followed in the day to day working for years, even when they were not listed formally. ***'Risk of collision'*** is a pure risk - not speculative like financial risks of a business. However, collisions can be extremely detrimental to people, ships, the environment and the very survival of an enterprise. ***'Preventing collisions'*** is achieved not by clash of egos or a battle of wits but correct, systematic, sensible and logical application of the ***'International Regulations for Preventing Collisions at Sea'***. Vessel-encounters generally differ; ***'risk of collision'*** has to be determined for each and every one of them, followed by correct analysis of the situation and proper application of these Rules to mitigate the ***'risk'***. Navigators should aim to prevent even the development of a ***'close-quarters situation'*** and in the process should also be aware of their responsibilities, both to the law as well as to the community.

'Management' is a part and parcel of everyday life, be it a single person working or a group. Management is a systematic way for optimum utilization of all available resources and execution of the activities to achieve the desired objectives efficiently. It is dependent on the many interconnected processes, procedures, interactions and the people involved. Lack of or failure of good management causes disorder, confusion, wastage, delay, destruction and even depression. Good management is essential to achieve success, which means zero collisions for the purpose of this book.

'Leadership' is the ability of empowering people to do their best to achieve individual and organisational goals or objectives. Admiral Grace Hopper, US Navy (Retired) had said, ***"You cannot manage men into battle. You manage things; you lead people".*** **'Leadership'** or **'Effectiveness'** is **'Doing the Right Thing'** and **'Management'** or **'Efficiency'** is **'Doing the Thing Right'**, if done right the first time and every time any activity should achieve 100% effectiveness and efficiency, though not always experienced in real life.

Adoption of ***'resource management principles'*** for all watchkeeping activities, navigational, engine or cargo is now required by the revised STCW Convention.

[TASK: PLEASE READ PARAGRAPH 8 IN PART 3 – 'WATCHKEEPING PRINCIPLES IN GENERAL' OF THE STCW CODE SECTION A-VIII/2]

HISTORY OF SHIPPING LEGISLATION: Venturing into the sea has always meant taking extreme risks. Past accident statistics show that working at sea was as risky as mining. Development of safety legislation, especially for maritime activities has been rather slow and almost always after repeated accidents and/or serious disasters.

However, in the last few decades', regulations governing maritime activities have been changing so rapidly that sometimes it gets difficult to even keep a track. Modern machinery systems are reasonably efficient, effective and reliable in most respects due to these efforts. Though there has been an overall reduction, accident and/or casualty rates have not gone down in the maritime industry in the same proportion as other shore based industries, unfortunately there has been a slight reversal as explained with trend analysis. It is now felt that the focus of development was on technology and the human factor has not been addressed sufficiently. The ISM Code did address this since inception and the amendments effective from July 2010 now focus on the effectiveness of management systems. The revised STCW Convention also addresses this issue further. Attention to the human factor in maritime industry has been given importance only after realising that ultimately it is the performance of people in the chain of management that determines the end result.

LEGISLATION GOVERNING SAFE NAVIGATION: This is a combination of the many requirements given in ***'SOLAS'***, ***'STCW'*** and the ***'International Regulations for Preventing Collisions at Sea'***. The requirements of the ***'ISM Code'***, a part of SOLAS, also have an impact on all activities, explained further.

'Safety of Navigation' as prescribed in Chapter 'V' of **SOLAS** prescribes many technical and other requirements. Apart from paragraph 10 of the STCW Code A-VIII/2 explained earlier, SOLAS places **'management'** of ***'safe navigation and avoidance of dangerous situations'*** directly under the control of the master in Regulation 34 of Chapter V, which allows absolute ***'Master's discretion'***:

'Regulation 34-1: The owner, the charterer, or the company, as defined in regulation IX/1, or any other person shall not prevent or restrict the master of the ship from taking or executing any decision which, in the master's professional judgement, is necessary for safety of life at sea and protection of the marine environment'.

'International Regulations for Preventing Collisions at Sea' provide the inputs for managing ***'any action to avoid collision'***. Mr. Justice Sheen, in a Judgement delivered in 1993, stated: *"The structure of the Collision avoidance rules is designed to ensure that, whenever possible, ships will not reach a close quarters-situation in which there is risk of collision and in which decisions have to be taken without time for proper thought. Manoeuvres taken to avoid a close-quarters situation should be taken at a time when the responsible officer does not have to make a quick decision or a decision based on inadequate information. Those manoeuvres should be such as to be readily apparent to the other ship. The errors of navigation which I regard as the most serious are those errors which are made by an officer who has time to think. At such time there is no excuse for failure to comply with the Regulations."*

The mandatory objectives of the ISM Code revised and effective from 1st July 2010 require that a Company should ***<u>'assess all identified risks to its ships, personnel and the environment and establish appropriate safeguards.'</u>*** The ISM Code objectives require that ***'the safety management system should ensure'***:

.1 compliance with mandatory rules and regulations; and

.2 that applicable codes, guidelines and standards recommended by the Organization, Administrations, classification societies and maritime industry organizations are taken into account.

The ***'functional requirements for a safety management system'*** should include ***'instructions and procedures to ensure safe operation of ships and protection of the environment in compliance with relevant international and flag State legislation'***. This is elaborated as: ***'the Company should establish procedures, plans and instructions, including checklists as appropriate, for key shipboard operations concerning the safety of the personnel, ship and protection of the environment. The various tasks should be defined and assigned to qualified personnel'***. While ensuring compliance with applicable legislation a Company may prescribe additional requirements which automatically become binding by virtue of the ISM Code.

Qualification of personnel is a critical element in any management standard, though similarly qualified people may actually perform differently, and this is a matter of intense continuing debates quite outside the scope of this book.

The master, finally responsible for safe navigation by SOLAS is also required by the ISM Code to be ***'verifying that specified requirements are observed'***, (clause 5.1.4).

The ISM Code requires that ***'the Company should periodically evaluate the <u>effectiveness</u> of the safety management system in accordance with procedures established by the Company'***. If accidents (collisions) take place it indicates that the ***'established'*** - ***'safety management system'*** is not ***'effective'***. These non-conformities are also noticed during the conduct of ***'internal safety audits on board and ashore at intervals not exceeding twelve months to verify whether safety and pollution-prevention activities comply with the safety management system'***.

The Preamble of the ISM Code in paragraph 6 contains extremely important statements: ***'The cornerstone of good safety management is <u>commitment from the top</u>. In matters of safety and pollution prevention it is the <u>commitment</u>, <u>competence</u>, <u>attitudes</u> and <u>motivation</u> of <u>individuals at all levels</u> that <u>determines the end result</u>'***. Each of the underlined words say a lot, both directly and in their implied meaning for the design and practical application of any ***'safety management system'***. On board ***'the top'*** role is assumed by the master who has to **'lead'** the team and **'manage'** the many activities taking place, empowered by ***"the top"*** of the Company and must demonstrate these qualities.

<u>'RISK OF COLLISION' - MANAGEMENT</u>

A voyage, still a ***'maritime adventure'*** in some sections of law, especially in maritime insurance, is considered safe if collisions and strandings (or groundings) can be prevented as clearly stated in paragraph 10 of the STCW Code section A-VIII/2.

'Risk' is the lack of precise prediction about the intended outcome of event, planned or not. Risk is usually taken as the product of the probability or expected frequency (F) of a negative occurrence and the magnitude of its consequences or severity (S), $R = F \times S$. The probability of a collision is, for example, related to traffic density and pattern of vessel movements coupled with the way the navigator's function, while the magnitude of consequences depends on the type of vessels, the angle and speeds at ***'collision'*** as well as the cargo being carried. Risks depend on the hazards present in an activity.

Managing Risk is to identify or determine the various hazards which have a potential to activate the risks and then to remove, nullify or lower them to acceptable levels through introduction of various safeguards. Traffic separation schemes, for example, are a safeguard ***'for preventing collisions'*** in areas of high traffic density and have proved their effectiveness as explained at the end of Rule 10. Use of seatbelts and airbags in a car or helmets at a place of work reduce severity in the event of an accident.

