# Chapter 2: Knowledge Base for Junior Officer

## 2-01 Situational awareness of small vessel Visual lookout

- 2-01 Visual lookout is first and last thing at bridge.
- 2-02 Set up vessel's collision risk Priority?
- 2-03 Make sure what direction target vessel is going?
- 2-04 Can we make sure small vessel's heading?
- 2-05 How can I make sure small vessel's bearing change?
- 2-06 Bearing change is slow, OK or not?
- 2-07 If we cannot make sure which side target vessel is facing us?
- 2-08 Starboard side vessel bearing change to starboard side 3 degrees.
- 2-09 Small boat crossing big vessel's Bow as ritual
- 2-10 Why blind sector is important to us?
- 2-11 First stage in turning: Stern moving only
- 2-12 Take bearing from target vessel stern
- 2-13 Standard maneuvering to avoid collision

## 2-02 Situational awareness of Ocean going vessel Radar lookout

- 2-14 Ocean going and coastal vessel strategy to avoid collision in multiple target encounter
- 2-15 shortcoming of Radar, ARPA lookout
- 2-16 Short-term memory or Working memory?
- 2-17 Many problems common to ARPA, do not affect AIS
- 2-18 Graphical situational awareness in Radar Lookout
- 2-19 Aware ownship Speed vector in ARPA
- 2-20 Aware target's speed by ownship speed vector
- 2-21 Aware Collision line and collision spot in ARPA
- 2-22 Aware Collision risk and collision time in ARPA graphical
- 2-23 Aware collision risk by changing ownship speed vector time
- 2-24 Aware collision risk by changing ownship speed vector direction
- 2-25 Aware big imaginary ownship with other vessel collision risk area on screen.

## 2-03 Situational awareness of ARPA/ECDIS/AIS/VHF

- 2-26 ARPA track, process, simultaneously display and continuously update.
- 2-27 ECDIS
- 2-28 SHIPBORNE AUTOMATIC IDENTIFICATION SYSTEM(AIS)
- 2-29 Graphical display of AIS
- 2-30 INHERENT LIMITATIONS OF AIS
- 2-31 USE OF AIS IN COLLISION AVOIDANCE SITUATIONS
- 2-32 USE OF AIS IN NAVIGATION
- 2-33 VHF: Use of VHF as Collision Avoidance Aid
- 2-34 Open Chart Plotter Navigator
- 2-35 An ideal presentation together with AIS signal
- 2-36 Make full use of Radar echo trail
- 2-37 Ship switch off AIS cause collision case

## 2-04 COLREG Part A- General (Rules 1-3)

- COLREG Rule 1 paramount clause: High seas and overriding authorities

COLREG Rule 2 Nothing shall exonerate any vessel, or the owner, master or crew
A departure from these Rules necessary to avoid immediate danger.
COLREG Rule 3 General definitions
2-05 COLREG Part B- Steering and Sailing (Rules 4-19)
Section 1 - Conduct of vessels in any condition of visibility (Rules 4-10)
COLREG Rule 4 Section 1 Apply in any condition of visibility
COLREG Rule 5 Look-out
COLREG Rule 6 Safe Speed
COLREG Rule 7 Risk of collision
2-06 Horizontal Bearing consideration
2-38 Vessel of 400 meters long at 4 nm distance horizontal bearing is 3.095 degrees.
COLREG Rule 8 Action to avoid collision
2-39 Ownship relative bearing change should be larger than blossom effect.
2-40 Three stages of ownship speed reduction: slow down, stop at sea and go backward.
COLREG Rule 9 Narrow channels
2-41 Local authority of Narrow channel or fairway has special rules override COLREG.
COLREG Rule 10 Traffic separation schemes
Section II - Conduct of vessels in sight of one another (Rules 11-18)
COLREG Rule 11 Rules in Section II Apply to vessels in sight of one another
COLREG Rule 12 Sailing vessels (omit)
COLREG Rule 13 Overtaking
COLREG Rule 14 Head-on situation
COLREG Rule 15 Crossing situation
2-42 Overtaking, Head-on or crossing is decided by relative bearing of target vessel.
COLREG Rule 16 Action by give-way vessel
COLREG Rule 17 Action by stand-on vessel
2-07 Vessel's obligation varied by COLREG, VHF, VTS or Pilots
2-43 Vessel's obligation in three stages of collision avoidance
COLREG Rule 18 Responsibilities between vessels
Section III - conduct of vessels in restricted visibility (Rule 19)
COLREG Rule 19 Conduct of vessels in restricted visibility
2-44 Possible relative bearing of different speed vessels which have collision risk
2-45 Sailing instructions received from VHF, VTS vessel traffic service or Pilot Station
2-46 Visual lookout techniques: best backup lookout on bridge
2-47 Too many faiths in ARPA is not nature.
2-48 Knowing COLREGS - some graphic information to clear the smoke

## Figure

FIGURE 2-01 FIRST WATCH: VESSEL JUST SAILED OUT OF HOME PORT
FIGURE 2-02 DETERMINE TARGET VESSEL DISTANCE BY SOLAS REGULATION OF VISIBILITY
FIGURE 2-03 SEE ANOTHER VESSEL AHEAD OR NEARLY AHEAD?
FIGURE 2-04 WHAT DID YOU SEE ABOUT TARGET VESSEL MOVEMENT?
FIGURE 2-05 WHAT DID YOU SEE ABOUT TARGET BEARING CHANGE?
FIGURE 2-06 BOW CROSSING BY SMALL BOAT. YOUR FIRST LOOKOUT LESSON IN FAR EAST.

FIGURE 2-07 VISUAL BLIND SECTOR: 500 METERS AHEAD OR TWO OWNSHIP'S LOA.
FIGURE 2-08 DISTANCE OF ADVANCE SHOULD INCLUDE BLIND SECTOR
FIGURE 2-09 HORIZONTAL ANGLE AUGMENT AND RB CHANGE OF APPROACHING VESSEL
FIGURE 2-10: SOP FOR COLLISION AVOIDANCE IN SINGLE AND MULTIPLE TARGET VESSEL
FIGURE 2-11: WORKING MEMORY TEST
FIGURE 2-12: 6 MINUTES TRUE MOTION SPEED VECTOR AND 3 MINUTES TRUE MOTION TRAIL
FIGURE 2-13: ARPA, UTC 1517 HOURS, THREE MINUTES AFTER UTC 1514 HOURS.
FIGURE 2-14: ARPA, 6 MINUTES TM SPEED VECTOR AND 3 MINUTES COLLISION RISK AREA
FIGURE 2-15: ARPA, 3 MINUTES TM SPEED VECTOR IS SAME AS IMAGINARY BIG VESSEL
FIGURE 2-16: ECDIS SCREEN, WITH AIS 2 MINUTES SPEED VECTOR DISPLAYED
FIGURE 2-17: OPENCPN SCREEN, UTC 1514 HOURS WITH 6 MINUTES SPEED VECTOR.
FIGURE 2-18: OPENCPN OVERLAPPED ON ARPA SCREEN, UTC 1514 HOURS
FIGURE 2-19: RADAR ECHO WITH 3 MIN TRAIL PRESENTATION, RELATIVE MOTION, OFF CENTRE.
FIGURE 2-20: 20 METERS BOAT, TWO MAST SAIL BOAT, THREE SIDE WINDOWS POWER BOAT.
FIGURE 2-21: MEETING SITUATION BY RB OR RELATIVE POSITION OF TARGET VESSEL
FIGURE 2-22: VESSELS OBLIGATIONS IN COLLISION AVOIDANCE VARIED BY DISTANCE
FIGURE 2-23: POSSIBLE RB OF DIFFERENT SPEED VESSELS HAVE COLLISION RISK
FIGURE 2-24: AS CHAPTER 1 FIGURE 19 SANCHI'S X BAND RADAR DISPLAY AT 1939LT

# 資淺船副的知識基礎

海上的資淺船副與乙級船員不同的是，他有 STCW 所發的適任證書，這是一種國際標準。在實際的海上，我們認為這一些當值船副，是一群年輕人擁有使用雷達，阿帕，電子海圖等等航儀的執照，但是並不一定真正瞭解，航海儀器潛在的風險，與現場優先順序如何調整。公司與學校曾提醒他們，什麼樣的危險應該要注意，但是沒有人知道，情況發生的時候，他們真正的反應。對年輕船副來講，知識層面的警覺，是我們在使用航海儀器和當班的一些常識，只是我們將把它做一個分類整理，方便年輕的船副利用，來產生他所需要的情境感知。

2-01 視覺瞭望是我們在駕駛台做的第一件，也是最後一件事。

圖形 2-01 剛從母港開出的船隻。

本輪剛剛從母港開出，幸運的是，外面船隻的數量並不多。你的手正在雷達的軌跡球上操作，練習如何來取得可變距離圈以及電子方位線的資料，如何安排我們的速度向量線與目標船尾跡的長度，都需要調整。此時一位老先生，站在駕駛台門口的窗戶旁邊，開口說道，“長官，左舷有一條船橫越”，“ＯＫ，讓我檢查一下”你回答。"不，不，長官，我確定”他繼續說著呢。喔！屁啦，是急什麼？為什麼一個 AB 能夠對兩船相遇的態勢，如此確定？但是你並沒有說什麼，你是一個新手，而且還搞不清楚狀況，那到底是什麼問題呢？

接班時，你應該向駕駛台的窗戶外先看看，如果你目視瞭望訓練得還可以。目視瞭望應該看些什麼？是你還是航海實習生的時候，在駕駛台應該學到的技術，這應該在你得到適任證書之前，就要會的。

第一件事搜尋他船對本船距離的線索，在左舷，我看到水面反光跟航跡流，和一些比較小船隻的花開效應，跟我們的貨櫃比起來，這應該是我們要注意的線索。

在左舷，現在看到的有四條船，第五條在右舷的小船，應該有一兩海浬，還沒有花開效應，我如何知道他們的距離與視角？（也就是那一舷面對本船？）要怎麼樣處理這些船？是否該使用望遠鏡？

第五條在右舷的船隻，一個燈是否可能是大船的一盞尾燈？或是小船的桅燈？他的水線非常接近本船船頭的盲區，這是另外一個目標船距離的線索，乙級船員可能沒有這一方面的知識。下面是海上人命安全公約駕駛台視線盲區的規定，在第五章規則 22，從駕駛台操縱位置被遮蔽海面的距離，不得超過從駕駛台到兩倍船長或者是 500 公尺的距離，以其中較低著為標準。

所以我們要劃一條看不見的水平線，依照海上人命安全公約對盲區距離的要求來看，圖形 2-02 上，右舷的船隻是在這條水平線之前，所以他的距離是超過 500 公尺，左舷這兩條船是在這一條盲區的線上，這是一個很清楚的距離指示，所以不管他是大小船，他的距離呢都是本輪船頭前面 500 公尺左右。

加上他們甲板燈光的花開效應，以及水面反光，或是在我們駕駛台玻璃的白色餘輝，這些呢都可以讓我們對他們的距離，提供更多有信心的判斷。

圖形 2-02 使用海上人命安全公約盲區的規定，決定目標船的距離。

# Knowledge Base for Junior Officer

A junior officer at sea is different from rating by his competence license of OOW which is an honor of STCW compliance in international standard.  In the real world we see these OOW as bunch of young man who have the license to use Radar, ARPA, ECDIS etc., but not really understand what potential danger incorporated in it and at scene. Company and school had reminded them what danger should be careful. No one knows what their real reaction will be when the situation arises. Knowledge base awareness for Junior Officer basically are common scenes we used in navigational instruments and collision avoidance which we categorized those into useful hints for situational awareness of a beginner.

圖形 2-01 剛從母港開出的船隻

Vessel just sailed out of home port. Luckily, the traffic is not heavy outside. Your hands are on Radar tried to familiar with track ball usage of VRM (Variable Rang Mark) and EBL (Electrical Bearing Line). How to arrange speed vector and target’s trail length? An old man stands before window beside

bridge door asked “Sir, there is a vessel crossing in port side.” “Oh! OK! Let me check” you said. “No, no, Sir, I’m sure” he resumed. Oh! Hell! What’s the rush? How can you an AB so sure about it? But, you did not say anything. You are a rookie and you don’t know nothing yet. What’s wrong from here?

## 2-01 Visual lookout is first and last thing at bridge.

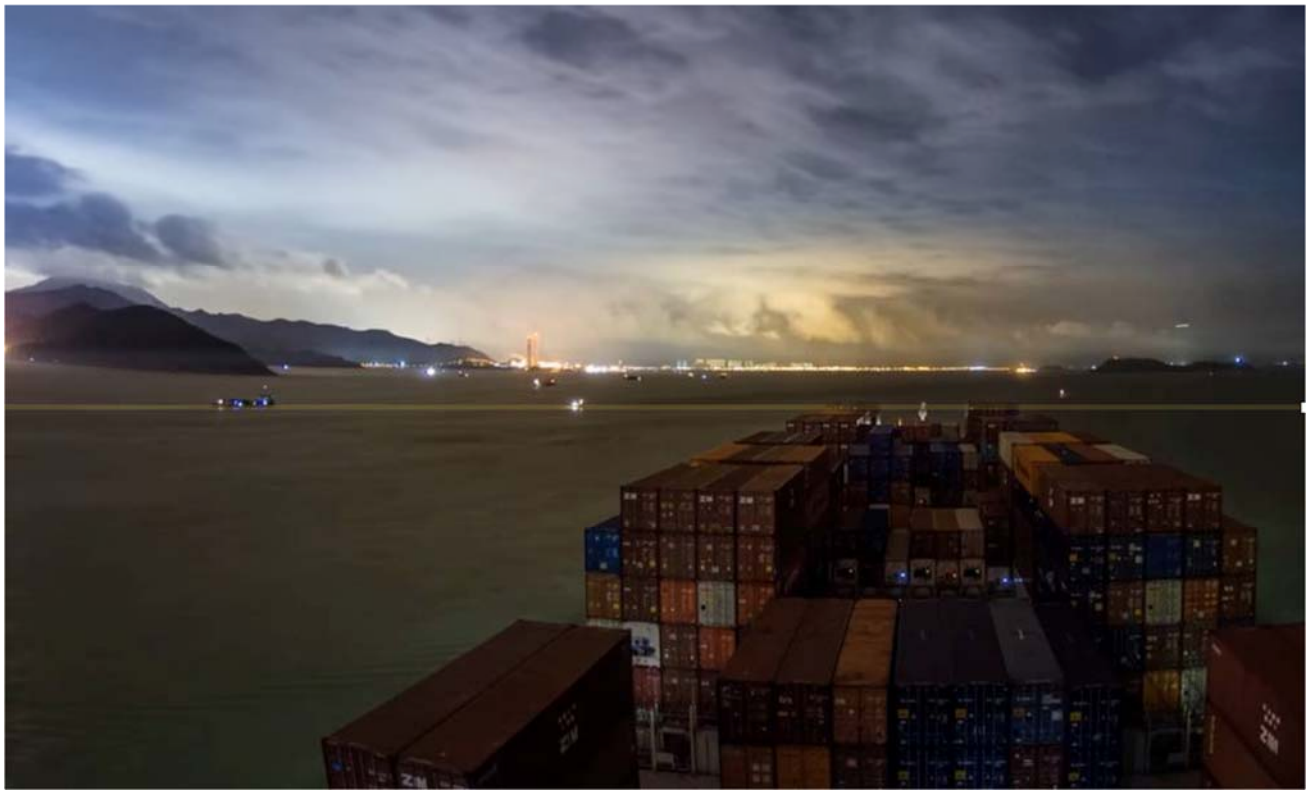
You should look out bridge window first if you had trained well in visual lookout. What to look at is the lesson you should have while you are a cadet officer on bridge before you got this COC certificate of competence of OOW. First thing is to search clues of their distance to us. In portside, I saw the reflection and wake current or few lights of relatively small vessel compared with our containers on board, see Figure 2-01. There are four vessels visible on portside now. Fifth one in starboard side one or two miles range or more with no blossom effect. *How can I know their distance and their aspect (which side is facing ownship)? What to do about these vessels? Should I use the binocular now?*

Fifth one is in starboard side: One light may be a stern light of big vessel or masthead light of a small vessel? Her water line is very close to ownship’s blind area (another clue of target’s distance not knowing by AB):

**SOLAS chapter V REGULATION 22 - Navigation bridge visibility**

*The view of the sea surface from the conning position shall not be obscured by more than two ship lengths, or 500 m, whichever is the less.*

Let’s draw an invisible horizon according to SOLAS visibility requirement: 500 meters from bridge conning position. In Figure 2-02. Starboard bow vessel is ahead of this horizon, her distance is more than 500 meters. Those two vessels on portside are on this visibility line, no matter it is a big vessel or small vessel. This is a clear indication of their distance: 500 meters ahead of ownship’s bridge. Together with their deck lights and reflection on water and glare of white light all give us more confidence of our distance judgement.



圖形 2-02 使用海上人命安全公約盲區的規定，決定目標船的距離。

## 2-02 設定碰撞危機的優先順序

如果兩條船與本船的距離相同，相對方位比較小的船隻，應該是我們優先瞭望的物件。相對方位比較小的船隻，有可能是迎艏正遇的情況，也就是兩條動力船隻，在相反或接近相反的航向航行，具有碰撞危機時，兩船都應該向右轉，以避免碰撞。迎艏正遇的相對速度非常快，比其他相遇情況更快。當一條船可以看到另外一條船在其船頭，或是接近船頭的位置，在夜間他能看到迎艏正遇的情況是，在船頭方向可以看到另外一條船的桅燈在一條線上，或是接近一條垂直線上。船頭方向，或接近船頭是當值船副在駕駛台，可以觀測到較小的相對方位。這是也是人類觀測的限制之一，當我們駕駛汽車時，這叫做隧道效應。人可以看到相對方位的角度，會依照開車的速度，在前方變小或是變大。當我們開的慢一點，我們的大腦可以處理資訊的角度比較大，就像騎腳踏車時，我們也能同時觀察，在身邊的各種事物，但開得快一些，我們的大腦就不能處理所有事物。我們的大腦就像開入隧道一樣，我們只能看到正前方出口附近，相當的視角，其他的視角都看不到。這在開車時，是自然反應，但是開船時，就像騎腳踏車時，會搞不清楚優先順序。

避碰規則第14條（b）碰撞危機應該認為發生，當看到他船在其船頭，或接近船頭，或是在夜間，當可以看到另外一條船的桅燈在一條線上，或是接近一條垂直線上，亦/或 看到兩盞舷燈。在白天，看到他船類似的視角。

**當你遇到他船在船頭或接近船頭方向時，不論他是否在相反的航向上，碰撞危機應該認為存在。**這是因為他船的航向或是視角，是很難在第一眼，就能用視覺和雷達來確定。認為碰撞危機存在，並不表示本船必須立刻採取避碰行動。我們必須先確認他的方位變化（碰撞危機），依照避碰規則第7條的定義。我們必須在本輪採取避碰行動時，應該先對目標船的動向，做一個確認。目標船的動向，應該並不光是他的羅經方位變化，我們可以同時確認他的航向 航速 CPA 等等，這樣比較好。

在避碰規則第 14 條（b）當看到他船在其船頭，或接近船頭，或是在夜間，當一條船可以看到另外一條船的桅燈在一條線上，或是接近一條垂直線上，亦/或 看到兩盞舷燈。在白天，看到他船類似的視角。這些航行燈與視角的觀測，對遠洋船隻是很有用的。對漁船或是小型船隻，就很難分辨它是什麼樣的燈光？或它在顯示什麼樣的燈光?圖形 2-03 我們設定瞭望的優先，給在左舷的一號目標船，因為他的距離最近。右舷的目標相對方位最小，但是距離仍然離近接的情況很遠，沒有花開效應或是水面的反光。一號目標船不是迎艏正遇，而且他也不在本船的船頭，造成被追越的情況。**通常船隻的相對方位超過本船前桅左右 10 度，就不認為是迎艏正遇的情況，**如果來船超過這 10 度的相對方位，即使兩船是以相反的方向航行，也沒有碰撞危機的發生。這個我們會留到下一章學習或是你可以自行證明，在雷達測繪圖紙上面，或是其他的測繪工具上證明。

圖形 2-03 他船在船頭，或接近船頭的位置。

## 2-02 Set up vessel's collision risk Priority?

If two ships have same distance from ownship, the one has small relative bearing angle (bearing measured from our fore mast) should has first priority in lookout. Vessel with smaller relative bearing are more likely to have an head-on situation (*When two power-driven vessels are meeting on reciprocal or nearly reciprocal courses so as to involve risk of collision each shall alter her course to starboard*) where relative speed of two vessels are fastest than other situation. Head-on situations are only *exist when a vessel sees the other ahead or nearly ahead and by night she could see the masthead lights in line or nearly in line and/or both sidelights. "ahead or nearly ahead" vessels* have smallest relative bearing as OOW can observe at bridge.

Seeing target vessels at smaller relative bearing range is also part of human limitation which we will also experience when driving a car which Called: **Tunnel Effect**: **The relative bearing we can see in our vision ahead narrowed w\ourt driving speed is faster.** When we drive slower our brain can handle more vision angle ahead us like we riding on a bike we can see everything around us. When we drive faster our brain cannot handle all vision ahead it would like driving into a tunnel we can only see fewer vision angle like

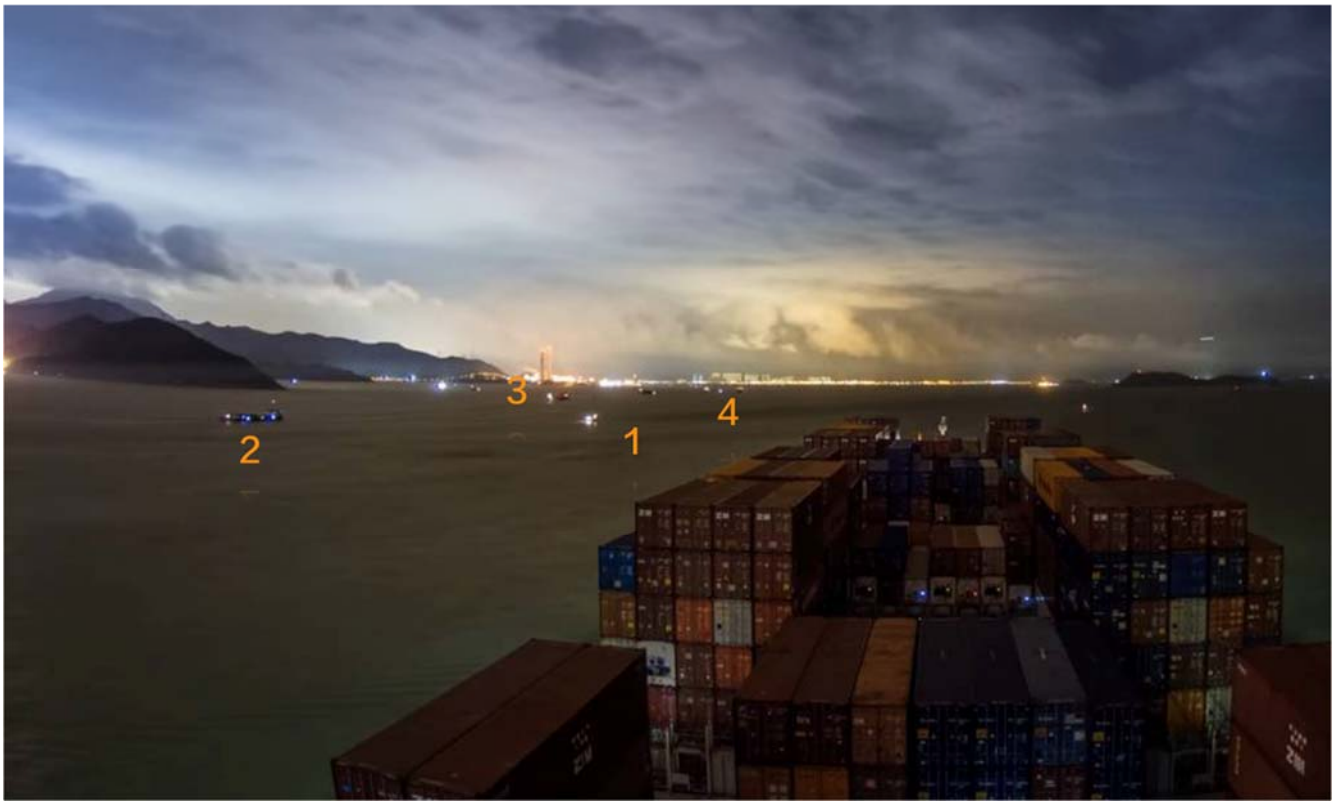
driving in a tunnel with relative smaller angle of vision. If ownship moving faster our attention would focus on things ahead of us automatically. Part of reason for this reaction is target's relative movement is slower ahead and faster in abeam direction. **If our memory capacity is not enough, we will ignore peripheral targets in order to focus on forward one**. In COLREG term, we will focus on head-on first than crossing situations. The target forward has higher relative speed if both vessels in reciprocal course as Head-on situation in COLREG: Rule 14

> *(a). When two power-driven vessels are meeting on reciprocal or nearly reciprocal courses so as to involve risk of collision.*
>
> *(b). Such a situation shall be deemed to exist when a vessel sees the other ahead or nearly ahead.*

When you meeting other vessel ahead or nearly ahead whether it is on reciprocal courses, collision risk shall be deemed to exist. This is because other vessel's course or aspect is hard to tell by first sight in visual or radar but the time available to do proper action is limited. So, Collision risk shall be deemed to exist which does not mean ownship have to take action immediately. We have to ascertain their bearing change (collision risk) according to COLREG rule 7. **Before ownship take avoidance actions another vessel's movement should be ascertained first. This is a golden rule**. Target's movement is not only her compass bearing change, if we can make sure their course, speed, CPA….etc. would be better. (nowadays, maybe by AIS data) In rule 14 (b) said:

> *when a vessel sees the other ahead or nearly ahead and by night she could see the masthead lights of the other in a line or nearly in a line and/or both sidelights and by day she observes the corresponding aspect of the other vessel*.

These lights and aspect of vessel ahead are useful for ocean going vessels. For fishing or small vessels, it is hard to tell what lights they are showing. Figure 2-3 we set lookout priority to number one target vessel at port side due to its distance closer to ownship. Starboard side target has smallest relative bearing but his distance is not in close quarter range, no blossom effect and no reflection on water. No. 1 target is not in head-on situation and she is not assumed as overtaking situation. **Usually, vessels relative bearing over 10 degrees to both side of ownship's fore mast are not deemed as head-on situation(although COLREG had not specified this)**. Outside this relative 10 degrees bearing sector even two vessels have reciprocal courses it will not have collision risk with ownship. The reason will be left for junior OOW to study in next chapter or you can verify it on maneuvering board or radar plotting sheet by yourself.



圖形 2-03 他船在船頭，或接近船頭的位置。

## 2-03 確認目標船的去向

看看這圖形 2-03，天啊！饒了我吧！誰能看一眼，就告訴我一號目標船的燈光顯示是什麼？本輪船長已經有很嚴格的規定，並且寫在他的值更命令簿上：“如果你不能確認，目標船前進的方向，就不要採取任何避讓的行動”。船長是對的，為了符合他的要求，我們必須確認這條目標船的前進方向。最簡單的就是去確認他的船首向，檢查他的視角，換句話說，確認他是哪一舷面對本輪，左舷或是右舷，（請參考第一章）。

如果我們能夠確認，是左舷對左舷，那我們就能夠清爽通過。如果他的視角，是他的右舷對我們的左舷，我們需要更進一步觀測他的方位變化，來判斷他的船首向。一旦我們確認它的船首向，我們就能夠採取適當的措施，來避免碰撞。

## 2-03 Make sure what direction target vessel is going?

Look at Figure 2.3. Mama Mia. Give me a break. Who can tell me in first sight what lights this no. 1 target vessel are displaying now? Captain have given us a strict rule and written in his standing order: **If you cannot make sure what direction target vessel is going? Do not take any action to avoid**. Captain is right. To comply his order, we have to make sure what direction this target is going. The easiest way to make sure her heading is by checking his aspect i.e. make sure which side she is facing ownship? Port side or starboard side. (refer to chapter one) If we can make sure this vessel meeting situation is port to port then we are clear. If the aspect seems her starboard to our portside we will need further observation on her bearing change to judge her heading later. Once we make sure her heading, we can take necessary actions to avoid the collision.

## 2-04 我們能否確認小船的船艏向？

即使使用望遠鏡去觀測核對，仍然無法知道他的船頭和船尾在哪裡？要解決漁船這些神秘的燈光，是浪費時間。我們應該利用漁船或小船的方位變化，來估計他的船艏向。1 號目標船在圖形 2-03 上，他的船首向是東北，是 045 度，或是向東 090 度方向，對我們來講，並不重要，**小船相對方位的變化，是向船頭或是船尾通過，才是我們瞭望真正關切的事情。**試著想像這條小船是

哪一舷面對本船？有時候，這就是浪費時間，如同圖形 2-03 一號目標船，已經到了這個距離，瞭望的時間就變得非常寶貴，因為距離近只有 500 公尺。

## 2-04 Can we make sure small vessel's heading?

Even we used binocular to look and check, we still cannot know where her bow or stern located. Try to solve the mystery of fishing boat's light is a waste of time. **We should use target's bearing change to estimate her movement or relative movement.** For number 1 target in Figure 2-03 whether her heading is going northeast $045^0$(T) or eastly direction $090^0$(T) is not important to us. **Her relative bearing change (going ahead or astern) is the thing really matter to ownship in lookout.** Trying to Figure out what side this small vessel is facing us is useless? Sometimes, it will waste our time like no.1 target at Figure 2-3 in this range. The time is precious due to the range is close (500 meters).

## 2-05 如何確認小船的方位變化

當使用羅經來測量方位，我們需要一個與電羅經同步的電羅經複數器（羅經盤），1 個方位圈，已經調整好夜視的一個方位圈，方便在晚上讀取目標的方位。在晚間的海面上，找到我們所需要觀測船隻的燈光，有時候背景燈光很強，或是有曙光，陽光反射很強，要去讀取羅經盤上面的方位數字，有時這是困難的工作，尤其是當有很多的小船，在我們的視線之內。我們的夜間視力，也許需要 30 秒到 1 分鐘的時間，來適應夜間光線的亮度，如果我們是從駕駛台外面的走道，進入駕駛台。

使用目測的羅經方位，有很多困難。如果是使用雷達的電子游標線來讀取目標的羅經方位，是比較簡單一點，但是雷達目標的回跡，時有時無，還要與窗戶外面看到目標的燈光，先做正向的確認，才能開始使用電子游標線來量取他的方位。雷達目標的回跡，在近距離的時候，也許會因為海浪回跡的干擾而消失，如果我們不想失去我們的夜視能力，或在近距離的時候，與海浪回跡的干擾掙扎。如果這時候我們使用目測方位的技術：使用駕駛台現在站立的位置，去檢查目標船方位的變化，在圖形 2-04 如果你需要知道目標的動向，就要與圖形 2-03 相比較。當我們核對圖形 2-03 與圖形 2-04，我們會自動找出一些方位參考點，來確認目標船的方位變化。使用這些方位的參考點，來核對目標的方位變化，需要一些經驗跟練習，如何取得方位參考點，不論是在圖形 2-03 或是 2-04，都需要一些熟悉，**但我們一旦試著如何取得？不論是在圖形 2-03 或是圖形 2-04，我們的大腦就會自動的幫我們找出參考點，**我們在第一章寫的是，如何找到方位參考點？來建立視線以培養我們的工作習慣與直覺。至於為什麼我們沒有辦法處理數位資訊，會在以後討論。在我們核對了這兩組方位數位，目標 1 號與 3 號的方位變化，大約相同，向船尾移動，對本船來講，是安全通過。目標 2 號與 4 號的方位變化非常慢，但也可以接受，因為他們與本船同向。但是對右舷船頭的燈光，我們是有麻煩的，即使我們不知道他要向何處移動？是左舷還是右舷面對本輪，他在我們船頭只有 500 公尺，接近國際海事組織的可見距離的規定，而且我們也看到它燈光，在水面已有些模糊的反光，這些都是我們眼睛現在看到的，我們要如何安排瞭望的優先？或我們現在就應該採取行動？這是我們的直覺嗎？

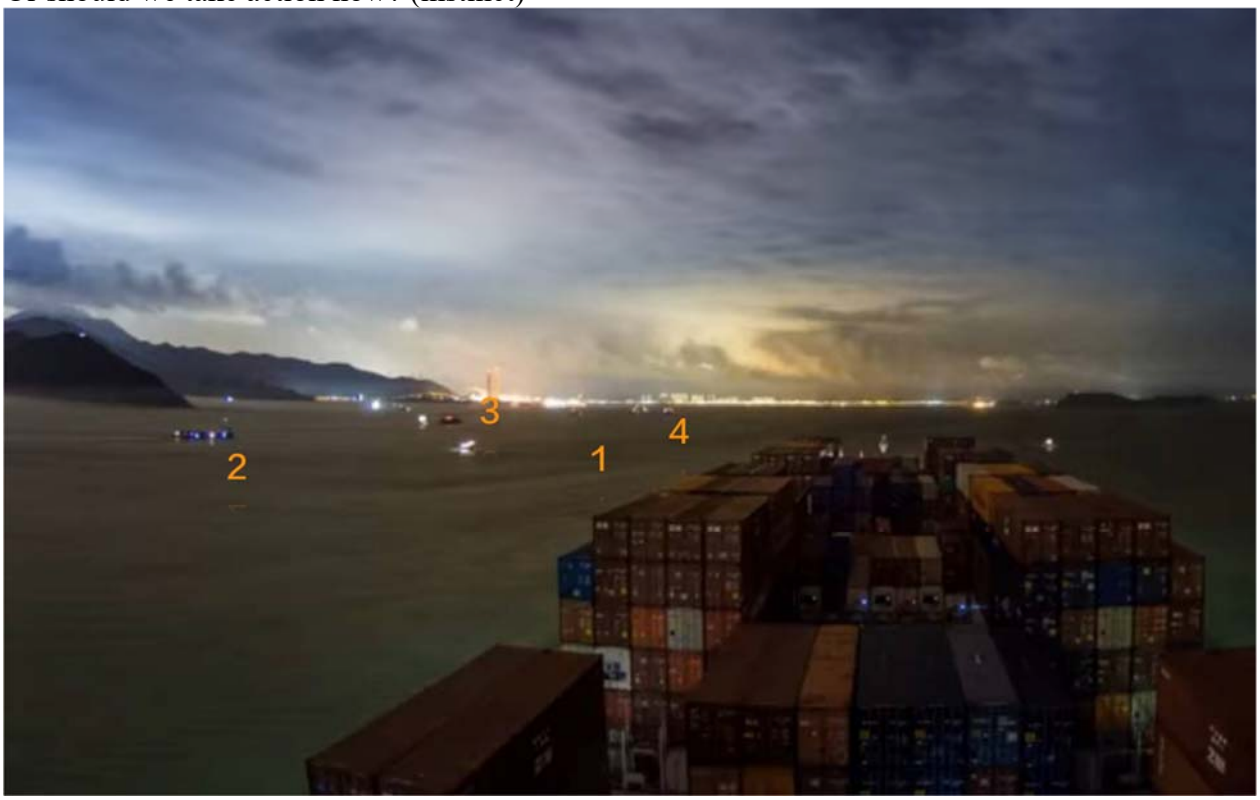
圖形 2-04 看到的目標船動態是什麼？

## 2-05 How can I make sure small vessel's bearing change?

When using compass to take bearing we need a gyro repeater synchronized to master gyro compass, one azimuth circle, adjusted night vision to read the bearing in night or pick up the target correctly from night time or sparkling twilight or sunshine. This is not an easy job if small vessels are lot in sight. In night time, target's brightness may impair by reflection of bridge surrounding light on window, or our eyes need another 30 seconds to 1 minutes to adapt to night vision if we just get into bridge from outside alleyway. It has many inconveniences to use visual compass bearing at night in many ways. By using radar's Electric Bearing Line EBL to read target compass bearing is easier. But radar target echo corresponding to visual target's lights

outside the window need some time to positive identify before we can take her bearing by EBL. Radar echo in question may be lost in close range by sea clutter interference. **If we don't want to lost our night vision or struggle with echo identification in radar there is a better way by using visual bearing checking skills: to stand where you are and use your lines of sight to check target vessel's bearing change.** In Figure 2-04, line of sight is not visible. You need to compare target movement with Figure 2-03. Please look at these two Figures to find out target's bearing change. When we compare Figure 2-03 and Figure 2-04 we will automatic use some reference point on board to help our bearing verification. These reference points for checking target bearing change need some experiences and practices to familiar whether it is in 2-03 or 2-04. Once we try to use one reference mark to compare target's bearing change in these two Figures our brain will find reference points automatically. What we learned in chapter one is **how to find visual reference point to create line of sight to cultivate our working habit and instinct**. The reason why we cannot process bearings change in just one Figure will discussed later.

After we checked on these two Figures, Target No.1 and 3 bearing change is about the same (moving astern) which should be OK to pass (No matter it is port to port or starboard to port). Target No.2 and 4 bearing change is slower but acceptable for they are moving in same direction as ownship (overtaking in port to starboard situation). But, we do have the problem with the white light on our starboard bow (even we don't know where she is heading? whether she is port side or starboard side facing to ownship?). She is about 500 meters ahead of ownship's bow by IMO visibility line we placed in Figure 2-02 and some blurry reflection of her lights on water is evident to our eye now. **How can we arrange our priority of lookout now? (feeling) Or should we take action now? (instinct)**




圖形 2-04 看到的目標船動態是什麼？

## 2-06 方位變化慢，可以嗎？

我們還很幸運，這些目標是小型船隻，不會像妖怪一樣，越變越大，然後擋住我們的去路。讓我們看看圖形 2-05，1 號目標船是從圖形 2-03 的白點，移動到現在的位置，他的方位向本輪的左舷增加約 6 度，他距離本船現在大約是 500 公尺。這 500 公尺的距離乘上 6 度的方位變化，大約是 52.3 公尺,

**500 x Sin ( $6^0$) = 52.3 meters.**

可以創造 52.3 公尺的正橫距離，52.3 公尺距離大約是小船的兩倍全長（30 米小船），兩倍船長的距離，這樣足夠一號目標船安全通過。一號目標船在船頭的 500 公尺距離，是用我們 IMO 盲區的距離，所估計出來的。

如果目標距離本船是 926 公尺（半海浬），我們使用同樣的公式， 6 度的方位變化，能夠產生 96.8 公尺的正橫距離，926 x Sin ( $6^0$) = 96.8 meters.。就這計算的結果，我們的可以綜和一下：對少於 30 米長的小型船隻，只要他的距離有半海浬，他的方位變化 6 度以上，就 OK，可以清爽碰撞危機。（因為 6 度的方位變化，在半海浬的正橫距離是 97 公尺），實際情況可能並不是如此，如果 1 號目標是向前移動，向本輪的船頭接近，也就是向右舷方向移動，照理論，船隻的相對方位有變化，就沒有碰撞危機，事實上，可能因為小船的突然轉向，或機械故障，或在本輪船頭熄火，況且距離這麼近，我們不要冒險，要持續監控。所以這安全通過的規則呢，應該修正為，如果目標向本輪船尾方向移動 6 度，且在半海浬的距離以外，與本輪的碰撞危機是安全的。

## 2-06 Bearing change is slow, OK or not

We are lucky here. Did you know? These targets are small vessel and they did not grow bigger and bigger like a monster then block our way out. Let's take a look at Figure 2-05, No.1 target (from white spot at Figure 2-03 moving to current ship's position Figure 2-04) bearing had increased about 6 degrees to ownship port side. Her distance to ownship now is about 500 meters. This distance 500 meters multiple with 6 degrees bearing change can create 52.3 meters beam distance.