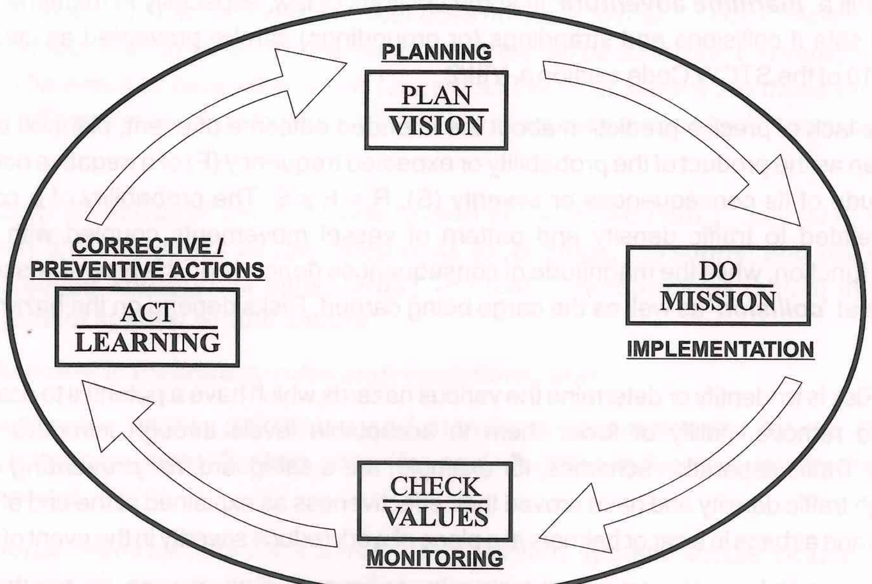
Statistics show that human error is the biggest single cause in activating ***'risk of collision'*** which is amongst the highest risk exposure factors at sea; the groundings have reduced substantially. Though modern radars are fairly accurate and AIS can be of some assistance, management of ***'any action to prevent collisions'*** still rests with the navigators; that is the practical application of these ***'Regulations'***. ***'Collisions'***, sometimes even assisted by Radar, ARPA, VHF or AIS, are regularly in the news.

Most investigation reports on maritime accidents show that the root causes for ***'collisions'*** are similar and there appears little difference between recent reports versus those made years ago. One such report of 1963 by the Liverpool Underwriters Association is quoted at the end of Rule 10, recent findings have been quoted in the chapter on 'trend analysis'.

Amongst the root cause of failures of management systems is frequently the lack of importance given to **'leadership'**. Every seafarer has to play the role of a leader to his teammates and be a teammate to the leader. It sounds strange, but good management practices actually require that people are able to shift through these two roles as situations demand, unless a person is a good team-mate, s/he cannot aspire to be a good leader. An OOW has to assume both the roles when alone on watch during routine navigation.

The famous PDCA Cycle of Dr. Deming, another famous Guru of modern quality management concepts describes the four stages of management as: <u>P</u>lan – <u>D</u>o – <u>C</u>heck – <u>A</u>ct, referred earlier with Rule 8(d). It addresses both leadership and management, applies almost to all activities including collision prevention and may be elaborated as follows:

- **<u>Planning</u>** is always the first step for any activity, since, as it is said that ***'Failing to Plan means Planning to Fail'***;
- **<u>Do</u>** is to carry out the activity as per the plan;
- **<u>Check</u>** is to verify the efficiency and effectiveness; and,
- **<u>Act</u>** is to correct the actions so that the same is within the framework of the plan.



The PDCA cycle can be adapted for leadership in the form:

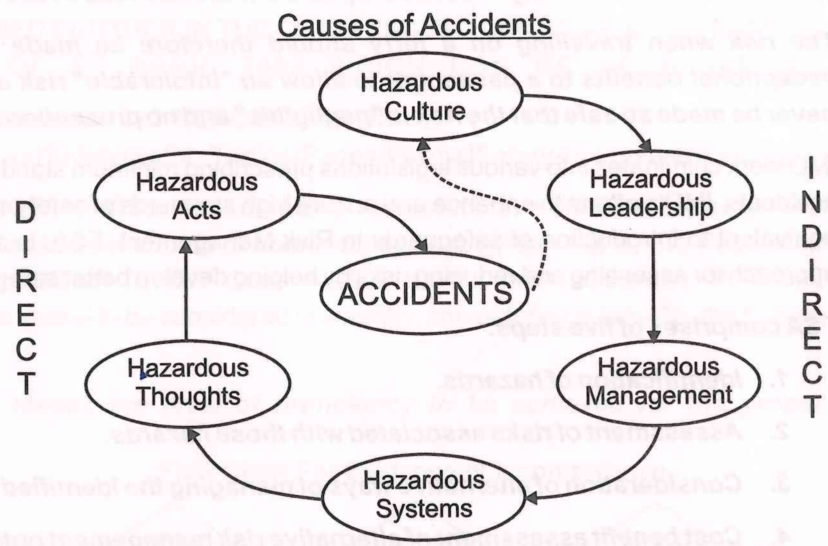
In the now famous Maritime/Bridge Resource Management (MRM/BRM) Programmes, (adopted from the aviation industry), and of which the author is a qualified workshop leader since 1995, practical management is described as a cycle of **<u>Planning</u>** – **<u>Briefing</u>** – **<u>Monitoring</u>** – **<u>Debriefing</u>**, very similar to the PDCA cycle described earlier. **Briefing** is an important activity so that all

concerned are clear on the way the plans made have to be executed, **Monitoring** is verifying the execution of the plans but also correcting the activities so that they proceed as planned, sometimes dynamic changes may be made to the Plan itself during execution, in which case a short **Briefing** to update the plans is again required. ***Debriefing*** is to review the efficiency and effectiveness after completion of the activity and acts as a continual learning and improvement tool. These concepts remain applicable even for the **'management'** of ***'any action to avid collision'***.

'Preventing collisions' cannot be planned in advance; it is an extremely dynamic activity. When ***'a close quarters and/or risk of collision'*** develops, all vessels involved are expected to take correct ***'action to avoid collision'*** in compliance with the ***'International Regulations for Preventing Collisions at Sea'***. Commercial aspects including any minimum performance criteria of speed or any other deadlines, like trying to maintain ETA, are secondary to the safety of a voyage and should not be considered when planning and executing ***'any action to avoid collision'***.

'Accidents do not happen, they are caused' is the guiding theme of ***'MRM'***, and are preventable by proper management. Every navigator must remember that:

1. **The sea is dangerous;**
2. **We cannot change the laws of nature;**
3. **We all make mistakes; and**
4. **We cannot fully avoid risks of collisions.**



Accidents are rarely because of one single failure; usually many direct or indirect failures take place in an error chain culminating into an accident or ***'collision'***, the adjoining flowchart shows the same. Analysis of failures helps develop short term corrective and long term preventive actions to manage the risks, this is linked to Formal Safety Assessment explained further.

Management systems based on the ISM Code, which in turn echoes the ISO-9000 quality management concepts, aims to improve efficiency and effectiveness of processes such that they are ***'done right the first time and every time'***. When applied ***'for preventing collisions'*** the objective simply is zero collisions. Unfortunately the accident trends do not reflect this, a sure indication that improvements are required.

[TASK: PLEASE RESEARCH AND FIND THE BEST DEFINITIONS OF THE WORDS 'SAFETY' AND 'ACCIDENT'].

FORMAL SAFETY ASSESSMENT (FSA): A part of IMO processes since 2002 is ***'a rational and systematic process for assessing the risks associated with shipping activity and for evaluating the costs and benefits of IMO's options for reducing these risks'***, it is another way of **'risk management'**. FSA development was in response to the **Piper Alpha** disaster of 1988, this offshore platform suffered an explosion and fire in the North Sea killing 167 people.

There are many ways of doing risk assessment, qualitative based on past experience or quantitative using statistical data, the former depends on perceptions developed through individual or collective experiences. ***'Fault Tree Analysis'***, ***'Event Tree Analysis'***, ***'Failure Mode and Effect Analysis'***, ***'Hazard and Operability Studies'***, ***'What if Analysis Technique'*** and ***'Risk Contribution Tree'*** are amongst those listed in FSA guidelines. Perceptions of ***'risk'*** in real time operations may change abruptly, for example failure to maintain a proper ***'look-out'*** may lead to missing a target and create a false impression that it is all clear or of low risk. If a vessel is suddenly sighted and the relative approach indicates low CPA, the perception would immediately change to one of high risk.

FSA guidelines state: ***'The current best practice is to recognise that there are three levels of risk:***

1) Intolerable: the risk cannot be justified except in extraordinary circumstances,

2) Negligible: the risk has been made so small that no further precaution is necessary. And

3) As Low As Reasonably Practicable (ALARP): the risk falls between these two states.

The risk when travelling on a ferry should therefore be made "ALARP". There are no exceptional benefits to a passenger to allow an "intolerable" risk and sea travel can clearly never be made so safe that the risk is "negligible" and no precautions need to be made.

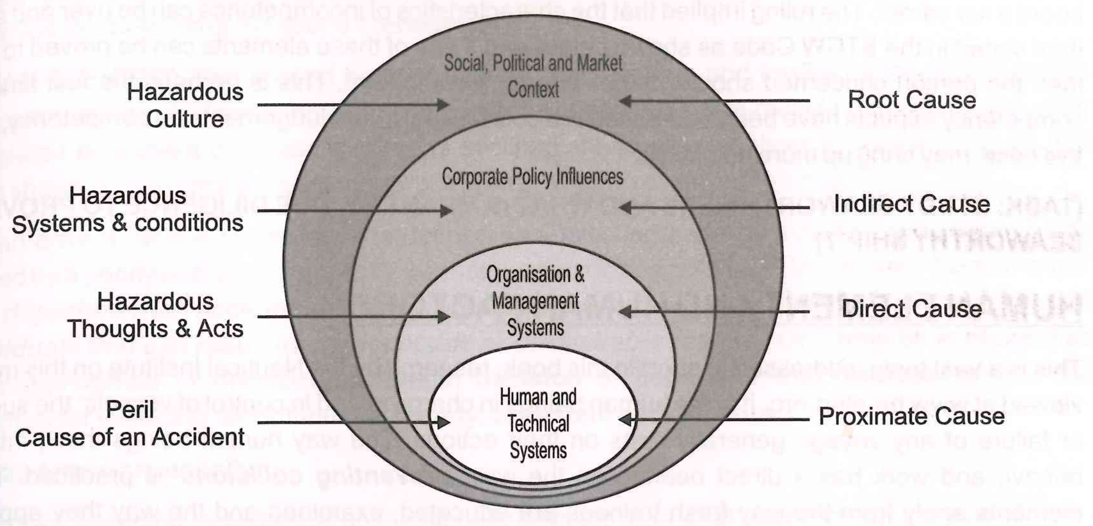
IMO work culminates into various legislations prescribing minimum standards to minimise or prevent accidents. IMO's efforts to enhance and ensure high standards of safety and pollution prevention are equivalent to introduction of safeguards in Risk Management. FSA, is a pro-active and structured approach for assessing and reducing risks by helping develop better safeguards.

FSA comprises of five steps:

1. ***Identification of hazards.***
2. ***Assessment of risks associated with those hazards.***
3. ***Consideration of alternative ways of managing the identified risks.***
4. ***Cost benefit assessment of alternative risk management options.***
5. ***Decisions on which option to select.***

FSA in turn is based on 'Regulatory Influence Diagrams' or RID's shown later. Most accidents are caused by a complex combination of events; they do not happen in isolation, but are part of a wider system of causal factors. Conventional risk assessment tools often fail to detect, pinpoint or clearly identify the complexities of many elements leading to accidents. RID's helps identify many critical influences, some of which may be latent and remote from the operational field, for example in areas responsible for planning or even beyond. Any element may be the cause of an accident, and may need to be addressed through error prevention and risk control measures.

Accident Causation Model based on IMO - RID



The following diagram on ***'Nested System of Influences'*** is based on the RID concept.

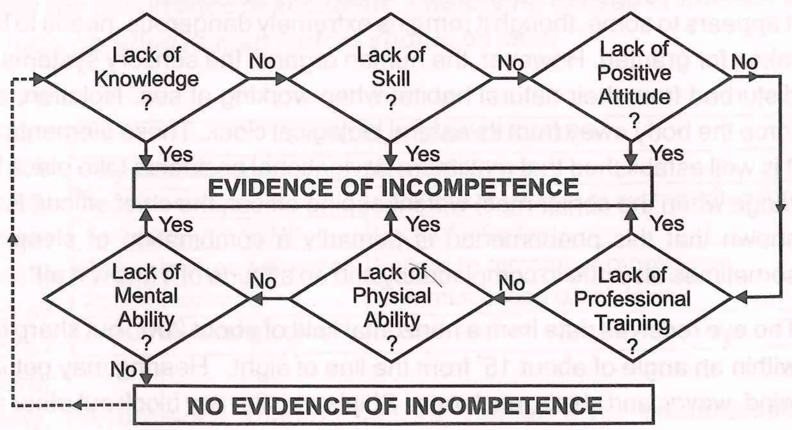
Note: The captions placed outside with arrows are not part of the original diagram published by IMO; they are based on error chain development and the direct/indirect causes of accidents.

[TASK: FSA MAY BE STUDIED FURTHER IN THE COMBINED IMO CIRCULAR MSC/CIRC.1023 AND MEPC/CIRC.392 OF 5TH APRIL 2002 WHICH CAN BE ACCESSED AT: http://www.safedor.org/resources/1023-MEPC392.pdf OR http://www.imo.org/OurWork/Safety/SafetyTopics/Pages/FormalSafetyAssessment.aspx]

COMPETENCY AND SEAWORTHINESS: Are both part of legislation, ***'every officer in charge of a navigational watch -- shall hold a certificate of competency'***, *(paragraph 1 of STCW Regulation II/1)* and ***'shall be duly qualified'*** *(STCW Code A-VIII/2 extract from paragraph 1)*. These requirements are a must for a vessel to be considered seaworthy, competency is linked to the human factor.

Standard of competence ***means the level of proficiency to be achieved for the proper performance of functions on board ship in accordance with the internationally agreed criteria as set forth herein and incorporating prescribed standards or levels of knowledge, understanding and demonstrated skill***, *(STCW Code A-I/1)*.

Flow Chart For Evidence of Incompetence



On competency, in a judgement delivered by the Honourable Mr. Justice

Cresswell in the High Court of Justice at London on 7th February 2002 for a case regarding fire on board a car carrier. The ruling implied that the characteristics of incompetence can be over and above than stated in the STCW Code as shown below, and if any of these elements can be proved to exist, then the person concerned should be considered incompetent. This is perhaps the first time that competency aspects have been addressed in a court ruling, future judgements on competency, citing this case, may bring up more points too.

[TASK: STUDY SEAWORTHINESS AND WHAT IS MEANT BY 'DUE DILIGENCE TO PROVIDE A SEAWORTHY SHIP'?]

HUMAN ELEMENT AND HUMAN FACTORS

This is a vast topic, addressed in short in this book, research by the Nautical Institute on this may be viewed at www.he-alert.org. It is the human beings in charge of and in control of vessels; the success or failure of any voyage generally rests on their actions. The way human beings think, interact, behave and work has a direct bearing on the way ***'preventing collisions'*** is practiced. These elements apply from the way fresh trainees are educated, examined and the way they apply the subject in practice. For further studies the book: **"The Human Element - a guide to human behaviour in the shipping industry"** should be studied, a read only PDF version may be downloaded from http://www.mcga.gov.uk/c4mca/mcga-ds-ssh-human-element.htm.

In the 88th session of the IMO's Maritime Safety Committee held towards end 2010 a proposal was put forward to incorporate human element principles in the working of IMO. Once approved it would mean that any future proposals of IMO must demonstrate that the human element has been sufficiently addressed before the same can be accepted.

HUMAN PHYSIOLOGY / LIMITATIONS: The origin of human beings has evolved over a long time. A person can work but always within the limits of the human body allowing for some individual variations. The human body has its own limitations, sight, hearing, working thinking or anything else, some examples on sight and hearing follow. The body timings and functions are said to be linked to the natural biological clock and perhaps genetically embedded. Human beings walk on solid and stable surfaces, have got up and slept with sunrise and sunset respectively; these natural systems set in through multiple generations are under severe pressure of the present modern industrial world. To change and adapt to new requirements is not an easy task.

Human beings are known to have ventured out to sea from 6000 BC; as such the sea is not as alien as it appears to some, though it remains extremely dangerous, needs to be respected, and can never be taken for granted. However, the human organs, the sensory systems, the social connectivity, all get disturbed from their natural habitat when working at sea. Isolation, awkward work timings in shifts force the body away from its natural biological clock. These elements also lead to fatigue and stress, it is well established that maximum navigational accidents take place in the morning 0500-0700 time range when the senior most watchkeeping officer, the chief officer, is usually on duty. Research has shown that this phenomenon is primarily a combination of sleep patterns linked to fatigue but sometimes also due to complacency and an attitude of **'I know it all'**.

The eye receives data from a horizontal field of about 200°, but sharp high resolution images are only within an angle of about 15° from the line of sight. Hearing may get impaired at sea by the noise of wind, waves and ship's machinery. Ship's whistle may block out other sounds and temporarily reduce

hearing ability of person(s) on ***'look-out'***. The human ear is also not designed to accurately determine the direction of the sound it receives.

HUMAN ELEMENT: This subject has bewildered many experts and invoked a lot of discussions since early 1990's. As technological advances have resulted in more reliable machinery and other associated equipment their failure rate has declined sharply, but analysis of accidents again and again shows human error as the single largest cause of failures leading to accidents.

Human error is difficult to explain, it is defined as a mistake made by a person rather than being caused by a poorly designed process or the malfunctioning of a machine. IMO defines ***'human error'*** as ***'a departure from acceptable or desirable practice on the part of an individual or a group of individuals that can result in unacceptable or undesirable results'***. **Or it may be explained as 'an inappropriate or undesirable human decision or behaviour that reduces, or has the potential for reducing, effectiveness, safety, or system performance'.**

Human errors are usually:

1. An act, assertion, or belief that unintentionally deviates from what is correct, right, or true.
2. The condition of having incorrect or false knowledge.
3. The act or an instance of deviating from an accepted code of behaviour.
4. A mistake.