500 x Sin ( $6^0$) = 52.3 meters.

This 52.3 meter beam distance is about two times of small vessel length (about 30 meters) which is enough for no.1 target to pass clear. No,1 target distance 500 meters are derived from visibility limitation ahead of bridge.

If 926 meters is assumed as No.1 target's distance to ownship which are **5 cables,** half nautical mile. We use same calculation: This distance 926 meters multiple with 6 degrees bearing change can create 96.8 meters beam distance.

926 x Sin ( $6^0$) = 96.8 meters.

As the calculation results we had here, can we summarize it as follow:

**For small vessel less than 30 meters while her distance is still half nautical mile away, 6 degrees bearing change is OK to clear collision risk with ownship.** (because the beam distance created by 6 degrees bearing change is 97 meters in half nm distance). Actually, this is not the case. What if No.1 target is moving toward ownship's bow, to our portside direction. So, the rule for passing safely should be:

**Small vessel moving 6 degrees astern in half nautical mile distance away is safe.**

## 2-07 不能確認目標船何舷面對我們？

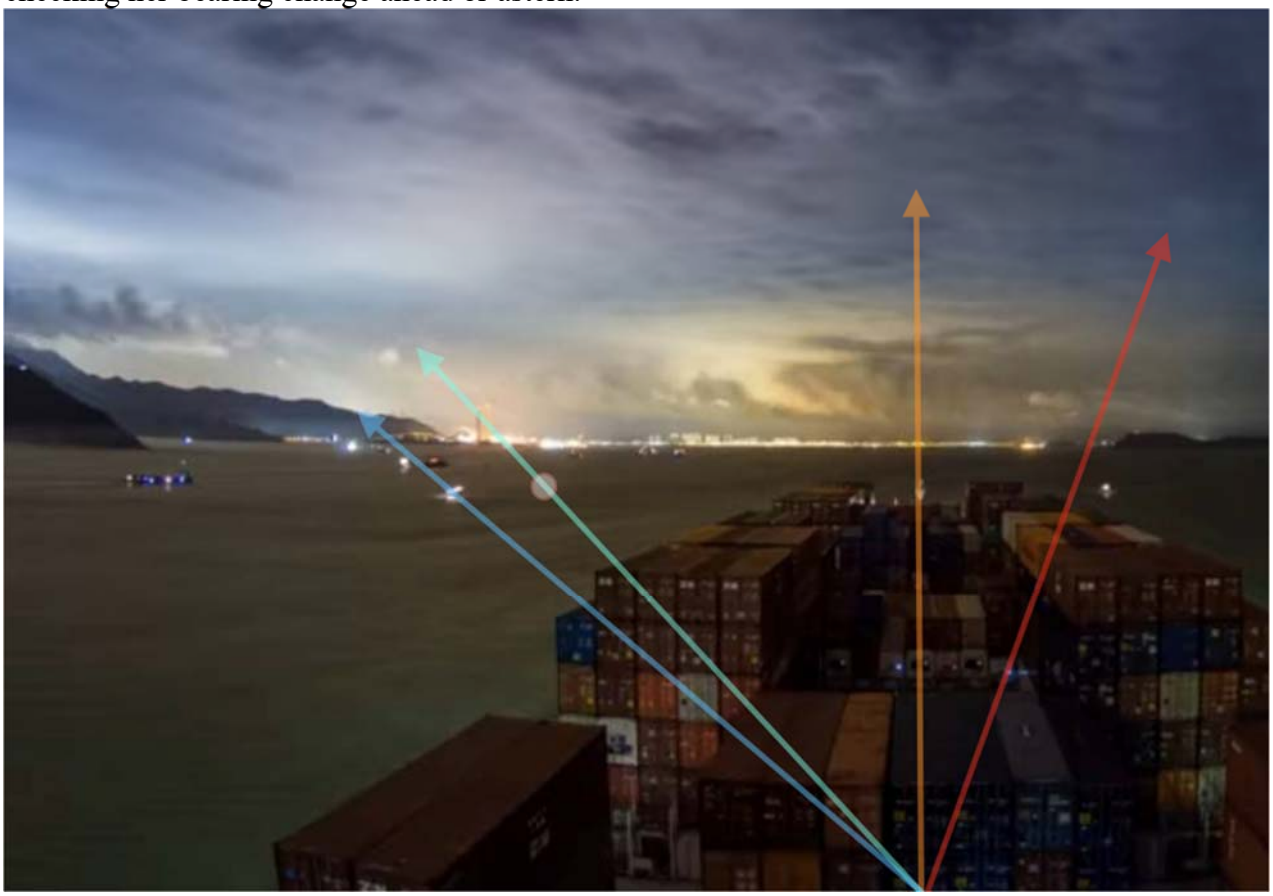
另一個方面，如果左舷的船隻向右舷移動，表示這個目標是航向本船，並且試圖橫越本船的船頭，這就是不安全。在第一章我們討論過來船的視角，目標船的左舷面對本船的左舷，左對左，就是安全。如果我們不能確認目標船是，哪一舷面對本輪？他的方位是在我們的左舷，向左邊移動，這個目標就是安全的，是左對左，或是在左舷被本船追越。判斷碰撞危機時，大船跟小船使用的方法不同，大船是看它哪一舷，面對本船，小船就是看它往什麼方向移動。我們不能浪費太多的時間，在確認小船的排水量，或是航行燈工作燈的構造，我們再看一下圖形 2-04 的 2 號目標，我們不能分辨它的燈光是在顯示什麼？但是我們能夠依靠著對他相對運動的觀測，來決定碰撞危機，這樣就夠了。如果我們不能確認目標船是何舷面對著我們，我們只需要確認他的動態，它的方位變化是朝前？還是朝後？

圖形 2-05 目標船的方位變化，你看到什麼？

## 2-07 If we cannot make sure which side target vessel is facing us?

In another direction, portside vessel moving to starboard side which means this target is sailing toward ownship and trying to cross ownship's bow is not safe. In chapter one we had discussed passing vessel's aspect. If target vessel port side facing ownship's port side is safe, port to port. If we cannot make sure what side target vessel's is facing us but her bearing is moving to port side in ownship's port side then this target vessel is safe, port to port or crossing in portside. **The difference in judging collision risk in big vessel and small vessel** are*:*

**Big vessel is by which side they are facing ownship (make sure her true motion) and small vessel is by which way they are going (make sure her relative motion).** Because we cannot waste too many times in verifying small vessel's displacement or construction of navigation/working lights, etc. Take one more look of target no. 2 in Figure 2-04. We cannot tell what lights she is showing? But we can determine she is going the same direction as ownship by her relative movement. That will be enough for her. If we cannot make sure which side target vessel is facing us, **make sure ownship knows which direction target vessel is going by checking her bearing change ahead or astern.**



圖形 2-05 目標船的方位變化，你看到什麼？

## 2-08 右舷船隻方位變化，向右 3 度

對在本輪右舷的目標船，在圖形2-05上，它的視角，我們並不清楚。我們只知道它被觀測的第一條視線是紅色的，它的方位變化大約是向右舷3度，而且很明顯的有水面反光，這是現在圖形2-05看到的。（在圖形2-03時，這個目標並沒有水面反光）。這些信號都會讓我們有一些危險的警覺，如果你的目視瞭望，可以發現目標方位的變化，與水面的反光。也許目標船正在向本輪接近？或是他的CPA正在快速的減少？或者他是本輪在近距離追越的船隻？右舷的船隻正在向本輪接近，這是確定的，而且他的相對方位有增加，他的相對位置，應該是向本輪的船尾移動，是否我們可以向左轉向5度，加速它通過的過程，然後保留更多的安全距離。讓我們再仔細的看

看，在右舷的船隻，他的位置已經少於IMO 規定的盲區距離，請參照圖形2-02。目標的位置少於IMO 規定的距離，對當值船副來講，代表一個行動的標誌，這個我們會在2-10節裡面討論。

圖形2-06小型船隻橫越船頭，這是你在遠東瞭望的第一課

## 2-08 Starboard side vessel bearing change to starboard side 3 degrees.

For target vessel on ownship's starboard side in Figure 2-03, her aspect is not clear to ownship. We only knew her first observed bearing line is red line of sight: her bearing changed about three degrees to starboard side together with obvious reflection on sea surface now in Figure 2-05(in Figure 2-03, this target has no reflection light on water). These signs all give us a sense (awareness) of danger if your visual lookout can pick up these differences in bearing and reflection on water. Maybe target vessel is approaching ownship now? Or her CPA is not enough and distance is closing quickly now? Or she is overtaken by ownship in close range? This starboard side vessel is closing to ownship is for sure? And her relative bearing had increased which means her relative motion to ownship is moving to ownship's stern. *Can we alter course to portside 5 degrees to speed up the passing process and reserve more safe distance?* Let's take close look again. This starboard side vessel ahead distance is less than 500 meters now for her position is inside IMO required visibility line in Figure 2-05. Target position inside IMO required visibility line usually marked an action signal for OOW on watch. Why? Discuss in 2-10 below.

圖形 2-06 小型船隻橫越船頭，這是你在遠東瞭望的第一課

## 2-09 小船橫越大船船頭是常態

在圖形2-02，我們發現IMO 限制盲區的規定，可以用作距離的輔助線，我們也成功地找到兩條船，在500公尺的線上，1號跟2號目標。我們也討論了，是否對右舷小船讓路？因為他的相對方位只有3度的變化。我們為什麼會如此焦慮？因為他的距離已經少於500公尺。這些船隻離我們越來越近，也就是快要進入我們的盲區內，如果失去視覺的接觸，在盲區之內，這些目標船發生任何事情，我們都無法知道，即使是雷達，也沒有辦法。也許小船會主機故障，舵機失靈，或是纏繞到其他船隻的魚網等等。在港區的拖船，往往在接近本輪船頭的位置，或在我們的盲區裡面工作，他們的安全，是因為本輪經常是減速操作。減速減低到相當低的速度之下，在3-5節的速度內。在海上，如果有船進到盲區，我們的事業就會有很高的不確定性。請看圖形2-07在遠東的海岸和海上，經常會遇到很多的漁船，在近距離橫越本船的船頭，即使進入本輪的盲區，他們也不自覺。請看圖形2-06，這是一個習俗，主要是認為搶船頭，會讓漁獲滿載。這些船在近距離，船副就會有很大的壓力，因為雷達的回跡，會被海浪回跡所遮蔽，如果我們不能熟悉目

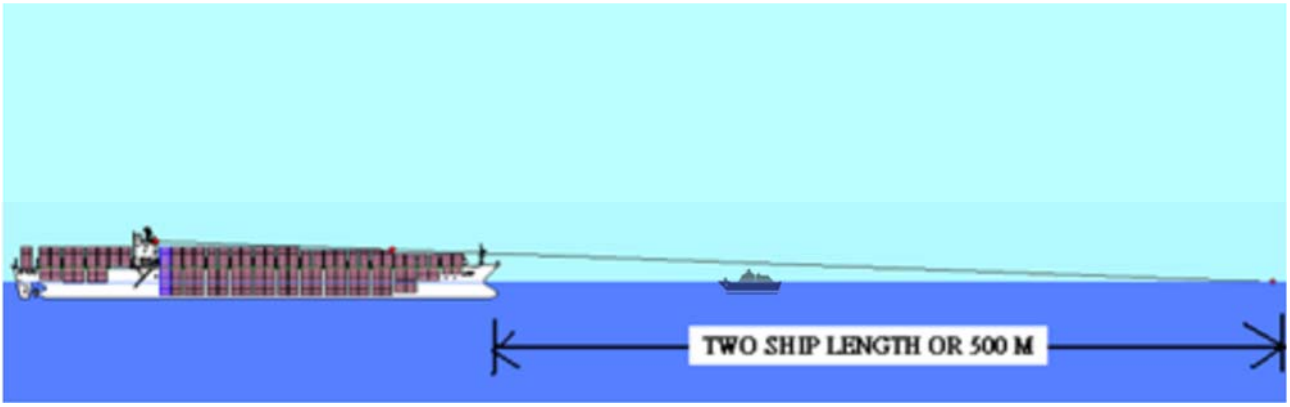
標方位變化目測的技術，使用不可靠雷達回跡，會很難確認它們的碰撞危機。它們的相對方位是向前或向後移動，可以當作有用的安全信號。就0.5海浬現在的距離，到底多少度的方位變化？對小船來說是足夠的，能夠保證他們的安全通過。

圖形2-07視覺瞭望的盲區，船頭之前500公尺或兩倍本船的全長。

## 2-09 Small boat crossing big vessel's Bow as a ritual

In Figure 2-02, we find ownship's visibility line defined by SOLAS visibility regulation can be used as a reference line to us and we successfully found two vessels are at distance of 500 meters line, No. 1 and 2. We also discussed to give way to starboard side vessel which has only three degrees bearing change. The reason why we are so anxious to take avoidance action in less 500 meters distance ahead ownship bow is these targets about to sink inside 500 meters ahead of ownship's bow (into our visual blind sector). **If we lost visual contact with target vessel everything could happen blindly inside our visibility limit.** Maybe those targets will have an engine breakdown or lost steering or foul with her fishing nets, etc. In harbour area tug boat usually worked very close to ownship's bow and inside our blind sector their action is safe guarded by ownship's reduced speed (dead slow ahead with 3-5 knots only). Once a vessel inside this blind distance, our sea career faced serious uncertainty. See Figure 2-07 below.

In Far East coastal or high sea area we experienced lots fishing vessel has the tendency to come across ownship's bow with very close range even inside our blind sector. See Figure 2-06 above. This is a ritual to beg for good harvest in fishing. When these vessels are crossing in close range OOW are under extreme pressure for radar echo may lost by sea clutter depression setting. If we are not familiar with visual target bearing change skills we will have very hard time to verify collision risk by unreliable radar echo. Their relative bearing moving ahead or astern could be a useful sign of safety. How many degrees bearing change for small vessel is enough for safe passage at current distance of 0.5 nm ahead now?




圖形2-07視覺瞭望的盲區，船頭之前500公尺或兩倍本船的全長。

## 2-10 為什麼盲區對我們很重要

目標船在本船盲區裡面的適航性，不單是我們唯一的擔心。我們主要關心的是，大船在這 500 公尺內，並沒有辦法利用減速或停車，避免船頭的碰撞。

#船體的形狀，是無法在這 500 公尺內，離開我們原來的航線。

#只有 500 公尺遠的距離，本船沒有辦法停車或者減速。

圖形 2-08，這是計算轉舵點的論文，由俄國人 Drachev 所寫，

前面 500 公尺（大約 1.5 倍船長前面）船體是沿著原來的航線前進，即使使用了滿舵。

#本輪（小的紅船）即使使用右滿舵，前面 500 公尺，本船的船頭也沒有離開原來的航線。

#只有本船的船尾，在轉舵開始的時候，被推到左舷。

#舵板被推，離開我們要回轉的方向。

#在這 500 公尺，本船並沒有回轉，只是向前直行。

#只因為本船的船尾移動，造成本船船首向的改變。

這是第一階段的回轉，不論使用了多少舵角，在第一階段，船頭只會向前移動，舵角會將船尾推開。船隻的回轉，是有三個階段，對資淺船副，我們只有討論到第一階段。

## 2-10 Why blind sector is important to us?

Target's seaworthiness inside blind sector is not our only concerns. **Our major concern inside these 500 meters is big vessel has no way to avoid collision within this distance at all.**

- Ship hull is incapable to move away from our original course line in first 500 meters.
- Ownship has no way to reduce engine and stop within these 500 meters.

In Figure 2-08, courtesy of essay of Calculating wheel over point, author Vladimir N. Drachev. http://www.msun.ru/dir/marinejournal/issues/2012v02no01/03Ddrachev.pdf

In first 500 meters (about 1.5 times ship's length) ownship's hull is moving along original course line even hard over rudder is used.

- Even ownship (small red ship) use starboard rudder angle 500 meters before, ownship bow is moving away a little.
- Only ownship's stern is pushing to portside by starboard rudder angle in beginning.
- Rudder plate is pushed away from direction we want to turn.
- In these 500 meters ownship is not turning, Ownship is going straight ahead.
- Only ownship's stern moving had changed ownship's heading.

This is first stage of turning when rudder angle been applied. We can see that no matter how much rudder angle had used ownship bow go dead ahead in first stage only rudder plate in aft of ship's body push stern away. Vessel turning is actually in three stages, we only discuss first stage for Junior OOW now:

## 2-11 迴轉的第一階段：只有船尾動

回轉第一階段，只有船尾被舵板推出，因為她遭受到水流的橫向阻力。在人員落水的操作上，我們向著人員落水的一個側，使用滿舵，是希望本船的船尾會被舵板推開。第一階段的回轉，船頭在原始的航線上，沒有任何移向側面的動量。我們可以看到圖形 2-08 的右邊（小的紅船），雖然已經有 1.5 倍船長的前進距離，但是他的船頭，仍然在他原來的航線上。第一階段的回轉，我們都叫做轉舵階段，這在電子海圖的訓練課程裡面，預期是有 1 到 1.5 倍船長的前進距離。

#無論我們多麼急著，想要把本船轉開危險的區域，在第一階段，本船沒辦法開始真正的回轉。

#在這個無法移動的階段，無法移動的，並不是只有船隻本身的長度。

#如果我們是一條 300 公尺的船，還要加上 1 到 1.5 倍長的距離，也就是說有可能在 450 公尺之前，本船都無法動彈。

#如果考慮我們是後面的這條大的紅船，本輪要避免目標碰撞，目標距離要超過 C 點，超過 4.5 倍船長，你現在駕駛台站立的位置之前。。（大的紅船=4.5 倍船長 是考慮目標的橫向距離）

#目標的距離少於 4.5 倍船長，目標必須自行採取避碰行動脫離，我們無法在這階段，有效行動，他們的主機跟操舵設備，也不能在這個關鍵的距離內故障。

#本船必須載著，這個巨大且無法移動區域，跟著我們移動。就像其他陸地上的交通工具一樣，具有一些操作上的死角。

#這些無法移動的區域，就是船長交給資淺船副操作的區域，可以同時覆蓋 4000 輛汽車，畢竟我們是地球上最大機械的操作者，大過 101 大樓的大小，這不是開玩笑，現在我們知道這是一個奇跡，是遠遠大於我們眼睛所能看到的區域。

我們必須要有這樣的知識與警覺，到 C 點的距離與 IMO 盲區的距離限制一樣，500 公尺的或者是兩倍本船的長度，這就是為什麼當一個小船，進入到我們的盲區的時候，為了雙方船隻的安全，我們會感到非常的焦慮。

圖形 2-08 前進的距離，應該包含盲區。

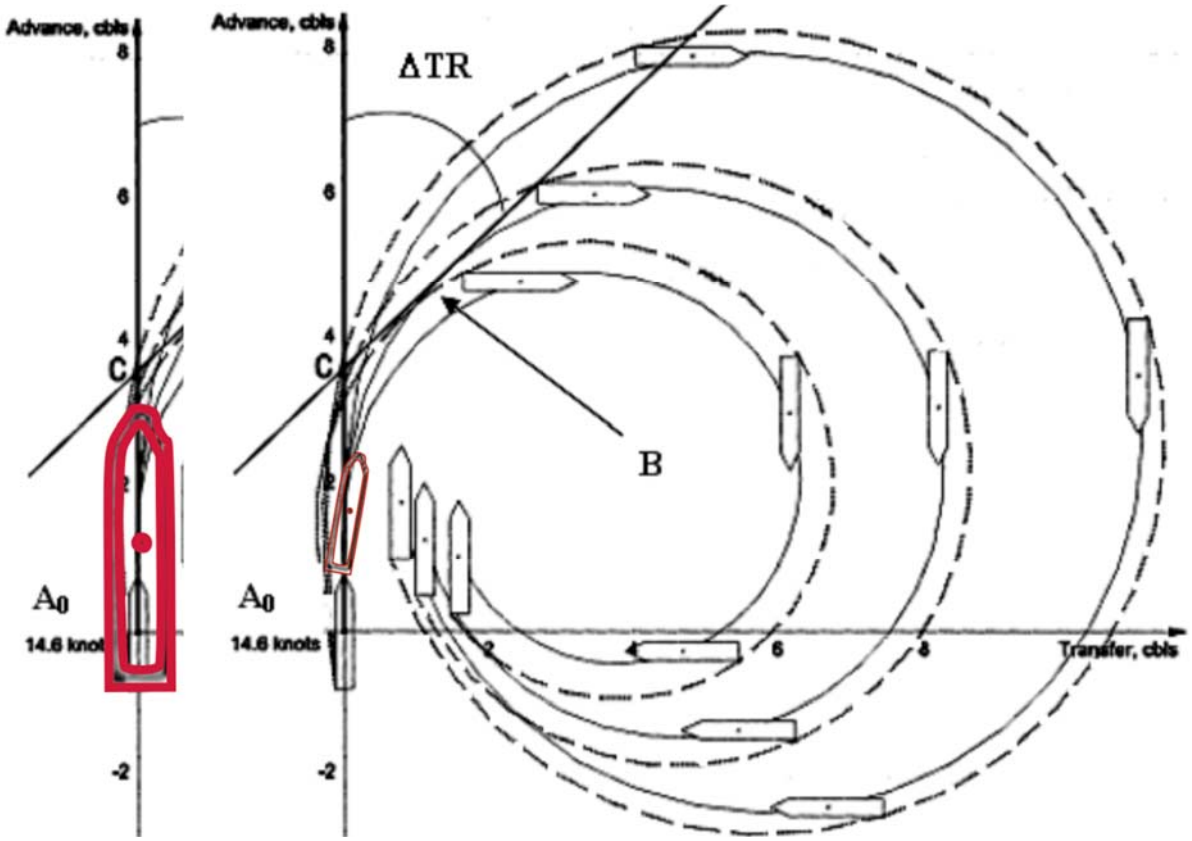
## 2-11 First stage in turning: Stern moving only

Only ship's astern were pushing outward by rudder plate which had sustained athwart thrust of water flow over it. In man over board maneuvering, we use full rudder to the side victim falling in hoping ship's stern will push away by rudder plate. **In first stage of turning, ship's bow just follows original course line without any side way movement.** We can see small red ship at right from Figure 2-08 already has about 1.5 ship's length advance but her bow is still on her original course line. This first stage of turning is commonly known as wheel over stage in ECDIS training course where 1-1.5 ship's length advance is expected. （red ship=4.5 ship' s length are considering transverse distance needed for avoid collision）

**No matter how emergency we need ownship to turn away from danger, in first stage ownship's bow is immobilized.**

- This immobilized stage makes ownship immobilized not only within ownship's 1.5 times length only.
- We are a vessel of 300 meters long but 1-1.5 ship's length ahead of ownship bow is immobilized. (up to 450 meters ahead is immobilized)
- Considering we are the Big Red ship at left**, ownship only can avoid collision with target distance beyond point C by course changing: one and half ship's length ahead your current bridge position now.**
- When ownship bridge is at starting point Ao we can only avoid target distance beyond point C away.
- Any vessel distance less than point C have to make their way out by themselves. Ownship has no way to avoid collision within this distance (within our immobilized stage). Their engine power and their steering gear should not be failed at this critical range.
- Ownship will always carry this big no movement area with us like other vehicles on earth.
- These non-movement area (as big red ship) covered 4 thousand cars space at the same time which is the duty of junior OOW on watch.

After all, we are licensed OOW of biggest robot on Earth, water or sky, No kidding. Now we know this robot is actually bigger more than what we can see by eye. We have to have this kind knowledge and awareness. *The distance to Point C is about the same as IMO visibility limitation, 500 meters or 2 times ownship's length*. **That's why we feel anxious when we saw a small vessel about sailed into our blind sector.**




圖形 2-08 前進的距離，應該包含盲區。

## 2-12 從目標船尾取方位

在避碰規則第 7 條，如果接近船隻羅經方位沒有明顯改變，碰撞危機應視為存在。有時候來船羅經方位明顯改變，碰撞危機仍然存在，尤其是接近大船或是一組拖船，或近距離接近他船。如果羅經方位不變，碰撞危機應視為存在。下一項又加上，即使羅經方位明顯改變，碰撞危機可能存在。這些規定不清不楚，現在我們知道是花開效應的關係。這理由請看圖形 2-09 來船的大小與水準夾角，在近距離變大。這是眼睛的視差：目標方位，大小與水準夾角的明顯改變。我們看目標的大小，在近距離時，看起來會變大，目標隨著距離而變，稱為花開效應。

是會變多大？想像有一冰山或島嶼在船頭，擋住我們左舷到右舷所有角度。在圖形 2-09，在左圖上，我們看到右舷的來船，他的前桅是在本輪的船頭，就像紅色的視線標示的，在右圖，雖然他的船頭，已經通過了本船的船頭 45 度，但這碰撞仍然無法避免，因為它的船尾就像綠色視線，仍然在他原來的方位上，這條船也許有些速度，或只是在漂流，這都碰撞的結果無關，只要他的船尾沒辦法通過本輪的船頭。

他與本船的距離，在這兩組圖形上面是不一樣的，但是他們的船尾方位，如同綠色視線，幾乎沒有改變。如果我們使用目標船尾的方位做目視瞭望，我們對碰撞危機的估計，可以有一個比較好的結果。如果他船尾的視線方位，能夠通過本輪船頭，就安全。如果他的船尾不能通過我們的船頭，那就會有就麻煩。

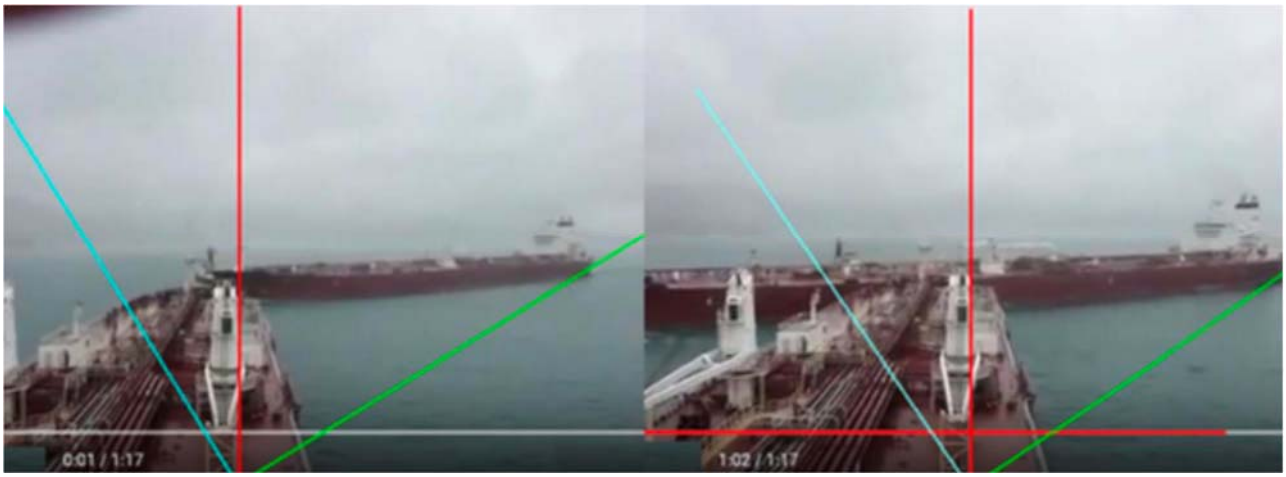
圖形 2－09 來船水準夾角的放大及相對方位的改變

## 2-12 Take bearing from target vessel stern

In rule 7 of COLREG, *Collision risk shall be deemed to exist if the compass bearing of an approaching vessel does not appreciably change. Collision risk may sometimes exist even when an appreciable bearing change is evident, particularly when approaching a very large vessel or a tow or when approaching a vessel at close range.*

In this rule: *if compass bearing does not appreciably change collision risk shall be deemed to exist*. In next minute, it said: *Collision risk may sometimes exist even when an appreciable bearing change is*

*evident*. The reason is illustrated in Figure 2-09, approaching vessel shape and their horizontal angle are growing bigger at closer ranger. This is parallax of eye: an apparent change in the target's bearing, size and horizontal angle. We see target vessel's size different according to it distance to us. We called it blossom effect: target vessel getting bigger in close range.
How big it will be? Image an island or iceberg ahead of ownship blocking all way from our starboard bow to portside bow.
In Figure 2-09 we can see approaching vessel coming from starboard side. Her fore mast is at ownship's bow as red line of sight in left Figure. In right Figure, although her bow had passed ownship's bow 45 degrees the collision is still inevitable due to her stern as green line of sight is still in its original bearing. This vessel may have some speed over ground or just drifting. Her speed is irrelevant to collision consequence as long as her stern cannot clear ownship's bow. Her distance to ownship is different in these two Figures but their stern bearing (green line of sight) almost unchanged. **If we use target stern bearing for visual lookout we will have a better estimation of collision risk.** If her stern line of sight (visual bearing) can pass ownship bow we will be safe. If not, it will be a problem.



圖形 2－09 來船水準夾角的放大及相對方位的改變

## 2-13 避免碰撞的標準操作

避免碰撞時，對目標船的船尾轉向，是一個標準的作業，尤其是對資淺船副而言，對目標的船尾轉向，在近距離的時候，尤其重要，這是花開效應的影響。能夠對目標的船隻尾轉向，把這當作最佳的實務，能夠以三方面來說：
第一是資淺船副比較容易符合要求，而不會產生任何的混淆。
第二船長可以當作是一個標準的值更命令，讓資淺船副去遵守。
第三管理公司可以作為他所有船隊裡面，資淺船副的標準作業程式。

圖形 2-10，在單一或是多船隻避碰的 SOP

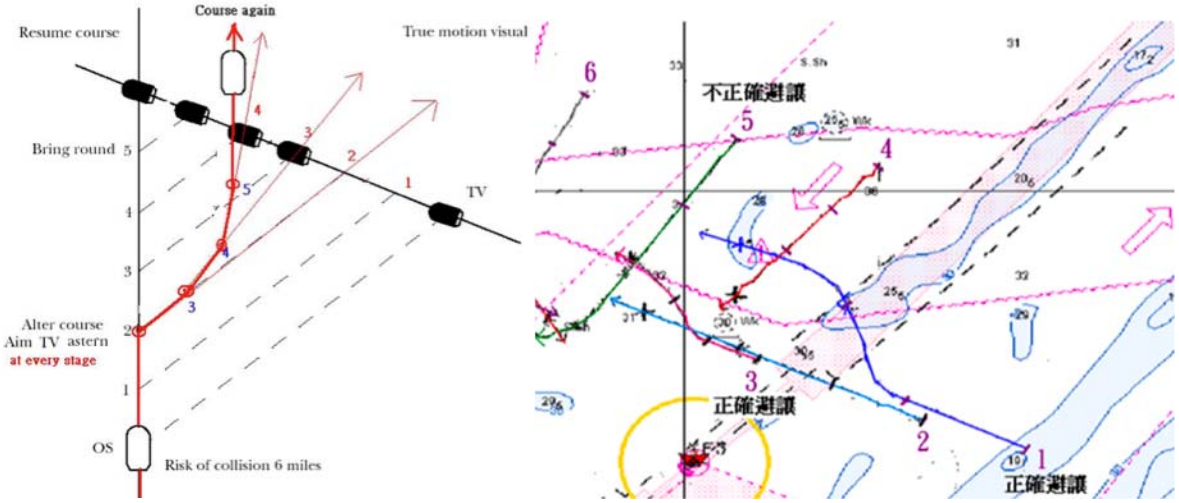
圖形 2 之 10，在左圖如果當值船副認為，碰撞危機存在於位置 6 的時候，（碰撞 18 分鐘之前），每一個預期的船位是 3 分鐘的距離，避免碰撞操作，在不同位置的示範，
在位置一，當觀測到目標船的羅經方位，或是相對方位沒有改變，仍然在右舷 52 度時，確認碰撞危機，15 分鐘後會碰撞，本船船副應該轉向到目標船的船尾。
在位置二，本船在位置二完成，對右轉向 52 度，使用 3 分鐘的時間。當船副終於看到本船的船頭，通過目標船的船尾，感到有些解脫，理由是本船現在跟目標船是左舷對左舷，在我們對目標船的船尾轉向之後，我們已經安全。航向變更 52 度，需要 3 分鐘的時間才能完成。
在位置三上，當值船副看到目標船船尾的相對方位，在我們的左舷船頭已經增加，本船向左轉向到 039 度，本船從 052 左轉到 039 度，（這是圖形 2-10 目標船船尾的方位），慢慢要回到原始航向 000 度。保持目標船的船尾在本輪的船頭，以方便清楚的指示本船的意向，是左對左通行，符合國際避碰規則，就是左對左通行，來讓路給目標船。

在位置四，本船轉向到 020 度，仍然落後在目標船船尾方位的右邊幾度之外。
在位置五，本輪回到原航向 000 度正北，目標船的船尾方位，以視線來看，是在本船左旋的 15 度。
標準的避碰操作，是對單一目標執行。始終保持本船左舷面對橫越船的船尾，或是左對左舷。避碰的航向改變，應該足夠大角度，以便清楚的對目標船顯示，然後慢慢小心的轉回原始的航向。
#保持橫越船的船尾，在本船左舷，所以通行變成左對左。
#始終保持橫越船尾在我們左船頭，對安全通行的目的，就已足夠，不論 CPA 是否很小。
#這樣子的操船，可以保持目標船船尾永遠清爽，不論直航船後續的任何行動，這樣聽起來，目標船為直航船時，會採取行動，似乎很愚蠢。
#依照避碰規則，直航船應該保持航向航速，當讓路船採取避碰行動時，當只有兩條船牽涉到碰撞危機時，這是真的。
#如果直航船要對第三條船讓路，它的航向航速，可能隨時會改變，即使呢本船並未注意到。
#保持目標船左對左的通航，對本輪來講是最安全的，如果在船隻密集的區域，要避免碰撞危機的不確定性。

## 2-13 Standard maneuvering to avoid collision

In collision avoidance, **alter course to target vessel's stern is a standard operation for junior OOW regardless the distance. Alter course to target's stern is even more important in close range to avoid blossom effect.** This can be used as best practice in three ways:

1. It is easier for a junior OOW to comply visually without any confusion or mental calculation
2. Used as a standing order by master for OOW to comply with or
3. Managing Company collision avoidance policy stipulated it as SOP for her fleet's OOW.




圖形 2-10，在單一或是多船隻避碰的 SOP

In Figure 2-10: In left drawing, if OOW deems collision risk of crossing situation exists at position 6 (18 minutes later, one point is 3 minutes run), the maneuvering to avoid collision is illustrated at different position No.

At point 1 C-15, collision risk ascertained to take place after 15 minutes (5 points more). Ownship OOW shall alter course to stern of target vessel TV when OOW observed target vessel compass (or relative) bearing had not changed in starboard side 052 degrees.

At point 2 C-12, Ownship finish the turn to starboard 052 degrees after three minutes. When OOW finally saw ownship (OS) bow had passed Target Vessel (TV) stern (course 052 degrees) he feels some kind of relief. The reason: ownship OS are port to port with target vessel TV after course changed to her stern. Both vessels are safe now (from "starboard to port" to "port to port" . Course change 52 degrees needs three minutes to finish.

At Red point 3, When OOW saw relative bearing of target vessel stern had increased in ownship's port bow, OS OOW alter course to port side to 039 degrees (measured from Figure 2-10 at TV's stern), he decide to steer back to original course (000 degrees) slowly. Keeping target vessel stern always on OS port bow to clarify ownship's intention (port to port as complied with COLREG) to give-way.

At Red point 4. OS alter course to 020 degrees, still some degrees behind target vessel's stern.

At Red point 5, OS had course again 000 degrees to north, TV stern bearing line of sight is about 15 degrees at OS's port side.

This **standard maneuvering** is executed to avoid collision with one TV only. Keep OS ownship portside to crossing target vessel's stern at all time, or port to port all the time. Course altering to avoid collision should be large enough to be readily visible to Target vessel at beginning. Then, slow and careful turning back to original course again

- Keep crossing vessel stern at our port side, so the passage become port to port situation.
- Keep crossing vessel stern at our port side all the time will be enough for safe passage purpose no matter the CPA might be very close.
- This maneuvering has the effect to keep TV stern clear all the time regardless the stand-on vessel's following actions. It sounds silly what action TV could take as a stand-on vessel. In real sea, Target vessel will have a lot action by his own will without caring for COLREG obligation.
- By the COLREG, the stand-on vessel should keep course and speed when give-way vessel takes avoidance action. *It is true when only two vessels are involved in the risk of collision.*
- If the stand-on TV vessel has the obligation to give way to third vessel her course and speed may change in any time without Ownship's notice (as we cannot estimate their collision risk from our bridge).
- **To keep port to port passage to target vessel is the safest way for give-way vessel in heavy traffic area to avoid all uncertainty of collision risk caused by target vessel TV's course or speed changing.**

# 2-02遠洋船雷達瞭望的情境感知

## 2-14 遠洋與近洋船在多船相遇的避碰策略

在圖形2-10左邊的圖形是多佛海峽岸基雷達所測繪的6條船的路徑，在路徑上每一逗點的標誌，代表6分鐘的行駛距離。這個圖形很清楚的顯示，使用標準避碰操作，可以保持本論的安全，
#1號船隻航向293度，藍色的航跡，在第二個逗點位置，轉向到345度，對著右舷目標船4號的船尾行駛，（在第二點的位置，4號船的羅經方位是342度），1號船對著目標尾的船尾多3度的船艏向，以保持左對左的通行。
#另外一個比較不明顯的航跡是3號船，航向293度，粉紅色航跡，他對著5號目標船轉向，5號目標的船尾方位是349度，（第二個逗點位置），3號船呢只有轉到324度。
這3號船由293度右轉到324度，只有31度。3號船雖然沒有像一號船一樣，右轉52度。向右轉31度，這也是足夠大角度的轉向。
#1號與3號的船隻，使用不同的策略去轉向，因為他們並不是同樣大小的船隻。
#1號船是一個快速的遠洋船隻，需要更多的前進海域，也就是更多前進的距離，去完成轉向的動作。他也需要更多的操作空間，700公尺，兩倍本船的長度的前進距離。經常這些船隻因為太大，所以主機沒有辦法立刻停車。
3號船隻是一慢速的近洋船隻，只需要比較小的前進距離轉向，需要比較小的距離來避讓目標。他們轉向比大船容易，當碰撞無法借由30度航向的改變來避免，這些小船還能夠及時停車，以避免碰撞。這是小船比大船機動的地方。

當1號的大船看起來非常危險的情況，因為距離的需求不同，在3號的小船看來，是很ok的。
遠洋與近洋的服務型態不同，造成他們當班以及避碰時不同的工作經驗，遠洋船主要工作是航行當班，放洋多靠岸少，近洋船主要工作是碼頭當班，靠岸多放洋少，造成近洋船往往把航行當值，當做休息的時間，駕駛台經常無人當值，漁船也不例外。
年輕的船副，穿著帶金條的制服，事實上比近洋船的當班人員，更沒有經驗，遭遇船隻操縱的限制，比小船多很多，在多佛海峽，只有資深的船副，能夠適當的瞭望當班。

## 2-02 Situational awareness of Ocean going vessel in Radar lookout

### 2-14 Ocean going and coastal vessel strategy to avoid collision in multiple target encounter

In Figure 2-10: the drawing in the right is shore surveillance radar plotting track of 6 vessels at Dover strait, each dotted point mark on the track is 6 minutes run. It clearly demonstrates by giving way in this way can keep OS safe as below :

- Vessel No. 1 is in course $293^0$ blue color track. She altered course to $345^0$ degrees at second dotted position 6 minutes later aimed to give way to vessel No.4 in her starboard side (at second dotted position the compass bearing of No. 4 to No.1 vessel is $342^0$ degrees.). No.1 vessel is heading into some place behind No.4 target vessel to keep port to port passage.
- Another less obvious track is No. 3 vessel in same course $293^0$ degrees pink colored track who had alter course to Target vessel No. 5 but not all the way to No. 5's stern bearing which should be $349^0$ degrees at second dotted position of both vessels. No. 3 vessel alter course to $324^0$ degrees only after passed second dotted position.
- No. 3 vessel alter course about 30 degrees to starboard side (from 293 to $324^0$ degrees) compared with her original course $293^0$ degrees, not 52 degrees to starboard side as required to pass target vessel's astern (from 293 to $345^0$ degrees).
- *No. 1 vessel and No.3 vessel use different strategy to give way is because they are not same type of vessel.*
- No. 1 vessel is a fast ocean-going vessel who need more sea room ahead (advance) to alter course and more space for her maneuvering (at least 700 meters, 2 times ownship's length advance distance) before her bridge position. If altering course is too late, usually these vessels cannot stop their engine immediately because they are too big.
- No. 3 vessel is a slow coastal vessel who need less advance and less distance from her bridge to alter course. There are easy to alter course than big vessel. When the time comes, collision cannot be avoided by these 30 degrees course change, this small vessel can stop engine in last minute to avoid collision or still have enough distance to make second times turning.
- What No. 1 big vessel deemed very dangerous situation (or distance) may deemed by NO. 3 small vessel as OK.
- The service nature of ocean going and coastal vessels also differ with their experience in watch keeping and collision avoidance.

Those junior OOW with golden stripe on their uniform are actually less experienced than Coastal vessel watch keeper, and suffer much more restrictions in ship's maneuvering than small vessels. *In Dover Strait, it is only suitable for senior OOW to keep the watch.*

### 2-15 雷達阿帕瞭望的缺失

在第一章我們看到雷達回跡，在雷達螢幕上的顯示，有很多的缺失。這是從第二次世界大戰以來，就是如此。在 21 世紀可以使用航儀瞭望，包括雷達 阿帕 電子海圖或是 AIS，雷達的單獨瞭望是不夠的，不論能見度是否良好，使用雷達測繪來確認碰撞危機，對於當值船副來講，都是

一種負擔。所以聯合國海事組織要求，從 1997 年裝設 ARPA 自動雷達測繪裝置，以改善海上避碰的標準：

一，減輕觀測者的負擔，使他們能夠得到測繪目標的資訊，所以他們能夠測繪各個不同的目標，就像他們能夠人工為單一目標測繪。二，提供連續 正確快速的情勢評估。

二，原本一個當值船副的雷達測繪工作能力是，能夠人工測繪單一目標。裝設了自動測繪雷達，可以自動得到各個不同目標船的資訊，第一個目標，能夠同時測繪各個不同的目標，是已經達成。

不幸的，第二個目標，提供連續 正確 快速的目標資訊，沒有辦法達成。 與第三個目標，減輕雷達測繪的工作負擔。帕阿帕只有做到三項要求的其中一項，自動獲得測繪目標的資訊。但是對於減輕觀測者的工作負擔，跟同時評估數個目標，是沒有辦法達成。

阿帕的資料是跟雷達回跡同步的，一旦雷達回跡失去了，阿帕的資料就會混淆，就像桑吉輪的案件，失去目標回跡的警告聲音，實際上會增加當值船副的工作負擔。

對於這新的工作（雷達回跡失去）之解決方法，就是連續監測 ARPA 顯示的資料，尤其是當目標船的距離很近，當值船副就無法從事其他工作。如果他的夜間視力，無法調整到窗戶外，他對於有問題的目標，沒辦法建立視覺的接觸與確認。

#阿帕的資料是以數位的形式呈現，阿帕訓練跟教育的課程，並沒有提供圖形判讀目標碰撞危機的能力，給當值船副，這就是我們在這一章的主要工作。

#大家都知道，阿帕能夠提供數個目標的資料，但是沒有人知道，人類無法由單一船副處理數個目標的資料。一個人的記憶容量，只能管到 1 個目標，不管呢是否有使用阿帕來協助測繪。

#國際海事組織認為觀測者的工作負荷，只夠由人工測繪單一目標，但是他們不知道人類的短期記憶限制，當值船副無法記得所有阿帕所提供的資料。所以每件事都又回到原點，如果我們不能記得目標的資料，跟我們不知道目標的資料一樣。任何超出我們記憶容量的事情，都需要事後不斷的更新記憶。以前沒有阿帕的時候，當值船副只能測繪單一目標，使用了阿帕以後，當值船副當值也只能記得一個目標的資料，雖然在避碰的同時，可能會有數個目標有問題。

## 2-15 shortcoming of Radar, ARPA lookout

In chapter one we have seen many deficiencies of radar echo in their presentation on radar screen since World War II. In 21 centaury, instrumental lookout including Radar, ARPA, ECDIS and AIS. Radar lookout alone is not enough. Whether the visibility is good or not use radar plotting to ascertain collision risk is a burden to OOW. So, IMO ask for ARPA installation after 1997.

*Automatic radar plotting aids (ARPAs) should, in order to improve the standard of collision avoidance at sea:*

1. *reduce the workload of observers by enabling them automatically to obtain information about plotted targets, so that they can perform as well with several separate targets as they can by manually plotting a single target; and*
2. *provide continuous, accurate and rapid situation evaluation.*

Originally, an OOW productibility in radar plotting is *they can plot a single target movement by manually.* One target needs one OOW to do the plotting. With ARPA installed OOW can *enable them automatically to obtain information about several separate plotted targets.* First goal of reducing workload of radar plotting is achieved. Unfortunately, second goal ***provide continuous, accurate and third rapid situation evaluation*** had not achieved. ARPA had did only one out of three what they are asking for: ***automatically to obtain information about plotted targets***. But ***reduce the workload of observers and evaluate several separate targets at same time*** had not achieved at all.

- ARPA data is synchronized with radar echo. Once radar echo is lost AIS data is confused as well as last chapter SANCHI case shown. Lost target warning actually increase workload of OOW which may have same warning sound as collision risk. The solution to this new workload is continuously stand-by ARPA monitor especially when the target distance is close to ownship. This OOW cannot do other works on bridge. If his night vision cannot adjust to outside visibility, he even has the problem to establish visual contact with target in question.
- ARPA data are presented in digital form. ARPA training and education course had not provide visual interpretation of targets collision risk to OOW. This is what we are working for in this chapter.
- Everybody knows ARPA can provide the data of several targets but nobody knows human cannot process all these data by one OOW. **One man's memory ability is limited to one target only no matter ARPA is in use or not.**
- IMO recognized *workload of observers can by manually plot a single target* only without ARPA but they don't know OOW limitation in short term memory make them cannot remember all data ARPA provided.

Everything is back to original point. If we cannot remember target's data is just like we don't know target's data. Anything out of our memories need to be refresh afterward. When there is no ARPA before, one OOW can handle one target only by radar plotting. *After ARPA installed OOW can remember one target data only* in collision avoidance in time.

## 2-16 短期記憶或工作記憶

為什麼當值船副，不能有效利用 ARPA 資料？原因就是我們工作記憶的限制。工作記憶只有非常少的容量，能夠保留可以處理的資訊，有時候，我們也叫做短期記憶。要瞭解我們在這些記憶上面的限制，我們可以用下面的步驟測試，

一，蓋上右邊的照片，看著左邊的照片 30 秒。

二，在一張紙上，寫下你在左邊的照片上面看到的東西。

三，遮住左邊的照片，然後看著右邊的照片 30 秒。

四，在第二張紙上，試著寫下你在右邊照片看到的東西。

五，在第三張紙上，試著寫下左右照片上面，有什麼不同的物品？

這三張紙上，能寫出五樣東西是平常，能寫出七樣算天才。一般人的工作記憶是 5+-2 項。

圖形 2-11 工作記憶的測試

在經過這些測試以後，很難說我們還記得照片上面有什麼東西？除了這位女士臉上的笑容。如果我們同時遮住這兩張照片，我們就很難記得，在這兩張照片上面，發現有什麼不同。使用我們的短期記憶，在在這 3 張不同紙上，我們能記住的項目，非常有限。在 2001 年的一項研究發現，普通人的記憶在 20 秒內，只有 4±1 項，也就是說，超過了 20 秒，我們連 4 樣東西，可能都記不清楚。我們的工作記憶呢，也沒有比短期記憶好多少。要指出這兩張照片上面的袋子，有什麼不同？在照片指出來，比用文字敘述更方便一些，因為要記住一樣東西，我們處理畫面的能力，還是強過於文字處理的能力。如果我們需要在這個圖片上面，指出這個那個包包，我們還需要記住相關的架子上面的位置，要不然我們就無法確定。

這也就是說我們的記憶需要圖形的說明，這些測試還是在靜態的紙上，如果是在海上，所有船隻都在航行中，這些動態的資訊，我們又能夠處理多少？

#所以任何在阿帕上面的資料，以畫面呈現，比文字好。

#阿帕的資料，需要連接到正確目標的回跡上。

在真實生活中，更具挑戰性的是人類處理數位資料的能力，非常有限。想像你有一個漂亮女孩子的電話號碼，如果你不想要忘記，那你要對這十位元數位如何處理？因為這些數字，對你在

今天之前，並沒有任何意義。所以你就知道，如果要處理對我們身家財產有威脅的目標船，我們應該要怎麼處理？保留在我們的短期記憶裡？或者是把他們寫下來！
碰撞危機是來船羅經方位沒有著明顯改變。檢查羅經方位的改變，需要記住兩組羅經方位的數位，跟觀測時間。羅經方位的改變，必須在可以接受的時間範圍之內，不是改變時間的無限。方位的讀取最好是以 6 分鐘的間隔地讀取，我們還必須記住最後觀測時間的數字。在這兩次觀測的時間之內，那目標的距離呢？我們是否應該記住目標的距離？或是他的距離變化？在海上任何方位的來船，都可能會有碰撞危機，都可能是對生命有威脅的那一條船。我們看到上一章的桑吉輪的案子，當值船副就沒有使用阿帕的資料。阿帕的目標是要減少觀測者的工作負擔，桑吉輪沒有使用阿帕的功能，即使在威脅到生命的複雜情況之下。到底是什麼地方錯了？這些在阿帕上面的資訊，如果他們是以數位資訊的形式呈現，很容易使我們工作記憶超載，就像在圖形 2-11 那些浮在空中的袋子一樣。在駕駛台當值，因為其他的工作，船副很容易分心，而忘記了目標船的數位資料。為什麼要浪費當值船副寶貴的短期記憶資源，來記錄一些數位，然後又很容易就被忘掉，結果就是大家都放棄阿帕上面的數位資料，連帶放棄目標的擷取。要當值船副去擷取目標的回跡，如果目標很容易在近距離被海浪回跡遮蔽，就是最瀟灑的船長，往往也不會堅持，要求當值船副去處理 ARPA 擷取的資料，如果他們還有更好的選項。

## 2-16 Short-term memory or Working memory?

Why OOW cannot take the advantage of ARPA data? The reason is the limitation of our working memory. Our working memory has very limited capacity to hold information for processing. Working memory sometimes called short-term memory. To understand our limitation in these memories, try to do these steps:

1. Cover right side picture and look at left picture for 30 seconds.
2. Try to write down in paper 1 what items you had seen in left picture.
3. Cover left side picture and look at right side picture for 30 seconds.
4. Try to write down in paper 2 what items you had seen in right picture.
5. Try to write down in paper 3 what items are different in these two pictures.

圖形 2-11 工作記憶的測試

After these test, we can hardly remember anything in the pictures except the lady's smile. By covering two pictures at the same time, we cannot remember any difference of these two pictures by our memory. In these 3 papers we can remember very little items. A study of 2001 found average people *short-term memory has capacity of 4 ± 1 item in 20 seconds duration time*. Working memory is no better than this. To point out the difference of these two pictures, it is easy to point out in picture than write it down on paper. *To remember a target is easier by graphic than wording*.

⇒ Any data shown on ARPA is better in graphic presentation than digital.

⇒ ARPA data need to attach to correct target vessel when OOW requested.

Any bag we see on the pictures has to remember with relevant shelf around it. Otherwise, we cannot make sure we had found any difference of these two pictures. These tests are done in a static picture on paper. How many data we can handle in dynamic environment like all vessels are underway at sea? Something even more challenging in real life is **human has very limited ability to handle digital data properly**. Imaging you got a pretty girl's telephone number and you don't want to lost it, what will you do with these 10 digits which means nothing to you before today? Ah ha.

What will you do to handle life-threaten target vessel's compass bearing? To keep in short term memory or to write it down. The collision risk is "**compass bearing of an approaching vessel does not appreciably change**". Checking bearing change need to compare at least two set of compass bearing numbers and observation times. **Appreciably change** means bearing change are happened in acceptable time frame, not infinite. Bearing is better taken at 6 minutes interval. Yes, we have to remember the digits of last observation time. What about target distance? Shall we remember target's distance or distance change in these two observation times?

Every direction could have collision risk at sea. Every ship could be the life-threaten one. Like we saw in last chapter M.V. Sanchi case, there are no ARPA data inside their radar pictures. ARPA is aimed by IMO to *reduce the workload of observers by enabling them automatically to obtain information.* But Sanchi 3/O had not use ARPA's function even in a complicated life threaten situation. What's wrong? Those information in ARPA if they are in digital form will easily overload our working memory as those bags floating in the air in Figure 2-11. OOW easily distract by other errands in bridge and forget about target vessel's digital data. Why waste OOW's limited resources of short term memory to remember something in digital which will easily be forgot? The result is everybody give up the data of ARPA. Why bother OOW to acquire target vessel's echo which could easily lost in close range with sea clutter? Even smartest captain would not insist OOW to use ARPA acquisition data if they have better option.

## 2-17 阿帕上面很多問題，不會影響到AIS

AIS 的資料對阿帕來說，是比較好的選項。它可以解決雷達追蹤目標產生的許多問題，例如海浪回跡，雨雪干擾，目標回跡交換（當船隻太過接近它船的時候），或是目標回跡消失在一個快速的操船後，這些都不會影響到 AIS。

AIS 能夠協助目標識別,可以使用他的船名，或是呼號，或是船隻的形式，或是船隻航行的狀態。這個是在聯合國海事組織的 1106 號修正決議案裡面，"有關船上使用自動識別系統的標準"

阿帕的功用並不理想，自從聯合國海事組織強制在船上安裝 ARPA 以後，在 1995 年到 2010 年，這 15 年間的統計，碰撞案件的統計數字上，碰撞案件的次數，沒有顯著的下降。

如果 AIS 的功能，被認為是比較好，就像 A. 1106 號決議案的認可，航運界需要更徹底的研究，如何將 AIS 的好處，傳遞到下一個世代的阿帕規格裡面。

## 2-17 many problems common to ARPA, do not affect AIS

The better option is AIS data which are good at:

> *many of the problems common to tracking targets by radar, namely sea, rain clutter, target swap as ships pass close by and target loss following a fast manoeuvre, do not affect AIS. AIS can also assist in the identification of targets, by name or call sign and by ship type and navigational status.*

**(IMO Resolution A.1106(29) REVISED GUIDELINES FOR THE ONBOARD OPERATIONAL USE OF SHIPBORNE AUTOMATIC IDENTIFICATION SYSTEMS (AIS)**

ARPA function is not idea for collision avoidance is also evident in statics of collision number had not drastically reduced during the survey over 15 years period from 1995 to 2010 after IMO compulsory ARPA installation on board. If AIS function is considered better as Resolution A.1106(29) did, more throughout study should be done to incorporate AIS advantage into next generation ARPA's specification.

## 2-18 雷達瞭望的圖像警覺

就像我們在上一章看到的，目標船的雷達回跡，並不能跟他真實的尺寸相配合。我們不能使用雷達回跡的大小，來決定來船是大船或小船。雷達回跡在近距離，有時候會消失。因為近距離目標回跡與海浪回跡強度一樣大小，或是雨雪干擾的抑制，或是跟海浪回跡，或是跟其他船隻回跡，混在一起。這些都是很嚴重的問題，因為這些問題，瞭望人員必須保持連續的測繪，否則接收到的資料，沒有辦法立即使用。這就意味著一個有執照的當值船副，必須保持連續的雷達瞭望，他能夠從雷達上注意到的船隻，1 分鐘前的資料，在下一分鐘近距離的時候，可能就失去了蹤跡，偏偏這時候又是當值船副最需要這些資料，來採取避碰行動的時候。雷達的瞭望，當值船副無法只往螢幕看上一眼，就決定目標船的動向，雷達目標要確認碰撞危機，必須連續的雷達測繪。像避碰規則第 7 條（a），使用適當的雷達設備，如果有雷達設備而且可用時，包括長距離的掃描，以便早期獲得碰撞危機的警報，或使用雷達測繪，或相類似有系統的探測目標。(b)切勿以不充份的資料，擅做假設，尤其是不充份的雷達資料。

雷達需要有系統觀測，去計算目標船的速度及航向。一位元當值船副要有系統觀測，如果使用人工，只能觀測一條船。問題是目標的回跡，也許沒有辦法測繪，尤其是在近距離，就像我們上一章所看到的。幸運的是，我們的阿帕含有自動提供下列資料的能力，

#被擷取目標的航向航速，應該使用 1 個向量形式顯示，或是圖形，能夠清楚地顯示目標預期的動向跟相關的符號。在這一方面

#對這些向量模式的選擇，應該有真運動與相對運動向量。

#運動向量模式的選擇，使用真運動向量時應該有顯示，他是對水或是對地速度。

#一台 ARPA 能夠圖形顯示目標的航向航速的資料，如果有要求時，應該提供目標的真或相對速度向量線。

#向量顯示的長度，應該可以調整時間長短。

#提供使用向量時間比例的一個明確指示。

請參考 IEC 872M,請參考海事自動雷達測繪的規格

在下面圖形 2-12，螢幕顯示 6 分鐘真運動速度向量線的設定，3 分鐘真運動目標尾跡，1.5 海浬的海面顯示，真北向上的顯示，在這畫面上面，我們的需要的直覺是：

1. 確認觀測海面的多少，利用讀取左上方角落的資料，這是 1.5 海浬的設定。（距離設定的圖形警覺）

2. 確認速度向量的時間長度設定，利用本船跨越多少距離圈？本船跨越長度達 5 圈多（1.4 海浬），因為本船是 14.1 節的速率，本輪速度向量線是 6 分鐘的長度。（速度向量時間設定的警覺）

3. 確認尾跡的長度設定，用 6 分鐘速度向量線的長度比較。回跡長度大約是 6 分鐘速度向量線的一半，回跡的長度是 3 分鐘。（目標過去動向的圖形警覺）

4. 確認是真或是相對運動模式的速度向量線？核對本船的速度向量線。本船的速度向量線顯示，是從距離圈的中心出發，代表真運動模式。（目標未來動向的圖形警覺）

5. 確認現場最危險的目標，現場有三條船有紅色的速度向量線，代表有碰撞危機，但是只有一條船是真的，另外兩個目標是沒問題的。某些目標沒有阿帕擷取的資料。（這是碰撞危機的圖形警覺）

這些直覺，是我們在雷達瞭望上，所需要圖形的情境感知，我們這些非常儀式化的行動，是重要的，可以培養我們雷達瞭望的直覺。

圖形 2-12 6 分鐘真運動速度向量線跟 3 分鐘真運動的尾跡。

## 2-18 Graphical situational awareness in Radar Lookout

As we can see from last chapter, target vessel radar echo size did not match their actual size. We cannot use radar echo size to determine approaching vessel is big or small. Radar echo lost from time to time in close range due to depression of sea or rain clutter or target swap with another vessel. These are serious problems because the lookout in RADAR have to keep continuous tracking otherwise the data received cannot put in immediate use. This means a licensed OOW has to keep RADAR lookout all the time. What data he noticed from radar one minute ago may lost track in close range where OOW need these data to take avoidance actions most. In radar lookout OOW cannot decide target vessel's movement by one look. Target in radar have to ascertain her collision risk by continuous radar plotting as COLREG
rule 7 *(b) Proper use shall be made of radar equipment if fitted and operational, including long-range scanning to obtain early warning of risk of collision and radar plotting or equivalent systematic observation of detected objects.*
(c) *Assumptions shall not be made on the basis of scanty information, especially scanty radar information.*
Radar need "*systematic observation of detected objects*" to calculate Target vessel's speed and course. One OOW can make one "systematic observation of detected objects" only manually. The problem is objects may not be detectable especially in close range like last chapter we saw. Luckily, we have ARPA which can automatically provide following data:

- The course and speed information generated by the ARPA by acquired targets should be displayed in a vector (speed vector) or graphic form which clearly indicates the target's predicted motion with relevant symbols. In this regard:
- an ARPA presenting prediction in vector form only should have the option of both true and relative vectors.

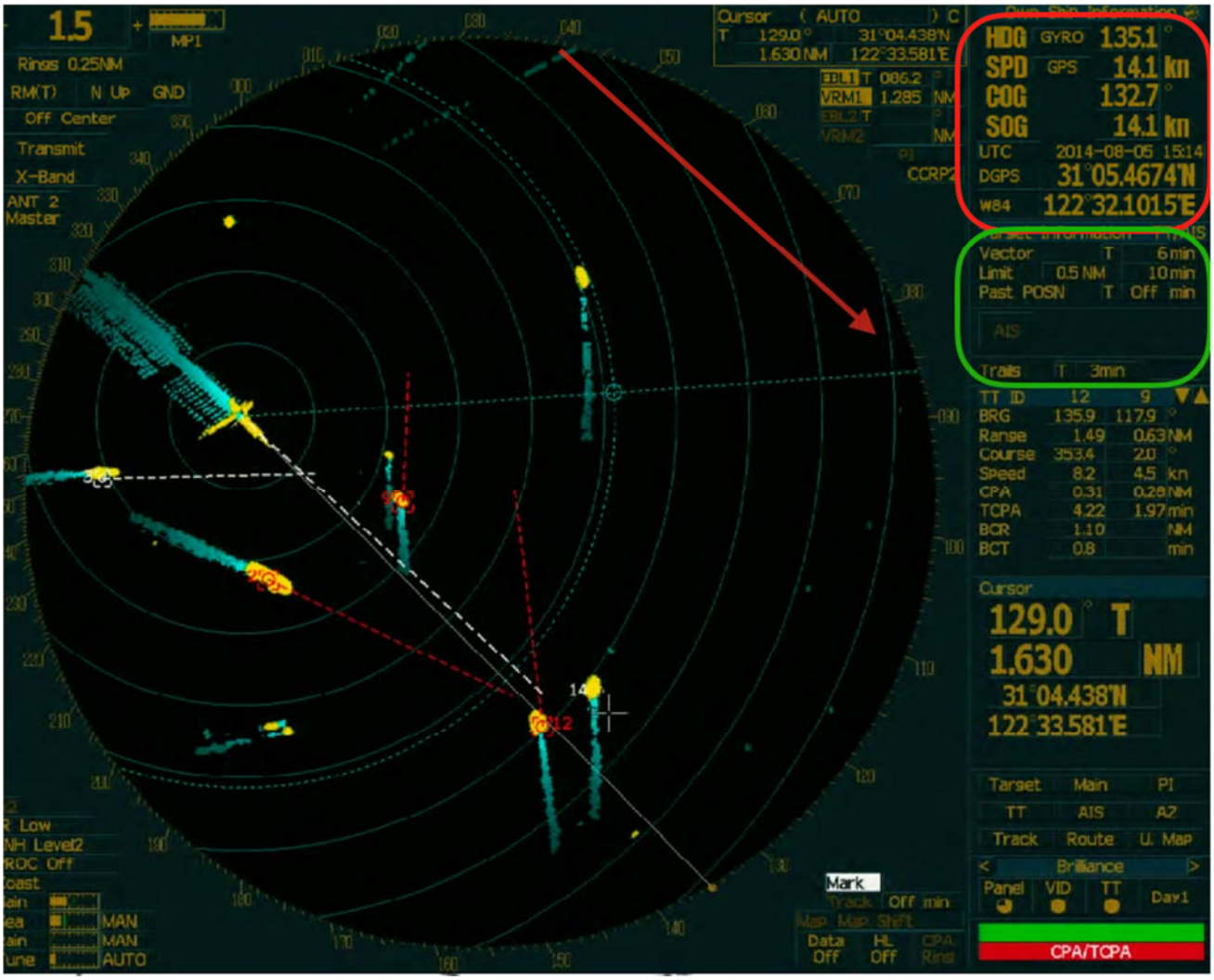
- There should be an indication of the vector mode selected and, if true vector mode is selected, the display should show whether it is sea or ground stabilized;
- an ARPA which is capable of presenting target course and speed information in graphic form should also, on request, provide the target's true and/or relative vector;
- vectors displayed should be time-adjustable;
- a positive indication of the time-scale of the vector in use should be given; and

* Refer to IEC 872M : Marine Automatic Radar Plotting Aids (ARPAs)

In Figure 2-12 below: ARPA screen displayed with 6 minutes True motion speed vector setting and 3 minutes True motion trail in 1.5 nautical miles range scale and north up display. The instinct we need in this picture are:

1. Verify range scale first by reading the display in upper left corner which is 1.5 nautical miles setting. (graphical range setting awareness)
2. Verify speed vector length setting by how many range rings it covered which ownship had covered 5 rings more (1.4 nm long) with ownship 14.1 knot speed now. This speed vector is 6 minutes in length. (graphical distance awareness: 1.4 nm long)
3. Verify trail length setting by comparing with 6 minutes speed vectors which is about half length of 6 minutes speed vector. The trails are displayed in 3 minute length. (graphical target past movement awareness)
4. Verify the true or relative motion mode of speed vector by checking ownship's speed vector. Ownship has speed vector shown from center of range rings which represent true motion mode of speed vectors on each target. (graphical target future movement awareness)
5. Verify most dangerous target at scene. Three targets have red speed vector which represent collision risk but only one is real. Other two targets are OK. Some target had no ARPA acquired data. (graphical collision risk awareness)

These instincts are our graphical situational awareness in Radar Lookout. These verify rituals are important to cultivate our radar lookout instincts to avoid confusion in reading.




圖形 2-12 6 分鐘真運動速度向量線跟 3 分鐘真運動的尾跡。

## 2-19 注意本船的阿帕速度向量

速度向量是一個載具，向量同時具有數量跟方向的特性。一個向量可以帶著本船，從起始點 A 到終點 B。在圖形 2-12，我們可以看到每個截取的目標，都有一個虛線的線段，從從他的雷達回跡出發，它所指的方向，就是目標前進的方向。在這虛線的盡頭是，這一個目標 6 分鐘後的位置。在螢幕的右上方，一條紅色的箭頭是特別顯示速度向量線，從羅經方位 040 度的位置到 080 度的位置。這不是一個正常顯示的箭頭，只是示範本船的速度向量線，6 分鐘能夠到達的位置與方向。本船的速度向量線長度，它的方向是 135.1 度，速度向量線的長度，代表本船的衛星定位速度 14.1 節，在 6 分鐘的時間，能夠前進 1.41 海浬的長度。向量在數學上攜帶的兩種性質，速度與方向。

在阿帕螢幕上，速度向量線的起點，就是這個目標與本船現在所在的位置，它的終點是本船與目標船在設定的時間間隔之後，本船和目標船未來的位置。（例如 6 分鐘的時間）

本船的起始點在距離圈的中心，目標船的起始點是位於他現在的回跡，每一速度向量線的終點，是由目標船現在的航向與航速與航行的時間所設定的。

在圖形 2-12，速度向量線的長度設定是 6 分鐘，真運動模式。每一距離圈代表 0.25 海浬，本船的現在速度是 14.1 節，船首向是 135.1 度，就像阿帕螢幕右上方顯示。14.1 節的速度向量線，6 分鐘的長度等於 1.41 海浬。1.41 海浬/0.25 海浬（每一圈等於 10.25 海浬）= 5.64 圈。請參考圖形 2-12，本船的速度向量長度

## 2-19 Aware ownship Speed vector in ARPA

Speed vector is a carrier both have quantity and direction. A vector is to "carry" ownship from initial point A to terminal point B; the Latin word vector means "carrier". In this Figure 2-12, we can see each acquired target has a dotted line projected from where her echo is to the direction it goes and the end of the dotted line is where this target will be after 6 minutes. One speed vector is separate shown as a red arrow begin from compass card $040^0$ position to $080^0$ position on top right of the screen. This is not a arrow normally shown on ARPA screen. It displayed here to demonstrate the distance and direction ownship can travel after 6 minutes interval. Ownship speed vector length is equal to this red speed vector length, the heading is $135^0$.1 (T) degrees and this speed vector length represent ownship GPS speed 14.1 knots in 6 minutes run is 1.41 nautical mile. Speed vector in mathematic carried two properties, its direction and its travelling length.

In ARPA screen, speed vectors has its initial point where the target or ownship located now and terminated point is ownship or target vessel's future position where target or ownship will be after preset time interval(6 minutes in this example). Ownship's initial point is located at center of those range rings. Target Vessel's initial point is located where her echo is now. The terminal point (length) of each speed vector is decided by ownship or target vessel's present course and speed and time interval setting.

In Figure 2-12: speed vector setting is 6 minutes in True motion. Each range ring represents 0.25 NM. Ownship speed now is 14.1 Kn (knot) and heading is $135^0$.1 degrees as shown on upper right corner of ARPA screen. The speed vector length of ownship in this diagram should be as followed:

14.1 Kn speed vector length in 6 minutes = 1.41 nautical miles

1.41 nm / 0.25 nm each circle = 5.64 circles (refer to Figure 2-12 ownship speed vector's length)

## 2-20 利用本船速度向量觀測目標速度

利用這一個概念，可以讓我們估計一下目標船的速度，目標 12 號在本船的正船頭，它的速度向量線，是 3.2 圈固定距離圈的寬度，長度應該是 3.2 圈乘上 0.25 海浬等於 0.8 海浬，它的速度就應該是 8 節，因為 6 分鐘的時間跑 0.8 海浬。現在讓我們檢查圖形 2-12 阿帕的螢幕，在這右下角綠色的方塊裡面，是十二號目標的資料區。12 號目標的速度是 8.2 節，速度向量線的長度，是直接跟他的速度成正比。利用固定距離圈的寬度，可以幫助我們估計來船的速度，有一個大概的概念。在海上，我們並不在乎目標船的速度是多少？我們呢，只在乎他是否比本船要快速？尤其是在航行巷道裡，當所有船隻都在一般流通方向前進的時候。如果我們關切的目標船速度，能用它的速度向量線來跟本船的做一個比較，就能估計它的船速快慢。任何目標船，它的速度向量線比本船的長，那他就是比本船的速度要快。如果反之，它的速度向量線比本船短，他就是比本船慢。

舉例來說，12 號目標的速度向量大約是本船速度向量線的三分之二，他的速度呢就是我們 14.1 節乘上三分之二，他的速度就大約是 9.4 節，這個速度不是非常正確，但是對於本船來講，我們的比較關切呢，它的速度與本船速度的比率是多少？現在他是本船速度的三分之二，那這個我們會晚點再討論。

速度向量依照國際海事組織的決議書是，"預期的航向航速，使用向量的形式"，速度向量在阿帕上面的顯示，可以給我們一些圖形上的認知，將目標的航向航速一起估計，我們可以得到目標或本船的預期位置。再一次，在實際的海上，本船並不關心目標船的速度，只關心本船和目標船在速度向量線上的預期位置。如果速度向量線時間設定是 6 分鐘，那在 6 分鐘之內，本船和目標船的位置，一定會在它的速度向量線上的某處。

舉例來說，本船現在的位置，是在本船速度向量的起始點，本船 6 分鐘後的位置，是在本輪 6 分鐘速度向量線的尾端。本船在 3 分鐘之後的位置，是在這條 6 分鐘速度向量線的中點的位置。本船兩分鐘後的位置，是在這條 6 分鐘速度線三分之一的位置。

目標船的估計位置，可以使用同樣的規則。目標船 3 分鐘後位置，是它的 6 分鐘速度向量線的中點，目標船的 4 分鐘會後位置，是它速度向量線三分之二的位置。依此類推。

只要阿帕上面有速度向量線的顯示，我們就可以對目標船的位置，有一個大約的概念。經過幾分鐘後，目標船可能的位置在哪裡？作為避碰的參考。每條船都有自己的速度向量線，但是在圖形 2-12，我們可以看到某些船，並沒有速度向量線顯示，如果沒有速度向量線與目標回跡相連結，就表示這個目標呢沒有被擷取，也就是他的資料呢，沒有被阿帕的軟體做運算追蹤，擷取是一個術語，用來形容這個目標的航向 速度 位置是被阿帕所追蹤的。沒有擷取表示目標沒有追蹤，所以當值船副也沒辦法知道，目標的什麼事情？這是當值船副的決定，是否對目標加以擷取追蹤？如果他們認為追蹤沒有必要的時候，單單只因為沒有時間去擷取。在大多數的時間，目標船都沒有被擷取，因為當值船副使用目標的尾跡，以過去的動態來估計他未來的動態。

## 2-20 Awareness of target's speed by ownship speed vector

Use this concept, let's estimate target's speed by her speed vector's length. The speed vector length of Target No. 12 (the one dead ahead ownship) is 3.2 circles long, its vector length should be

3.2 circles x 0.25 nm each circle= 0.8 nautical miles, its speed should be

Six minutes speed vector length is 0.8 nautical miles = her speed per hour is 8.0 knots

6 Minutes is one tenth of one hour. So, 0.8 NM in 6 minutes is 8 NM in one hour. Now let's check on Figure 2-12 ARPA screen, below the green square is Target No.12 data area. Target No. 12 speed is 8.2 knots. Speed vector's length is direct proportioned to her speed. The longer the faster. The speed estimation with fixed range ring can help our situational awareness. In real sea, ownship did not care what speed target vessel is making now. We care about "is she faster than ownship?". Especially, in traffic lane of Traffic Separation Scheme where all ships proceeded in *general direction of traffic flow for that lane*. If this is our concern of target vessel, we can compare target's speed vector length with ownship's speed vector length on screen to estimate her speed. **Any target has longer speed vector length on ARPA is faster than ownship**. Any target has shorter speed vector than ownship her speed is slower which can be estimated by comparing with ownship's vector length. **Faster vessel may have collision risk with ownship from all direction**. Slower vessel has collision risk with ownship in limited relative bearing ahead (this will discuss later). For example, No. 12 target's speed vector is about two third length of ownship. Her speed estimated will be 14.1 x 2 / 3 = 9.4 knots. The speed estimation is not exactly but OOW only care about her speed ratio to ownship (two third speed). This will discuss later.

Speed vector as IMO resolution said is a "*predicted course and speed in vector form*". The speed vector showed on ARPA can give us some graphic awareness. Together with predicted course and speed we can get a predicted position along ownship or target's speed vector. Once again, in real sea ownship did not care what speed target vessel is making now. We care about "where is ownship or target's position after set time interval?" If its time set is 6 minutes then in next 6 minutes ownship or target's position must be on somewhere of her speed vector. For example:

Ownship position now is in initial point of ownship speed vector.

Ownship position after 6 minutes is in the end of 6 minutes ownship speed vector.

Ownship position after 3 minutes is in the middle of 6 minutes ownship speed vector.

Ownship position after 2 minutes is in one third of 6 minutes ownship speed vector length.

Estimate position and arrive time of target can apply the same rule.

Target vessel position after 3 minutes is in middle of her 6 minute's speed vector.

Target vessel position after 6 minutes is in the end of her 6 minute's speed vector.

Target vessel position after 4 minutes is in two third of her 6 minute's speed vector.

With the speed vector displayed on ARPA we can have a rough idea where target vessel will be after set minute intervals for our reference. Every ship has its own speed vector. But, in Figure 2-12 we can see some

vessel did not have the speed vector attached. **If no speed vector attached in ARPA target it means this target is not acquired (plotted by ARPA software) by OOW**. We will lose our ability to estimate her future position as mentioned above. Acquired is a term used to describe this target's heading, speed, position etc. are tracking by ARPA. NO acquiring means ARPA knows nothing about this target, OOW knows nothing either. It is OOW decision not to track certain target's data if they deemed unnecessary, or just because OOW had no time to acquire. Very often, targets are not acquired due to OOW use trail of target (her past movement) to estimate her future movement.

## 2-21 注意阿帕上的碰撞點與碰撞線

更進一步說，從本船與目標船速度向量線的交點，當值船副能夠決定本船與目標船會到達交點的時間？在第一章 1-08 我們提到"這個交叉點其實是一個碰撞點，如果兩條船在同一時間到達。"下面的敘述，同樣的也可以應用在阿帕的螢幕上。

如果目標船到達交叉點，早於本船，它的相對方位會經過本船的船頭，相對運動是向我們船頭方向移動。

如果目標船比本船晚到達交叉點，他的相對方位會往本船的船尾移動，他的相對運動也向本船船尾移動。

例如圖形 2-12，目標 12 跟本船的速度向量線，有一個交點，本船會在 6 分鐘後，到達這個交點，然而 12 號目標在半分鐘後，就會抵達這個交點，所以這兩條船到達的時間就有 5 分半鐘的差距，我們可以假設沒有碰撞危機。

無論如何，我們確實看到，在羅經方位正南方的一個目標，跟本船在 6 分鐘後有碰撞危機。在上一章，對當值船副來講，兩條船航線的交點，是看不到的。在 ARPA 螢幕上，航線的交點變得可見，前提是，船副需要先取得他的速度向量線。

速度向量線是我們稱為碰撞線，用來探測碰撞危機。一段線條用來探測碰撞危機跟碰撞點。如果沒有碰撞線，在阿帕的螢幕上的顯示，我們就會失去碰撞危機與碰撞點的圖形警覺。就像我們看不到水平線時，我們會失去對能見距的警覺。不要依賴阿帕的數位資料，在你的短期記憶裡面，你沒有辦法處理這些數位。我們需要速度向量線的圖像直覺，在緊急跟平常時候。碰撞線的概念是這樣的

利用這條船的速度向量線估計，目標船會在 6 分鐘之後，到達可能的碰撞點，也就是現在時間 1514 加 6 等於 1520。

- 本船到達這個碰撞點，會在 1 分鐘之後，1 分鐘到達這個碰撞點 1514 加 1 等於 1515。本船提早 5 分鐘到這個碰撞點，比目標船早 5 分鐘通過他的船頭，目標船 6 分鐘後會通過本船的船尾。這個目標的速度向量線的阿帕顏色是白色，表示安全通航。兩條船通過同樣的碰撞點，也許不會發生碰撞，所以第二條規則用來決定碰撞危機，應該是像這樣
- 兩條船要在同樣的時間，通過同樣的地點，才會發生碰撞。在圖形 2-12 有一個目標在本船的右船頭，相對方位 30 度，羅經方位正南，符合這些條件。阿帕速度向量線顏色是紅色的，阿帕認為他有碰撞危險

## 2-21 Aware Collision line and collision spot in ARPA

Furthermore, from intersect point of ownship and target vessel's speed vector OOW can decide what time ownship and target vessel will arrive intersected position? In chapter 1-08, we have "This intersection is actually a collision point if both vessels arrive at same time." It also holds true of below statement quoted from last chapter if applied in ARPA screen:

- If target vessel arrives the intersection earlier then her relative bearing will move across ownship's bow. Her relative motion is also moving ahead of ownship.

- If target vessel arrives the intersection later then her relative bearing will move across ownship's stern. Her relative motion is moving astern of ownship.

For example: Target No. 12 and ownship speed vector in Figure 2-12 has one intersected point. Ownship will arrive this point after 6 minutes and No. 12 target will arrive after half minute. The arriving time has 5.5 minutes difference in these two ships. We can assume no collision risk involved. However, we do see one target at due south of ownship has collision risk with ownship after 6 minutes. In last chapter collision point or intersection point is invisible to OOW. Here in ARPA screen intersection point become visible to OOW but we have to acquire target vessel's speed vector first.