And are closely linked to the **behaviour of a** person which could be **'Skill-based', 'Rule-based' or 'Knowledge-based'.**

Human error can be reduced or controlled by cross checking and verification. A very senior master, Capt. S.S. Sekhon I had sailed with as Chief Officer in 1989, had got the following notice posted at several places ***'CHECK – RECHECK – CHECK AGAIN'***. It was his philosophy that one must think through the tasks before starting to execute the same, modern systems on loss prevention echo this philosophy in different versions, one of them being ***'engage the brain before the hands'***. These concepts are helpful when planning and executing ***'any action to avoid collision'***.

FSA Guidelines state: ***'The human element is one of the most important contributory aspects to the causation and avoidance of accidents. Human element issues throughout the integrated system shown in figure 3 should be systematically treated within the FSA framework, associating them directly with the occurrence of accidents, underlying causes or influences. Appropriate techniques for incorporating human factors should be used'.***

TYPICAL HUMAN ERRORS	
Physical Errors	***Mental Errors***
Action omitted	Lack of knowledge of system/situation
Action too much/little	Lack of attention
Action in wrong direction	Failure to remember procedures
Action mistimed	Communication breakdowns
Action on wrong object	Miscalculation

With respect to human error the FSA requirements contain guidelines on ***HUMAN RELIABILITY ANALYSIS (HRA)*** which uses terms like ***Human error analysis, Error producing condition, Human error recovery, Human error consequence, Human error probability, Human reliability, Performance shaping factors, Human error quantification,***

Technique for Human Error Rate Prediction (THERP) and ***Human Error Assessment and Reduction Technique (HEART)***. The following chart from the IMO guidelines well explains the human errors.

The IMO's FSA guidelines further explain that ***'human error occurs onboard ships when a crew member's ability falls below what is needed to successfully complete a task. Whilst this may be due to a lack of ability, more commonly it is because the existing ability is hampered by adverse conditions.***

The principal causes listed are:

1) Personal factors;

2) Organizational and leadership factors;

3) Task features; and

4) Onboard working conditions

COMPLACENCY: Is a critical human factor function which largely contributes to human errors and may be described as:

- A false sense of well being and security.
- Satisfaction or self-satisfaction accompanied by unawareness of actual dangers or deficiencies.
- An unrealistic concept of the situation.
- A negligent or an over-confident attitude that nothing serious (or negative) will happen or all will turn out well.
- A passive, uncritical acceptance of other people's actions.

Complacency may set in for many reasons, but usually is due to lack of experience and/or knowledge about the risks associated with the tasks; At times the routine of the activity and sheer boredom of watchkeeping may invoke complacency. It may also be because of "ignorance" or "arrogance" or their combination.

It is surprising, but over-experience may lead to an over-confident attitude and that in turn leads to complacency. Well experienced people with all the knowledge are more prone to fall prey to this dangerous phenomenon. Good management techniques mean that people should guard against this, always questioning their own and their team members actions and monitoring the expected results.

It is said that the following questioning approach helps in all operational and risk management activities, not just for carrying out accident investigations or development of management systems.

What / Why / When / Where / Who / How?

MOTIVATION, HUMAN RELATIONSHIPS AND TEAMWORK: Human nature and behaviour is complex, human relationships are built up through interactions in families, social circles and organizations. People like to be treated with respect and dignity, in a just manner, irrespective of the position held or the type of job performed. People need a feeling of belonging and of importance for the activities they do apart from a social status. These aspects can help understand motivation. However, a rather critical aspect but often neglected is the emotional or religious beliefs (*) of a

person; these influence both the behaviour and individual motivation. The era of motivation by fear has faded as civilisations have progressed and though there are a lot of factors which may motivate a person, usually survival is said to be the biggest factor. People are not motivated by the directives they receive on what to do, but by the goals they are asked to achieve. Further, people are motivated by what they themselves desire to achieve. Motivation leads individuals to advance in their professional fields.

(*) The Maritime Labour Convention adopted at the ILO in February 2006 states: ***'In the case of ships where there is need to take account, without discrimination, of the interests of seafarers having differing and distinctive religious and social practices, the competent authority may, after consultation with the shipowners' and seafarers' organizations concerned, permit fairly applied variations in respect of this Standard on condition that such variations do not result in overall facilities less favourable than those which would result from the application of this Standard'.***

Good teamwork is important, though when a vessel is in open seas the sole OOW on watch in daytime, or when supported by a lookout person at night, will usually take all decisions. However, as a vessel moves into congested waters or into restricted visibility the number of people on watch may be proportionately increased with pilots joining in for manoeuvring the vessel into and out of ports or assisting in navigating transits through some congested waters.

Research done on teamwork shows that most often it is management failures in various areas resulting in incidents and accidents and not lack of professional competency. The below is based on the research findings of N.T.S.B. and N.A.S.A., (National Transportation Safety Board & National Aeronautics and Space Administration, both in USA).

Most common management errors during team work:

- Preoccupation with minor technical problems (paralysis of analysis).
- Failure to delegate tasks and assign responsibilities.
- Failure to set priorities.
- Inadequate monitoring / feedback.
- Failure to utilise available data.
- Failure to communicate intent and plans.
- Failure to detect or challenge deviations from SOP's (Standard Operating Procedures).
- Failure to handle minor deficiencies in skills.

The same research had concluded that teams which performed well and best handled the situations had the following qualities.

- They had good situational awareness, they anticipated the next condition.
- They made cognitive resources free.
- They obtained relevant information early.
- They built a shared mental model.

- ➢ They applied conservative strategies, kept options open.
- ➢ Their decisions were sensitive to constraints.
- ➢ They applied explicit task allocation.
- ➢ They monitored progress.
- ➢ They had good interactive closed loop communication.

The aviation industry, using the above research elements has developed several versions of management and team building courses; the one most widely known is CRM, or Cockpit/Crew Resource Management, which aims on developing teamwork and operational managerial skills. These concepts have filtered into the merchant marine too, SAS Flight Academy, a pioneer in conducting CRM Courses, had transformed the aviation CRM into a marine BRM (Bridge Resource Management) course, which is also run under the name MRM (Maritime Resource Management) by The Swedish Club Academy. These and similar courses help develop good practical managerial skills and are strongly recommended. ***'Bridge resource management'*** and ***'Engine-room resource management'*** *now feature in the* ***'standards of competence'*** *in the STCW Convention revised in 2010.*

[TASK: WHAT ARE THE QUALITIES YOU WOULD EXPECT IN A GOOD TEAM MEMBER?]

PRACTICAL MANAGEMENT ASPECTS

The various elements addressed and explained under this heading are inter related. for example A person suffering from fatigue will not be able to perform any of the activities to the expected standard. Lookout functions may not be done correctly or targets seen may not be reported which initially may be seen as failure of communication but further analysis may show up the fatigue aspect.

GUIDELINES ON FATIGUE: Fatigue, is no more an activity left to the Companies and/or maritime organisations to manage but features as part of law.

Fatigue may be defined in many ways. However, it is generally described as a state of feeling tired, weary, or sleepy due to prolonged mental or physical work, extended durations of anxiety, exposure to harsh environments, or loss of sleep. The result of fatigue is impaired performance and diminished alertness. Fatigue can also affect vision. The effects of fatigue can be dangerous, the specialized nature of maritime industry requires constant alertness and intense concentration from its work force. Fatigue is dangerous because it affects everyone regardless of skill, knowledge or training; and is linked to human body capabilities and frailties.

In a few very rare cases navigators have even been found sleeping due to sheer fatigue and exhaustion or sometimes due to total boredom. Regulation VIII/1 on ***'Fitness for duty'*** in the STCW Convention requires ***'that watch systems are so arranged that the efficiency of all watchkeeping personnel is not impaired by fatigue and that duties are so organized that the first watch at the commencement of a voyage and subsequent relieving watches are sufficiently rested and otherwise fit for duty'.*** Sections VIII/1 of Codes A and B further amplify the requirements which should be observed to protect everyone from potential dangers associated with fatigue and related accidents.

The Maritime Labour Convention of 2006 also addresses this issue as follows:

Regulation 2.3 - Hours of work and hours of rest.

Purpose: To ensure that seafarers have regulated hours of work or hours of rest.

1. ***Each Member shall ensure that the hours of work or hours of rest for seafarers are regulated.***
2. ***Each Member shall establish maximum hours of work or minimum hours of rest over given periods that are consistent with the provisions in the Code.***

Effectively dealing with fatigue in the maritime environment requires a holistic approach. There is no one-system approach to addressing fatigue, but there are certain principles (like lifestyle habits, rest, medication and workload, etc.) that must be addressed in order to gain knowledge and understanding of this phenomenon to enable manage this human element issue.

[TASK: STUDY FULLY ALL SECTIONS NUMBERED VIII/1 IN THE STCW CONVENTION; THAT IS IN THE REGULATIONS, CODE A AND CODE B.