Speed vector is what we called collision line. A line used to detect collision risk and collision spot. **If no speed vector shown on ARPA screen we will lose our ability to detect collision risk by ARPA graphic presentation**, just like we lost sight of horizon will lose our visibility sense. Without target vessel's speed vector target vessel situation will be a mystery to OOW. Don't count on ARPA digital data. You cannot handle those digitals in your short term memory. We need visualized instinct by speed vector in emergency and casual. The concepts of collision line are:

1. Collision may happen if ownship speed vector touched another target's speed vector. In Figure 2-12, the eastbound vessel course $090^0$ (T) at ownship starboard beam has his white speed vector touched ownship speed vector at 0.25 nm range ring. This intersection point means these **two vessels have one position in common in their course line: possible collision spot.**

By this target vessel's speed vector, target will arrive possible collision spot after 6 minutes 1514 + 6 = 1520 hours UTC. Ownship will arrive this collision spot after one minute 1514 + 1 = 1515 hours UTC. Ownship is arrive this collision point 5 minutes earlier than target. Ownship will pass her bow after one minute. She will pass ownship's stern after 6 minutes. ARPA is not fool. This target speed vector is colored white which means safe to pass. Two vessels pass same collision position or location may not have a collision case. So, the second rule to decide collision risk may be like this:

2. **Two vessels have to pass same location at same time to become a collision situation.** In Figure 2-12, there is one target at ownship starboard bow relative bearing 30 degrees compass bearing due south meets these criteria. Her speed vector colored red to mean collision danger by ARPA.

## 2-22 注意阿帕圖形上的碰撞危機與時間

這一目標的速度，目測大約是9節，航向大約是115度。不幸的是，在圖形2-12資料區裡面，並沒有這一個目標船的資訊。目標船與本船現在有碰撞危機，這是我們已經知道的。怎麼知道的？這個目標船在6分鐘之後，會到達這個碰撞點，在這兩條船6分鐘速度向量線終點的位置上，1514加6等於1520時，也就是1520時的位置上。由這一個例子，我們知道單獨使用速度向量線，我們就能確認碰撞危機，不需要阿帕的數位資料。這是個簡單的事實，可是我們沒有把它，列入阿帕訓練課程裡的基礎知識。在實際海上，也沒有人提到這一塊。

我們要怎麼做，來取得這碰撞目標的數位資料？當然，我們可以用阿帕點選這個目標，在資料區取得他的航向 航速 CPA等等資料，來取得目標12和9號目標航向航速，但這航向航速並不是第一優先，他們的距離方位也不是，CPA TCPA也不是，我們已經知道他的CPA是零。避碰最重要的資訊，是要知道碰撞還有多少時間？從現在算起，離碰撞還有多少時間？現在這個問題，對我們已經不是秘密，1514加6等於1520，這個目標船與本船會發生碰撞。到碰撞還有多少時間，對船隻的操縱者是非常重要的，這是適當避碰行動的關鍵，這以後會學到。

本船正在追越目標船，因為我們的速度向量線比他長。另外兩個目標12號跟9號，如果保持現在的航向航速，對我們來講，是安全的。不幸的是，他們的速度向量線是紅色，因為阿帕的錯誤顯示，為何？也許只是單純的失去目標船的回跡，我們也講不清楚，對當值船副來講，不清楚速度向量線為何是紅色？會產生不必要的心理壓力，以及對真正危險的分心。

## 2-22 Aware Collision risk and collision time in ARPA graphical

This target has speed about 9 knots and course about 115 degrees by visual estimation. Unfortunately, in Figure 2-12, data area has no information of this target vessel. This target has collision risk with ownship we already know. But how? This target vessel will have collision with ownship after 6 minutes (both vessels position will at the end of their speed vector at the same time 1514 + 6 = 1520 hours UTC). By this example, we know by using speed vector along we can verify the collision risk correctly without ARPA data area. **This simple truth is not part of our knowledge base in ARPA training.**

Can we show digital data of this collision target in question? Sure, we can click this target in ARPA to show course, speed, CPA…etc. in data area. Target's course/speed is not first priority, nor her range/bearing or CPA/TCPA (we already know CPA is zero). **In collision avoidance the most important information is how long collision will happen from now on?** Well, it's no secret here. At 1514 + 6 = 1520 hours UTC, this target vessel will have collision with ownship in 1520 hours. What time to collision is important for a ship handler. It should be used as a trigger for proper avoidance action. We will learn it later. Ownship is overtaking her for ownship's speed vector is longer than her. Another two Targets no. 12 and 9 are safe from ownship if they keep current course and speed. Unfortunately, their speed vectors are also in red color by ARPA's mistake. The reason of this mistake is unknown to us but these red speed vector will give OOW mental pressure or distractions to real danger.

## 2-23 改變向量線時間的碰撞警覺

在圖形2-10我們學過怎樣借由向目標船的船尾轉向，以避免碰撞。在海上要避碰，我們需要做的事是，避免到達碰撞點，或與目標船不同的時間，到達碰撞點。如果其他目標船的航向航速不變，改變本船的速度向量線（航向或是航速），就會改變我們的碰撞危機。我們處理本船速度向量線的能力，就是我們處理碰撞危機的能力。在理論上，本船的速度向量線有下列的幾個性質：

1.速度向量線越長，本船越危險。比較長的速度向量線，代表較高的速度。（在同樣的時間內，會有較多的碰撞危機），如果本船有比較短的碰撞線，本船就比較不可能交叉到目標船的速度向量線。在圖形2-12，如果本船隻有10海浬的速度，6分鐘之後，本船不會有碰撞發生，因為6分鐘後的位置，距離現在位置是4個距離圈的位置，（不是原來的5.64圈，現在不是原來14節的速度，所以我們的船位會落後原來碰撞點0.4海浬），換句話說，較慢的速度是較安全的速度。

2.如果本船的碰撞線是6分鐘的長度，本船的碰撞線與其他船隻並沒有交點，在這設定的6分鐘間隔內，就沒有碰撞危機。然後當值船副應該將速度向量線設到9分鐘的長度，去看看與它船是否產生新的交點？同樣的過程，應該設為15分鐘，或是30分鐘的向量線長度設定，來探測是否有任何碰撞點，這是長距離掃描的技術。可以得到早期的碰撞警報跟警覺。如果我們看到很多船的速度向量線，跟本船的速度向量線有交點，應該研究利用一次性的航向改變，是否可能去避免這一群船隻，就像圖形2-10右邊的圖片。1號目標必須讓路給四條船，必須讓路給目標船2號，3號，4號，5號，而他利用轉向到最後一條船的船尾，四號船的船尾，一次讓過。如果你的你的技術還不足以處理四條船，請呼叫船長。

3. 速度向量線可以發現碰撞危機，但是有時間限制。速度向量線的時間長度，是由當值船副所設定的。可能發生在6分鐘後的碰撞，可是在本船的3分鐘速度向量線上，是不會發現任何碰撞

點，在上一節，我們要求你要交互設定，速度向量線的時間長度，以便得到早期的碰撞警報。這是在船隻並不多的時候，探測1，2條船的碰撞危機。如果在我們設定的時間間隔內，碰撞危機已經太多且混淆，那我們應該考慮啟動另外一部雷達使用，並且減少碰撞線的時間設定，集中注意在近距離的碰撞目標。

4.在圖形2-12，如果速度向量線的設定減到3分鐘的間隔，將不會有任何碰撞點產生。但是本船隻有在這3分鐘的時間，是安全的。（1514到1517的時間），6分鐘之後，本船就會跟右船頭30度的目標，發生碰撞。本船到達這個碰撞點是1520時，與目標船同時。在3分鐘內本船是安全的，過了6分鐘，在1520的時間，本船就不安全，而且有一個碰撞等在哪裡。

5.從安全到危險，我們需要有些警覺，來瞭解有哪一條船，我們需要擔心？在圖形2-12，過了3分鐘的時間，在1517時，目標船隻的位置，如同圖形2-13，這是阿帕的螢幕，（如果所有船隻，保持現在的航向航速），在這個時刻1517時，哪一條船可能在4分鐘後發生碰撞？（或者3分鐘，如果我們加上本船長度的估計），就非常清楚。我們不需要去想像3分鐘後，這些目標船在那裡（這是額外的工作）。我們可以簡單的設定，速度向量的長度為3分鐘去檢查碰撞危機，就像下面圖形2-15。3分鐘的速度向量線，可以給我們對近距離碰撞危機，比較清楚的的畫面。航海是預測的藝術，我們必須擁有利用速度向量的時間設定，預視3分鐘，6分鐘，9分鐘後情況的能力。

圖形2-13 阿帕 1517時，1514時 3分鐘後的情勢。

## 2-23 Aware collision risk by changing ownship speed vector time.

In Figure 2-10 we have learnt how to avoid collision by steering to target vessel's stern. In real world, what we have to do to avoid collision is by avoiding ownship arrive collision spot or arrive collision spot at different time with target vessel. If other targets course and speed remain the same, change ownship speed vector's course and speed will change our collision risk. Our ability to handle ownship's speed vector is our ability to handle collision risk. In theory, ownship's *speed vector have some properties*

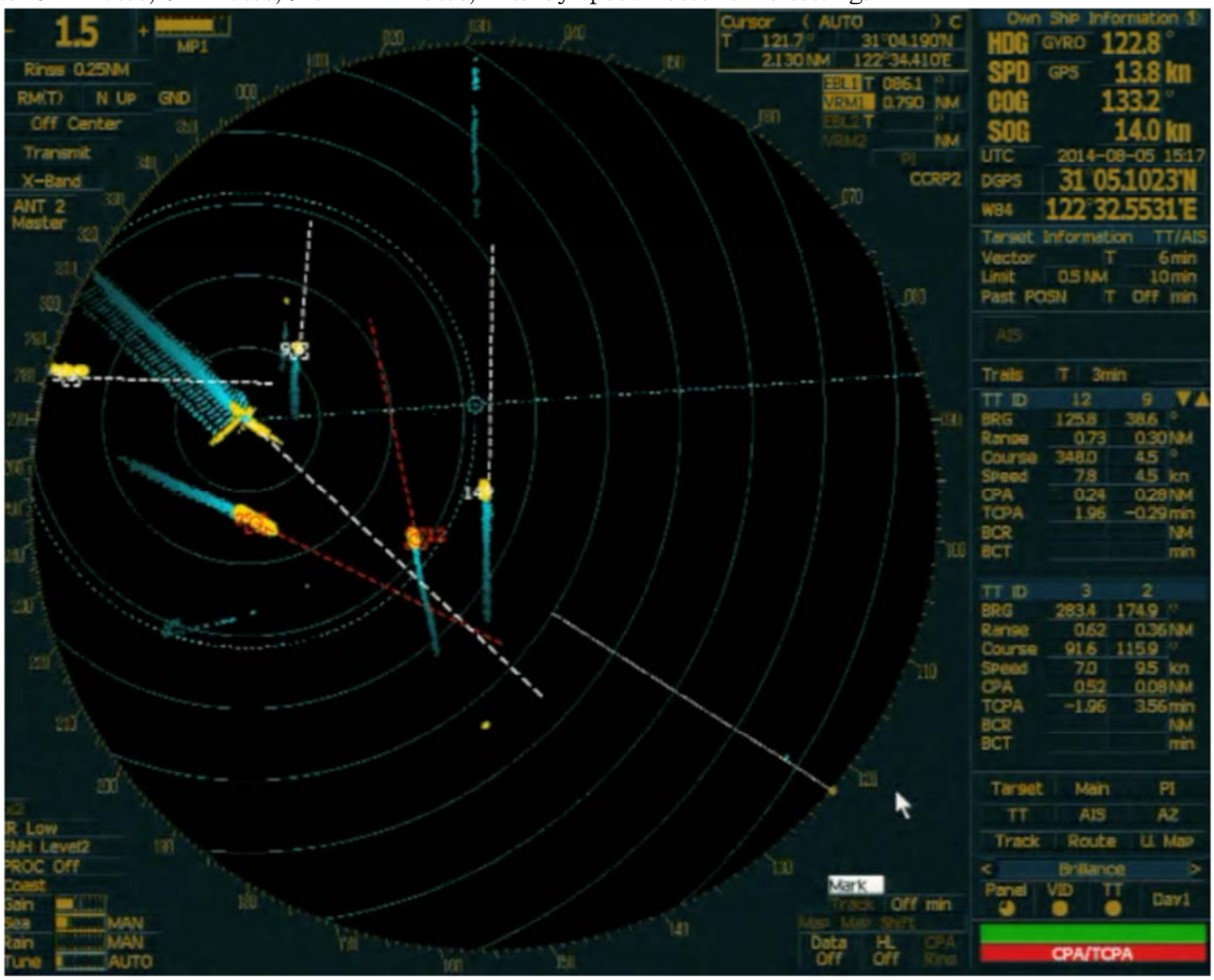
1. The longer speed vector the risky ownship will be. Longer speed vector (higher speed) will have more collision risk within same time interval. If ownship has shorter collision line (speed vector) ownship will has less possibility to come across target vessel's speed vector. In Figure 2-12, if ownship has 10 knots only, after 6 minutes there will be no collision for ownship position is 4 circles from current position (not 5.64 circles with 14 knots speed which is 4 cables distance behind current collision point). In another words, **slower speed is safer speed**.

2. If ownship collision line in 6 minutes length have no crossed point with other vessel there will be no collision risk within this time interval (6 minutes). Then OOW should set the speed vector to 9 minutes length to see any cross point in collision line in future 9 minutes time. Same process could apply to 15 minutes or 30 minutes speed vector setting to detect collision point if any. **This is long-range scanning skill to obtain early warning of collision risk and awareness.** If we saw lots vessels speed vector have cross point with ownship's speed vector, we should study the possibility to avoid whole vessels group by one course change like No.1 target in Figure 2-10 right drawing who have to give way to four vessels NO.2, 3,4 and 5 targets and he avoided all by altering course to last ship's stern (No.4 ship stern). Call the master if you are not ready for this.
3. Speed vector detect collision has its limitation as speed vector time setting. The length of speed vector is decided by the time interval OOW had set. A collision happen after 6 minutes will not have collision spot show in ownship's three minutes speed vector. In last paragraph, we ask you to set speed vector's length longer to get early warning of collision. That is to detect one or two vessels collision risk if passing vessels are less. If collision risk overloaded (too many collision points and

confused) in set time interval **we should consider to use extra RADAR and reduce Collison line time setting to concentrate on close range collision target.**

4. In Figure 2-12 if speed vector setting is reduced to 3 minutes interval there will be no collision point with any vessel. But ownship is safe only within this three minutes from now on (1514 to 1517 hours). After 6 minutes there will be a collision spot with starboard bow 30 degrees target. Ownship will arrive this collision spot at the same time 1520 hours as target vessel. For first three minutes ownship is safe. After 6 minutes at 1520 hours time, ownship is not safe and a collision is waiting there.
5. From safe to danger, we need some awareness to understand what vessel we should worry about in Figure 2-12. After three minutes UTC 1517 hours, all vessels are shown at Figure 2-13: ARPA screen (if all vessels remain on current course and speed). In this moment 1517 hours which vessel more likely to have a collision after 4 minutes (or 3 minutes if we take account of ownship's length into account) is very clear. We don't need to image where are these targets after three minutes (extra workload). We can simply set speed vector length to 3 minutes to check collision risk as Figure 2-15 below. **3 minutes speed vector can give us a clearer picture of close range collision risk.**

Navigation is an art of prediction. We need to have the ability to visualize what situation will be after 3 minutes, 6 minutes, 9 or 12 minutes, ….. by speed vector time setting.




圖形2-13 阿帕 1517時，1514時 3分鐘後的情勢。

## 2-24 改變碰撞線方向的碰撞警覺

1.如果本船向左舷轉向，本船速度向量線就會掃過左舷，就會增加我們在左邊的碰撞危機，在左舷的船隻原來是沒有碰撞危機，現在碰撞的風險就會增加。選擇船隻比較少的一邊轉向，在近距離是非常重要。在圖形2-08 記得那個大的紅船，就是本船轉向時候，會發生的真正問題。在圖形2-13 1517時的碰撞情勢，如果本船在兩分鐘後向左轉轉向，那就會撞到左船頭12號目標。如果本船不向左邊轉向，跟12號目標就沒有碰撞危機。

2.在這樣的口袋裡面，本船能怎麼做？4個方向裡有5條船，將本船的速度向量線與其他目標船的速度向量線平行，是避碰最好的選擇，兩條平行線不會有任何的交點，不論本船與目標船的速度是否相同？都沒有交點。就像火車的鐵軌，因為平行，沒有交點，這是在這個情況之中，避碰最後的希望。本輪可以使用霧發出5短聲，幫助其他船隻與本船的警覺，因為距離只有0.3海浬。要與它船平行，問題是我們必須知道目標船走的航向是多少？如何找到他的航向？如果我們還不知道，我們可以使用本船的電子游標線與目標船的速度向量平行，就會有一個很好的概念。

3.如果沒有速度向量線的顯示，本船就會失去對碰撞點與碰撞危機的警覺性。

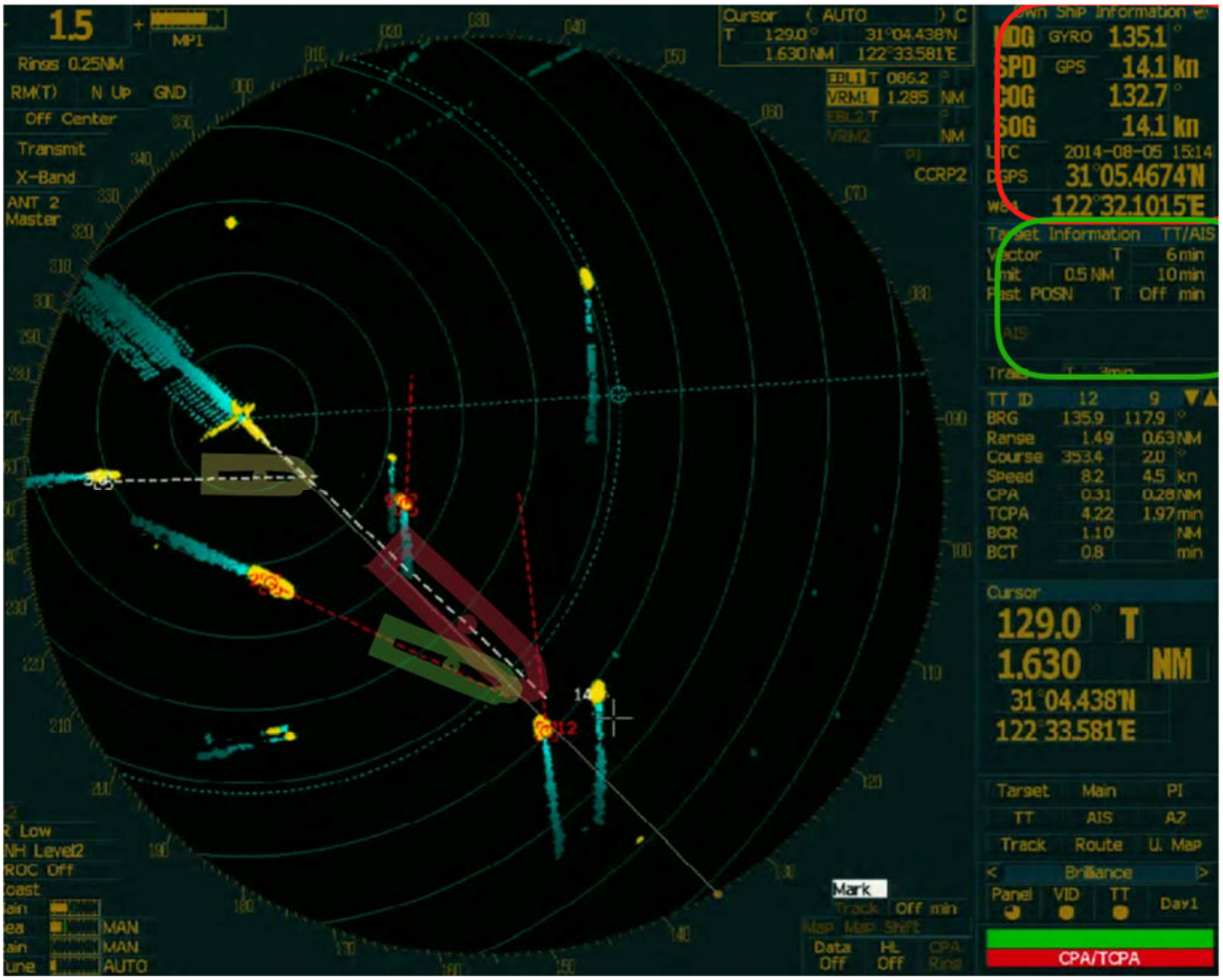
在圖形2-14，我們能否想像在1520時，也就是6分鐘之後，阿帕的螢幕是什麼樣的情勢？當我們還在1514時，利用6分鐘的速度向量線，對6分鐘後的情勢做一個估計。對資淺船副，我們可以準備另外一個比較具象的方法，如同圖形2-14 這些大船都是由圖形2-08拷貝過來的，代表的是3分鐘回轉特性的限制。

圖形2-14阿爸6分鐘真運動向量線跟3分鐘的碰撞危機區域

## 2-24 Aware collision risk by changing ownship speed vector direction.

1. If ownship alter course to port side our speed vector will also sweep to portside. Our collision risk will increase in port side. Ownship's port side vessels originally have no collision risk, now the chance to collide with ownship increased. **Choose the direction has less vessel in close range is very important.** Remember the big red vessel in Figure 2-8 is ownship's actual problem in altering course. In Figure 2-13 UTC 1517 hours, collision will happen after 2 minutes if ownship alter course to port side which will collide target no. 12 on port bow. If ownship don't alter course to portside there will be no collision risk with No.12.
2. What ownship can do in this pocket? 5 vessels in all four directions. **To parallel ownship speed vector with other target's speed vector is best choice to avoid collision no matter what speed ownship or target vessel has.** Two paralleled line will not have crossing point as the railway rails have no intersection point. This is last hope in this case. Five short blast on whistle may help as the range is only 3 cables away. The problem is we have to know what course this target is steering? 116 degrees, right? **Where to find her course if we did not know yet? By using ownship EBL to parallel with target vessel's speed vector may be a good idea.**
3. **If no speed vector displayed on ARPA ownship, we will lost collision spot and collision risk awareness.**

In Figure 2-14, can we image the vision of UTC 1520 hours (6-minutes later) ARPA screen while ownship is still at 1514 hours ARPA picture to get the collision awareness with 6 minutes speed vector. For junior OOW, we can prepare ourselves in another more visionary way as Figure 2-14. These big vessels are copied from the idea of Figure 2-08 which represent 3 minutes restriction in each vessel turning characteristics.



圖形2-14阿爸6分鐘真運動向量線跟3分鐘的碰撞危機區域

**2-25 警覺本船與目標船的碰撞危險區**

如果你認為本船隻是雷達上面的一個點，有這樣的想法，你還不成熟。沒有一位船長或是領港，會把本船想像成一個點。在圖形2-08我們可以想像本船是一條大的紅船，是本船長度4.5倍，這是配合避碰操船所需要的距離，在雷達的顯示，我們對於船隻操縱的需要，有同樣的擔心，對於是否能夠避免碰撞，我們希望保留3分鐘的時間，做為轉向的安全時間。這個3分鐘的時間，就像在圖形2-14 大的紅船，我們稱之為碰撞的危險區域。我們用一個大船在螢幕上加以顯示。在螢幕上，我們有3條大船。對於碰撞危險區域的瞭解如下：

1. 3分鐘的時間，是為轉向避碰的需要，應該保留起來，作為我們的容許時間，如果本船或是目標船主機，發電機故障的時候，會產生不自主的碰撞。
2. 3分鐘的前進距離，需要保留做停車緩衝之用。它也是我們無法回轉的距離長度。任何船隻在這個危險區，跟本船都可能發生碰撞，如果是資淺船副在當班。
3. 每一條船都有他自己的碰撞危險區域，或是碰撞面，就在它自己的速度向量的尾端，如果它保持現行的航向航速。
4. 如圖形2-14（紅色與綠色船隻），只有兩條船的碰撞區域相重疊，會有碰撞危機。我們能否視覺化本船與目標船的碰撞危機,(這條黃色的大船）是否安全？
5. 這些碰撞危險區域是3分鐘的行進時間，利用這些3分鐘的時間，本船可以保持與其他目標的安全距離。

實際的海上，我們的心智慧力要過濾些不相關的目標船，是非常寶貴的，像在本船右正橫後的船隻。這種想像的大船，在我們做資淺船副的階段很重要，當我們比較熟悉避碰的操作時，這也是個很重要的概念。

圖形2-15 阿帕 3分鐘真運動向量＝想像的大船

在我們來來回回比較過這些圖形後，很明顯的圖形2-14，是我們最需要的自覺。我們可以用來

#檢查速度向量線的交點，來確認碰撞危機

#使用速度向量線的交點，來預測碰撞時間。

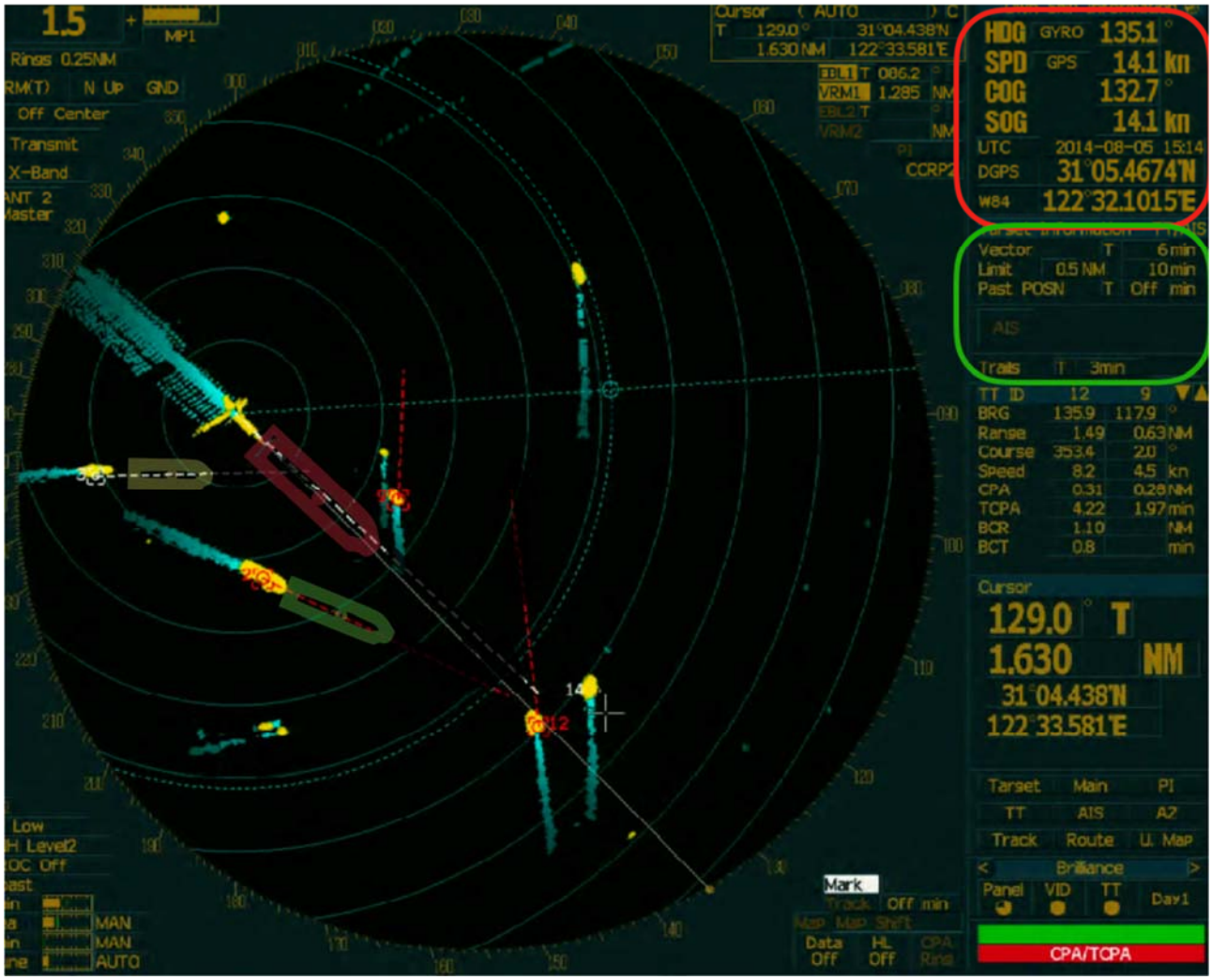
但是3分鐘的安全容許值，對一個資淺船副來講，是太少。所以當值船副最好是具有6分鐘，9分鐘，12分鐘後情勢的警覺性。在圖形2-14 我們有6分鐘的速度向量線設定。在不同的速度向量線時間設定裡，我們需要檢查他們最後3分鐘的部分，利用想像的大船，就像圖形2-14 ，這我們晚點會討論。當我們比較熟悉這些概念後，以當值船副而言，你需要遵守下面的格言，“如果看到很多船隻的速度向量線，跟本船的速度向量線，在9分鐘長度內有交點，請呼叫船長，如果你還不確定要怎麼辦？”

## 2-25 Aware big imaginary ownship with other vessel collision risk area on screen.

If you thought ownship is only a point in Radar or ARPA this is a simplified thinking. No pilot or captain will think ownship is like that. In Figure 2-08 we had imaged ownship as a big red vessel with 1.5 times ship's length over all (LOA) to meet her maneuvering requirement to avoid the collision. In radar display we had same worry of maneuvering requirement to avoid the collision. It is in this concern we will reserve 3 minutes time to make the turn for collision avoidance. **This 3-minutes time is the big red ship in Figure 2-14 which we call it collision risk area s**hown as big vessel on screen. We have three big vessels here. For collision risk area:

1. Three minutes time **is needed in altering course to avoid collision** or reserved for safety allowance if steering /main engine/generator failure by ownship or target vessel which will cause collision unwillingly.
2. It's **three minutes advance distance needed for stop engine.** It is point of no turning back. Any vessel inside this collision risk area may be collided by ownship if a junior OOW on watch.
3. Every vessel has its own collision risk area in the end of its speed vector no matter what course and speed she is steering.
4. Only two vessel's collision risk area overlapped these two vessels have collision risk in Figure 2-14 (red and green big ship). Can we visualize ownship collision risk with yellow big vessel, safe or not?
5. These collision risk areas are in 3 minutes time. Using these 3-minutes distance as safe distance ownship can keep safe distance to another target vessel.

In real sea, our mental ability to filter out irrelevant target like the one aft ownship's starboard beam is very valuable. This imaginary big ownship is not only useful in our junior OOW stage. It is also an important concept when we become more familiar with collision avoidance.

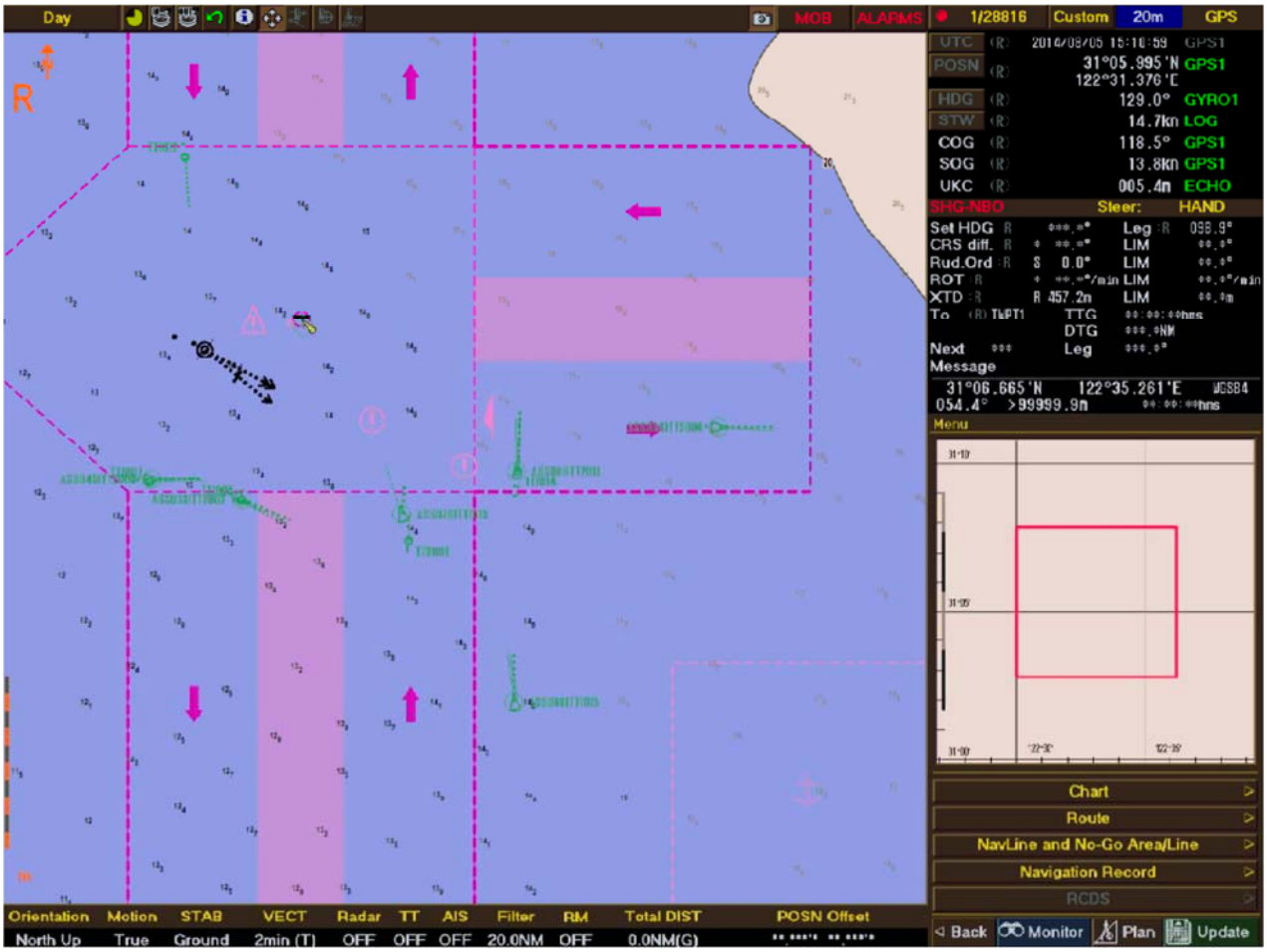



圖形2-15 阿帕 3分鐘真運動向量＝想像的大船

After we navigate through all these pictures back and forth, it is obvious that Figure 2-14 is the final awareness we need

- to verify collision risk by speed vectors intersection point
- to predict collision time by intersection position in speed vector.

But 3 minutes safety margin will be too small for a junior OOW. It is better that OOW can have the collision awareness in 6, 9, 12 minutes before collision. We had 6 minutes setting speed vector at Figure 2-14. **In different speed vectors time setting, we need to check their last three minutes section by using imaginary big ship as figure 2-14.** We will discuss later when we are more familiar with these concepts. Right now, as an junior OOW, you need to follow this motto" **If we saw lots vessels' speed vector have cross point with ownship's speed vector within 9 minutes, call the master if you are not sure of what to do.** "




圖形 2-16 電子海圖畫面 2 分鐘速度向量線的長度

## 2-03 阿帕/AIS/VHF的情境感知

### 2-26 阿帕航跡運算，立即顯示與持續更新

當聯合國海事組織設立阿帕的操作性能標準時，擔心電腦會超載，規定阿帕應該能夠自動追蹤處理，立即顯示跟持續更新，至少20個目標的資訊，不管他是自動或是人工擷取。現在因為新一代的電腦，能夠擷取目標的數量，已經增加到40個。實際上，太多的目標同時顯示在阿帕螢幕上，對我們來講，也是沒有用處，如果我們不能同時記得太多的目標。在人類的能力，我們只能一次處理一個目標。其他ARPA所擷取的目標，儘管是持續更新，對我們毫無意義，如果他們與本船並無碰撞危機。如果我們在阿帕上面，設定需要最小的CPA，碰撞警報可以自動響起。當值船副每一次看到阿帕的碰撞警告，他必須決定“這是不是我現在需要處理的目標？”，如果這個目標不是最危險的目標，那在這個時間，他就必須把它放在一邊，日後再處理。這些程式，“注意警報，確認危險目標，決定目標的優先順序”，在船隻密集的區域，會一再地重演。

這些程式是在浪費當值船副的時間跟精力，如果他對阿帕的螢幕資料，沒有圖形警覺的能力。在圖形2-14，我們有三條船的速度向量線是紅色，但是只有一條船是正確的。在實際的海上，使用阿帕的情況之下，我們應該能夠正確的指出那一條船有危險？這就需要有正確的碰撞危機警覺。再熟練一點的當值船副就會記得，在右邊有幾條船，在左邊有幾條船，即使現在他們看起來，並不相關的圍繞本船，當本船需要轉向的時候，這些船將會是新的碰撞危機。

## 2-03 Situational awareness of ARPA/ECDIS/AIS/VHF

## 2-26 ARPA track, process, simultaneously display and continuously update.

When IMO set up the ARPA PERFORMANCE STANDARD, they worried about overload the computer capacity. *The ARPA should be able automatically to track, process, simultaneously display and continuously update information on at least 20 targets, whether automatically or manually acquired.* The target number available to track on ARPA is increased to 40 targets by new generation of computer. Actually, too many targets *simultaneously display* are useless in ARPA if we cannot handle these targets one by one. In human capability, we only can handle one target at a time. Other targets acquired by ARPA *continuously updated* is useless to us if they have no collision risk with ownship. We can set collision alarm automatically if we had set Minimum CPA in ARPA. Every time OOW had seen collision alarm in ARPA he has to decide "Is this the crucial target I have to take care now?". If this target is not most dangerous target at the time its needs to be left behind for later reference. These process of "to notice alarm, to identify which target, to decide the priority of target" may go on and on in heavy traffic area. These processes are waste of time and energy of OOW if he has no idea of visual awareness inside ARPA screen. In Figure 2-14 we have three vessels with red speed vectors but only one is correct. In real sea, we should be able to pick up the correct one (should have correct awareness of collision risk) even with usage of ARPA. More **prudent OOW will remember how many vessels in starboard side and how many in port side now even they seem irrelevant.** All these vessels at scene (around ownship) will need a new collision risk assessment when ownship need to alter course.

## 2-27 電子海圖系統

電子海圖資訊系統ECDIS是一個用於航海的地理資訊系統，並符合國際海事組織所規定的規範，用來代替紙海圖的一個選項。電子海圖系統資料的可能來源，可能是電子航海圖ENC，或是數位海圖DNC，然後整合本船的其他航海資訊，像是位置，船首向，速度，對水的參考系統，其他選用的探測器，可以連結到雷達，航海電報，自動識別系統，測深儀，電羅經，跟測速儀，衛星定位系統等等。當聯合國海事組織設立電子海圖系統的規格，對於電腦的能力，太有信心，電子海圖系統在同一時間內，有做不完的工作。每一個水深的數字，在數位海圖上面，對本船來說，都是一個潛在的危險，這些都必須加以計算，他距離本船的安全距離。電子海圖的螢幕，就像是圖形2-16.

電子海圖是一個非常複雜的系統，他能夠說明現代的航海者，使用數位海圖的資料，用為航程計畫，在船副有很多的時間，很少工作量的駕駛台時使用，也許在碼頭裡面，比較合適做航程計畫。

電子海圖證書的發證，需要5天的訓練，電子海圖他比其他的工程電腦都還要複雜，就像是一個大黑洞一樣，對當值船副來說，電子海圖最大的問題是，他的比例尺，電子海圖螢幕並不像紙海圖這麼大，他的資料雖然完整，但是在不同的階層顯示，就像阿帕一樣，看不到等於沒有，對當值船副來講，不可能同時觀測完整資料，他的設定太複雜。對船副來說，如果他沒有從事航路規劃的工作，就只能看到在電子海圖螢幕上面，非常有限的資料，他會對電子海圖擁有錯誤的信心，當值船副可能相信電子海圖可以核對，並且防止所有的航行危險，電子海圖並不能做到。除非船長非常的小心，設定電子海圖所需要的各種規則，並且所有船上船副都已經非常瞭解，每一班當值船副都要重新核對電子海圖的設定，早年電子海圖所牽涉到的海事案件，與衛星定位系統的連線有問題，現在其他的案件，也許是沒時間做好航程計畫，或設定龍骨下的水深的安全需求等等。

## 2-27 ECDIS

An Electronic Chart Display and Information System (ECDIS) is a geographic information system used for nautical navigation that complies International Maritime Organization (IMO) regulations as an alternative to

paper nautical charts. An ECDIS system displays the information from Electronic Navigational Charts (ENC) or Digital Nautical Charts (DNC) and integrates information from ownship position, heading and speed through water reference systems and optionally other navigational sensors. Other sensors could interface with an ECDIS are radar, Navtex, Automatic Identification Systems (AIS), and depth sounders, gyro compass, speed log, GPS. When IMO set up ECDIS PERFORMANCE STANDARD they had over confident about the computer's capacity. It has endless jobs to take care at same time by ECDIS, every water depth number on Digital Nautical Charts (DNC) is a potential safety concern to ownship which have to calculate to verify its safe distance from ownship. Official ECDIS screen may look like this in Figure 2-16. ECDIS is a very complicated system to help modern navigator in using Digital Nautical Charts DNC, it should be used for voyage planning only when OOW have many times and less workload at bridge (may be at port). Without 5 days of ECDIS training, ECDIS are more complicated than any other engineering computer which is like a big black hole to OOW. The major problem with ECDIS is their scale. Its screen is not as wide as a paper chart and its data although complete are displayed in many layers which are very hard to show OOW in a convenient way. Its setting is too complicate to other OOW who had not involved in its voyage planning. The result is OOW on watch can see very limited data on ECDIS screen still he may have false faith with ECDIS. OOW believed ECDIS can be checked and stop all navigational danger, actually it cannot. Unless captain is cautious enough to set up necessary rules in ECDIS setting and commonly known by all OOW on board, each OOW should double check the ECDIS setting in their watch hours. In early years ECDIS case are grounding involved with wrong ship's position system (GPS). Other cases are grounding with wrong setting of safety depth of under keel clearance, etc……

## 2-28 船用自動識別系統

如果連結AIS的資料到電子海圖系統的畫面，可以用作避碰用途，聯合國海事組織的決議案MSC.74(69) 1998，建議自動識別系統的操作標準，性能規格如下：
這個AIS應該能增進航行安全，利用船對船模式的避碰，AIS應該能夠做到以下幾點
1. 提供自動連續的資訊，給主管官署及其他船隻，不必人工作業。
2. 自動接收處理資料，來自他船或岸上單位
3. 自動回應高優先及安全相關的呼叫，使用最少的延遲。
4. 提供本船位置與操縱資訊，以適當的資料傳輸率，使得主管官署或其他船隻，能正確的使用或追蹤。
AIS提供位置操縱資訊,當船隻有裝設並可以使用時，這些位置跟操縱的資訊，對於避碰是有良好的成效。這是自動交換避碰資料，是一個很大進步。目標船的資料，並不會像雷達回跡一樣，在近距離消失，忽然就不見了。AIS資料跟阿帕遭遇到的根本問題一樣，人類短期記憶的容量容易超載，即使呢AIS系統設計的，可每分鐘處理2000份報告，我們只能記得一條目標船的十位元數位，並非所有船隻的資料，都有用。良好的目視瞭望訓練，我們可以立刻知道哪一條船是比較危險的？
在這一方面，我曾要求過要增加走道的航行燈，來指出目標船的長度 船首向跟回轉速率，這在第一章的附錄。AIS的另外一個問題，就是他的系統並沒有自己的圖形顯示。AIS的資料，現行的做法是這樣，是顯示在電子海圖，或是自動避碰測繪雷達上面。當值船副如果依賴AIS作為避碰的主要資料來源，如果AIS資料是獨立顯示，這沒有什麼錯誤。當AIS資料連結到阿帕顯示的時候，問題來了，因為雷達回跡在近距離消失了，AIS失去顯示的回跡位置，這時候當值船副，會收到一個警報信號，這會讓當值船副時常感到困惑，就像我們在第一章桑吉輪案件，圖形22 1946時的畫面一樣，紅色的AIS碰撞警報，有在AIS的資料區，但是在阿帕的螢幕上，沒有目標回跡，也沒有紅色的速度向量線的顯示。當值船複要好好利用AIS的資料，應該借著瞭解下列的術語，跟他代表的意義開始，

聯合國海事組織的決議案A1106(29)裡面,船上自動識別儀操作指導書

## 2-28 SHIPBORNE AUTOMATIC IDENTIFICATION SYSTEM(AIS) .

ECDIS had been used for collision avoidance purpose is because its connection to AIS data. IMO RESOLUTION MSC.74(69) 1998: recommended performance standard of AIS. *The AIS should improve the safety of navigation by assisting in a ship-to-ship mode for collision avoidance. AIS can*

.1 *providing information automatically and continuously* to a competent authority and other ships, without involvement of ship's personnel;

.2 *receiving and processing information from other sources*, including that from a competent authority and from other ships;

.3 *responding to high priority and safety related calls* with a minimum of delay; and

.4 *providing positional and manoeuvring information at a data rate* adequate to facilitate accurate tracking by a competent authority and other ships.

AIS is providing positional and manoeuvring information automatically from ship fitted operational AIS. These positional and manoeuvring information are good for collision avoidance purpose. This is a great improvement of collision avoidance by automatic electrical data interchange. Target vessel's data will not lose as their radar echo lost in close range.

The ultimate problem in AIS data as ARPA is the same. Human short term memory capacity is overloaded. Even AIS is designed to handle 2000 reports per minutes, we only can remember 10 digitals from one target, not all vessel's data. Proper trained in visual lookout we can immediately know which vessel is more dangerous. In this regard, I had made the request to add additional navigational side lights to indicate target ship's length, heading and rate of turn if any (see Annex 1 in last chapter). AIS has another problem is this system did not have graphic presentation of its own. AIS data is shown on ECDIS and ARPA radar monitor right now. If navigator depends on AIS for major source of collision avoidance there is nothing wrong if AIS is displayed independently. If radar echo is lost but AIS data remain OK there will be a warning signal make OOW confused from time to time as we see in Figure 22 1946 hours in chapter 1 SANCHI's case. Red AIS COLLISION warning is shown in AIS data area but in ARPA screen no target with red speed vector are displayed. AIS lookout is not the final solution in instrumental lookout.

OOW should make best use of AIS by understand following terms and its representation. Extract from IMO Resolution A.1106(29) 2015 Guidelines for the onboard operational use of shipborne Automatic Identification Systems (AIS)

## 2-29 AIS的圖形顯示

*當AIS資料用來做圖形顯示時，下列的目標型態，可以加以區分：*

*危險目標：一個AIS的目標（不論是否啟動），經過計算會少於我們預設的CPA與TCPA的限制，它就會被分類並且顯示為一個危險目標，並發出警報。*

*失去的目標：在預設距離之內，沒有接收任何目標的資訊，失去目標的符號會顯示，在最後接收到資訊的位置，並發出適當的警報。（像桑吉輪的雷達，雖然AIS有資訊，但雷達回跡失去，讓AIS顯示的位置與速度向量線都不見，讓當值船副無法適從，這就不對）*

*沉睡的目標：只有指出出一條目標船有AIS的設備，與它現在的地點。啟動前，不會有其他額外的資料顯示，避免資料的超載。*

*啟動的目標：如果船副希望啟動沉睡目標的動態，AIS 能夠立即顯示下面的資料:*

*一個速度向量線:包括對地的航向航速*

*船首向*

*回轉速率，（如果可能）包括起始的航向，改變了多少？*

*選擇的目標：如果使用者希望知道更詳細的資料，不管他是否啟動，或是沉睡狀態，都可加以選擇，然後接收到的資料，連同計算的CPA跟TCPA的資料，都會顯示在數位化視窗內。特殊的航行狀態，同樣也會在此數位資料視窗內顯示，不必直接連在目標上。*

## 2-29 Graphical display of AIS

*Where AIS information is used with a graphical display, the following target types may be displayed:*

*Dangerous target: If an AIS target (activated or not) is calculated to pass preset CPA and TCPA limits, it will be classified and displayed as a dangerous target and an alarm will be given.*

*Lost target: If a signal of any AIS target at a distance of less than a preset value is not received, a lost target symbol will appear at the latest position and an alarm will be given.*

*Sleeping target: A sleeping target indicates only the presence of a vessel equipped with AIS in a certain location. No additional information is presented until activated, thus avoiding information overload.*

*Activated target: If the user wants to know more about a vessel's motion, the target (sleeping) may be activated so that the display shows immediately:*

- *a vector (speed and course over ground);*
- *the heading; and*
- *ROT indication (if available) to display actually initiated course changes.*

*Selected target: If the user wants detailed information on a target (activated or sleeping), it may be selected. Then the data received, as well as the calculated CPA and TCPA values, will be shown in an alpha-numeric window.*

*The special navigation status will also be indicated in the alpha numeric data field and not together with the target directly.*

## 2-30 AIS 的潛在限制

當值船副應注意到 AIS 最大的問題，就是在避碰的時候，沒有的 AIS 的資料。
#當值船副應該經常注意，其他船隻特別是遊艇 漁船 或是軍艦，包括某些岸區的 VTS 的管制中心，也許並沒有 AIS 的設備。
#當值船副應該注意，有裝 AIS 的船隻，也有可能關閉 AIS 的訊號，雖然是法規的強制要求，這也許是船長專業上的判斷。
#換句話說，AIS 提供的資料，可能不是本船附近情況的完整畫面。
#使用者應注意，傳送錯誤的資訊，對本船與對其他船隻，都是一種風險。

#使用者對於所有傳送的資料，或是其他系統傳輸給 AIS 的資料，應該要負完全責任。
#AIS 資料的接收精確度，只有達到傳送時的精確。
#當值船副應該注意，AIS 規劃不良，或是感測器未校正的船隻，（包括船位船速船首向）可能會造成不正確的資料傳送。
#在駕駛台顯示的資料，如果使用了別船不正確的資料，會造成危險的混淆。
#如果感測器沒有裝設，或是感測器不能作用，例如電羅經不能提供資料，AIS 自動發射"不適用 N/A Not Available"資料。
#無論如何，是否有內建的自動偵測錯誤系統，不能保證資料內容的有效性。
#接收到的他船資料，是一個相對的數值，其準確度可能只是對他船而言，這是一個老練當值船副應該有的假設。

### 2-30 INHERENT LIMITATIONS OF AIS

The major problem is OOW had to aware of no AIS transmitting vessel in collision avoidance.

- *The OOW should always be aware that* other ships, *in particular leisure craft, fishing boats and warships, and some coastal shore stations including VTS centres,* might not be fitted with AIS.
- *The OOW should always be aware that* other ships fitted with AIS *as a mandatory carriage requirement* might switch off AIS *under certain circumstances by professional judgement of the master.*
- *In other words,* the information provided by AIS may not be a complete picture of the situation around the ship.
- *The users must be aware that* transmission of erroneous information implies a risk to other ships *as well as their own.*
- The users remain responsible for all information entered into the system and the information added by the sensors.
- The accuracy of AIS information received is only as good as *the accuracy of the AIS information* transmitted.
- *The OOW should be aware that* poorly configured or calibrated ship sensors (*position, speed and heading sensors)* might lead to incorrect information being transmitted.
- *Incorrect information about one ship displayed on the bridge of another could be dangerously confusing.*
- If no sensor is installed or if the sensor (e.g. the gyro) fails to provide data, the AIS automatically transmits the "not available" data value.
- *However, the built-in integrity check cannot validate the contents of the data processed by the AIS.*
- *It would not be prudent for the OOW to assume that the information received from other ships is of a comparable quality and accuracy to that which might be available on its own ship.*

### 2-31 使用AIS 避碰的情勢

- 使用AIS 協助避碰，他的潛力已經被認可，在適當的時候，AIS 可能被推薦，做為這樣的裝置。
- 然而AIS的資料，也許應該單純用來協助避碰的決策，然而當使用AIS 在船對船的模式，來做避碰的目的，下面的注意事項，應該記在心中：

1. AIS 是一個額外的航行資料來源，他並不能取代其他的航行系統，只是支援，例如雷達的目標追蹤跟VTS 監控雷達的目標追蹤。

2.使用AIS並不能減輕當值船副的責任，應隨時符合避碰規則的要求，特別是規則7，當決定碰撞危機是否存在。

- 使用者不應該依賴AIS 為唯一的系統，而是應該確保所有安全有關的資訊，隨時可用。
- 在船上使用AIS，不應該對現行的航行當值人力分配，產生特別的影響。駕駛台的人力配置，應該繼續由STCW來決定。
- 一旦某輪被探測到，借由該目標所發送的資訊，AIS可以協助追蹤該船，可以監控該目標。在雷達追蹤目標的時候，很多經常的問題，例如雜斑，目標交換（當兩船近距離通過時），或是在快速的操縱之後，目標回跡消失，都不會影響到AIS。AIS使用船名，呼號，船型與航行狀態，可以說明對目標的確認。

我們引用這麼多的AIS 指導書，是因為使用雷達追蹤目標會有的問題，對AIS 都沒有問題。做決策所需要的所有資料，都能夠由AIS 來提供，無可避免的，當值船副會最依賴AIS 的資料，來評估碰撞危機。AIS 對提供目標追蹤，動態與識別，都很優良。幾乎所有船副需要的資料，都能夠由AIS 提供資料。唯一的問題是，有那些沒發送AIS資料的目標船，使得本船很容易就失去對碰撞的警覺。

- 注意：並不是所有船隻都有AIS的設備

- 當值船副應該永遠注意其他船隻，尤其是遊艇，漁船或軍艦，岸上管制站包括VTS船隻通航服務，也許並沒有裝設AIS 設備。
- 當值船副應該永遠注意，雖然船上裝設AIS系統是一個強制的要求，在某些情況下，關閉AIS資料的傳送，也有可能是基於船長的專業判斷。
- 錯誤的使用阿帕的資料，會增加新的碰撞危機，這個叫做“阿帕協助碰撞”，近些年來，我們同樣也看到“AIS協助的碰撞”，因為關閉了AIS發送的資料，特別是那些近洋船，經常需要對AIS系統開開關關，尤其是在港區的時候。

## 2-31 USE OF AIS IN COLLISION AVOIDANCE SITUATIONS

- *The potential of AIS as an assistance for anti-collision device is recognized and AIS may be recommended as such a device in due time.*
- *Nevertheless, AIS information may merely be used to assist in collision avoidance decision-making. When using the AIS in the ship-to-ship mode for anti-collision purposes, the following cautionary points should be borne in mind:*

  *.1 AIS is an additional source of navigational information. It does not replace, but supports, navigational systems such as radar target-tracking and VTS; and*

  *.2 the use of AIS does not negate the responsibility of the OOW to comply at all times with the Collision Regulations, particularly rule 7 when determining whether risk of collisions exists.*

- *The user should not rely on AIS as the sole information system, but should make use of all safety-relevant information available.*
- *The use of AIS on board ship is not intended to have any special impact on the composition of the navigational watch, which should continue to be determined in accordance with the STCW Convention.*
- *Once a ship has been detected, AIS can assist in tracking it as a target. By monitoring the information broadcast by that target, its actions can also be monitored. Many of the problems common to tracking targets by radar, namely clutter, target swap as ships pass close by and target loss following a fast manoeuvre, do not affect AIS. AIS can also assist in the identification of targets, by name or call sign and by ship type and navigational status.*

The reason we quoted so much guidance of AIS here is: Many of the problems common to tracking targets by radar, do not affect AIS. It is inevitable OOW will rely on AIS data most in their watch to determine collision risk. AIS is good at target tracking, movement, actions and identification. Almost everything OOW need for decision making supply by AIS already. Only problem is for those target vessels did not send AIS data ownship OOW may easily lose situational awareness of collision.

CAUTION: Not all ships carry AIS

*The officer of the watch (OOW) should always be aware that other ships, in particular leisure craft, fishing boats and warships, and some coastal shore stations including Vessel Traffic Service (VTS) centres, might not be fitted with AIS.*

*The OOW should always be aware that AIS fitted on other ships as a mandatory carriage requirement might, under certain circumstances, be switched off on the master's professional judgement.*

Wrong usage of ARPA data may have new threat of collision risk which called ARPA assisted collision. In these years, we also see AIS assisted collision by switching off AIS transmission especially for those coastal vessels which need to switch on and off constantly during port time.

## 2-32 AIS 在航海的運用

*（節錄與英國 Marine Coast Guard agency MCA 航行安全指導書 -實施 SOLAS 第五章）*

*1. AIS 的設計，是能夠提供現成雷達與電子海圖顯示的額外資訊，直到最佳的顯示模式，經過完全評估並且得到國際認可之後，AIS 仍將屬於單獨運用的個體，不會整合到其他的顯示系統。*

*2. AIS 會提供目標的識別，連同其他的靜態與動態資料，依照國際海事組織指導書第 12 節所提，航海者應該小心注意，下列幾個重點，*

*a. 避碰必須在嚴格符合避碰規則的情況下實施，在避碰規則裡面，並沒有條款是使用 AIS 的資料，避碰決策應該基於目視與其他雷達的資料。*

*b.使用特高頻 VHF 來討論兩條互相接近船隻的行動，不被鼓勵並且充滿危險。MCA 的觀點認為，使用 AIS 的系統確認一個目標，並不能解除碰撞的危險。避碰的決策，應該嚴格遵守避碰規則的規定。*

*c. 不是所有船隻都會裝設的 AIS，特別是小船與漁船，其他的漂浮物體，也許會有雷達的回跡，AIS 並沒有辦法探知到。*

*d. AIS 的位置是由目標船的 GPS 的位置而來，推導出來的位置，也許並不吻合實際目標的位置。*

*e. 錯誤的資料輸入在 AIS 的系統，可能導致不正確或誤導的資訊，顯示在他船隻的系統。航海者應該記得，從雷達測繪推導出來的資料，完全是由本船雷達測量出來，並且提供目標的相對運動的航向跟速度，這是決定避碰行動時，所需要最重要的資料。現成船少於 500 總噸，不需要裝置電羅經，不太可能傳送船首向的資料。*

*f. AIS 未來的發展，是有能力提供合成的 AIS 目標跟航海符號，使得海岸官署能夠在任何位置上顯示該符號。航海者應該記得這個能力將導致虛擬的 AIS 目標，而且要特別小心，當一個 AIS 目標與雷達目標的位置，並不吻合的時候。（意思為在電子海圖上，會看到的虛擬浮標，其實只是電子符號的圖形顯示，其實海上並沒有布建該浮標）。AIS 有時候能夠在雷達的陰影區域，發現目標。*

## 2-32 USE OF AIS IN NAVIGATION

*(Extract from MCA Guidance on the Safety of Navigation – Implementing SOLAS Chapter V)*

*1. AIS is designed to be able to provide additional information to existing Radar or ECDIS displays. Until the optimum display modes have been fully evaluated and decided upon internationally, AIS will comprise "stand alone" units without integration to other displays.*

*2. AIS will provide identification of targets together with the static and dynamic information listed in the IMO Guidelines paragraph.12. Mariners should, however, use this information with caution noting the following important points:*

*a.) Collision avoidance must be carried out in strict compliance with the COLREGs. There is no provision in the COLREGs for use of AIS information therefore decisions should be taken based primarily on visual and / or radar information.*

*b.) The use of VHF to discuss actions to take between approaching ships is fraught with danger and still discouraged. The MCA's view is that identification of a target by AIS does not remove the danger. Decisions on collision avoidance should be made strictly according to the COLREGs.*

*c.) Not all ships will be fitted with AIS, particularly small craft and fishing boats. Other floating objects which may give a radar echo will not be detected by AIS.*

*d.) AIS positions are derived from the target's GNSS position. (GNSS = Global Navigation Satellite System, usually GPS). This may not coincide exactly with the target.*

*e.) Faulty data input to AIS could lead to incorrect or misleading information being displayed on other vessels. Mariners should remember that information derived from radar plots relies solely upon data measured by the own-ship's radar and provides an accurate measurement of the* ***target's relative course and speed, which is the most important factor in deciding upon action to avoid collision****. Existing ships of less than 500 gt. which are not required to fit a gyro compass are unlikely to transmit heading information.*

*f.) A future development of AIS is the ability to provide synthetic AIS targets and virtual navigation marks enabling coastal authorities to provide an AIS symbol on the display in any position. Mariners should bear in mind that this ability could lead to the appearance of "virtual" AIS targets and therefore take particular care when an AIS target is not complemented by a radar target. AIS will sometimes be able to detect targets which are in a radar shadow area.*

## 2-33 使用 VHF 避碰工具 MCA 並不推薦

*7.過去曾經有次數不少的碰撞，在後續的調查中發現，在碰撞前的某些時刻，有一條船和其他單位正在使用 VHF 無線電，試圖避免碰撞。使用 VHF，這個情境下，並沒有幫助，有時甚至被證明是危險的。*

*8. 在夜間 能見度受限制或是在附近有兩條以上的船隻時，需要正確的確認目標船是重要的，但是這卻不能得到保證。目標傳送的訊息，與本船接收的訊息，都有很大的不確定性。即使目標船已經確認，還是有可能誤解，因為語言的困難，無論對話雙方對語言的掌握，是否良好，都會有誤解產生的可能。如果有一個不精確或是模糊的表達，可能產生嚴重的結果。*

*9. 會浪費寶貴時間，當航海者在船上試著保持 VHF 無線電的接觸，連絡另外船隻的時間，應該用來符合避碰規則。還有更進一步的危險，即使接觸已確認並且建立，對語言溝通，或是對訊息的內容，都沒有問題，兩條船卻選擇了一個不符合避碰規則行動的方案，導致發生他預期要避免的碰撞。*

*10. 1995 一個碰撞案件的法官說到，“這非常可能是使用 VHF 無線電， 在這些船隻之間對話，造就的碰撞因素，只是因為船副的分心，無法去注意他們的雷達。我必須重複，是希望能夠得到大家的注意，在前面我說過的。使用 VHF 去做任何避碰的安排，都是充滿了誤解的危險。海事經理應該勸告他們的船副，禁止如此使用 VHF 無線電，並且指導他們去符合避碰規則。”*

*11. 在 2002 年的案件中，兩條船其中一條，在霧中接近他船，使用 VHF 無線電呼叫，要求紅對紅（左對左）通航，這個呼叫被另外一條船認可，但是不幸的是，由於使用者對英文的掌握能力不夠，這個呼叫者的意圖是想要綠對綠，（右舷對右舷通行），這個行動沒有被這兩條船隻有效監督，所以接著碰撞發生。*

*12.還有在 2006 年公佈的案件中，兩條船相互接近他船，以至於有近接的情況，兩條船中的一條，與另外一條沒有被確認船隻的人員，同意右對右通航，而不是正要接近船隻的人員。甚而，這個通行的協定，需要其中一條船違反避碰規則的相關規定去轉向。如果船隻同意的通行計畫，是符合避碰規則的操船，這兩條船可以清爽的通過，即使在 VHF 的無線電上，確認了錯誤的船隻。不幸的是，當這兩條船瞭解到他們是朝著對方轉向的時候，他們之間的距離，已經在最後避碰的時刻，後續的行動，他們已經沒辦法避免碰撞。*

*13. 使用 VHF 無線電作為避碰工具，也許有時候很管用。例如在引航的水域，這樣的危機，可以被清楚的瞭解，避碰規則也能被遵守。*

*圖形 2-17 圖形 OPENCPN 螢幕，1514 時 6 分鐘的速度向量線*

## 2-33 VHF: Use of VHF as Collision Avoidance Aid is not recommended in MCA MGN 324

*7. There have been a significant number of collisions where subsequent investigation has found that at some stage before impact, one or both parties were using VHF radio in an attempt to avoid collision.* ***The use of VHF radio in these circumstances is not always helpful and may even prove to be dangerous.***

*8.* ***At night, in restricted visibility or when there are more than two vessels in the vicinity, the need for positive identification is essential but this can rarely be guaranteed****. Uncertainties can arise over*

*the identification of vessels and the interpretation of messages received. Even where positive identification has been achieved there is still the possibility of a misunderstanding due to language difficulties however fluent the parties concerned might be in the language being used. An imprecise or ambiguously expressed message could have serious consequences.*

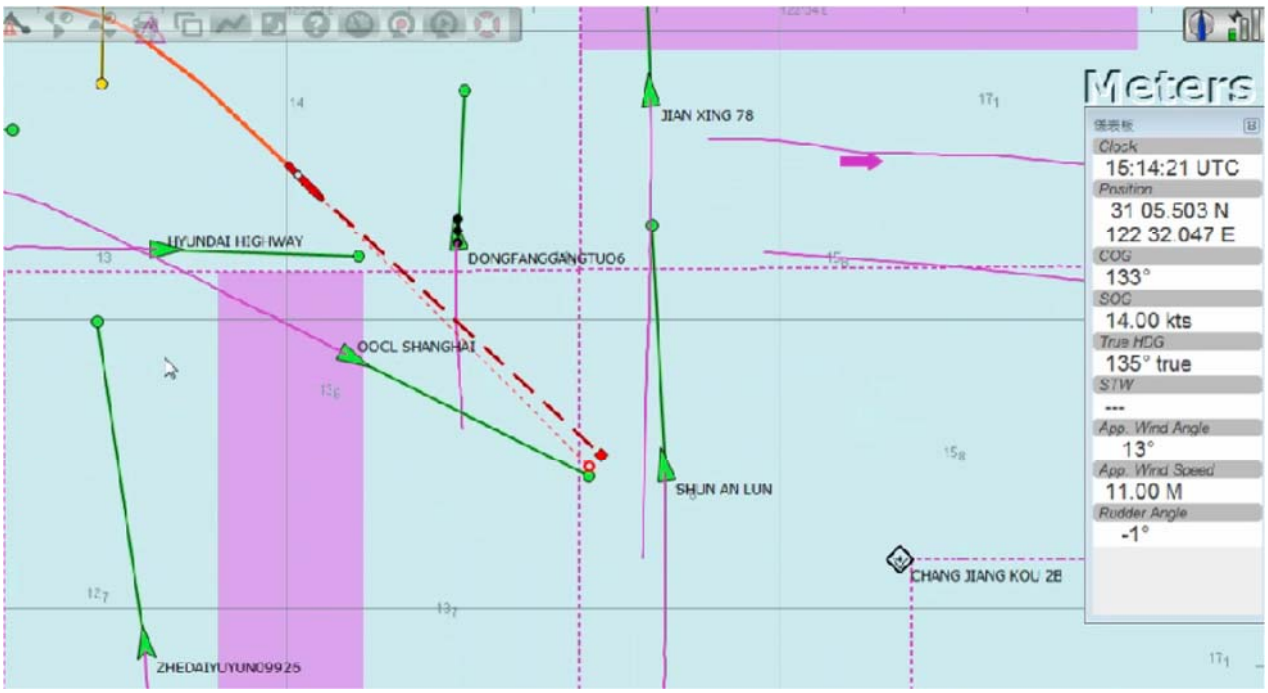
*9. Valuable time can be wasted whilst mariners on vessels approaching each other try to make contact on VHF radio instead of complying with the Collision Regulations. There is the further danger that even if contact and identification is achieved and no difficulties over the language of communication or message content arise, a course of action might still be chosen that does not comply with the Collision Regulations. This may lead to the collision it was intended to prevent.*

*10. In 1995, the judge in a collision case said "It is very probable that the use of VHF radio for conversation between these ships was a contributory cause of this collision, if only because it distracted the officers on watch from paying careful attention to their radar. I must repeat, in the hope that it will achieve some publicity, what I have said on previous occasions that any attempt to use VHF to agree the manner of passing is fraught with the danger of misunderstanding. Marine Superintendents would be well advised to prohibit such use of VHF radio and to instruct their officers to comply with the Collision Regulations."*

*11. In a case published in 2002 one of two vessels, approaching each other in fog, used the VHF radio to call for a red to red (port to port) passing. The call was acknowledged by the other vessel but unfortunately, due to the command of English on the calling vessel, what the caller intended was a green to green (starboard to starboard) passing. The actions were not effectively monitored by either of the vessels and collision followed.*

*12. Again in a case published in 2006 one of two vessels, approaching one another to involve a close quarter's situation, agreed to a starboard to starboard passing arrangement with a person on board another, unidentified ship, but not the approaching vessel. Furthermore, the passing agreement required one of the vessels to make an alteration of course, contrary to the requirements of the applicable Rule in the COLREGS. Had the vessel agreed to a passing arrangement requiring her to manoeuvre in compliance with the COLREGS, the ships would have passed clear, despite the misidentification of ships on the VHF radio. Unfortunately by the time both vessels realised that the ships had turned towards each other the distance between them had further reduced to the extent that the last minute avoiding action taken by both ships was unable to prevent a collision.*

*13. Although the practice of using VHF radio as a collision avoidance aid may be resorted to on occasion, for example in pilotage waters, the risks described in this note should be clearly understood and the Collision Regulations complied with.*



*圖形 2-17 圖形 OPENCPN 螢幕，1514 時 6 分鐘的速度向量線*

## 2-34 OpenCPN 航海家開放海圖架構

OpenCPN Open Chart Plotter Navigator 是一個免費軟體的計畫，目的是要建立一個簡要的海圖架構，與航海軟體，用來航行或是當作航行計畫的工具。OpenCPN 是由一群活躍的船員，使用真實世界的狀況，來做程式的測試與改進。OpenCPN 使用 GPS 的輸入資料來決定本船的位置，並且使用 AIS 接收的資料，來測繪附近船隻的位置，這並不是列在安全設備證書上的一項官方航海儀器。

這裡顯示的 OpenCPN，提供了比阿帕更清晰的畫面，使用 OpenCPN 的問題，就是他依賴 AIS 為單獨的資料來源，提供碰撞危機的計算。小型船隻沒有傳送 AIS 資料，像圖形 2-17 就沒有辦法顯示小船。我們比較圖形 2-12 阿帕的螢幕有 7 條船，但是在 2-17 OpenCPN 的畫面裡，只有 5 個目標顯示在螢幕上，兩條小的目標船遺失了。在 2-17 的螢幕的安排比較清爽，不管是圖形或是數位的資料顯示，比較圖形 2-15 阿帕，或是圖形 2-16 電子海圖.

圖形 2-18 OpenCPN 重疊在阿帕螢幕上 1514 時

## 2-34 Open Chart Plotter Navigator

OpenCPN (Open Chart Plotter Navigator) is a free software project to create a concise chart plotter and navigation software, for use underway or as a planning tool. OpenCPN is developed by a team of active sailors using real world conditions for program testing and refinement. OpenCPN uses GPS input data to determine the ship's own position and data from an AIS receiver to plot the positions of ships in the vicinities. **This is not an official navigational equipment list in Safety Equipment certificate on board.**

This display gives clearer picture of collision situation than ARPA. The problem in OpenCPN (Open Chart Plotter Navigator) is it depends on AIS sole to provide collision risk (no radar input). Small vessel without AIS data cannot shown on Figure 2-17. Compare with Figure 2-12: ARPA screen has 7 target echoes but here in OpenCPN Figure 2-17 only 5 targets shown on screen. Two small targets had missing. This Figure 2-17 is more neatly graphical or alphabet layout in screen for necessary data than Figure 2-15 ARPA and Figure 2-16 ECDIS.


圖形 2-18 OpenCPN 重疊在阿帕螢幕上 1514 時

## 2-35 結合 AIS 的理想顯示

在這裡，我們討論了所有 AIS 相關的議題，這是因為在近來的避碰行為裡，使用 AIS 已經有取代阿帕（使用雷達回跡）的趨勢。這個可以由國際海事組織的決議案裡面看出來，使用 AIS 協助避碰的潛力，已經被認知，而且在適當的時間，使用 AIS 這樣的裝置協助避碰，會被國際海事組織推薦。圖形 2-17 OpenCPN 的螢幕是比較理想的避碰畫面，他可以提供合成的 AIS 目標跟虛擬的助航標記。失去的目標可以從雷達探測的畫面，重疊在圖形 2-18 openCPN 1514 時螢幕上找到，這裡有兩個“沒有確認的雷達回跡”警告圓圈。圖形 2-18 是一個理想的畫面呈現，可以提供當值船副：

1. 合成的 AIS 目標跟虛擬的航海標誌。（AIS 避碰跟電子海圖資料結合）
2. 6 分鐘的速度向量（預測 6 分鐘碰撞危機的速度向量）
3. 兩個沒有 AIS 信號目標的紅色警告標誌。（虛擬無 AIS 信號警告）

圖形 2-18，是作者的想法，開源軟體的目標，是想要做航行或是航程計畫的工具，由一群活躍的海員所發展，他們的努力，應該被我們的航運界跟主管官署尊重尊敬，畢竟船員最瞭解自己的需求。

圖形 2-19 雷達回跡，使用 3 分鐘的尾跡，離中心點相對運動顯示

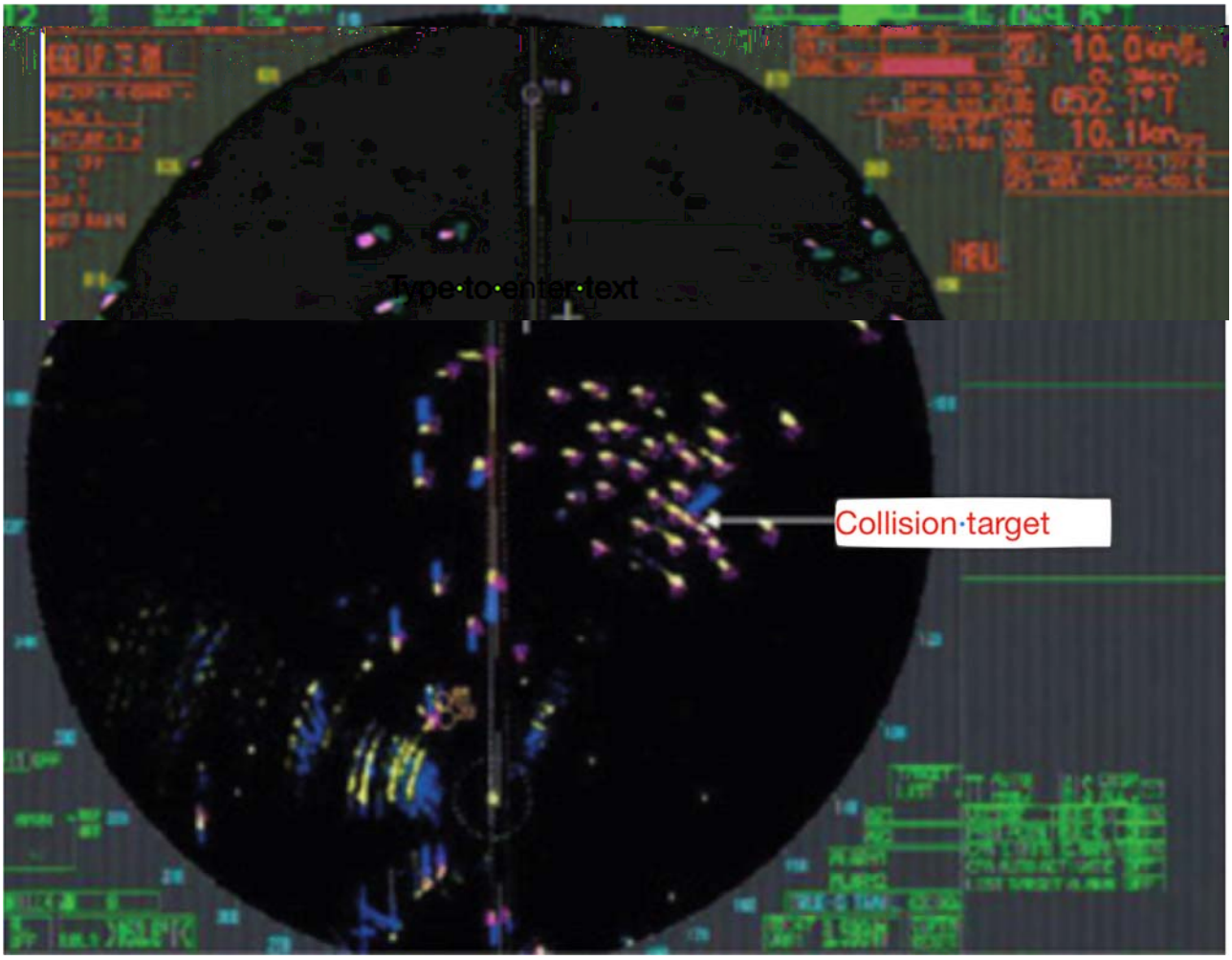
## 2-35 An ideal presentation together with AIS signal.

We had discussed all AIS concerns here. It is because AIS had replaced the ARPA (which based on radar echo) usage in collision avoidance in nowadays. This tendency could be seen in the ***IMO resolution*** above: *The potential of AIS as an assistance for anti-collision device is recognized and AIS may be recommended as such a device in due time.*

Figure 2-17: OpenCPN screen is a more idea picture for collision avoidance provided *synthetic AIS targets with virtual navigation marks*. The lost target can be found in Radar detection picture overlapped on Figure 2-18: OpenCPN screen, UTC 1514 hours with two unidentified radar echo warning circles (*virtual navigation marks)*. Figure 2-18 is an ideal presentation which can provide for OOW:

1. *synthetic AIS targets with virtual navigation marks(AIS collision and electric chart information).*
2. 6 minutes speed vector (6 minutes prediction of collision risk)
3. Two targets have no AIS signal in red warning circles (*virtual collision warning mark)*

Figure 2-18 is an idea of author. For open source software aimed to be uses underway or as a planning tool developed by a team of active sailors, their efforts should be respected and honored by our industrial and authorities.