QUIZ Q? WHAT DOES SECTION B-VIII/1 RECOMMEND REGARDING REST HOURS AND THE WAY THE MANDATORY REQUIREMENTS OF SECTION A-VIII/1 HAVE TO BE ENFORCED?

WHEN THE MLC 2006 IS AVAILABLE, READ SECTION 2.3 OF THE SAME IN FULL AND COMPARE WITH THE STCW REQUIREMENTS AND ANY REQUIREMENTS STATED IN FLAG STATE LEGISLATION.

QUIZ Q? AS PER THESE REQUIREMENTS, DO THE AUTHORITIES HAVE A RIGHT TO VERIFY WORK / REST RECORDS MAINTAINED ON BOARD?]

The human element, in particular fatigue, is widely perceived as a contributing factor in many accidents. The Exxon Valdez stranding and oil pollution in 1989, one of the worst maritime environmental disasters in this century, is one where fatigue was identified as a major contributing factor. The Air India Express aircraft crash in May 2010 at Mangalore is also said to have been caused due to the commanding Pilot's fatigue, he was sleeping in the major part of the flight from Dubai and when he did get up, he was unable gain situational awareness (discussed later) and/or take correct actions, he also did not heed to the co-pilot's warnings to abort landing, turn around and make a fresh approach. Rest hour requirements in commercial aviation are far more stringent than required by maritime laws.

[TASK: RESEARCH AND STUDY THE GROUNDING ACCIDENT OF EXXON VALDEZ OFF ALASKA.

QUIZ QS: WHICH LAW WAS ENACTED AND MADE MANDATORY FOR VESSELS CALLING AT USA PORTS AFTER THIS ACCIDENT?]

LOOK-OUT: Research into reasons for collisions has revealed that in a very large proportion of these accidents the watchkeeping officers were either completely unaware about the presence of the other vessel or saw it too late, some having dispensed with visual ***'look-out'*** and relying only on Radar. A recent study by MAIB states:

- ***65% of vessels involved in collisions were not keeping a proper lookout;***
- ***33% of all accidents that occurred at night involved a sole watchkeeper on the bridge; and***

- ***19% of the vessels involved in collisions, the bridge watchkeeping officers were completely unaware of the other vessel until or, in some cases, after the collision.***

Vision does get affected adversely when a person moves rapidly between extremes of light, and takes time to adjust to changing conditions. Watchkeeping requirements address this as ***'no impairment of night vision or other impediment to the keeping of a proper lookout'***, *(STCW Code A-VIII/2, extract from paragraph 16)* and ***'particularly as regards their adjustment to night vision. Relieving officers shall not take over the watch until their vision is fully adjusted to the light conditions'***, *(STCW Code A-VIII/2, extract from paragraph 20).*

MGN 357 issued by the MCA of UK in December 2007 states: ***'No suitable period for dark adaptation is stated, but MAIB's report says that research indicates that this period is typically 10 to 15 minutes. This needs to be taken into account in determining the watchkeeping regime for the vessel'.*** This MGN also states, ***'photochromic lenses, even after being in the dark for an extended period and in their most translucent state, can reduce night vision significantly. They <u>should not be worn</u> for lookout duties at night'.***

Capt. Beer of U.K Marine Accident Investigation Branch (MAIB) had stated, ***'earlier detection, appraisal, prediction and situational awareness are the principal duties of any watchkeeper. Without these functions the ship can be put at risk. Clearly, some watchkeepers have come to the conclusion that maintaining a proper look-out is somehow unimportant. This must be corrected.***

Rule 5 is indisputably the most important: complying with it is a fundamental prerequisite for the other rules to be of any use. If you do not see or detect another vessel, how can you know what action is necessary, let alone what action is appropriate.'

Usually all court verdicts on collisions link the judgements to the Rules from the ***'International Regulations for Preventing Collisions at Sea'*** and few refer to the watchkeeping requirements from the STCW Code. It may be worth looking at the way paragraph 32 of the STCW Code Section A-VIII/2 can be interpreted purely from a legal **"rule construction"** point of view, the paragraph is quoted with the key words highlighted.

'It is of special importance that at <u>all times</u> the officer in charge of the navigational watch <u>ensures that a proper lookout is maintained</u>. In a ship with a <u>separate chartroom</u>, the officer in charge of the navigational watch <u>may visit the chartroom, when essential, for a short period for the necessary performance of navigational duties, but shall first ensure that it is safe to do so and that proper lookout is maintained'</u>.

This paragraph has two limbs, the first relates to the <u>Duty</u> of an OOW regarding ***'lookout'***. The second limb describes situations where deviation from the first limb is permissible and can be broken down into as follows:

01. The OOW may visit a SEPARATE CHARTROOM - ONLY when;
02. It is ***ESSENTIAL***, ***<u>and</u>***
03. It is ONLY ***for a SHORT PERIOD <u>and</u>***
04. It is ***for the NECESSARY PERFORMANCE OF NAVIGATIONAL DUTIES***;
05. Provided that, the ***OOW SHALL FIRST ENSURE that***;

06. ***It is SAFE to do so, <u>and</u>***;
07. ***That <u>PROPER LOOKOUT</u> IS MAINTAINED.***

If an OOW does not ensure ***'that proper look out is maintained'*** the OOW should be considered negligent for having committed a **<u>breach of duty</u>**. Interpreting the Rules by breaking them into segments brings home the manner in which Rules should ideally be interpreted for better understanding.

As stated in Rule 5 on ***'look-out'***: ***'every vessel shall at all times maintain a proper look-out by sight and hearing'*** and if an OOW blinks the eyes even for an instant - the OOW would not have kept ***'a proper look-out' - 'at all times'***.

A ship not using radar collided with a large, newly constructed oil platform in the Gulf of Mexico. The platform was not properly lit, but so are many other vessels and objects. Just because a person fails to sight something at night in good visibility, does not mean it is not there.

Apart from Rule 5 other Rules also refer to and depend on this critical function. Use of radar is also accepted for 'lookout', ***'a vessel which <u>detects by radar alone</u> the presence of another vessel shall determine if a close-quarters situation is developing and/or risk of collision exists'***, (extract from Rule 19-d) and ***'or interfere with the keeping of a <u>proper look-out</u>'***, (extract from Rule 20-b). The STCW Code amplifies a lot more on lookout as explained, especially with Rule 5.

COMMUNICATION – INTER PERSONAL: Analysis of accidents in highly operational environments show that failure of communication frequently leads to dangerous situations and/or accidents. Interaction between professionals is a key element towards safe and sound navigation including efficient and effective ***'action to avoid collision'***.

From a vessels operational point of view, communication broadly covers two areas, on board and external. The former is one of the most important activities in the dynamic management of operations on board. However, there is a difference between the two, especially if the latter is undertaken for communicating with other vessels in the vicinity for ***'preventing collisions'***.

Essentially the concepts of '***closed loop communication***' (a term adopted from the aviation CRM courses) should be followed in all communications to prevent failures. The following steps are considered the best for good '***closed loop communication***' which is an interactive communication pattern between all players involved to minimise failures. This pattern of communication is recommended for all communications irrespective if it is internal or external. This system is almost always used on the bridge for wheel or engine orders, where the order is repeated by the receiver and then reconfirmed after execution.

All orders, instructions and messages, referred to as message below should be brief, to the point and follow the following steps before being implemented.

1: SENDER:	Sends a verbal message or instruction.
2: RECEIVER:	Repeats the same or the important elements of the same.
3: SENDER:	Confirms to the receiver that the understanding is correct.
4: RECEIVER:	Confirms to the Sender that the action has been initiated / completed.

In case the receiver gives a wrong feedback in step-2, the communication is aborted and the sequence started again from step-1.

[TASK: MAKE A SCHEMATIC BLOCK DIAGRAM SHOWING CLOSED LOOP COMMUNICATION.]

From the human element aspect, ship board personnel do not spend much time with each other and people do take time to learn about each other and get along. There is a classic statement on this made by the late Mr. Martin Luther King often called ***fear of the unknown***, quoted below. This can be used for understanding interrelationships, human factors, and to develop good communication.

- **People do not get along:** ***Because they fear each other.***
- **They fear each other:** ***Because they do not know each other.***
- **They do not know each other:** ***Because they have not properly communicated with each other.***

This barrier also extends to the sometimes unsatisfactory senior – junior communication in some bridge teams, the reluctance of juniors to speak up, sometimes assuming that the senior 'knows all'. The passenger liner 'Queen Elizabeth 2' suffered a major grounding on 7th August, 1992 South of Cuttyhunk Island, Massachusetts, USA. Amongst the major causes stated in the NTSB investigation report were ineffective or rather negligible communication between the vessels bridge team and the Pilot, which resulted in no briefing between them for the intended passage, both had separate intended routes to follow and the OOW who did notice the error did notice the error did not speak up. This was coupled with hidden pressure (explained later) to go fast for maintaining ETA at the next port and make up for the time lost for some delays in the previous port.