圖形 2-19 雷達回跡，使用 3 分鐘的尾跡，離中心點相對運動顯示

## 2-36 充分利用雷達尾跡

目標回跡的尾跡，對於顯示該目標船的過去航跡，跟相對運動是非常有用的。該目標船的尾跡，是單色或是漸層色調的餘輝，代表目標船相對於本船的運動，（相對運動）或是他真正的動向，對地的航向航速（真運動），目標船運動的顯示模式，是由本船的雷達所設定。

真運動的尾跡，是目標船的對地航向航速。相對運動的尾跡，代表目標船相對於本船運動的方向跟速率。如果兩條船是在碰撞航向上，這兩條船相對運動的羅經方位，就不會有明顯的變化。來船的相對運動軌跡，就會在某一羅經方位穩定的顯示，這就讓他的尾跡看起來似乎是，指向本船，就像圖形 2-19，標誌著“碰撞目標”。

這個目標的尾跡，是他過去 3 分鐘在螢幕上的位置，像彗星的尾巴，或是雷達詢答機的餘輝，能利用他的方位鑒別性，顯示它的位置。因為所有目標的尾跡，都是設在同一時間長度，他們尾跡的長度，可以給我們其真運動，或相對運動的速度方向的大概概念，就像是他的速度向量線一樣。

尾跡不需要人工作業的功能，就像 AIS 資料的顯示，一旦當值船副設好了阿帕尾跡的時間長短，就會老實的工作。不需要浪費阿帕計算的能量。也不必多餘的人力，去擷取目標，即使目標的回跡抓不到，有時消失，尾跡仍然會有一部分殘留在阿帕的螢幕上，所以尾跡的顯示，毫無浪費，隨時可靠。他的真正價值，就像我們在圖形 2-19 所看到的，雖然阿帕的螢幕上，有非常多的船，千軍萬馬，但是哪一條船有碰撞上的顧慮？是非常明顯，只要我們使用相對運動的尾跡顯示。

在相對運動模式，目標的尾跡是寶貴的，可以給當值船副快速的碰撞警報，當他沒有時間去擷取跟確認目標，在駕駛台的繁忙時刻。我們會有很多的目標船，出現在雷達螢幕上，是很難避免，尾跡的價值，是在雷達螢幕上，要在數不盡的目標上，只看上一眼，立即確認危險目標，就像圖形 2-19。它的功能，就像在目視時，看到目標船的視角，安不安全是明確的（一翻兩瞪眼）。當值船副可以立刻找出目標船的危險方位，作為立即避碰的行動依據。如果不知道要向哪裡轉向？可以利用本船中心點出發的電子游標線，指向危險碰撞目標船的尾跡。除了避碰，尾跡對於監控他船的航向改變，尤其在避碰的最後階段，兩船必須同時轉向時，也是一眼可見（一翻兩瞪眼），特別有用。

## 2-36 Make full use of Radar echo's trail.

The trails of target are useful in showing target vessel's past tracks or relative movement. Echo trails are monotone or gradual shading afterglow of target echoes that represent their movements relative to own ship (Relative motion) or true movements over ground depending on ownship RADAR settings. True motion trail presents target vessel Speed and Course Over Ground (SOG and COG). Relative trail presents target vessel's relative movements toward ownship depending on their relative course and relative speed. If two vessels are in collision course *compass bearing of an approaching vessel does not appreciably change*. The relative motion trail of collision target will steady in one compass bearing which will make it trail appears as pointing toward ownship as Figure 2-19 marked with "collision target". This target's trail are her past three minutes' echo position on screen like the tail of comet or a RACON can emphasize where it is by its directional discrimination. Since all target's trails are displayed in same time interval, the length of their trail can also give us a rough idea of target's speed and direction of her relative or true movement (like speed vector).

The trails are something hands free function like AIS data displayed. Once OOW had set the time interval of trails ARPA will work faithfully. No need to waste ARPA capacity of computing. No extra manpower needs to acquire target. Even target echo lost from time to time there still have some trails left shown on ARPA screen. Nothing wasted, old faithful. Its true value is what we saw in Figure 2-19. **Although the targets are many on ARPA screen which one has collision concern is obvious by its relative motion trail presentation**. Trail of target especially in relative motion mode is priceless which can give OOW a quick collision warning when he has no time to acquire and identified collision target in the rush hours at bridge. It is inevitable that you have countless targets on your radar screen. **The value of trail is helping OOW identify dangerous target at one look in numberless targets** as Figure 2-19. OOW can pick up the dangerous target bearing for immediate avoidance actions if OOW pointing center originated EBL at trail of target. Besides its collision risk, **target vessel's trail is especially useful to monitor other vessel's course change** in later stage of collision avoidance.

## 2-37 船隻關閉 AIS 造成的碰撞

使用 AIS 顯示的資料避碰，已經成為海上主要的方式，因為它有自動顯示的性質。節錄 MAIB 調查報告 2015 年 28 號

"三副監控右舷的雷達顯示，輪流在 3 海浬跟 6 海浬的距離範圍內轉換，在船上的實務，就是在雷達的螢幕上，使用 AIS 資料做為避碰的工具，取代阿帕。"在這個案件裡面，有一條船使用 AIS 做避碰。另外一條船隻有使用阿帕避碰工具，AIS 的系統被關閉了。

"阿帕是用來避碰的，AIS 被關閉了。"

這兩條船後來發生碰撞，就像發生 IMO 與 MCA 所擔心的，一條船使用 AIS 來避碰，另外一條船依賴阿帕來避碰，並且關閉 AIS 。（船隻把 AIS 系統關閉，是 SOLAS 所不允許的，有裝設 AIS 的船隻，必須保持 AIS 隨時都在運作。）在 IMO 決議案 A. 917(22)，提供了下列的指導，使用 AIS 的潛在限制

32. 船隻裝設 AIS ，雖然是強制規定，某些情況下，由船長的專業判斷所決定，可能關閉 AIS 信號。

很多碰撞的案件發生，是因為關閉 AIS 系統，尤其是軍艦。

### 2-37 Ship switch off AIS had caused collision case.

Using AIS data and its presentation had become major collision avoidance means on board due to it automatically display feature. Extracted from MAIB investigation report 28-2015,

> *"The third officer monitored the starboard radar display, which he switched between the 3 nm and 6 nm range scales. It was onboard practice to use AIS data on the radar displays for collision avoidance rather than ARPA."* One vessel used AIS for collision avoidance in this case.
>
> Another vessel used ARPA only, AIS switched off. *"ARPA was used for collision avoidance. The vessel's AIS was switched off."*

These two vessels have collision later just as IMO and MCA had worried about. One ship depends on AIS collision avoidance, another depends on ARPA collision avoidance and switch off AIS (switch off AIS is not allowed by SOLAS: Ships fitted with AIS are required to maintain AIS in operation at all times). The IMO Resolution A.917 (22), which provides guidance: INHERENT LIMITATIONS OF AIS

> *32. The OOW should always be aware that other ships fitted with AIS as a mandatory carriage requirement might switch off AIS under certain circumstances by professional judgement of the master.*

Many collision cases happened due to AIS been switched off especially with warship. These are captain's decision but not professional as they said.

這裡要介紹一下，避碰規則，只是方便各位快速瞭解其內涵，沒有要逐字講解名詞定義，其中會特別討論有關避碰解釋不清的部分，或許是需要改進，或不盡理想的地方。

## 2-04 COLREG Part A- 總則 (Rules 1-3)

### COLREG Rule 1 至上條款: 公海與最高許可權

## COLREGS - International Regulations for Preventing Collisions at Sea 1972

## 2-04 COLREG Part A- General (Rules 1-3)

### COLREG Rule 1 paramount clause: High seas and overriding authorities

**Rule 1 Application:**

*(a). These Rules shall apply to all vessels upon the high seas and in all waters connected therewith navigable by seagoing vessels.*

- 如果你是在遠洋船隻上服務，這些規則將會運用在，所有你船能夠進入的水域。
- If you service on oceangoing vessel these rules shall apply to all waters your vessel may enter.

*(b). Nothing in these Rules shall interfere with the operation of special rules made by an appropriate authority for roadsteads, harbours, rivers, lakes or inland waterways connected with the high seas and navigable by seagoing vessels.*

- 主管官署所制定的特殊規則，在他管轄的水域內，將具有比國際避碰規則更高的效力。

But special rules made by an appropriate authority has overriding power over COLREG within his waters.

*(c). Nothing in these Rules shall interfere with the operation of any special rules made by the Government of any State with respect to additional station or signal lights, shapes or whistle*

*signals for ships of war and vessels proceeding under convoy, or with respect to additional station or signal lights or shapes for fishing vessels engaged in fishing as a fleet.*

- 相較于普通船隻，軍艦或是編隊航行的船隻與漁船船隊，主管官署可以同意其有不同的佈屬燈跟信號燈，號標與霧號。
- ships of war and vessels proceeding under convoy and fishing vessels in a fleet may have different station or signal lights, shapes or whistle signals as ordinary vessels.

(*e*). *Whenever the Government concerned shall have determined that a vessel of special construction or purpose cannot comply fully with the provisions of any of these Rules with respect to the number, position, range or arc of visibility of lights or shapes, as well as to the disposition and characteristics of sound-signalling appliances, such vessel shall comply with such other provisions in regard to the number, position, range or arc of visibility of lights or shapes, as well as to the disposition and characteristics of sound-signalling appliances, as her Government shall have determined to be the closest possible compliance with these Rules in respect of that vessel.*

- 特殊構造和目的的船隻，對於號燈號標的數目，位置，能見距離，可見光的弧度，以及他們霧號的配置以及性質，可以與避碰規則不同，但是必須由其政府決定。
- Vessels of special construction or purpose with respect to their number, position, range or arc of visibility of lights or shapes, as well as to the disposition and characteristics of sound-signalling appliances may have different rules as COLREG determined by their Government.

COLREG Rule 2： Nothing in these rules shall exonerate any vessel, or the owner, master or crew. A departure from these Rules necessary to avoid immediate danger.

COLREG 規則 2：本規則任何規定不能豁免任何船隻，船東，船長或船員。為了避免立即發生的危險，他們可能必須違反這些規則。

**Rule 2 Responsibility:**

(*a*). *Nothing in these Rules shall exonerate any vessel, or the owner, master or crew thereof, from the consequences of any neglect to comply with these Rules or of the neglect of any precaution which may be required by the ordinary practice of seamen, or by the special circumstances of the case.*

- any neglect to comply with these Rules or any precaution which may be required by the ordinary practice of seamen, or by the special circumstances of the case is your fault and COLREG cannot be used as excuses to get away *(exonerate)* your obligations.
- 任何疏於遵守本規則和疏于遵守海員常規需要的注意事項，或是疏於注意該案件的特殊情況，這些都是你的錯。而且避碰規則不能用來豁免你的義務。
- *ordinary practice of seamen*: if every ship did the same thing then ownship should follow. This is an awareness seaman must have beside their education. It is a habit, a custom, a culture or an unspoken rule complied by everybody in nearby area. When others vessel did not have a collision and you had one, it is your fault. We should learn from local wisdom, street wise. The reason why they did this *ordinary practice of seamen* may be discussed with local pilot or agency to understand.
- *海員常規：* 如果每條船都這麼做，我們就應該遵守。這是一種警覺，除了他們所受的教育之外的必需品。它是一種習慣，一種風俗，一種文化或是在這附近海域的人，都會遵守的潛規則。當其他船隻沒有發生碰撞，但是你發生碰撞，這是你的錯。我們應該向當地的智慧學習。為什麼他們這樣做的原因？這些海員常規的理由，我們可以向當地的引水人或代理行去瞭解。

(*b*). *In construing and complying with these Rules due regard shall be had to all dangers of navigation and collision and to any special circumstances, including the limitations of the vessels involved, which may make a departure from these Rules necessary to avoid immediate danger.*

-*船隻所受到的限制，所有航行與碰撞的危險：*本船可能穩定度不好而擱淺，可能與附近的第 3 條船發生碰撞，可能迴旋圈太大，停車距離太長，主機經常故障，在緊急時發電機會跳電，舵機在冬天容易故障，本船正接近航行險阻，淺灘其他船隻等等。
-在特殊情況下，背離本避碰規則去避免立即的危險，是可以接受的。本船的安全高於避碰規則的規定，不必犧牲本船的安全。
- *limitations of the vessels involved and all dangers of navigation and collision*: Ownship may go aground due to stability is no good, collision with third vessel in close by, turning circle too big, stopping distance too long, Main Engine broken down very often, generators black out in critical time, steering gear failure in cold weather or close to navigational hazards, shallow waters, other vessel, etc.……In special circumstances if you make a departure from COLREG to avoid immediate danger is acceptable. Ownship's safety is above COLREG. Don't sacrifice ownship's safety.

## COLREG Rule 3 General definitions

**Rule 3**
**General definitions (omit)**

# 2-05 COLREG Part B- Steering and Sailing (Rules 4-19)

## COLREG Part B- Steering and Sailing (Rules 4-19)

## COLREG Section 1 - Conduct of vessels in any condition of visibility (Rules 4-10)

## COLREG Rule 4 Section 1 apply in any condition of visibility

Part B- Steering and Sailing (Rules 4-19)
Section 1 - Conduct of vessels in any condition of visibility (Rules 4-10)

**Rule 4 Application**

. *Rules in this section apply in any condition of visibility.*

## COLREG Rule 5 Look-out

**Rule 5 Look-out:**

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

- 所有可用方法：VHF,ARPA,AIS,ECDIS,GPS，都是在風險自付下使用，就像我們看到 MCA 的指導書， ARPA 現在都被認為是雷達瞭望的一部分，如果當值船副沒有使用阿帕，去擷取目標，會被認為沒有保持避碰規則的雷達瞭望，就會增加案件判決裡的過失比例。
- *all available means:* VHF, ARPA, AIS, ECDIS, GPS is at your own risk to use as we see at *MCA Guidance*, but ARPA is now deemed as part of RADAR if OOW did not have acquired target by ARPA usually deem as not complied with proper radar lookout in COLREG which will increase liability ratio in collision verdict.

-*保持適當目視跟聽力的瞭望：*使用聽力瞭望，只有一兩海浬的距離有用，因為聲波的傳播距離限制。VHF的瞭望會被認為是聽力瞭望的一部分，這在法院的看法，會認為是對附近船隻動態的警覺。使用視力瞭望受能見距的限制，也會被大霧和其他的氣象理由所妨礙，任何碰撞案件的發生，不論任何理由，不論是暴風雨，大霧，惡劣天氣，衛星定位不行，雷達故障，本船主機故障，或是其他船隻的舵機故障，法院都會說你沒有適當的瞭望，不論你有多少限制和在當時的情況下，你有多無能為力。
- *maintain a proper look-out by sight and hearing*: Lookout by hearing is good at only one or two nautical mile due to sound wave propagation distance limitation. VHF watch may deem as part of lookout by hearing to keep awareness of nearby vessel movement in the court. Lookout by sight is

limited by visibility which may be hampered by fog or any other reasons. Any collision happened in whatever reason (regardless the storm, fog, rough sea, GPS don't work, RADAR breakdown, ownship engine failure or other ship steering gear failure) the court will say you did not have proper lookout no matter how many limitations or restrictions you may have at that time.

## COLREG Rule 6 Safe Speed

**Rule 6 Safe speed**

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

- 安全速度幾乎不變的，被法庭認為是較低的速度。（事實上，如果船隻不多，也許高速才更安全，因為安全的相對方位較小。）
- Safe speed almost invariant means slower speed.
- *安全速度...以避免碰撞*：只有當本船可以在合理的距離內（本船現在能見距的一半距離）停止前進，甚至倒退去避免碰撞，會被認為是安全速度。
- *safe speed …… to avoid collision*: only when ownship can stop within a reasonable distance (which is half the distance of current visibility distance) to avoid collision ownship will deem as in safe speed.

*In determining a safe speed the following factors shall be among those taken into account:*

*(a). By all vessels:*

*(i). the state of visibility;*

- 在過去，安全速度是本船能夠在現在能見距一半的距離內停止的速度。如果能見度是一海浬，本船的安全速度，應該可以在半海浬的距離裡停止前進。如果能見度是零（下大霧），沒有速度才是安全速度。
- in ancient time, safe speed is the speed ownship can be stopped within half the distance of current visibility. If visibility is one Nautical Mile, ownship speed can reduced to zero within half Nautical Mile is our safe speed in that visibility. When visibility is zero (dense fog) no speed is safe speed.

(*ii). the traffic density including concentrations of fishing vessels or any other vessels;*

航路密度: 漁船群或其他船隻的聚集程度

- 安全速度要考慮，減速以避免與漁船群或其他船隻的碰撞。
- The need to slow down to avoid collision with fishing vessels in group or any other vessels,
- 本船在現行船隻密度的情況下，能避免碰撞的速度。
- the speed ownship can avoid collision in current traffic density.

(*iii). the manoeuvrability of the vessel with special reference to stopping distance and turning ability in the prevailing conditions;*

- 本船避碰的操船特性，在做安全速度時要考慮。
- those characteristics of ownship have to consider when take safe speed (avoidance actions).

(*iv). at night the presence of background light such as from shore lights or from back scatter of her own lights;*

- 夜間的安全速度，要考慮眼睛適應黑暗，與避免錯覺所引起的混淆與分心，如同第一章討論的一樣。
- *determining a safe speed*: the speed which our eye can adapt to darkness and avoid night illusions caused by confusion and distractions as chapter 1 discussed.

(*v). the state of wind, sea and current, and the proximity of navigational hazards*;

- 決定安全速度要避免不可抗力（風，浪，流）的影響。

- *determining a safe speed to avoid* unwilling or unprepared collision caused by *Force Majeure (wind, sea and current).*

(*vi*). *the draught in relation to the available depth of water.*

- 本船受吃水限制所需的減速或轉向，與小型船隻的航路不同，所引起的混淆與奇怪的碰撞傾向。

- Ownship have to go slow speed or alter course in deep water track which may different from small vessels' route and confused them with strange collision risk.

*(b). Additionally, by vessels with operational radar:*

*(i). the characteristics, efficiency and limitations of the radar equipment;*

-在被判定超速的碰撞案件中，你不能用雷達不良做理由。

- You cannot use your radar malfunctions as excuse in collision case caused by excess speed.

(*ii*). *any constraints imposed by the radar range scale in use;*

- 你不能用雷達的探測距離不夠，當做超速的理由。

- You cannot use your radar detection range is not enough as an excuse of over speed.

(*iii*). *the effect on radar detection of the sea state, weather and other sources of interference;*

- 你不能用雷達的探測，受限於海象，氣候與其他的干擾擾亂做為超速的理由。

- You cannot use radar detection of target impaired by sea state, weather and other sources of interference as an excuse in collision case caused by over speed.

(*iv*). *the possibility that small vessels, ice and other floating objects may not be detected by radar at an adequate range;*

- *小型船隻，冰山或其他漂浮物無法被雷達探測到*，是你的錯。避免這些*無法偵測的*危險，你應該減速。

- *small vessels, ice and other floating objects may not be detected by radar i*s your fault. To avoid these dangers, you should reduce speed to a safe speed.

(*v*). *the number, location and movement of vessels detected by radar;*

- 如果雷達螢幕裡目標太多，你無法確定他們的動向，你應該減速。

- if too many vessels inside Radar screen which you cannot make sure of their movements you should reduce to a safe speed.

(*vi*). *the more exact assessment of the visibility that may be possible when radar is used to determine the range of vessels or other objects in the vicinity.*

-如果你不知道現在的能見距，不能用現在能見距的一半距離去停止本船，你就不是安全速度。

- If you don't know visibility now you cannot stop your vessel within half distance of visibility. Then, you are not in a safe speed.

## COLREG Rule 7 Risk of collision

**Rule 7 Risk of collision**

*(a). Every vessel shall use all available means appropriate to the prevailing circumstances and conditions to determine if risk of collision exists. If there is any doubt such risk shall be deemed to exist.*

-所有可用的方法，包括使用雷達 阿帕 VHF, AIS, GPS 電子海圖 等等，但是風險自負。

- *all available means*- Visual, RADAR, ARPA, VHF, AIS, ECDIS, GPS is at your own risk to use.

*-如果對於目標方位變化，可用的資料不充分，有任何疑問，碰撞危機應該認為存在，最好是採取行動，以免無謂的等待。*

- *If there is any doubt*- Target bearing change is not obvious or insufficient data available in this.

- *such risk shall be deemed to exist*- it is better to take action than just waits.

*(b). Proper use shall be made of radar equipment if fitted and operational, including long-range scanning to obtain early warning of risk of collision and radar plotting or equivalent systematic observation of detected objects.*

*-雷達設備如果裝置並可用時：如果有裝置雷達並可用時，應該適當地運用，以探測碰撞危機，這是避碰規則的規定。*

*- Proper use shall be made of radar equipment if fitted and operational*- If ownship has good radar we shall use Radar to detect collision risk.

*-長程的掃描以獲得早期碰撞的警報：使用雷達和阿帕，取得碰撞危機的早期警報，也是避碰規則的要求。*

*- long-range scanning to obtain early warning of risk of collision*- obtain early warning of collision risk by radar or ARPA long range scanning setting is a requirement in COLREG

*-長距離掃描到的目標*，並不是*系統化觀測*，如果長距離的掃描已發現目標，被探測到的目標應該被系統化觀測。- *long range scanning* can find target but is not *systematic observation of detected objects*. If long range scanning had found objects, systematic observation of detected objects shall be done.

-最少一部雷達設備，應該可用，否則你就不適航。在美國，海岸防衛隊可以禁止你開船。

- At least one radar equipment should be operational, otherwise you are not Seaworth today.

(*c). Assumptions shall not be made on the basis of scanty information, especially scanty radar information.*

*-目標的雷達回跡，可能在海浪，或是雨雪雜斑中消失，或是目標回跡在近距離與它船回跡交換，或是在長距離無法探測到目標。這些都是不充份的雷達資料，如果用這些做錯誤假設的依據，都會是你的錯誤。*

- Target radar echo may lose in sea/rain clutter or target swap in close range or may not detectable in long range. These are *scanty RADAR information* which will be your fault to make assumptions on these bases.

-目標的動向，可能在最初幾次掃描到的時候，並不正確，或是在接收的時候，收到間斷的目標回跡，因為本船雷達的在接收的時候，受到干擾。在這些時候，當值船副使用雷達和阿帕的瞭望，是很不管用的。

-Target movement may not correct by first few scanning of antenna or interrupted in receiving due to interferences experienced by ownship's radar. In this moment, OOW are helpless by radar/ARPA lookout.

- 目測/雷達/阿帕/AIS/VHF等探測到/或是接收/交換到的資料，當值船副應使用適度的勤勉去確認其正確性。

- Visual / Radar / ARPA / AIS / VHF data detected or received or exchanged should positive identify by OOW with due diligent.

-百分之百的正確是不可能，無論如何，使用適度的注意，去確認正確是當值船副的工作。

- 100 percent correctness is impossible. Anyway, it's OOW job to do it with due diligent.

*(d). In determining if risk of collision exists the following considerations shall be among those taken into account:*

*(i). such risk shall be deemed to exist if the compass bearing of an approaching vessel does not appreciably change;*

*- 羅經方位的明顯變化：*取決於目標船的船型，尺寸與本船的距離來決定的。在圖形 2-05 我們知道小型船隻在左邊，向左移動 6 度的方位，在半海浬的距離外，是安全的，這是對長度 30 米的小船而言，如果是 300 公尺的大船，這就不一定安全。

- *compass bearing appreciably change:* depends on target vessel's type, size and distance to ownship. In Figure 2-05, we learned **Portside vessel moving 6 degrees to portside in half nautical mile distance away is safe for small vessel size in 30 meters.**

- 小船在半海浬的距離，方位改變 6 度，（往正確的方向，也就是遠離本船的船頭）是 97 米的安全通過距離，這是 926 米 * sin($6^0$) = 97 米。

- For small target at distance of half nautical mile away (926 meters), the bearing change of 6 degrees in correct direction (away from ownship's bow) can create 97 meters safe passing distance. 926 m x Sin ( $6^0$) = 97 meters.

-在323公尺長的大型船，四海浬的距離外，方位變化5度，通過的距離會是 1852公尺 X 4 X SIN(60) 等於645.6公尺。這就大約是大船兩倍的船長，也就是我們通行時，需要的安全距離。

- For big vessel in 323 meters length over all LOA at distance of 4 nm, the bearing change of 5 degrees, the passing distance is **1852 m x 4 x Sin (60) = 645.6 meters.** This is about two times length over all LOA of 323 meters vessel needed for safe passing.

(*ii). such risk may sometimes exist even when an appreciable bearing change is evident, particularly when approaching a very large vessel or a tow or when approaching a vessel at close range.*

- 即使方位明顯改變，有可能碰撞危機仍然存在

*such risk may sometimes exist even when an appreciable bearing change*

## 2-06 考慮目標的水平方位

## 2-38 400 米長的船舶在 4 海浬遠的水平夾角是 3.095 度

- 400 米長的船隻，在 4 海浬的距離外，他的水平夾角是 1852 公尺 X 4 海浬 X Sin ( $\theta$ )＝ 400 公尺, $\theta$ 等於 0.395 度。

- 這是我們在四海浬的距離，看到 400 公尺長的船隻，他的水平夾角是 3.095 度，
  在兩海浬的距離，他的水平夾角是 6.2 度，
  在 1 海浬的距離，他的水平夾角是 12.47 度，
  在半海浬的時候是 25.59 度，
  在 1/4 海浬時候是 59.76 度。

請參考圖形 2-09 來船的水平夾角放大

-這是 400 公尺船隻，在不同距離的水平夾角。

如果該船在一海浬的距離外，持續的向本輪接近到半海浬距離，他的水平夾角會從 12.47 度，變成 25.59 度。

## 2-06 Target vessel's Horizontal Bearing consideration

### 2-38 Vessel of 400 meters long at 4 nm distance horizontal bearing is 3.095 degrees.

- For vessel of 400 meters length over all at 4 nautical mile distance the horizontal bearing he has

  1852 m x 4 nm x Sin ( $\theta^0$) = 400 meters. horizon angle $\theta$ =3.095 degrees:

- this is what we see a 400 meters vessel in 4 nautical miles distance away, his profile takes about 3.095 degree of horizon angle.

- For vessel of 400 meters long at 2 nautical mile distance her horizon angle taken is

  1852 m x 2 nm x Sin ( $\theta^0$) = 400 meters. $\Theta$= 6.20 degrees ( 2 nautical mile)
  1852 m x 1 nm x Sin ( $\theta^0$) = 400 meters. $\Theta$=12.47 degrees ( 1 nautical mile)
  1852 m x ½ nm x Sin ( $\theta^0$) = 400 meters. $\Theta$=25.59 degrees ( 1/2 nautical mile)
  1852 m x 1/4 nm x Sin ( $\theta^0$) = 400 meters. $\Theta$=59.76 degrees ( 1/4 nautical mile)

Please refer to Figure 2-09 horizontal angle augment of approaching vessel

This is the horizontal angle of a 400 meters long vessel take in close distance.

If the vessel is in one nautical mile distance away and continue to approach to half nautical mile her horizontal angle will increase from 12.47 degrees to 25.59 degrees.

對一個大船，即使在半海浬內，他的方位變化有10度，對於避碰的目的來講，還是不夠的。因為他的方位變化是花開效應，而不是他的相對方位變化。（花開效應見第一章）這對本船轉向的時候，也是同樣的道理，本船轉向避碰的時候，如果不能克服花開效應的話，也是沒有用。目標船在4海浬的話，本船可以轉向5度去避碰。如果目標船是在一海浬的距離外，就必須轉向15度，來避免碰撞。

For a big vessel, even her bearing had changed 10 degrees in half nautical mile distance it is not enough for collision avoidance purpose because her bearing change is due to blossom effect not her relative bearing change. This is also true that ownship alter course will be ineffective to avoid the collision if we cannot overcome the blossom effect. If Target vessel is 4 NM away, ownship can alter course 5 degrees to avoid because horizon angle $\theta$ =3.095 degrees. If target vessel is 1 NM distance away ownship have to alter course 15 degrees more to avoid collision because horizon angle $\theta$ =12.47 degrees.

## COLREG Rule 8 Action to avoid collision

*Rule 8 Action to avoid collision*

*(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.*

-*如果案件情況許可：* 附近無其他船隻，並且無水深限制……無其他碰撞或擱淺的安全顧慮。

- *if the circumstances of the case admit*- No other vessels around and no draft limitation... No other safety concerns of collision or grounding.

- *避免碰撞的行動應該明確：*避碰行動要明確的符合避碰規則在這一部分，第二節與第三節的規定（避碰規則11-19條），避碰行動，轉向或減速要大到足以改變目標船的相對方位，也就是克服花開效應。

- *action to avoid collision shall be positive:* positive *complied with Section II and III in this part* (COLREG rule 11-19) which means big enough to change target's relative bearing (or overcome blossom effect).

-*在適當的時間執行：*在足以改變目標船的相對方位，適當的時間之前執行。及早，例如在4海浬距離之遠，去避讓目標，對於相對速度18節的船隻來講，需要碰撞前13.3分鐘採取行動。(4/18 Knots X 60 min = 13.3 min.)

- *made in ample time*: early enough to change target's relative bearing or overcome its horizontal bearing change due to distance. Long before collision time. For example, 4 mile distance away to avoid collision for an vessel of relative speed 18 knots need 13.3 minutes before collision. (4/18 Knots X 60 min = 13.3 min.)

- *遵守優良船藝*：預測他船的動向(他船也許需要用到深水航道)，本船去採取預防的行動。或是顧慮到本船在操船性能方面的限制，在附近的航行險阻，也許需要去背離避碰規則的讓路或直航的義務。我們前面講過，船隻的安全高於避碰規則（本船或他船），以避碰規則的規定，他有一定的義務，如果他執行義務，會產生危險的話。他是可以背離避碰規則的要求。如果這樣的背離行動，是被認為是保全船隻合理的行動，就會歸類為優良船藝，其他船隻就要替它船考慮一下，不能死守規則不放。換句話說，這是海員的義氣，相互保全。如果你沒注意到他的困難，罪名就是沒有適當瞭望。

- *observance of good seamanship*: take precaution in prediction of another vessel's action (she may need to use deep water route) and respect ownship's limitation including maneuvering characteristics and navigational hazards nearby which may need ownship or target vessel to deviate from COLREG.

*(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.*

- *航向改變要夠大：*在夜間，他船目視可見本船的兩個桅燈，排列位置的改變，或是在白天，本船的視角或水平夾角，有立即可見的改變。在夜間或是白天，本船相對方位或水平夾角的改變，在長距離的時候，並不明顯。
- *alteration of course be large enough:* Visually saw ownship two masthead lights change alignment at night or target vessel's aspect or horizon angle changed at daytime *readily apparent to another vessel*. Relative bearing or horizontal angle change at long range is not obvious.
- 或看到本船雷達目標的速度向量線或是他的尾跡，有立即明顯改變方向。
- or saw radar target speed vector or trail had readily apparent changed direction.
- *改變航速要夠大*：在晚上，他船目視本船的桅燈，排列位置不變，或是在日間，目視本船的船舷側影不變，沒有很明顯的立即改變方向和形狀，但本船的相對方位角度，快速的增加。或是看到本船的雷達速度向量線，快速的變短。
- *alteration of speed be large enough: In* Visual, target vessel saw ownship masthead lights at night or ownship's side profile at daytime had not change direction/shape in the beginning but relative bearing of ownship had increased quickly, or saw ownship radar speed vector shorten quickly.

## 2-39 本船相對方位變化應該大於花開效應

- *對它船立即可見：*本船相對方位的改變，應該大於花開效應（水平夾角變大），對 2 海浬距離遠的船隻，本船避碰轉向，應該最少 10 度以上。（轉向多少的理由，會以後再探討）

## 2-39 Ownship relative bearing change should be larger than blossom effect.

- *readily apparent to another vessel:* ownship relative bearing change should be larger than blossom effect (horizontal bearing augment): **For avoiding collision in 2 nautical mile distance away, ownship alter course need at least 10 degrees more.** (1852 m x 2 nm x Sin ( $\theta^0$) = 400 meters. $\Theta$= 6.20 degrees ( 2 nautical mile))
- *對它船立即可見：*它船在兩海浬的距離外，本船的相對方位改變，對他船來講，應該大於 3 度，見前一個例子，400 米長的船隻的水平夾角，從四海浬到 2 海浬的時候，水平夾角是變大的。
- *For readily apparent to another vessel* in 2 nautical mile distance away, ownship relative bearing change to other vessel should bigger than horizontal bearing augment 3 degrees (see above example of 400 meters long vessel horizontal angle augment from 4 nm to 2 nm),
- 連續小角度的轉向或減速，應該避免：

  在四海浬的時候，當值船副發現目標船並標注它的方位，
  當目標船在兩海浬遠的時候，本船改變 3 度的航向，
  當目標船在一海浬遠的時候，本船改變航向 6 度，
  當目標船在半海浬遠的時候，本船改變了 13 度的航向。

這些航向的改變，從 3 度 6 度到 13 度是不夠的。讓我們比較一下在規則 7 算的，400 米長的船隻，水平夾角的變大，

4 海浬的時候是 3 度，
2 海浬的時候是 6 度，
1 海浬的時候是 13 度，
半海浬的時候是 26 度。

水平夾角的變化從 4 海浬到 2 海浬是 6-3=3 度，

從 2 海浬到 1 海浬是 12-6 = 6 度，

從 1 海浬到半海浬是 26-13 = 13 度，

雖然本船做了三次的航向改變，3 加 6 加 13 等於 22 度，但是碰撞仍然發生了。所以最好就是目標船還在 2 海裡的距離之外，就一次轉向 22 度，不要等到他只有半距離遠的時候，才來轉 22 度，也是沒有用。

- *a succession of small alterations of course and/or speed should be avoided*"*:*

Found target in 4 nautical mile distance away, OOW marked her relative bearing and

When target in 2 nautical mile distance away, ownship change 3 degrees course,

When target in 1 nautical mile distance away, ownship change 6 degrees course more,

When target in 1/2 nautical mile distance away, ownship change 13 degrees course more.

These courses changes increased from 3 degrees + 6 degrees + 13 degrees ARE NOT ENOUGH.

Let's compare with of 400 meters long vessel horizontal angle augment in rule 7's example.

1852 m x 4 nm x Sin ( $\theta^0$) = 400 meters. Θ=3.095 degrees

1852 m x 2 nm x Sin ( $\theta^0$) = 400 meters. $\Theta$= 6.20 degrees,

1852 m x 1 nm x Sin ( $\theta^0$) = 400 meters. $\Theta$=12.47 degrees

1852 m x ½ nm x Sin ( $\theta^0$) = 400 meters. $\Theta$=25.59 degrees,

from these horizontal angle augment, we can derive the relative bearing change are

horizontal bearing change from 4 nm to 2 nm, 6 -3 = 3 degrees

horizontal bearing change from 2 nm to 1 nm, 12-6 = 6 degrees

horizontal bearing change from 1 nm to 1/2 nm, 26-13 = 13 degrees

Ownship may change course three times, 3+6+13= 22 degrees, but collision still happen. So, It is better to alter course 22 degrees once for all when target is in 2 nautical mile distance away, not when it is at ½ nm distance away.

(*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.*

- *轉向也許是最有效的行動*： 這經常會牽涉到，最少 20 度以上航向的改變，就像我們上一節所討論的。本船的兩個桅燈或是舷燈，在夜間會立即改變相對位置，或是在白天，對目標船的眼睛來說，本船的舷邊形狀有立即明顯的改變，很容易確認，所以目標船不會採取任何行動，來反對我們的意圖。

- *alteration of course alone may be the most effective action*: Usually involve with at least 20 degrees course change as last paragraph discussed. Ownship two masthead lights and side light *readily apparent change* its disposition at night or ownship's side profile *readily will have apparent change shape* at daytime immediately to target vessel's eye. So, target vessel won't take any action against ownship intention,

- *足夠的海域：* 本船做了大角度的航向改變，不會擱淺。就在今天 2020 年的 5 月 11 號，有報導確認沒有碰撞發生，但是有兩條船隻擱淺在同一淺灘附近，這兩條船都是向東航行，這是當他們試圖避讓另外一條西航拖船的時候，在狹窄水道裡面，因為避碰所引起的擱淺。以後會討論這案件。

- *sufficient sea-room*: ownship won't go aground after large alteration of course. Just today May 11 2020, Local reports confirm there was no collision, but that the accident occurred as both vessels attempted to avoid a tug boat. Both vessels were travelling eastbound in the narrow Singapore straits when the grounding occurred.

近接情況： 兩條船的距離減少到2海浬內，但是碰撞危機沒有解除。

- *close-quarters situation:* two vessels distance decreased to less than 2 nm but collision risk unchanged.

*及時執行：* 早於距離 4 海浬之外執行。

*- made in good time:* alteration of course earlier before distance reduced to 4 nm away.

*- 改變航向需要明顯夠大：兩海浬遠的目標，需要最少10度的航向改變，來避免碰撞。這在資深船副的章節裡面，會討論。*

*- alteration of course is substantial:* 2 nautical mile distance target need at least 10 degrees course change to avoid collision (you will know it in Senior OOW chapter).

*- 不會引起另外一個近接的情況：* 本船改變航向去避免碰撞，不會跟附近船隻製造新的碰撞近接情況。本船的避碰行動，對於海上所有的目標來說，必須有效。參看圖形2-10的說明。

*- does not result in another close-quarters situation*: ownship alter course to avoid one target's collision won't create new close-quarters situation with another vessel nearby. Ownship's avoidance actions must be effective for all targets at sea as Figure 2-10.

(*d). 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.*

*- 以安全距離通過*: 資淺船副應該由他船船尾之外安全通過。資深船副應該在碰撞點之外安全通過。

*- passing at a safe distance:* Junior OOW should pass other vessel's stern at a safe distance, senior OOW should pass collision spot at a safe distance.

*- 行動的有效性，應該仔細檢查*：資淺船副應該保持他船的船尾，連續在本船的左船頭方位。資深船副應該保持他船的船尾方位，持續向本船的左船頭方位移動。

*- effectiveness of the action shall be carefully checked:* Junior OOW should see other vessel's stern at port bow direction continuously, senior OOW should see other vessel's stern relative bearing change is continuous.

*- 最後通過並清爽*：資淺船副應該保持它船船尾通過左船頭方向，直到本船回到原航向。資深船副應該保持它船船尾的相對方位，應該保持移動，最終到達本船的左船頭方向。

*- finally, past and clear*: Junior OOW see other vessel's stern at port bow direction continuously until ownship had course again and senior OOW should see other vessel's stern relative bearing had moved to port bow finally.

(*e). If necessary to avoid collision or allow more time to assess the situation, a vessel shall slacken her speed or take all way off by stopping or reversing her means of propulsion.*

*1 應該減速：*應該減速

*2 用停車停止前進：*停止主機讓本船的對地航速減到零。

*3 或反轉推進方式：*對固定螺距的傳統船隻，倒轉主機大軸的方向，或是在可變螺距船隻上，將葉片的角度反轉。改變螺旋槳推進到相反方向，這是在全方位推進的螺旋槳船隻上。

1. *shall slacken her speed:* reduce her speed.
2. *take all way off by stopping*: stop engine to let ownship ground speed reduce to zero.
3. *Or reversing her means of propulsion*: reverse main shaft of fixed pitch propeller in conventional vessel, or reverse the pitch direction of propeller in CPP vessels, or reverse propeller expel direction in AZIPOD vessel. (AZIPOD (Azimuth Podded Drive) Propulsion system)

## 2-40 Three stages of ownship speed reduction: slow down, stop at sea and go backward.

(**f**)*(i). A vessel which, by any of these Rules, is required not to impede the passage or safe passage of another vessel shall, when required by the circumstances of the case, take early action to allow sufficient sea-room for the safe passage of the other vessel.*

## 2-40 船隻減速的三階段 慢車 停車 倒車

船隻： 不得妨礙它船安全通航的船隻，長度小於 20 公尺船隻，或是一條帆船，或是依照規則 9 和 10 從事捕魚的船隻。小船也要有優良船藝，要講義氣。

不得妨礙他船的通航，或安全通航： 讓路給其他船隻，其只能安全的航行在狹窄水道，或是航道（規則 9），航行在航行巷道裡面（規則 10），不論小船從任何方向接近這些船隻，而且對兩條船都安全的時候。

這裡的但書（當情況的環境需要），就是第一保全小船自己，第二讓路優先於碰撞危機，第三其他讓路規則，在此無用，小船讓大船，不論大船是否是安全航行。(條文是：不得妨礙大船的通航，與安全通航)

- 當情況的環境需要：環境需要，就是對本船和目標船的危險，例如擱淺，和第三條船的碰撞，或主機故障，發電機跳電，舵機失靈，接近航行的險阻，淺灘，其他船隻突然轉向，小船都應該提早行動讓路。
- 充份的海域，容許他船安全通過" 充分的海域，是為其他大型船隻保留的海域，他只能在狹窄水道或航道裡面安全的航行，這是規則 9，或是遵循一般巷道，這是規則 10，這個規則裡面，20 公尺以下船隻或是帆船或是從事捕魚的，都是小船。他船意指大船。

- *A vessel:* A vessel of less than 20 metres in length or a sailing vessel or engaged in fishing in rule 9 or rule 10 shall
- *not to impede the passage or safe passage of another vessel:* give way to another vessel which can safely navigate only within a narrow channel or fairway (rule 9) or following a traffic lane (rule 10) from any direction to approach these vessels **are safe for both vessels to do so**.
- *when required by the circumstances of the case:* circumstances required: like danger to ownship or target vessel like grounding or collision with third vessel or main engine broken down, generators don't work, steering gear failure or close to navigational hazards, shallow waters, other vessel alter course…… *A vessel(in this rule: small vessel)* shall take action earlier.
- *to allow sufficient sea-room for the safe passage of the other vessel:* sufficient sea-room is for other big vessel which can safely navigate and maneuver only within a narrow channel or fairway (rule 9) or following a traffic lane (rule 10). 20 metres in length or a sailing vessel or engaged in fishing (*A vessel)* is small vessel.

(*ii). A vessel required not to impede the passage or safe passage of another vessel is not relieved of this obligation if approaching the other vessel so as to involve risk of collision and shall, when taking action, have full regard to the action which may be required by the Rules of this part.*

如果接近其他船隻以至於有碰撞危機，不得解除這一項義務（讓路）：當有碰撞危機的時候，小船不得妨礙他船通行或是安全通行，遵守他在避碰規格裡面的義務，在狹窄水道或是航道，這是規則 9，在航行巷道內通航，這是規則 10。這裡主要講的是，碰撞危機的發生，可能在很遠的距離外，不管距離的遠近，小型船隻都應該要盡可能地讓路，否則規則就白設了。

- 如果某輪（小船）牽涉到碰撞危機，並不能解除他讓路的義務，此時他應該採取的行動，應充分考慮到，因為本規則的要求，及早與充分的行動。
- 碰撞危機的階段，可能存在很久，一條小型船隻有很多的時間，可以不要妨礙其他遠洋船隻的通航，如果近距離的碰撞危機發生，小型船隻也許要保持原航向航速，以避免碰撞發生。

- *is not relieved of this obligation if approaching the other vessel so as to involve risk of collision*: *when have collision risk* **a vessel** *required not to impede the passage or safe passage should follow her obligations in COLREG* within a narrow channel or fairway (rule 9) or following a traffic lane (rule 10).

- *if A vessel involve risk of collision*: **A vessel** is not relieved of his obligation *shall, when taking action, have full regard to the action which may be required by the Rules of this part*
- *risk of collision*: may exist in very early stage when a small vessel has plenty time so as not to impede the passage or safe passage of another oceangoing vessel. If the risk of collision exist in close range **A vessel** may have to keep course and speed to give way to other vessel.

(*iii). A vessel the passage of which is not to be impeded remains fully obliged to comply with the Rules of this part when the two vessels are approaching one another so as to involve risk of collision.*

- 遠洋船隻在狹窄水道或航道(規則 9)在航行巷道內（規則 10），他的通航不得被小船妨礙時，遇到碰撞危機時，仍有完全的義務去符和部分 B 操舵航行規則。也就是從規則 4 到規則 19，瞭望，安全速度，避碰行動，碰撞危機等等的規定。
- **An oceangoing vessel** within a narrow channel or fairway (rule 9) or following a traffic lane (rule 10) the passage of which is not to be impeded involve risk of collision remains fully obliged to comply with Part B- Steering and Sailing (Rules 4-19) lookout, safe speed, risk of collision, action to avoid collision, narrow channel, TSS…….
- 當只用小船（必須不得妨礙他船通行，和安全通過）的單獨行動，碰撞無法避免時，遠洋船應該採取最佳的避免碰撞行動。

-在碰撞的第三階段，兩條船都必須採取行動的時候，這時候呢遠洋船，就需要採取行動以避免碰撞。前面第二階段的部分，遠洋船在有碰撞危機的時候呢，仍然有瞭望，安全速度，評估碰撞危機，採取避碰行動等等的義務，就是雖然是在通航，沒有讓路的義務，但是大船在牽涉到避碰危機的時候，仍然有他要負的責任，避碰的義務在碰撞的第三階段，還是在的。Figure 2-22: vessels obligations in collision avoidance varied by distance

- Rule 17 (b) when *collision cannot be avoided by the action of a vessel required not to impede the passage or safe passage of another vessel alone*, an oceangoing vessel *shall take such action as will best aid to avoid collision.*

## COLREG Rule 9 Narrow channels

*Rule 9 Narrow channels*

*(a). A vessel proceeding along the course of a narrow channel or fairway shall keep as near to the outer limit of the channel or fairway which lies on her starboard side as is safe and practicable.*

- 小型船隻或是慢速船隻，經常需要保持在狹窄水道或航道的外側航行。某輪沿狹窄水道，或是航道航行，應該儘量接近航道的外側，也就是本船航道的右側航行（如果沒有其他的船隻在航道邊緣）。
- Usually, slow or small vessel keep to outside (starboard side) of the channel. *A vessel proceeding along the course of a narrow channel or fairway shall keep as near to the outer limit* on her starboard side *of the channel or fairway as possible (*when there are no other vessels sailed along outer limit).
- 如果航道的外側，水深不夠，深吃水船隻需要用到在航道中間的深水航道。
- If water depth is not enough in outer limit of channel deep draft vessel need to use deepest water in center of channel or fairway.
- 船隻如果只能航行在吃水最深的部分，其他船隻應該遠離航道的中心線，保留一些安全的距離，讓深吃水船隻去航行。
- 在狹窄水道的中線或是航道的中間是深水航道的話，在他的右側的是吃水比較少的航道，在狹窄水道的最外側，一般是近洋船隻的航路，或者是淺水區域。
- Other vessels should keep away the route in center of the channel or fairway and give deep draft vessels some safe distance to navigate.
- In the center of narrow channel or fairway is deep water route, to it starboardside is less draft route, further to starboardside or outside the fairway is coastal vessels route or shallow water area.

(*b). A vessel of less than 20 metres in length or a sailing vessel shall not impede the passage of a vessel which can safely navigate only within a narrow channel or fairway.*

- 一般來說，營利的漁船，會利用 60 呎的魚船，也就是 20 公尺的魚船。休閒的釣魚船呢，或是娛樂用的小船，會用 10 到 40 呎的小船，最多到 60 呎的船隻 。當值船副沒有辦法，利用眼睛來確定目標船的尺寸，因為花開效應，如果有 AIS 的報告，就會有一些幫助。無論如何，要快速的檢查目標船的尺寸，我們需要像這樣子的圖片 2-20，60 尺的小船，如果是帆船呢，大約是由兩根桅杆，一根是主帆，一根是掛斜帆的小桅杆，動力小船有三片窗戶，可能會有 20 尺的長度。

-In general, commercial fishermen would utilize 60-footer (20 metres) fishing boats, casual fishermen and recreational boaters would use l0-40 foot boats up to 60 footer. OOW cannot make sure target vessel's size by eyes, AIS report may help. Anyway, a quick check of target vessel's size may be like this. Figure 2-20: 20 meters boat, 60-footer, sail boat with two masts, or one main mast with another small rig, power driven boat with three side windows are **A vessel of less than 20 metres in length.**

- 如果船隻大於 20 公尺，在狹窄水道或是航道，你就必須要遵守避碰規則，因為他沒有讓路的義務。

- if a vessel bigger than 20 meters in a narrow channel or fairway, you shall comply with COLREG rules without fail.

圖片 2-20，60 尺的小船兩根桅杆，動力小船有三片窗戶

*(c). A vessel engaged in fishing shall not impede the passage of any other vessel navigating within a narrow channel or fairway.*

- 從事捕魚的船隻，在狹窄水道和航道裡，不得阻礙其他船隻在其中的通航。

- **A vessel engaged in fishing** within a narrow channel or fairway shall not impede the passage of **any other vessel** navigating within it.

(*d). A vessel shall not cross a narrow channel or fairway if such crossing impedes the passage of a vessel which can safely navigate only within such channel or fairway. The latter vessel may use the sound signal prescribed in Rule 34(d) if in doubt as to the intention of the crossing vessel.*

-*船隻只能在這種狹窄水道或航道裡面安全通航的*，指的是規則 3 （h）受吃水限制船隻：因為他的吃水與可航水深與航道寬度的限制，嚴重的影響到他離開原航向的能力

- *a vessel which can safely navigate only within such channel or fairway is* Rule 3(h) "**vessel constrained by her draught"** 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.

- *船隻不應橫越狹窄水道或航道*：船隻不得橫越狹窄水道或航道，當阻礙到只能在此狹窄水道或航道裡面安全通行的其他船隻，

- *A vessel shall not cross a narrow channel or fairway*: No vessel shall cross a narrow channel or fairway *if such crossing impedes the passage of a vessel which can safely navigate only within such channel or fairway.*

規則 34（d) 指示這種懷疑，利用最少 5 短聲，或日間信號槍 5 閃光（摩斯信號燈）

*規則 34（d) 指示這種懷疑，利用最少 5 短聲，或日間信號槍 5 閃光（摩斯信號燈）*

*- Rule 34(d) : indicate such doubt by giving at least five short and rapid blasts on the whistle together with 5 short flashes on ALDIS light (Morse signal light).*

*(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).*

## 2-41 的主管官署對狹窄水道和行道的特殊規則

*- 狹窄水道或航道*是屬於當地官署管轄，這條規定 *“船隻被追越時，應採取行動讓他安全通過”* 的要求，這是在國際避碰規則的公約裡，但是當地的主管官署，像是麻六甲或是英吉利海峽，也許他有凌駕避碰規則公約的的特殊規則，*避碰規則1（b）規定：“在這些規則裡面，任何規定不得干擾，適當的官署為他的航道，港口，河流，湖泊和內陸水道所設置特殊規定的操作”* 。

## 2-41 Local authority of Narrow channel or fairway has special rules override COLREG.

- *narrow channel or fairway:* are of some country’s territory water. This rule specified the requirement of “ *the vessel to be overtaken has to take action to permit safe passing* “ in international convention COLREG. But local authorities’ Narrow channel or fairway belongs to an appropriate authority like in Malacca or English strait…..who has special rules override COLREG as Rule 1(b) stated: Nothing in these Rules shall interfere with the operation of special rules made by an appropriate authority for roadsteads, harbours, rivers, lakes or inland waterways.

- 適當主管官署的規則，必須被過往船隻尊重遵守。經常，船舶必須遵守交通資訊管理系統 VTIS 有關通航速度的限制，像是東京灣，規定通航船隻 12 節的對地速度。

- Appropriate authority rules also need to be respected by vessels in passage. Usually, vessels in transit follow the instructions of Vessel Traffic Information Service VTIS in sailing speed limitation like Tokyo bay require 12 knots speed limitation for all vessels in transit.

-VTIS 也許要求慢速船被高速船追越，不必獲得被追越船的口頭允許，或是任何行動容許其安全通過。

- VTIS may request slow speed vessel to be overtaken by High speed vessel behind without overtaking vessel to get overtaken vessel’s oral permission or any *action to permit safe passing*.

- 在航道，港口，河流，湖泊和內陸水道，因為追越鳴放音響信號，並不受歡迎。適當的權責機構，釋放音響信號的規定，同樣必須被遵守。

- In roadsteads, harbours, rivers, lakes or inland waterways to sound the sound signal for overtaking usually is not welcomed. Appropriate authority sound signal rules also need to be respected. When OOW is in doubt he should ask local pilot’s advise to sound the fog signal or not.

- 在規則 34 （C）（I）船隻想要追越其他船隻，必須符合規則 9（e）（i）的規定，指示他的意圖，以下列的信號：使用汽笛中，兩長聲跟著一短聲，表示意圖從你右舷追越，兩長聲跟著兩短聲，代表想要從你左舷追越。

*- in Rule 34(c)(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”*

- 准許他船安全通過的行動，是規則 34 （c）（ii）應該指示他的同意，使用下列音響訊號，一長聲加一短聲，一長聲加一短聲，以這樣的次序

*- action to permit safe passing: is Rule 34(c)(ii) shall indicate her agreement by the following signal on her whistle:*

one prolonged, one short, one prolonged and one short blast, in that order.

- 本規則要求船隻在追越的情況下，必須使用它規定的信號，以符合避碰規則的國際公約。

- this rule asks vessels involving overtaking situation have to use **signals on her whistle in international Convention.**

- 當地官署可以要求**額外的**無線電通訊，規定使用 VHF 報告點，和無線電值更系統，在他的領海。

- Local authority may ask for additional Radio communication requirement by VHF reporting point or radio watch system in their territory.

- 施放音響訊號，可以用來指示我們的意圖，有效距離非常有限，大約1.5到2海浬的距離。

- Sounding signal can be used to indicate your intention only in very limited range about 1.5 to 2 nm in open sea.

*(ii). This Rule does not relieve the overtaking vessel of her obligation under Rule 13.*

- 船隻想要追越其他船隻，應該讓路給被追越船隻，即使被追越船已經採取行動(被追越船隻保持儘量在航道的外側，也就是在他右舷，安全且實際可行的航線上)，去允許追越船的安全通過。

- a vessel intending to overtake another shall give way to the vessel to be overtaken even overtaken vessel has taken action (overtaken vessel *keep as near to the outer limit of the channel or fairway which lies on her starboard side as is safe and practicable*) to permit overtaking vessel safe passing.

**(***f). A vessel nearing a bend or an area of a narrow channel or fairway where other vessels may be obscured by an intervening obstruction shall navigate with particular alertness and caution and shall sound the appropriate signal prescribed in Rule 34(e).*

- 當船隻不能看到其他船隻，從狹窄水道的彎曲處或是某區域開過來，應該施放規則 34（ e）一長聲而且特別小心謹慎的航行。

- when one vessel cannot see another vessel coming from opposite direction of *a bend or an area of a narrow channel or fairway shall sound Rule 34(e) one prolonged blast and navigate with particular alertness and caution.*

*(g). Any vessel shall, if the circumstances of the case admit, avoid anchoring in a narrow channel.*

- 優良船藝或是海員常規，避免本船下錨在可能被通過船隻碰撞的地點，如果該船隻只能在這狹窄水道或航道內，安全的航行。

-- Good seamanship or ordinary practice of seamen, avoid ownship anchored at position where may collide by passing vessel who can only safely navigate within such channel or fairway.

## COLREG Rule 10 Traffic separation schemes

*Rule 10 Traffic separation schemes*

*(a). This Rule applies to traffic separation schemes adopted by the Organization and does not relieve any vessel of her obligation under any other rule.*

- 本規則在分道航行制內，被國際海事組織採用，是規則 10，避碰規則在分道航行之外使用，是優良船藝或是海員常規的規則 2，不要忘記，任何的碰撞，你都有錯。。

- *This Rule applies inside traffic separation schemes* adopted by IMO is rule 10, use this COLREG Rule to apply outside traffic separation schemes *is* Good seamanship or ordinary practice of seamen in rule 2.

- 本規則並未解除任何船隻，在其他規則下的義務。對其他避碰規則下的義務，並沒有被解除，義務不變，行動的時機不同。

- **this rule** *does not relieve any vessel of her obligation under any other rule*: her obligation to comply other rule in COLREG is not relieved.

(*b). A vessel using a traffic separation scheme shall:*

*(i). proceed in the appropriate traffic lane in the general direction of traffic flow for that lane;*

-不要進入船隻以相反或接近相反方向航行的航道，以減少迎艏正遇的情況，

- *proceed in the appropriate traffic lane*: Don't go inside the lane where vessels are of opposite or reciprocate course to ownship to reduce head-on situation.

使用該巷道的一般流通方向相同的航向，以減少橫越的情況。

- *in the general direction of traffic flow for that lane*: navigate about the same course as other vessels in our lane to reduce crossing situation.

(*ii). so far as practicable keep clear of a traffic separation line or separation zone;*

- *保持遠離分道線和隔離區：*，就像在狹窄水道，保持本船在航道外側和航道的右側。這樣可以

#減少迎艏正遇情況，與相反或相對航向的船隻。

#減少船隻橫越的情況，也許它船從另一邊航道，橫越分道線與隔離區，要加入本輪的航道，或要前往另外一邊的港區，請見第八章圖形 8-16。

#減少注意區域的碰撞危機。

- *keep clear of a traffic separation line or separation zone*: As in narrow channel ownship keep to outside or starboard side of traffic lane can

- reduce head-on situation with opposite or reciprocate course.
- reduce crossing situation with vessel (in another side of TSS area) cross traffic separation line or separation zone to join same traffic lane as ownship.
- reduce crossing situation with vessel try to cross ownship traffic lane to harbour area in another side of traffic separation scheme. See chapter 8 Figure 8-16
- Reduce collision risk in precautionary area of traffic separation scheme

(*iii). normally join or leave a traffic lane at the termination of the lane, but when joining or leaving from either side shall do so at as small an angle to the general direction of traffic flow as practicable.*

- *在航行巷道的終點加入或離開:* 只有本船已經是與一般流通方向船隻同向的時候，是好的。換句話說，*船隻如果要在航行巷道的終點加入或離開的時候，應該使用最小的交角*。與一般巷道流通方向，盡可能實際可行，不要用太大的角度進入分道航行制終點區域

- *join or leave a traffic lane at the termination of the lane*: is good only when ownship already has same course *as the general direction of traffic flow for that lane*. In another words, vessels *shall do so (join or leave a traffic lane at the termination of the lane) at as small an angle to the general direction of traffic flow as practicable.*

- 許多船隻把他們的轉向點，設在航行巷道的終點，然後在那邊轉向，這是一個很不好的習慣與實務，因為船隻在他的轉向點，會有很多的不確定性，最簡單的就是潮流與風浪的影響，使得本船的操縱很難穩定，或是其他船隻規劃的轉向點與本船不同，當本船在轉向的時候，都會使碰撞危機快速的增加。

- Many vessels set their turning point *at the termination of the lane* and alter course there. This is a bad practice as vessels are under a lot of uncertainty in turning point like current or setting not steady or ownship's maneuvering characteristics limitation or other vessel has different turning point with ownship…... the collision risk is increasing while ownship is turning.

- 當進入或離開航行巷道，應該使用與流通方向小的交角，這是避免跟在航道裡面的船隻，產生交叉相遇的情況，請看紅船加入分道航行制，圖形 7-28 完整的航道安排在分道航行制。

- *when joining or leaving from either side shall do so at as small an angle to the general direction of traffic flow as practicable:* to avoid crossing situation with vessels already inside the traffic lane. see red ship joining the TSS in Figure 7-28: Throughout course arrangement in Traffic Separation Scheme.

(*c*). *A vessel shall, so far as practicable, avoid crossing traffic lanes but if obliged to do so shall cross on a heading as nearly as practicable at right angles to the general direction of traffic flow.*

- 儘量縮短橫越的時間，以避免妨礙船隻的通行。這是同時橫越雙向的航行巷道。

- minimum crossing time to avoid impede another passing vessel traffic. This crossing means cross-over two side *traffic lanes* at same time.

(*d*).

*(i). A vessel shall not use an inshore traffic zone when she can safely use the appropriate traffic lane within the adjacent traffic separation scheme. However, vessels of less than 20 metres in length, sailing vessels and vessels engaged in fishing may use the inshore traffic zone.*

- 遠洋船隻不應該使用近岸航行區，除非是緊急狀況。

- ocean going vessel shall not use an inshore traffic zone unless in emergency.

(*ii*). *Notwithstanding subparagraph (d)(i), a vessel may use an inshore traffic zone when en route to or from a port, offshore installation or structure, pilot station or any other place situated within the inshore traffic zone, or to avoid immediate danger.*

- 遠洋船隻可以使用近岸航行區，以進入或離開該區域內的某處。

- ocean going vessel can use an inshore traffic zone when en route to or from any other place situated within the inshore traffic zone.

(*e*). *A vessel other than a crossing vessel or a vessel joining or leaving a lane shall not normally enter a separation zone or cross a separation line except:*

*(i). in cases of emergency to avoid immediate danger;*

*(ii). to engage in fishing within a separation zone.*

- 保留隔離區或分道線，做捕魚或緊急之用。

- reserve separation zone or separation line area for emergency or fishing usage.

*(f). A vessel navigating in areas near the terminations of traffic separation schemes shall do so with particular caution.*

- 也許有很多船隻，在哪裡設轉向點，加入或離開分道航行制區域，因為不瞭解規則的要求，正常時要從它的終點區域，加入和離開航行巷道，並沒有要船隻在那邊設轉向點。

- may have many vessels alter course there to join or leave TSS because mis-understood rule 10(b) (iii) requirement: *normally join or leave a traffic lane at the termination of the lane* is good but not to set turning point there.

(*g*). *A vessel shall so far as practicable avoid anchoring in a traffic separation scheme or in areas near its terminations.* - 優良船藝 good seamanship

(*h*). *A vessel not using a traffic separation scheme shall avoid it by as wide a margin as is practicable.*

- 船隻沒有使到使用分道航行制時，應該避免與分道航行制裡面的船隻產生碰撞危機。

- *A vessel not using a traffic separation scheme* shall avoid creating collision risk with vessels inside the TSS.

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

*(j). A vessel of less than 20 metres in length or a sailing vessel shall not impede the safe passage of a power-driven vessel following a traffic lane.*

- 船隻從事捕魚和小於 20 米的長度或是帆船，應該避開在分道航行制內之船隻。
- A vessel engaged in fishing or less than 20 metres in length or a sailing vessel shall avoid vessels inside TSS.

(*k). A vessel restricted in her ability to manoeuvre when engaged in an operation for the maintenance of safety of navigation in a traffic separation scheme is exempted from complying with this Rule to the extent necessary to carry out the operation.*

-船隻從事維護航行安全的作業，在分道航行制內工作，以至於他的運轉能力受到限制，可以豁免此規則。

- A vessel when engaged in an operation for the maintenance of safety of navigation in a traffic separation scheme restricted in her ability to manoeuvre is exempted from complying with this Rule.

(*l). A vessel restricted in her ability to manoeuvre when engaged in an operation for the laying, servicing or picking up of a submarine cable, within a traffic separation scheme, is exempted from complying with this Rule to the extent necessary to carry out the operation.*

- 在規則 3（h）運轉力受到限制的有 6 種作業，但是只有這兩種作業，可以豁免本規則 10，

在航行巷道內從事維護航行安全的保養作業。與 從事於安放，維護，撿起海底電纜的工作，准許豁免本規則，但是以其從事作業所必需的限度，而不是無限制的豁免。

- In Rule 3(h) have six kind of operation restricted in her ability to manoeuvre, only these two operations 1. for the maintenance of safety of navigation in a traffic separation scheme and 2. for the laying, servicing or picking up of a submarine cable are allowed to exempted from complying with this Rule 10, only to the extent necessary to carry out the operation.

## COLREG Rule 15 Crossing situation

*Rule 15 Crossing situation*

*. When two power-driven vessels are crossing so as to involve risk of collision, the vessel which has the other on her own starboard side shall keep out of the way and shall, if the circumstances of the case admit, avoid crossing ahead of the other vessel.*

- 橫越的情況，可以看到三盞燈兩盞桅燈跟 1 盞舷燈，是界於迎艏正遇，（可以看到四盞燈，兩盞桅燈跟 2 盞舷燈）與追越的情況（只能看到他船的一張尾燈）之間。
- *crossing situation* (see three lights, two masthead lights and one side light only) is between head-on situation (see four lights, two masthead lights and both side light) and overtaking situation (see her one stern light only).
- 當兩條動力船隻交叉相遇，當兩條船隻互相接近，從超過相對方位 7 度到正橫方向 22.5 度之前的方位接近，是為橫越或交叉相遇。
- *When two power-driven vessels are crossing:* When both vessels approaching one and other from more than relative bearing 7 degrees to 22.5 degrees abaft his beam in both sides.
- 這條規則讓路的義務，目標船在他的右舷，是經由相對位置來定義。
- This rule regulated *keep out of way obligations by relative position: on her own starboard side.*

## 2-42 追越 迎艏正遇 或是交叉相遇是由目標船的相對方位來決定的

現在是什麼會遇的情況？追越 迎艏正遇 和交叉相遇是由目標船相對方位，或是相對位置來決定，而不是由目標船的航向決定。

## 2-42 Overtaking, Head-on or crossing is decided by relative bearing of target vessel.

* In what meeting situation? Overtaking, Head-on or crossing is decided by relative bearing (or relative position) of target vessel, not target vessel's course.

- 船隻應該讓路：暗示路權屬於其他船隻，借由本船遠離碰撞點，或是比其他船隻晚點到達碰撞點來避碰。

- *vessel should keep out of the way:* imply the right of way belongs to other vessel, by keep away collision point by ownship, or arrive collision point later than another vessel.

- *應該讓路的船隻應避免橫越他船的船頭：使用本船的左舷經過目標船的左舷，而不是用本船的右舷來經過他的左舷，也就是要左對左通航。*

- *vessel should keep out of the way should avoid crossing ahead of the other vessel*: *give way vessel should* passing target vessel's port side with ownship's port side (by port to port) or stand on vessel's relative bearing is decreased, not with ownship's starboard side (by starboard to starboard).

- *船隻看到他船在他的右舷*，而且有碰撞危機：船隻在本船的右舷，且有碰撞危機，本船應該讓路，本船看到目標船的左舷紅燈，它的前桅燈在後桅燈的左邊（左低右高），本船應該讓路。

- *the vessel which has the other on her own starboard side so as to involve risk of collision:* the vessel on ownship's starboard side has collision risk ownship *should keep out of the way*. ownship see target vessel's red side light and fore masthead lights are at port side of aft masthead light ownship *should keep out of the way (seeing target vessel like heading to our portside).*

- 這條規則規定讓路的義務，它船在本船的右舷，是由相對的位置決定。

- This rule regulated *keep out of way obligations* by relative position: *on ownship starboard side.*

- *牽涉到碰撞危機：來船的方位不變，不管他是羅經方位或是相對方位。*

- *involve risk of collision:* approaching bearing remain unchanged whether it is compass bearing or relative bearing.

圖形 2-21 會遇情況由相對方位或是本船的相對位置決定

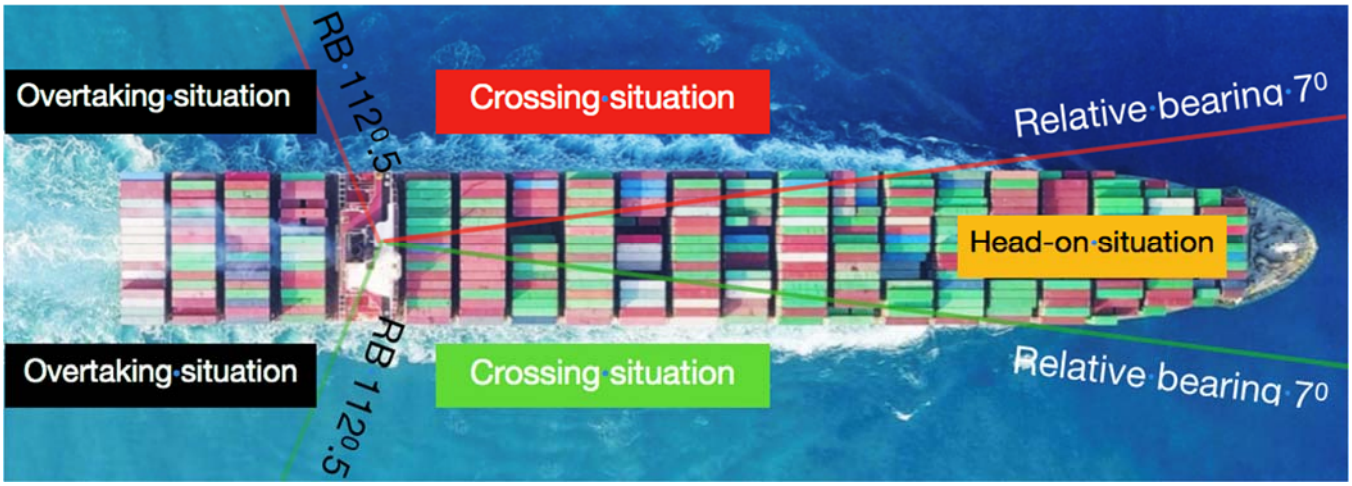



Figure 2-21 MEETING SITUATION BY RB OR RELATIVE POSITION OF TARGET VESSEL

## COLREG Rule 16 Action by give-way vessel

**Rule 16 Action by give-way vessel**

. *Every vessel which is directed to keep out of the way of another vessel shall, so far as possible, take early and substantial action to keep well clear.*

- 被指示是要讓路給其他船隻： 是由避碰規則，由適當的關發佈的特殊規則，VTSO航路交通指揮中心Vessel traffic service officer，引水，優良船藝，海員常規，任何特殊情況，本船的限制，其他船隻相關的作業影響，都應盡可能符合。

- *is directed to keep out of the way of another vessel*: is directed by COLREG rules, special rules made by an appropriate authority, Pilot, VTSO vessel traffic service officer, good seamanship,

ordinary practice of seamen, any special circumstances, including the limitations of ownship or other vessels involved *so far as possible*.

- 即早及明確的行動： 轉向，或減俥，停俥與倒車，直到目標船的相對方位，改變到本船的左船頭，這是在橫越的情況，同時保持安全距離與足夠的時間之前行動 。或是本船的船首向移動到目標船右側，並保持安全距離與時間，這是迎艏正遇的情況。或是本船移動到目標船的一側，保持安全距離去追越他船，這是追越。事實上，及早的行動，不需要太大的動作，否則本船會浪費太多浬程，這是避碰規則的缺陷，沒有明確的說出，如何參考目標的距離，做出需要多少角度的航向改變？ 要規範船隻的距離跟航向的改變的要求，因海上船隻的大小與長度不同，可以使用船隻長度的倍數來規範，需要多少在遠的距離開始避碰？聯合國海事組織對轉向戰術直徑是的要求，要少於5倍船長。轉向的時候，前進的距離要少於4.5倍的船長，這是在IMO-2002 a的決議案，進距：就是90度的航向轉向時，前進的距離。戰術直徑就是轉到180度的航向改變時，前進的距離，這在本書的後半段會再討論。

- *early and substantial action: to* alter course, reduce, stop or reverse propulsion way to cause target vessel relative bearing change to ownship's port bow (decreased) in crossing situation with safe distance and ample time ahead. Or ownship's heading move to starboard side (outer limit of fairway or traffic lane) with safe distance and time in head-on situation. Or ownship's movement away target vessels with safe distance to overtake her. In reality, early action no need substantial. Otherwise ownship will go around too many wasted mileages. This is the deficiency in COLREG: no specified reference in target distance related to required degrees of course change. The difficulty to regulate vessels distance and course change requirement with different size can be solved by using the ratio of ship's length to specified rules required. *IMO requires that the tactical diameter is to be less than 5 ship lengths and the advance is to be less than 4.5 ship lengths [IMO 2002a].( "advance = at 90° change of heading" and "tactical diameter= transfer at 180° change of heading"* This will discuss later in this book.

- *保持遠離本船*：應該保持與目標船的安全距離，這樣他能夠無困擾的操船。請看圖形 2-14：本船應該保持足夠的空間，給目標船速度向量線最後 3 分鐘的空間。目標船速度向量線上，最後 3 分鐘的空間，我們可以想像是一個大船，來視覺化這個區域，*本船應該要保持遠離。*

- *keep well clear*: ownship shall keep safe distance to target vessel so she can maneuver without trouble. See Figure 2-14 ownship should keep enough space away from target vessel's speed vector in its last three minutes section. This space (last three minutes in target vessel's speed vector) we used it as a big imaginary vessel ownship *should keep well clear*.

## COLREG Rule 17 Action by stand-on vessel

**Rule 17 Action by stand-on vessel**

**(***a).(i). Where one of two vessels is to keep out of the way the other shall keep her course and speed.*

當兩船中的一條船要讓路，另外一條船應該保持它的航向跟船速。

- 船隻被指定要讓路：如果讓路船要行動，直航船要保持它的航向航速
- 本船無法得知其他船隻是否要讓路：依照避碰規則，本船隻能知道目標船是讓路船，利用他的位置來判斷。我們只能由目標船的位置，知道他是要讓路的船隻。因為這個知識，本船必須保持航向航速，這是規則 Rule 17(a)(i)，但是這個要求可以被解除，依照本規則的下一條規則 17(a)(ii)。

- *one vessel is directed to keep out of the way*: *If* give-way vessel is to take action stand-on vessel *shall keep her course and speed*

- ownship is not able to know other vessel's intention to give way or not. By steering rules of COLREG, ownship only know portside target vessel is give way vessel by her position. By this knowledge ownship have to keep course and speed in **Rule 17(a)(i)**. But, this requirement can be relieved as next **rule 17(a)(ii)**.

- in this rule give way vessel *is to keep out of the way,* not is keeping out of the way. Before target vessel take action to give way ownship already have the obligation to *shall keep course and speed.*

- However, before target vessel take give way action ownship will not know her actual intention is to give way or not. Ownship situation now is passive and waiting target vessel's action. When the traffic density is low it is OK to wait. Sometime junior officer will confuse this rule with another small vessel close by which might need immediate action to avoid collision.

(*ii). The latter vessel may however take action to avoid collision by her manoeuvre alone, as soon as it becomes apparent to her that the vessel required to keep out of the way is not taking appropriate action in compliance with these Rules.*

- 其中一條船：

讓路船跟直航船的避讓義務，在橫越時，可能會交換，rule 17(a)(ii)，需要讓路的船隻，如果沒有採取適當的行動來符合本規則，此時直航船也可以變成讓路船。

- 讓路船與直航船的讓路行動，在追越的情況中，不能交換。避碰規則 13 條規定，不會有追越船變成橫越船的情況。

- 這就是說應該保持航向航速的船隻，在開始時，可能是讓路船。

- 一旦應該保持航向航速的船隻，採取單獨的行動，去避免碰撞，依照規則 rule 17(a)(ii)。另外一條船應該保持航向航速，依照規則 rule 17(a)(i)，不論誰在開始的時候是直航船。

- *One of two vessels*:

- give-way vessel and stand-on vessel obligation may be exchanged in crossing situation by COLREG **rule 17(a)(ii)** *the vessel required to keep out of the way is not taking appropriate action in compliance with these Rules.*

- give way vessel and stand on vessel obligation shall not exchange in overtaking situation by COLREG **rule 13(d)** *shall not make the overtaking vessel a crossing vessel* as crossing situation.

-That is to say the one **shall keep her course and speed** maybe a give way vessel in the beginning.

- Once the other shall keep her course and speed *take action to avoid collision by her manoeuvre alone* **rule 17(a)(ii)** *the other shall keep her course and speed* **Rule 17(a)(i)** no matter who is the stand-on vessel in the first place.

- 當那條船採取避碰行動，用他自己的單獨行動，依照規則 rule 17(a)(ii)，另外一條船就不必改變航向航速，因為避碰規則要求，採取行動的船隻（不論他是直航船或是讓路船，依照他們的相對位置）應該採取即早及明確的行動，保持清爽通過，這是規則 16。

- 讓路船失去他改變航向航速的主動性，只要直航船採取了避碰行動。

- 如果讓路船沒有採取行動，直航船可以，無論如何，採取單獨行動去避免碰撞（規則 17 (a), (ii)），或不採取單獨行動去避免碰撞（rule 17 (a).(i).）。

- 某輪應該保持航向航速，可以無論如何，採取單獨行動去避免碰撞：當直航船採取單獨行動，他就會變成讓路船，在這個時候 讓路船應該保持航向航速。

- The one is to *take action to avoid collision by her manoeuvre alone* **rule 17(a)(ii)** the other no need to alter course or speed because COLREG require take action vessel shall

*take early and substantial action to keep well clear by* **rule 16**. (no matter she is stand-on or give-way vessel by their relative position in the beginning)

- Give-way vessel lost its initiative obligation to alter course or speed once stand-on vessel take avoidance actions.

- *If* give-way vessel has not taken action stand-on vessel *may however take action by* **rule 17(a)(ii) or may not** *to avoid collision by her manoeuvre alone*（**rule 17(a)(i)**）.

- *the one shall keep her course and speed may however take action to avoid collision*: When stand on vessel takes action she become give way vessel. In this moment give way vessel shall keep her course and speed. *(become stand on vessel)*

- 避碰 使用他的單獨行動：直航船採取避碰行動，應確認他的行動是及早且明確的行動，以保持清爽通過，這是規則 16。

單獨行動：直航船改讓路船的單獨行動，是表示直航船讓路的行動要大，不要讓原來的讓路船再做避讓的行動。

- 讓路船從他讓路的義務中解除，一旦直航船採取避碰行動，除非他是在規則 17（b）的情況，該情況是碰撞無法由讓路船的單獨行動而避免，也就是避碰的第三階段，最後階段。

- *to avoid collision by her manoeuvre alone:* stand on vessel takes *avoidance* action *have to make sure her action is early and substantial action to keep well clear* **rule 16**.

- Give way vessel is relieved her obligations to give way once stand on vessel takes avoidance action unless it is in Rule 17 (b) situation: *collision cannot be avoided by the action of the give-way vessel alone.*

- *一旦這對他變得明顯：*在大海上，直航船永遠搞不清楚讓路船真正的意圖是什麼？尤其是在長距離的時候，要知道他的意向，除非他有採取極早及明確的措施，來清爽通過，規則 16。使用 AIS 資料，對清楚讓路船真正的意圖有幫助。

- *直航船可以先採取行動*，一旦清楚知道其他船隻，尚未採取避碰行動 。

- 規則 2（b）直航船可以背離本規則，只要足夠避免立即的危險，這是指直航船可以做最後的避碰努力，去避免碰撞，無論以何種方式，他認為是適當的。

- *as soon as it becomes apparent to her*: In real sea, there will never be apparent to stand on vessels what give way vessels intention are especially in long range. We only know her intention if give way had done *early and substantial action to keep well clear* **rule 16.**

- *Stand-on vessel may take actions first* as soon as it becomes apparent other vessel did not take action to avoid collision yet.

- rule 2(b*)* stand-on vessels *may make a departure from these Rules necessary to avoid immediate danger* means stand-on vessel can make last efforts (avoidance actions) to avoid the collision in any way she thought is in *immediate danger.*

**直航船可以在第一時間採取行動，以他的單獨行動去避免碰撞，**如果讓路的船隻尚未採取適當的行動避讓。一旦直航船採取避碰行動，他就必須負責單獨完成所有的避碰行動。

Stand-on vessel may take actions in first instance by her manoeuvre *alone to avoid collision as the vessel required to keep out of the way is not taking appropriate action yet.* Once stand on vessel take avoidance actions, she shall responsible to complete the avoidance by her efforts along. (good seamanship)

*(b). When, from any cause, the vessel required to keep her course and speed finds herself so close that collision cannot be avoided by the action of the give-way vessel alone, she shall take such action as will best aid to avoid collision.*

- *不論任何理由，需要去保持航向航速的船隻*，初始時也許是一個讓路船，在它船的左舷位置。

- *太接近它船，所以碰撞無法由讓路船單獨行動完成：* 現在兩條船都變成了讓路船，如果直航船發現讓路船的單獨行動，無法避免碰撞，兩條船都會變成讓路船，這是規則 17 條（b）。這是避碰的第三階段。

- 現在這兩條船都是讓路船，*兩船同時發現，他們已經無法由讓路船單獨的行動，來避免碰撞。*

- *from any cause, the vessel required to keep her course and speed:* this vessel originally may be a give way vessel on other vessel's port side.

-*finds herself so close that collision cannot be avoided by the action of the give-way vessel alone*: Now **both vessels become give-way vessels** if find herself cannot avoid collision by give-way vessel alone. **Rule 17 (b)**

-Now these two vessels are both give-way vessel at the time *finds herself so close that collision cannot be avoided by the action of the give-way vessel alone*.