VHF RADIO COMMUNICATION: The Rules contained in the ***'International Regulations for Preventing Collisions at Sea'*** have no clearly stated requirements on this aspect. Like anywhere else, for example vehicles on the road, vessels at sea are expected to take ***'action to avoid collision'*** without resorting to any communication between them. The Rules only provide for communication by sound signalling, supplemented by light signals as prescribed in Rules 34 and 36 or the sound signals in restricted visibility given in Rule 35.

'All available means' referred to in Rules '5' and '7' could well include communication between all concerned within or outside a vessel, (navigators, pilots, other bridge team members, various shore based stations including VTIS / VTMS etc.), which can give warning of any developing and/or existing ***'risk of collision'*** situations. However, Rule '8' and all following Rules do not use ***'all available means'*** and as such there is no direct or implied reference that vessels should communicate with each other for the purpose of deciding and/or executing ***'any action to avoid collision'***. There are inherent dangers of miscommunication or misunderstandings in this activity apart from wrong identification of the stations and/or their positions, though the latter has reduced substantially with the advent of AIS.

However, it has been argued that the Rules also do not explicitly state anything against use of communication and with the development of modern communication systems; it may be considered illogical to say none should ever be used. However, extreme caution is required to ensure that any communication remains effective if at all resorted to, and must never be counter-productive. This means, never ever should an agreement of ***'any action to avoid collision'*** be arrived at which is either contrary to the Rules or results in passing at too close a range.

Considering the investigation reports of various accidents and the recommendations made with a view of learning lessons, the general advice given in various publications including IMO and various flag state notices is that there is no need of any verbal or other communication between vessels for the purpose of ***'preventing collisions'*** and that miscommunication may cause more harm than good. Many collisions have taken place due to miscommunication between vessels, or when navigators have agreed to actions contrary to the Rules or due to sheer misunderstandings and this has led to the coining of the phrase 'VHF assisted collisions'.

Analysis of accidents on the IMO website contain a lot of details including comments against the use of VHF for collision avoidance, one such report is quoted below which was obtained from the IMO website: ***analysis based on report from Panama (FSI 11):***

- ***The collision was mainly caused by the failure of the passenger cruise ship, which was the give way vessel in a crossing situation, to make sufficient alteration of course or speed to avert collision.***
- ***The VHF conversation between the two vessels might have delayed a sense of urgency from building up in the minds of the bridge officers on the two vessels.***
- ***The use of VHF as a collision avoidance tool can be counter-productive. If the COLREGS are being followed correctly it would not be necessary to use VHF for collision avoidance and thus be distracted from the attentiveness in watchkeeping.***
- ***When overtaking another vessel, careful consideration should be given to the side on which to overtake. Factors to be taken into account should include available sea room and possible need to take avoiding action in respect of other vessels in the vicinity.***

This is further highlighted in the MGN 324 (M + F) of July 2006 issued by MCA of the UK. Similar guidelines are given in a circular issued by Maritime and Port Authority of Singapore on 16-06-2005; the latter is stated in the Annex section of this book.

[TASK: STUDY *'PROPER USE OF VHF CHANNELS AT SEA'* IN IMO RESOLUTION A.954(23) DATED 5TH DECEMBER 2003 AND PUBLISHED ON 26TH FEBRUARY 2004; AND, STUDY MGN 324 TO ACHIEVE A FULLER UNDERSTANDING OF THE DANGERS ASSOCIATED WITH USING VHF AND AIS AT SEA FOR PREVENTING COLLISIONS.]

Note: MGN 324 can be found on the website www.mcga.gov.uk where a lot of other useful information is also available, or can be seen at: http://www.mcga.gov.uk/c4mca/mcga-mnotice.htm?textobjid=908E08C2F38A0072]

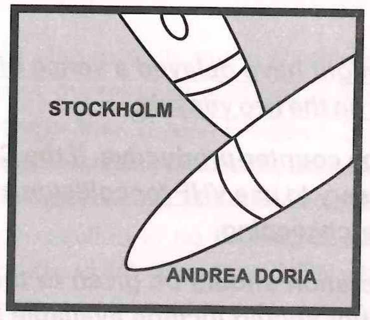
However, local requirements may vary; for example, it is a requirement under the USA laws for bridge to bridge communication between vessels when navigating in US territorial waters. Some US inland Rules refer to the use of communication for deciding ***'action to prevent collision'***, quite a variance from the international Rules where there is no such discretion. The US inland Rules do not extend beyond 3 miles from the US coast as stated in the **'Vessel bridge-to-bridge radiotelephone regulations given in US** 33 CFR 26'.

Many collisions have been caused due to improper VHF communication; a few have even been described in this book. The French report of safety investigation into the collision between 'Samco Europe' and 'MSC Prestige' states: ***'BEAmer has reservations about the***

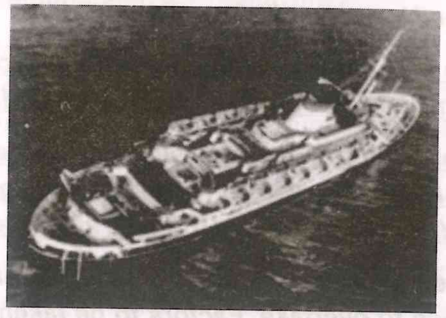
systematic use of VHF. That could be, in some particular situation, of no effective assistance, especially when an officer of the watch tends to exert influence on the officer of the watch of the other vessel. COLREG rules are sufficient to be enforced "in silence". That these Rules can be applied in silence is the principle on which they have been written and this guiding spirit should be put into their practice also.

RADAR: Radar / ARPA or equivalent systems, explained earlier, can monitor and track targets and have facilities to set alarms for various parameters like CPA and TCPA etc. These systems should be set and used properly so that they can be of assistance in the navigational activities.

Relative vectors give a near immediate indication of any developing risk of collision, but are not suitable to determine the relative aspects (relative angle) between the vessels or the correct application of these Rules ***'for preventing collisions'***. It should be noted that a vessel's speed



A graphic of the Stockholm and the Andrea Doria collision



Andrea Doria sinks into the Atlantic

through water and the true course steered should be the correct input into the ARPA systems to get proper future predictions of the targets concerned and their aspects.

*The severe collision between passenger liners 'Andrea Doria' and 'Stockholm' off New York a little after 2300 hrs., on 25th July 1956 is attributed to wrong assessment of the data from Radar and known as the first **'radar assisted collision'**. Andrea Doria was inbound and Stockholm was sailing out, the latter only had the 3rd Officer on the bridge. Restricted visibility due to fog patches is believed to have contributed to the collision as have been the high speeds of both the vessels, said to be around 22 and 18 knots respectively.*

The OOW on the Stockholm thought he was looking at radar data based on a 15 mile range scale, but the radar was mistakenly set at 5 miles. When he determined Andrea Doria being at 12 miles range, she was actually only 4 miles away, there was no indication of the same on the screen nor any range rings to check the exact distance.

The 'Stockholm' collided with the 'Andrea Doria' delivering a fatal gaping hole on her side and soon she was leaning dangerously to her starboard side. Watertight compartments helped keep her afloat while preparations were made to evacuate the people, many ships responded to the SOS calls. The next day Andrea Doria slowly started sinking at 0945 hrs disappearing at 1009, long after all survivors had been safely evacuated. It is said 46 people died on the 'Andrea Doria' and 5 on the 'Stockholm' due to the collision, 14 more have perished since then till mid 2006 while diving to see the wreck of 'Andrea Doria' resting on its side about 200 feet down in frigid waters North of Nantucket.

The collision took place about 40 miles southwest of Nantucket. Traffic lanes existed in the area even then but the Stockholm was heading North of its prescribed lane in order to save time. Neither vessels knew exactly where the other was and at the last minute the OOW on 'Stockholm' ordered starboard helm while the 'Andrea Doria' went to the port, both thinking that they were increasing the range but in reality these actions accelerated the collision.

*The collision between the Bahama registered passenger cruise liner 'Norwegian Dream' bound for Dover and the Panama registered container vessel 'Ever Decent' on 24th August 1999 around 0100 hrs. is attributed to misinformation on the radar of 'Norwegian Dream', which was the give-way vessel and had confirmed on VHF that she would keep clear. Her Radar/ARPA units were all set to show true vectors, the speed input was manual instead of being through water. Apart from this excessive speed, failure to reduce speed, failure of visual look-out, failure to take visual compass bearings and failure to take **'action to avoid collision'**, at a suitable range in ample time are the main reasons amongst others leading to the accident. The use of VHF between the two vessels confused the 'Ever Decent' that 'Norwegian Dream' would take **'action to avoid collision'** because she had verbally confirmed the same on VHF. Both vessels were close to 52'000 GT each.*

The Bahama Flag State Authority issued a circular about the correct use of ARPA/Radar after investigations in the above accident were completed. This and another one issued by the Marshall Islands Maritime Administrator are included in the Annex section of this book.

AUTOMATION: Automation has been a great boon in all spheres of life. However keeping a watch on the performance of the automatic systems is important. Since system failures are rare, it also becomes boring to keep watching something not prone to failure. Another aspect is controlling the settings of the automatic systems, the outputs generated will be as good or as bad as the inputs, the GIGO syndrome, ***'garbage in = garbage out'***.

Relying on guard rings of a radar is also dangerous. If a target crosses the guard ring it activates an alarm, the system on the earlier versions. However, if a target is detected inside the guard zone there may be no alarm, a usual phenomenon for weak targets. An OOW being confident that an alarm would get activated may get busy with other jobs and not maintain ***'a proper look-out'*** or radar watch leading even to collisions. Many a times, what all can go wrong in the operations of any equipment cannot always be accurately determined or forecast and can be realised only after an accident, that too after a detailed investigation or root cause analysis.

Design and ergonomics also have an impact on the way people see and react to the information.

A modern vessel was nicely fitted with computer control systems including the Auto Pilot. She suffered a few near misses as changing over to manual steering required a few keyboard/mouse controlled commands, a similar procedure applied to even change the auto pilot course settings. This led to severe disruptions in operations and the systems had to be changed back to the good old manually controlled switches.

Modern aircraft cockpit controls have evolved and have slowly changed to digital read outs, but most still carry the clock with its traditional dials since most pilots still prefer to see the time in the traditional fashion. Many digital displays have now been reversed back to dial type with needles as the readings are easier to sight and compare at a glance, for example the operating parameters of several engines.

A judge has rightly stated in a verdict that automatic systems are very valuable inventions if properly used, but they may lead to disasters if left alone, or vigilance relaxed in monitoring their effectiveness and actions. *'It is the people operating the vessels on whom safety at sea depends, and they cannot make a greater mistake than to suppose that machines can do all their work for them'.*

Automation and over reliance on electronic navigational aids has led to an erosion of many traditional good seamanship practices developed through long times contributing to many accidents. IMO and flag states have many recommendations on the cautions to be exercised when dealing with automation.

MGN 379 on correct use of navigational equipment by watch-keepers starts with, ***'accidents have occurred where the primary cause has been over-reliance on a single electronic navigational aid. Watch-keepers must always ensure that positional information is regularly cross-checked using other equipment, as well as visual aids to navigation. In other cases accidents have occurred where the watch-keeper was not fully conversant with the operation of equipment or its limitations'.*** This MGN addresses the following key points:

- ***Be aware that each item of equipment is an aid to navigation.***
- ***Be aware of the factors which affect the accuracy of position fixing systems.***
- ***Appreciate the need to cross check position fixing information using other methods.***
- ***Recognise the importance of the correct use of navigational aids and knowledge of their limitations.***
- ***Be aware of the dangers of over-reliance on the output from, and accuracy of, a single navigational aid.***

[TASK: READ AND STUDY MGN 379 ON THE FOLLOWING LINK

http://www.mcga.gov.uk/c4mca/mcga-mnotice.htm?textobjid=B94E7C9E5EB6C418]

VTIS / VTMS: At times all vessels, especially small coasters, pleasure and fishing craft may not report to the controlling authorities and navigators should be careful of such traffic. Unless clearly stated VTIS/VTMS services may act in an advisory role only with the final responsibility of safe navigation, which includes ***'preventing collisions'***, resting on the navigators on board a vessel.

BRIDGE DESIGN: Though some standards have been developed, bridge designs primarily depend on the style of individual ship yards, specific requirements by the owners and the type and/or models of equipment installed. Minimum visibility criteria and fields of vision only are mandatory and have been referred to at the end of the explanations of Rule 5. Bridge designs and the array of equipment varies so much that it takes considerable time for a new seafarer on board to get used to the systems, sister ships also may have major differences between them. However, from the day a person joins a vessel, the performance levels expected are of absolute perfection.

HIDDEN PRESSURE: Human beings are well known to take undue risks; sometimes these risks are associated with complacency and at times are self-imposed or due to external pressures. People tend to cut corners or attempt an activity knowing well that the way it is being performed is not as per the normal standard operating procedures. This is a phenomenon of the human mind and thinking. Sometimes it is an individual trying to preserve their name or reputation to show that they can always outperform others and at times it may be because of commercial considerations.

These acts are unknowingly done due to subtle thoughts of an individual concerned and not because of any one directly ordering or pressurising the person on the scene to deviate from the correct norms. This pressure affects individuals to cloud their judgement or decision making so silently that the person affected may not even notice it at all and even the other team members may miss noticing the same. When team members are working together, or for example, an OOW is alone, speaking out the thought process of reasoning and the intended actions acts as a good safeguard to help detect any hidden pressures. Verbalising the thoughts aloud allows the brain to analyse the planned action many times over and helps an individual detect any hidden pressures, once detected a person will normally correct the wrong decisions planned, it automatically also involves other team members who may be present and they are likely to detect any errors in the planned processes. The questioning approach to management explained earlier also helps detect and correct hidden pressure.

NORMALISATION OF DEVIANCE: People are prone to deviate a little from the stated and/or normally accepted norms, without a sense of guilt or remorse, because they rationalise that the minor deviation is insignificant. When the end result is not adversely affected despite this, it creates a sense of complacency and develops into a habit to bend the rules a bit, giving rise to an attitude and behaviour of accepting the risk involved as routine, even though this may be termed as an irresponsible act.

The phrase ***'normalisation of deviance'*** is used to describe this very gradual erosion of safety and quality standards caused by a taking-for-granted attitude that such small deviations are acceptable. This attitude of tolerance for gradual minute diminishing of safety and quality standards tends to gradually lower the accepted standard. Over time the deviance gets accepted as routine. If the lower accepted standard ultimately results in an accident, it takes everyone by surprise. The progressive acceptances of the lowered standards as a norm, that were perhaps initially considered high-risk, reduce the risk perception of the associated hazards.

With specific reference to ***'preventing collisions'***, rationalising the absence of a ***'look-out'*** on some occasions may slowly make it an accepted norm. Other examples are the sub standard performance levels of Radar, or any other navigational equipment, which gradually get accepted as the norm or an acceptable condition of the equipment. From the point of view of navigational skills, not many new generation officers know the correct use of a sextant because position fixing has become very easy with the GPS systems, but if the GPS fails, position fixing becomes a problem in mid ocean. Similarly, over dependence on ARPA or automatic target tracking systems has led to erosion of manual radar plotting skills. The ease of AIS data has led to lower levels of taking visual compass bearings.

Normalisation of deviance develops as a hazardous culture usually born out of hazardous leadership and hazardous management practices and is a major but hidden contributor to the human errors.

VOYAGE PLANNING & PREVENTING COLLISIONS: SOLAS Chapter V, regulation 34 states:

1. ***Prior to proceeding to sea, the master shall ensure that the intended voyage has been planned using the appropriate nautical charts and nautical publications for the area concerned, taking into account the guidelines and recommendations developed by the Organization.***
2. ***The voyage plan shall identify a route which:***

   .1 takes into account any relevant ships' routeing systems;

.2 *ensures sufficient sea room for the safe passage of the ship throughout the voyage;*

.3 *anticipates all known navigational hazards and adverse weather conditions; and*

.4 *takes into account the marine environmental protection measures that apply, and avoids, as far as possible, actions and activities which could cause damage to the environment.*

Link the above ***'sufficient sea room for the safe passage'*** with Rule 8(c) requirement, ***'if there is sufficient sea-room, alteration of course alone may be the most effective action to avoid a close-quarters situation'***, then it is very clear that voyage plans should allow for sufficient and safe sea room in all legs to allow execution of this recommended ***'action to avoid collision'***. This is also linked to a vessel's manoeuvring characteristics; the maximum allowed 4.5 and 5.0 ships length of advance and tactical diameter for a 90° and 180° turn respectively as explained in the basic ship handling chapter. In reality most vessels are able to turn in much shorter distances than the maximum allowed and thus the importance for an OOW to know the ***'handling characteristics of their ship'***. Voyage planning should be with the concept of safe margins on either side of the plotted track.

It has been frequently observed that with accurate position fixing there is a very strong tendency for navigators to rigidly follow the plotted course lines and allow just marginal cross track variations or sometimes not at all, not even to execute ***'action to avoid collision'*** in compliance with Rule 8(c) that, ***'alteration of course alone may be the most effective action to avoid a close-quarters situation'***. At times charted tracks are too close to dangers allowing little sea room for comfort, usually done as short cuts for commercial considerations to achieve minimum distance with the confidence that position fixing will always be accurate.

There have been numerous cases of grouping of vessels at certain key turning points and within TSS leading to dangerous situations. Vessels are known to have gone too close to each other in traffic lanes and some overtaking vessels have collided with the ones being overtaken simply because there was a tendency to maintain positions on the planned track and reduction of speed was not resorted to by the vessels overtaking, apart from a hesitation to leave a traffic lane and go out.

On 28th May 2001 an oil tanker in ballast named 'Rowan', collided with a smaller vessel 'Singapura Timur' while overtaking her within a traffic lane in the Malacca straits around 0240 in the morning. The 'Singapura Timur' sank soon thereafter, though all its crew were rescued by 'Rowan' the vessel was arrested. When the vessel was released after the usual legal process and financial guarantees, the OOW and the rating on look-out duty were detained for investigations along with the master, who was not even physically present on the bridge. When released on bail, their professional documents were seized by the court while the case went on, effectively prohibiting them from gainful employment for almost 2 years.

The OOW on the Rowan was reluctant to allow his vessel steer away from the charted course; he also was under the impression that he had to maintain his vessel inside the traffic lane though there was ample deep and safe water outside. The Rules actually do allow this ***'to avoid immediate danger'***. *It is also believed, that passing the smaller vessel at too close a range and at full speed may have induced interactive forces leading to the collision. Some of the websites containing information about this collision are:*

http://www.ipsofactoj.com/highcourt/2003/Part4/hct2003(4)-004.htm

http://www.ibiblio.org/maritime/Scheepvaartnieuws/Pdf/scheepvaartnieuws/2001/29-5-2001B.PDF

http://www.imo.org/includes/blastDataOnly.asp/data_id%3D8934/4.pdf

JUDGEMENT & DECISION MAKING: Watchkeeping at sea is normally a combination of activities of one qualified watchkeeping officer assisted by a rating as and when necessary. Doubling up of watches or the availability of master is not a routine activity, it is only in certain critical areas of a voyage like passing areas of restricted sea room, high traffic density, when experiencing heavy weather or sometimes in restricted visibility or any combination of any of these or other factors affecting safe navigation.

The way an OOW interprets, analyses, judges and acts in any situation will determine the outcome and therefore a lot of responsibility rests on them. Using all available information, cross checking the same from all sources coupled with their full and proper interpretation, to decide the best action and execute it in a sensible and logical manner are keys to good judgement, decision making and successful, efficient and effective operations.

Causes of accidents are frequently stated as human error, lack of teamwork, not having situational awareness, failure to apply the Rules and so on. But effective team work or work by a sole watchkeeper can be practiced successfully only and only when the professional competence of all the team members is of the highest order and they all think and work on similar professional wavelengths.

The following best advice from a long time practicing mariner Capt. Rastom M.A. Mody, ex Dufferin 1958-1960 batch, an active seafarer from 1960 to 1997 of which in command from 1971 and one whose vessels never did suffer any collisions or any other navigational accidents, may be found useful.

"Prevention has always been better than cure. While it is prudent to go by the collision prevention Rules, it is also important never to get trapped in a dangerous situation caused by the failure of someone else whose duty it was to give-way. Always take preventive action long before a situation develops into one of close-quarters or with a possibility of collision.

To assume that the navigators on the other vessel may not follow the rules due to ignorance, sheer laziness or even plain stupidity has helped create a pro active environment. That is always practice prudent navigation to ensure early action by your vessel and never allow a situation to even migrate close to grief.

Knowledge of the Rules is a must, but their application must be backed up by firsthand knowledge and practical ability of ship handling. Simply said, better to be always safe than ever sorry".

Like **'defensive driving'**, **'defensive navigation'** is one of the many methods of managing ***'risk of collision'*** and is effective as the above comments prove.

SITUATIONAL AWARENESS: A full analysis of the existing scenario, as the name suggests is awareness of the situation as to what all is happening, what is anticipated and any actions required to maintain safe navigation which can be contemplated in advance and planed. Knowledge and experience play an important part in maintaining situational awareness as do alertness, attention and presence of mind of the individuals involved at any given time. Situational awareness plays an important role in effectively managing and mitigating ***'risk of collision'***.

Having complete, accurate and up-to-the-minute **'situational awareness'** is essential for successful decision-making in the management of dynamically operational activities where technological and situational complexities influence the person in control. Situational awareness is the perception of the various operational elements within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future. It is important and linked to the perception of the activities by the people in control in any complex and dynamic activity like marine navigation, aviation and power plant operations but also in very routine but complex tasks such as driving a vehicle on the road or cooking in the kitchen.

Situational awareness involves being aware of what is happening around to understand how information, events, and actions will impact the expected goals and objectives, both at present and in the near future. Lack of or inadequate situational awareness has been identified as one of the primary factors in accidents attributed to human error. It is especially important where the information flow is relatively high and poor decisions may lead to serious consequences.

This term has evolved in the aviation industry where one study found that 26.6% of the accidents took place due to unsatisfactory decision making even though sufficient information was available for failure of situational awareness. In the maritime sector also there is a fair amount of similarity and it is usual to see reports which state that the master, the OOW and/or the pilot failed to assimilate all available information leading to a collision, contact or stranding.

Situational Awareness is also described as a function of perception versus reality and requires that all information is received and analysed factually to arrive at decisions which are executed, a factual approach to judgement and decision making is important, not ones based on wishful thinking. However, while training helps in this aspect, there is nothing which can be done to ensure that a team will pick up on all the available information available from many sources leading to an overdose and the danger of over reliance on automation being always omnipresent.

All requirements on watchkeeping directly or indirectly address situational awareness without naming it. Paragraph 21 of STCW Code section A-VIII/2 for example requires that:

Relieving officers shall personally satisfy themselves regarding the:

.1 standing orders and other special instructions of the master relating to navigation of the ship;

.2 position, course, speed and draught of the ship;

.3 prevailing and predicted tides, currents, weather, visibility and the effect of these factors upon course and speed;

.4 procedures for the use of main engines to manoeuvre when the main engines are on bridge control; and

.5 navigational situation, including, but not limited to:

.5.1 the operational condition of all navigational and safety equipment being used or likely to be used during the watch;

.5.2 the errors of gyro- and magnetic compasses;

.5.3 the presence and movement of ships in sight or known to be in the vicinity;

.5.4 the conditions and hazards likely to be encountered during the watch; and

.5.5 the possible effects of heel, trim, water density and squat on under-keel clearance.

Each and every point, if adhered to, will help achieve situational awareness. Analysis and interpretation of the existing situation and then projecting it into future to visualise what is the expected outcome is the key. That is ***'any action to avoid collision' – 'does not result in another close-quarters situation'*** as stated in Rule 8(c) and Rule 8(d) again addresses this element by stating, ***'action taken to avoid collision with another vessel shall be such as to result in passing at a safe distance. The effectiveness of the action shall be carefully checked until the other vessel is finally past and clear'***.

Nothing to do with preventing collisions, but contrary to the advise in most text books on chart work or voyage planning in several publications, on board most vessels a line with an arrow is marked parallel to the charted course line to indicate the direction to follow. The author is aware of one near miss where an OOW got confused and was steering the vessel on this line, not on the charted course. In another case a fresh 3rd officer told a vetting inspector that this line marks the boundary of the 'no go area', but got confused when the inspector asked, what about the other side? He explained, the 2nd Officer must have forgotten to mark the other side.

RECORD KEEPING: No matter how inconvenient it appears, there is a legal obligation to maintain records of all activities on board. ***'A proper record shall be kept during the watch of the movements and activities relating to the navigation of the ship'***. *(STCW Code A-VIII/2, paragraph 26).* ***'Operational tests of shipboard navigational equipment shall be carried out at sea as frequently as practicable and as circumstances permit, in particular before hazardous conditions affecting navigation are expected. Whenever appropriate, these tests shall be recorded. Such tests shall also be carried out prior to port arrival and departure'***. *(STCW Code A-VIII/2, paragraph 33)*

'All ships engaged on international voyages shall keep on board a record of navigational activities and incidents which are of importance to safety of navigation and which must contain sufficient detail to restore a complete record of the voyage'. *(SOLAS Chapter V Regulation 28 extract)*

Companies usually prescribe suitable guidelines as part of their SMS, sometimes directly in the various log books. All records should ideally be filled in one's own hand writing and soonest after the events in a factual manner. Errors, if any, should be neatly cut and the correct entry made with a signature.

Records are checked as a matter of routine in any audit or inspection but assume a very important role should something go wrong and can be of great help to prove that activities being followed were correct, legal and lawful.

APPLICATION OF THE RULES: The interpretations of the Rules and their best practical application have been explained in the preceding chapters. If the process of ***'preventing collisions'*** was to be shown as a flow chart, it should follow the following sequence.

Part I:

1. Watchkeeping being performed by competent navigators in compliance with the STCW and any additional requirements stated in the SMS.