- *最佳避碰的行動*，不必是減速 停車 倒車，也許增加回轉速率，使用大而短的進車，用來停止回轉，或使用滿舵等等。

- *best aid to avoid collision:* not necessary reduce, stop or reverse propulsion direction, maybe increase the turning rate by engine kick ahead or stop the turning by hard over rudder order,…… etc.

依照鳥群飛行的規則，當情況變得不清楚時，採取與附近船隻採取同樣的速度，經常檢查本船是否超速，有沒有跟別人同速，避免與他船速度不同，會減少我們與前面後面船隻之間的安全距離。

當近距離的時候，採取附近的船隻同樣的航向，或相對的航向。經常檢查本船是否在橫越他船的航線，速度向量線是否相交，避免增加兩條船航路的交點，也就是碰撞點。

By flock law: (discuss later)

When situation is confusing **take same speed as other vessels around**. Always check ownship is over speed or not which will reduce safe distance either forward or aft.

When in close range **take same course or reciprocal course as close by vessels**. Always check ownship is crossing other vessel's track or not which will increase intersection point and collision risk.

Stand-on vessel shall take best aid actions *to avoid immediate danger when collision cannot be avoided by the action of give-way vessel alone.*

(*c*). *A power-driven vessel which takes action in a crossing situation in accordance with subparagraph (a)(ii) of this Rule to avoid collision with another power-driven vessel shall, if the circumstances of the case admit, not alter course to port for a vessel on her own port side.*

- *17( a )(ii)： 這兩條動力船隻，是在早期碰撞危機之中，（避碰的第二階段，請見下面的圖形 2-22）*

- *(a)(ii) of this Rule: these two power-driven vessels* are in early stage of collision risk (second stage of Figure 2-22 below).

- *不應該向左轉向：*在橫越的情況下，動力船隻不應該與其他動力船隻右舷對右舷通過，在避碰的早期階段。

- *shall not alter course to port:* in a crossing situation ownship *power-driven vessel* shall not to avoid the collision by passing starboard to starboard side to other *power-driven vessel* in early stage.

(*d*). *This Rule does not relieve the give-way vessel of her obligation to keep out of the way.*

- *讓路船必須保持航向航速，當直航船已採取避碰行動。*

*- 讓路船必須採取避碰行動，當兩條船隻已經太接近，無法由其他船隻單獨行動來避免碰撞。*

*- 本規則是提醒讓路船，不要放棄其他的義務，例如瞭望，安全速度，碰撞危機的評估等等，不要擋到他船的去路，當避碰無法由其他船隻單獨的行動以完成。*

- give-way vessel have to keep course and speed when stand on vessel take avoidance action, not just go as give-way vessel like.

- give-way vessel have to take avoidance actions when two vessels already too close collision cannot be avoided by another vessel's action alone.

- this rule is to remind give-way vessels not to give up other obligation of lookout, safe speed, collision risk, etc… and keep out of the way when collision cannot be avoided by another vessel's action alone.

## 2-07 船隻避碰義務，因規則，VHF 通訊港務台或是領港的指示而改變

### 2 之 43 船隻避碰義務的三個階段

請參考圖形 2－21 會遇的情況，由相對方位和相對位置決定

- 當兩條船隻在很遠的時候，介於 6 到 9 海浬的第一階段，兩條船都可以自由運轉，轉向或改變航速，如果他們的航路上有轉向點，或是航行障礙需要改變航向來避免的時候，他們可以自由的轉向。

- 如果兩條船仍然在目前的航線上，碰撞危機應該加以評估，在這第一階段，6 到 9 海浬之間。

## 2-07 Vessel's obligation varied by COLREG, VHF, VTS or Pilots

### 2-43 Vessel's obligation in three stages of collision avoidance

Please Refer to Figure 2-22, for vessel's obligation in three stages:

⇒ When two vessels are still far away between 6 - 9 nm is in first stage, both vessels are free to alter course if their route on the chart has turning point need to do so or navigational hazards need to be avoided by alter course.
If both vessels remain in their present courses the collision risk should only be evaluated in this first stage.

- 1st line of sight may be established for later reference.
- In this stage, No vessels has obligations in COLREG as collision risk in not exist now.

⇒ 當兩條船隻的距離減到 3 到 6 海浬時，這是避碰的第二階段，碰撞危機應該再一次確認，在開始採取避碰行動之前。

- 兩船之間的距離是在 6 到 3 海浬附近，讓路船應該採取避讓行動，如果在這第二階段，評估有碰撞危機，。
- 直航船也能夠先採取避碰行動，只要讓路船還沒有採取適當的行動，以符合避碰規則，**這是規則 17（b）。**
- 直航船採取的避碰行動，應該盡可能及早與明確的措施，來清爽通過，這是規則 16。
- *讓路船沒有採取適當的措施*：讓路船還沒有採取行動。或是直航船知道讓路船的意圖，**它不會採取適當的行動**，由其他的來源，例如 vhf 的通訊，或是或是領港站的指示等等，這是直航船要採取行動的時候，可能是聽到其他來源的資訊。

⇒ When two vessels distance reduced to 3 - 6 nm in second stage, collision risk should be ascertained and before taking avoidance actions OOW should make sure target vessel's intention once again.

- Give-way vessel should take avoidance actions if collision risk exists in this stage (from 6 nm to 3 nm, soon or later). **Rule 16**
- Stand on vessel **may** take avoidance actions first when give way vessel *is not taking appropriate action in compliance with these Rules.* **Rule 17 (b)**
- Stand on vessel take avoidance actions **shall, so far as possible** *take early and substantial action to keep well clear.* **rule 16** Stand on vessel take avoidance actions should make sure avoidance actions cam clear of give way vessel with safe distance.
- *Give way vessel is not taking appropriate action:* give-way vessel has not taken action yet or stand on vessel know give way vessel's intention which **will not taking appropriate action** from other sources like VHF or Harbour Radio or Pilot station instruction….etc.
- *If collision risk exist one vessel has to take action to avoid it, no matter who is give way vessel or stand on vessel in the beginning.*
- 直航船應該保持航向航速，讓路船已經採取避碰的行動，這是 Rule 17 (a)(i)。
- 直行船能夠採取行動，以避免與其他船隻碰撞，如果與第三條船有碰撞危機存在，或是背離本規則的要求，以避免立即的危險，這是規則 2。
- 在規則 2 立即危險的情況，讓路船應該考慮直航船可能的避碰行動，如果他是在對第三條船採取避碰行動，或是任何注意事項，也許是因為海員常規的實務，或是當時特殊的情況。這是規則 2，直航船也許需要深水航路而轉向，或是太接近淺灘要繞行，這個情況，就像是六分鐘之內，有兩條船擱淺在 2020 年的 5 月 11 號。
- Stand on vessel should keep course and speed if give way vessel has taking avoidance actions already. **Rule 17 (a)(i)**
- Stand on vessel **may** take actions to avoid another vessel if collision risk exists with third vessel which is "*may make a departure from these Rules necessary to avoid immediate danger.* " **rule 2**
- In Rule 2 *immediate danger situation*, give way vessel should consider stand on vessel's possible avoidance action to avoid third vessel collision or *any precaution which may be required by the ordinary practice of seamen, or by the special circumstances of the case.* **rule 2** (stand-on vessel may need deep water route or too close to a shallow water to navigate or possible go aground, case like double grounding within 6 minutes in Singapore strait in May 11, 2020)

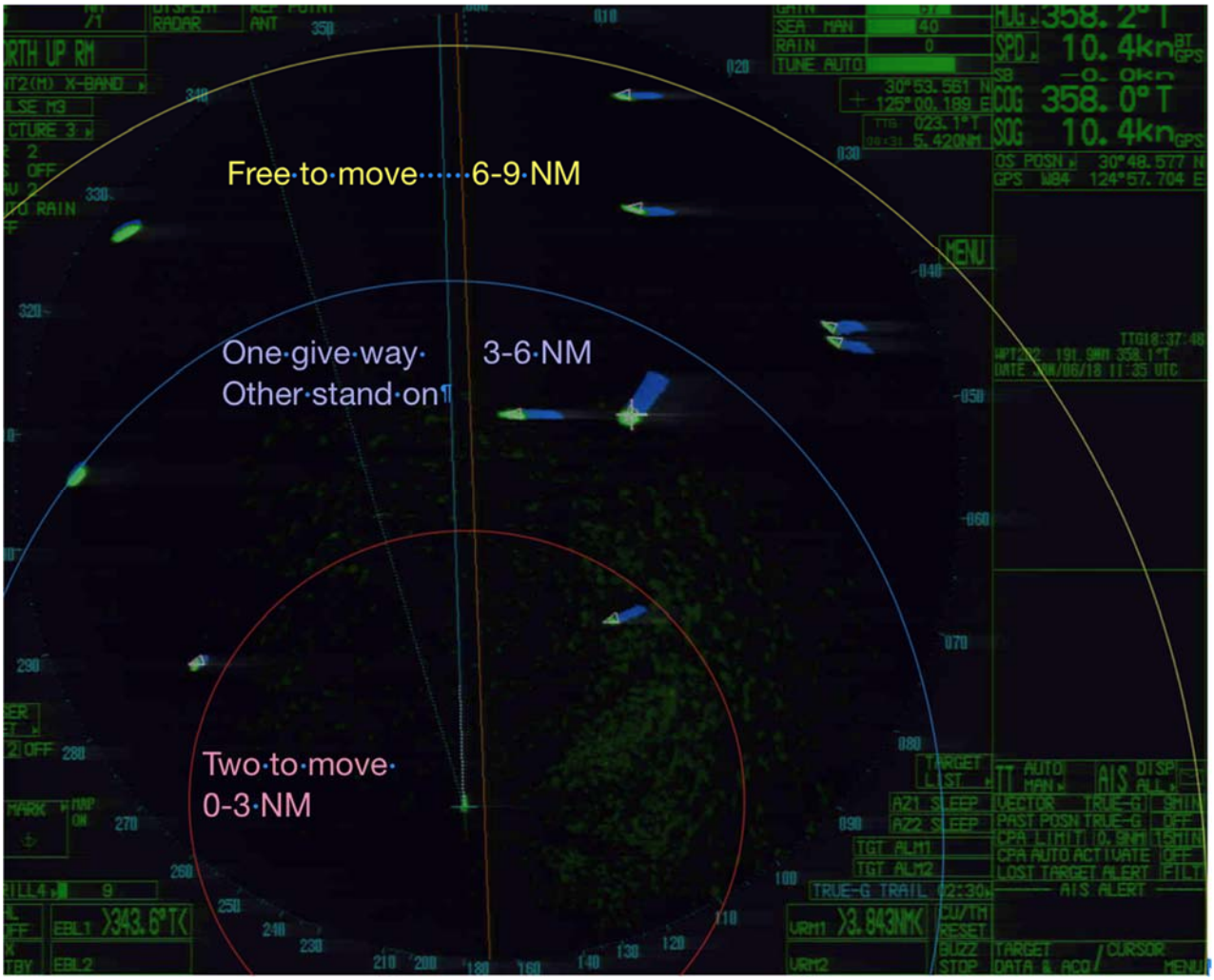
⇒當兩條船隻的距離減到 0 到 3 海浬，這是避碰的第三階段。讓路船應該採取避碰最佳的避碰行動，來避免碰撞。如果有碰撞危機，這是規則 17（b）。

- 直航船應該採取行動，可以最佳的避免碰撞，當碰撞不能由讓路船的單獨行動以完成，這是規則 17（b）
- 兩條船都應該小心，任何的注意事項，也許是由海員常規的需求，或是當時情況的特殊環境，來避免碰撞。適當的付出注意，應該是對所有航行的危險，或是碰撞，或是任何特殊情況，這是規則 Rule 2(a)(b)

圖形 2-22 避碰的義務是隨距離變化

⇒ When two vessels distance reduced to 0 - 3 nm is third stages, Both vessels should take avoidance actions *best aid to avoid collision* if collision risk exists. **Rule 17 (b)**

- Stand-on vessel shall also take such action as will best aid to avoid collision when collision cannot be avoided by the action of the give-way vessel alone. **Rule 17 (b)**
- Both vessels shall beware any precaution which may be required by the ordinary practice of seamen, or by the special circumstances of the case to avoid collision *due regard shall be had to all dangers of navigation and collision and to any special circumstances.* **Rule 2(a)(b)**




圖形 2-22 避碰的義務是隨距離變化

## COLREG Rule 18 Responsibilities between vessels

規則 18 船舶間責任

- 除了規則 9 狹窄水道，規則 10 分道航行制跟規則 13 追越，另外的要求。
  - 規則 9：一艘船隻小於 20 公尺的長度，或是一艘帆船，或是從事捕魚的船隻們，不應該妨礙其他船舶，在狹水水道或是航道裡面的通行，或是一艘船舶橫越狹窄水道，或是在狹窄水道或行道內追越，只能發生在得到被追船隻的允許……
  - 規則 10(d)(i) 一艘小於 20 公尺長度的船隻，和帆船，不應該妨礙動力船隻在航行巷道內的通航 。
  - 規則 13 追越船應該避讓被追越船的航線……
  - 除非船隻操縱失靈或是轉力受限制，航行中船隻不應該疏忽，在一般海員常規所需要的注意事項，或該環境特殊的需求，這是規則 2（b）。
  - 優良船藝與注意事項是去避免漁場，或者與漁船區，或是船隻受吃水限制區域...

**Rule 18 Responsibilities between vessels**

. *Except where Rules 9, 10 and 13 otherwise require:*

- Except where Rules 9 narrow channel, 10 TSS and 13 overtaking otherwise requirements.
  - Rule 9: *A vessel of less than 20 meters in length or a sailing vessel, Or vessels engaged in fishing shall not impede the passage of any other vessel navigating within a narrow channel, or fairway. Or A vessel shall not cross a narrow channel … Or in a narrow channel or fairway when overtaking can take place only if…,*

- Rules 10(*d)(i) A vessel of less than 20 meters in length or a sailing vessel shall not impede the safe passage of power-driven vessel following a traffic lane*. Or,
- Rule 13 *shall keep out of the way of the vessel being overtaken.…..*

- Except vessel not under command and vessel restricted in her ability to manoeuvre, vessel under way should not neglect of any precaution which may be required by the ordinary practice of seamen, or by the special circumstances of the case by rule 2 (b).
- Except good seamanship and precaution are to avoid fishing farm or fishing vessels groups or vessel constrained by her draught.

**(a).** *A power-driven vessel underway shall keep out of the way of:*

*i. a vessel not under command;*
*ii. a vessel restricted in her ability to manoeuvre;*
*iii. a vessel engaged in fishing;*
*iv. a sailing vessel;*

*- 應該遠離航路：應該讓路給這些船隻，顯示號燈號標在避碰規則 part C 的下列例子*

I. 一艘操縱失靈船隻：主機故障，舵機，或發電機或是船殼破損……
II. 一艘船之運轉力受限制：因為他的工作性質，不能符合避碰規則的要求。
iii. 從事捕魚的船隻：他的漁具限制了它的運轉能力。
iv. 帆船： 正在駛風沒有動力，在強風之中難以改變航向，有些可能是非常大的高船。

- 應該遠離航路：應該讓路給這些船隻，顯示號燈號標在避碰規則 part C 的下列例子
I. 一艘操縱失靈船隻：主機故障，舵機，或發電機或是船殼破損……
II. 一艘船之運轉力受限制：因為他的工作性質，不能符合避碰規則的要求。
iii. 從事捕魚的船隻：他的漁具限制了它的運轉能力。

*v.* 帆船： 正在駛風沒有動力，在強風之中難以改變航向，有些可能是非常大的高船。

- *shall keep out of the way of*: vessel underway shall give-way to vessels exhibited lights and shapes specified in COLREG Rules part C as below case.

**(***i). a vessel not under command***;**
- broken main engine, steering gears, generator or ship's hull.

*(ii). a vessel restricted in her ability to manoeuvre;*
- by her work carry on board at that time make she cannot comply with COLREG

**(***iii). a vessel engaged in fishing***;**
- fishing gears restricted her maneuvering.

**(***iv). a sailing vessel***.**
– sailed by wind, no machinery, Hard to change course at strong wind, some are very big Tall Ship with many cadets on it.

**(***b). A sailing vessel underway shall keep out of the way of:*

*(i). a vessel not under command;*
*(ii). a vessel restricted in her ability to manoeuvre;*
*(iii). a vessel engaged in fishing.*

*(c). A vessel engaged in fishing when underway shall, so far as possible, keep out of the way of:*

*(i). a vessel not under command;*
*(ii). a vessel restricted in her ability to manoeuvre.*

*(d).*

*(i). Any vessel other than a vessel not under command or a vessel restricted in her ability to manoeuvre shall, if the circumstances of the case admit, avoid impeding the safe passage of a vessel constrained by her draught, exhibiting the signals in Rule 28.*
*(ii). A vessel constrained by her draught shall navigate with particular caution having full regard to her special condition.*

- *如果情況的環境許可，避免妨礙船隻吃水受限制的通行*，前提是你不會擱淺或碰撞。

- 規則 2 *應該注意所有航行的危險，包括擱淺，碰撞，任何特殊環境*，例如船體下水深的容許值，*包括所受到的限制，* 也許船會船尾下蹲，或是船頭左右擺動，以至於難以保持航向，因為在淺水區域。

- *if the circumstances of the case admit, avoid impeding the safe passage of a vessel constrained by her draught,*: if you will not go aground or have other immediate danger.

- **rule 2:** *Due regard shall be had to all dangers of navigation including grounding and collision and to any special circumstances* (limited draft under her keel), *including the limitations of the vessels involved (*vessel may have squat or smelling ground cause it hard to maintain steady course due to shallow water).

(*e). A seaplane on the water shall, in general, keep well clear of all vessels and avoid impeding their navigation. In circumstances, however, where risk of collision exists, she shall comply with the Rules of this part.*

- 一般水上飛機的起降，有其預計的航路，應該遠離一般水面船隻所使用的航路。一旦水上飛機飛到空中，與水面船隻就沒有碰撞危機。
- 水上飛機的航路與水面船隻的航路重疊的時候，應該改變它預定的航路，使其儘量遠離水面船隻。
- 當碰撞危機發生時，水上飛機應該視為水面船隻，並符合避碰規則之要求。其實這一條並不合理，因為水上飛機的速度太高，水面船隻要運用操船，來避免與水上飛機發生碰撞，是很不可能的。

- planed route for usual seaplane taking off or landing should keep away from (well clear **of)** routes used by common surface vessel. Once seaplane is in the air high enough (70 meters) there are no collision risks with surface vessels.

- when seaplane intended route overlapped with surface vessels route, seaplane shall keep her planned route early enough to well clear of surface vessel. This is in first stage of collision avoidance obligation which seaplane shall give way to surface vessel by very large distance.

- *where risk of collision exists*- seaplane shall deem as surface vessel to comply with COLREG. This is in second stage of collision avoidance obligation which seaplane is deemed as surface vessel to maintain port to port as usual.

- the stage of collision avoidance is obvious decided by two parties' maneuvering distance. This distance is not their physical dimensions only, like to say 400 meter longs vessel and 60 meter long airplane. This distance is their advance distance in turning as big red ship's requirement in Figure 2 – 08.

- Actually, this second stage is not necessary as WIG craft's rule. Simply to ask airplane to give way to all surface vessel because their bump in maneuvering.

**(***f).*

*(i). A WIG craft shall, when taking off, landing and in flight near the surface, keep well clear of all other vessels and avoid impeding their navigation;*

- Wing in Ground WIG craft 水面效應飛機，主要運動階段是接近水面飛行，利用水面效應滑行。水面效應飛機起飛和降落時，不能改變航向來避免碰撞。 水面效應飛機接近水面飛行時，改變航向，需要很大的回轉半徑。
- 雖然這些水面效應飛機有操作的障礙，水面效應飛機被要求，遠離水面船隻的航路，因為他的前進速度太高。除非有良好的航路規劃，現場避碰根本不可能。

- Wing-In-Ground (WIG) craft" means a multimodal craft which, in its main operational mode, flies in close proximity (20 – 30 meters) to the surface by utilizing surface-effect action.

- When taking off, or landing WIG craft cannot alter course to avoid collision.
- When in flight near the surface WIG craft alter course need a large turning diameter.
- Although all these handicaps in WIG maneuvering had, WIG is required to keep out the way of surface vessels due to its speed is much higher.

**(***ii). a WIG craft operating on the water surface shall comply with the Rules of this Part as a power-driven vessel.*

- 水面效應飛機在水面運行的時候，需要像動力船隻一樣行動，符合 Part B- Steering and Sailing (Rules 4-19)，這裡的敘述 18 條（f）比水上飛機的 18 條（e）清楚。
- Wing-In-Ground (WIG) craft" operating on the water surface is required to act like a power-driven vessel. This 18(f) is more clear than the seaplane one in rule 18(e).

## COLREG Section III - conduct of vessels in restricted visibility (Rule 19)

## COLREG Rule 19 Conduct of vessels in restricted visibility

### Section III - conduct of vessels in restricted visibility (Rule 19)

**Rule 19 Conduct of vessels in restricted visibility**

*(a). This Rule applies to vessels not in sight of one another when navigating in or near an area of restricted visibility.*

- 能見度受限制：當水平線看不到，目標船的距離，就只能由雷達來決定（沒有其他的方法可靠，除非是我們的船頭浪跟船航跡流，現在對目標的距離，可以從 AIS 系統上面得知他船的位置，但是跟本船之間的距離的運算，還是要借用雷達的顯示）。
- 船隻不能互見：在夜間，本船不能看見它船航行燈。日間，本船不能看到他船的輪廓或是側影。
- 能見度受限制的區域：某區域水平線看不到，在雷達上能看到船隻，但是視覺上，目視看不到目標。
- *restricted visibility*: where horizon is not in sight, target vessel distance has to determine by RADAR (no other way available except our visual knowledge of Bow wave and wake current astern).
- *vessels not in sight of one another*: by night ownship could not see navigational lights or by day ownship cannot observes profile or silhouette of another vessel.
- *an area of restricted visibility:* an area where some part of horizon or all is not in sight, OOW can find vessel echo in Radar but not in visual.

**(b).** *Every vessel shall proceed at a safe speed adapted to the prevailing circumstances and conditions of restricted visibility. A power-driven vessel shall have her engines ready for immediate manoeuvre.*

- *安全速度*：本船能夠在現在能見距的一半距離，安全停止前進的速度。
- *能見距*：是隨時在變，安全速度也不是永遠不變。
- *主機備便可以立即運轉*：船隻應該保持主機備便，以便在能見度受限制時候，能立即運轉。或是在他們沒有信心，能夠控制他們的碰撞危機的時候。
- **在能見度受限制時間內發生的碰撞，兩條船都不是安全速度**，不管你的速度多慢，就是你當時在拉倒車，或是已經在實際後退，都不是安全速度 。
- 當值船副應該運用雷達阿帕或是 AIS 去評估能見距的限制，而且要立刻向船長報告，或向他要求額外船副的協助，因為只有船副適用于雷達阿帕的訓練證書，或是備便本船的主機。
- *safe speed*: a speed ownship can stop within half distance of current visibility safely.
- *visibility* is changing all times, so safe speed is not always same speed.
- *have her engines ready for immediate manoeuvre:* vessel shall have engine ready for immediate manoeuvre in restricted visibility when they don't have confidence in controlling their collision risk.

Any collision happened in restricted visibility both vessels are not at safe speed.

- *OOW* should use RADAR ARPA or AIS to evaluate visibility restrictions and report to master immediately when he needs extra help of another OOW (because only OOW is qualified to use RADAR/ARPA to help) and stand by her engine.

**(c)**. *Every vessel shall have due regard to the prevailing circumstances and conditions of restricted visibility when complying with the Rules of section I of this part.*

這一部分：這一部分是部份 B，操舵與航行規則（規則 4 到 19 條）

第一節- 船隻行動在任何能見度，是（規則 4-10）

規則 4 本節之規定適用於所有能見度。

規則 5 瞭望：需要每一艘船應該都保持一個適當的瞭望，運用他的視力跟聽力……

規則 6 安全速度：每條船應該隨時以安全速度航行，描述牽涉到安全速度的因素 ……適用安全速度的因素很多，尤其是對於裝設雷達的船隻所適用的……

規則 7 碰撞危機：對於不充分的資料所做的假設，應該避免。特別是不充分的雷達資料……

規則 8 避免碰撞的行動

規則 9 在狹窄水道和航道裡，要保持在水道的外側航行，只要是安全且實際可行。同樣這一條規則限制船隻小於 20 公尺長度，或是帆船，不得去妨礙一艘船隻只能在狹窄水道或航道裡面的安全航行。這規則同樣禁止船隻去橫越狹窄水道和航道。如果橫越會妨礙到動力船隻，只能安全在此狹窄水道和航道裡面航行的時候。

- 不要妨礙的意義：被歸類到規則 8 在 1987 年，一個新的章節（f）被加上去，強調某船被要求“不要妨礙其他船隻的通行，應該採取行動以確保足夠的海域，給予其他船隻安全通行”，這些船隻被迫去實行這些義務，同時應當採取避碰行動，以符合操舵航行規則的時候，當有碰撞危機存在時。

規則 10 說到船隻橫越航行巷道時，必須以實際可行，接近直角去橫越航行巷道的一般流通方向。這同時減低了其他船隻，對橫越船隻的意圖猜測，使得橫越船能夠更快速的橫越。漁船不得妨礙船隻在航行巷道內地通行，但是並沒有被禁止捕魚，這跟規則 9 是相似的，規則 9 說漁船不應該妨礙其他船隻在狹窄水道或航道裡面的通行。

*this part:* is Part B- Steering and Sailing (Rules 4-19)

*Section 1* - Conduct of vessels in any condition of visibility (Rules 4-10)

- *Rule 4 says the section applies in any condition of visibility.*
- *Rule 5 look-out requires that "every vessel shall at all times maintain a proper look-out by sight and hearing …..*" which include restricted visibility.
- *Rule 6 safe speed. It requires that:* "*Every vessel shall at all times proceed at a safe speed...*". which include restricted visibility and some part of it refer specifically to vessels equipped with radar in restricted visibility.
- *Rule 7 risk of collision, which warns that* "*assumptions shall not be made on the basis of scanty information, especially scanty radar information"*
- *Rule 8 covers action to be taken to avoid collision.*
- *In Rule 9 in narrow channel or fairway is obliged to keep "as near to the outer limit of the channel or fairway which lies on her starboard side as is safe and practicable."* The same Rule obliges a vessel of less than 20 metres in length or a sailing vessel not to impede the passage of a vessel *"which can safely navigate only within a narrow channel or fairway."*
- The Rule also forbid ships to cross a narrow channel or fairway *"if such crossing impedes the passage of a vessel which can safely navigate only within such channel or fairway."*
- The meaning "not to impede" was classified by an amendment to Rule 8 in 1987. A new paragraph (f) was added, stressing that *a vessel which was required not to impede the passage of another vessel should take early action to allow sufficient sea room for the safe passage of*

*the other vessel.* Such vessel was obliged to fulfil this obligation also when taking avoiding action in accordance with the steering and sailing rules when risk of collision exists.

- Rule 10 states that ships crossing traffic lanes are required to do so **"***as nearly as practicable at right angles to the general direction of traffic flow."* This reduces confusion to other ships as to the crossing vessel's intentions at the same time enables that vessel to cross the lane as quickly as possible regardless their crossing track is right angle or not.
- Fishing vessels **"***shall not impede the passage of any vessel following a traffic lane"* but are not banned from fishing. This is in line with Rule 9 which states that **"***a vessel engaged in fishing shall not impede the passage of any other vessel navigating within a narrow channel or fairway. "*

*(d). A vessel which detects by radar alone the presence of another vessel shall determine if a close-quarters situation is developing and/or risk of collision exists. If so, she shall take avoiding action in ample time,*

*- - 只用雷達探測到：*不只使用雷達感測到，現在有阿帕跟 AIS 的資料可以整合。雷達 阿帕或是 AIS，任何一個偵測到目標，應該決定是否是一個近接的情況，且/或碰撞危機正在產生。

*- 近接的情況在發展，且/或碰撞危機產生：*是由各別船隻來決定，因為每條船的安全容許值，（也就是最小的 CPA 的需求，會從 1 海浬到半海浬）因為船隻長度而不同，特別在港區，當每條船都經常在改變航向航速。

*- 如果如此他應該採取適當時刻的避碰行動：*他就是在雷達上，發現其他船隻出現的船。

*- 在適當的時間：*一般適當時間的需求，是本船必須採取行動的時間。行動時間與目標／本船間的相對速度，是息息相關的，適當的時間去避免碰撞，很難用兩條船的距離來界定，雖然目標距離，在雷達上非常清楚。碰撞的時間呢，卻不一定。碰撞的時間就是像行動的時間一樣，取決於兩條船的相對速度。如果本船在高速，適當的時間去做避碰行動，比本船在慢速的時候早。**- 比較高的相對速度，需要提早行動的時間。**

*-detects by radar alone:* not RADAR alone, today we have ARPA, and AIS data all together.

- RADAR ARPA or AIS, any one of this detects the presence of another vessel shall determine *if a close-quarters situation is developing and/or risk of collision exists.*

*- close-quarters situation is developing and/or risk of collision exists:* are hard to **determine** as each vessel has its own criteria of safety margin (The minimum CPA required may be 1 NM or ½ NM by different Master standing order.) especially in harbour area where every vessel under constantly course and speed change. *close-quarters situation* nay be described as two vessel's distance is reducing continuously as to make both vessels feel the collision risk exist. This sound like a feeling rather than just bearing unchanged only. *The conscious of distance reduce in close quarter situation is more important than bearing change.*

*- if so, she shall take avoiding action in ample time*: **she** is the vessel detects other vessel by radar alone then **she** became a give way vessel automatically. In fog, both vessels are give way vessel as in third stage of clear visibility.

- in ample time: Usually, Ample time requirement is for ownship to take action. Action time is close related to target and ownship's relative speed. Ample time for avoiding action is hard to define by two vessels distance along. Although target distance is readily available in RADAR, collision time is not. Collision time is like action time depend on two vessels' relative speed. If ownship in higher speed ample time to action is earlier than ownship in slower speed. **Higher relative speed needs earlier action time. (ample time)**

Collision time can easily decide by both vessel's speed vector intersection point which we call collision point in Radar Lookout.

*provided that when such action consists of an alteration of course, so far as possible the following shall be avoided:*

(*i). an alteration of course to port for a vessel forward of the beam, other than for a vessel being overtaken;*

- *向左轉向，對正橫之前的船隻應該避免*，因為呢避碰規則比較喜歡左對左地通行，不管是任何情況。早期建議能見度受限的時候，轉向到右舷去避免碰撞，需要轉向的角度是30度到60度，對於正橫之前的船隻，轉向避讓的角度要求，否則就是沒有符合避碰規則，明確的行動。
- *an alteration of course to port for a vessel forward of the beam shall be avoided.* As COLREG prefer port to port passage for all situations, in early day's suggestion **alter course to starboard side to avoid collision in restricted visibility** need to be at least 30 to 60 degrees **for a vessel forward of the beam.**

## 2- 44 不同速度船隻有碰撞危機時，他的可能相對方位

- 在圖形2-23本船是在雷達螢幕的中心點，本船的速度是12節，航向000(T)正北，本船30分鐘行駛的距離是6海浬，假設使用30分鐘的速度向量線，在30分鐘後，本船的位置，就是位於現在位置北邊的6海浬。也就是北邊4個小的同心圓的圓心所在位置。
- 在這一章2-21節裡面學過，兩條船必須在同一時間，通過同一地點才會發生碰撞。如果本船在30分鐘後，會發生碰撞，碰撞的位置，就是在現在位置的北邊6海浬，目標船他的速度是本船的一半，跟本船有碰撞危機時，他也會到達這個同樣的位置，也就是在本船北邊的六海浬，他可能從任何方向接近。我們使用六節的目標船半個鐘頭所能行駛的距離，3海浬的長度做半徑去劃一個藍色的圓圈，代表這條6節速度的目標船，現在可能的位置。

## 2-44 Possible relative bearing of different speed vessels which have collision risk

- In Figure 2-23, ownship in the center of radar screen now, ownship speed is 12 knots, course is $000^0$ degrees, our 30 minutes run is 6 nm. If we use 30 minutes speed vector, after 30 minutes ownship position is located at 6 nm north of current position (in center of four small circles above). In section 2-21 of this chapter we had learnt "**Two vessels have to pass same location at same time to become a collision situation.** " If ownship has collision after 30 minutes the collision position is at 6 nm north of current position. Half speed (6 knots) target vessel who has collision with ownship may arrive this position (6 nm north of center of radar now) from all directions. We use 6 knots target vessel half hour distance run 3 nm length as semidiameter to draw a blue circle to represent all possible position of 6 knots target vessels now.
  - 藍色圓圈是一半速度目標船，如果他跟本輪會發生碰撞，現在的可能位置。
  - 紅色圓圈，是 8 節速度，也就是本輪三分之二速度的目標船的可能位置。
  - 020 方位標誌的紅色船隻，是四節速度的船，也就是本輪 3 分之 1 速度的目標船。白色圓圈。

  由這個我們可以從圖形上看出。
  - 最大的相對方位，對 3 分之 1 速度的目標船來講，大約是兩舷左右的 20 度。（從綠線中間到兩舷的 20 度）
  - 對於半速目標船最大的相對方位，藍色的圓圈的切線，大約是左右兩舷的 30 度。
  - 對於 3 分之 2 船速的目標船，最大的相對方位大約是左右兩弦 41 度。
  - Blue circle is possible position of 6 knots - half speed target vessel
  - Red circle is possible position of 8 knots - two third speed target vessel

- Red vessel in 020 bearing mark is one of 4 knots (one third speed of ownship 12 Knots) target vessel

We can see

- maximum relative bearing of 4 knots (one third speed) target vessel is about 20 degrees to each side. (green line from center to 20 degrees to each side)
- maximum relative bearing of half speed target vessel blue circle is about 30 degrees to each side. (blue line to 330 degree)
- maximum relative bearing of two third speed target vessel red circle is about 41 degrees to each side. (red line to 041 degree)

- 我們可以從這邊的建議來看看：向右轉轉向 30 度，如果船速是本船的一半，並且有碰撞危機的船隻，我們都可以避開，無論他現在是走的什麼樣的航向。這是因為他如果跟本船有碰撞危機，他現在可能的位置，就在藍色的圓圈上面。
- 如果本船右轉向 40 度，可以避免本輪速度三分之二的船隻的碰撞，如果本船向右舷轉向 60 度，可以避免船隻，幾乎是跟本船同速的船隻。（當然各位應該呢可以在圖形上量出來，應該是在 11 節以下，都可以借由轉向 60 度避免碰撞）
- We can see from this suggestion: **alteration course 30 degrees to starboard side, for vessel with half (1/2) speed and have collision risk with ownship, ownship can avoid her no matter what course she is heading at that time.**
- **Alteration course 40 degrees to starboard side can avoid collision of vessels with 2 / 3 speed of ownship (in this case is 8 knots = 2 / 3 of 12 knots vessel).**
- **Alteration course 60 degrees to starboard side can avoid collision of vessels with almost same speed of ownship (in this case is 11 knots, reader need to judge from figure 2-23).**

圖形 2-23 不同速度的船隻碰撞危機時，他可能的相對方位

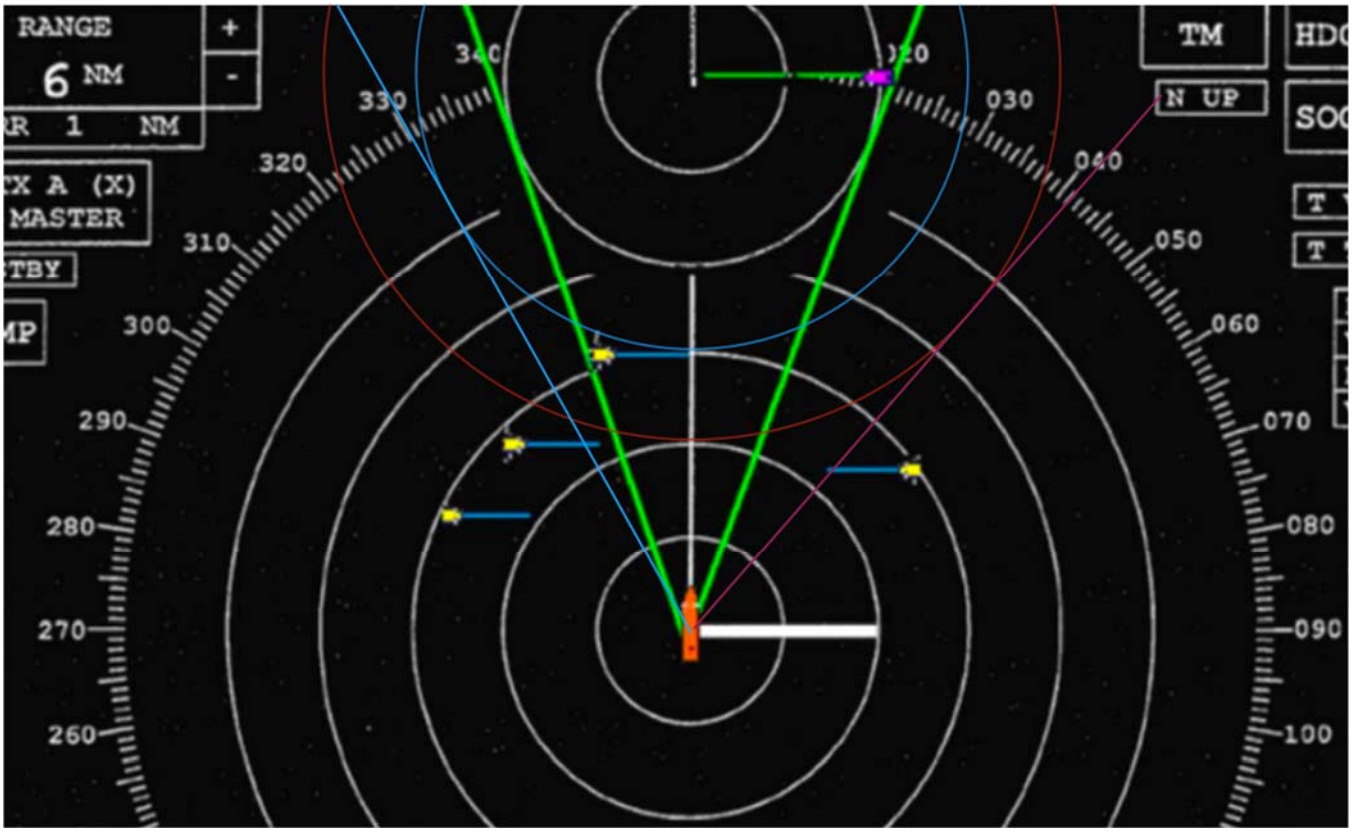



FIGURE 2-23: POSSIBLE RB OF DIFFERENT SPEED VESSELS HAVE COLLISION RISK

讀者必須瞭解，這些結論，“可以避免什麼樣速度的船隻？”是建立在這些船隻，在同樣的時間，到達同樣地點的假設上面。跟本船同時同地到達，畢竟呢我們應該知道，哪裡是碰撞點？這才是避碰的一個主要關切。
如果碰撞的位置，是在船的右邊，向右轉向就是增加我們的碰撞危機，就好像我們在這一章 2-24 節裡面所討論的，這個早期的建議，早期的研究報告建議，向右舷轉向最少 30 度到 60 度，如果某一船隻在正橫之前，會有潛在的限制，更詳細的討論，會在第四章為大副們所做的講解。（參見圖形 4-12 安全相對方位，對 1/3 ½跟 2/3 速度的目標船）

Reader have to know these conclusions **can avoid collision with vessels of ……. speed** are based on the assumption these vessels arrived same position at same time as ownship. After all, we can know "knowing where is the collision point" is a major concern of collision avoidance. If the collision position is on starboard side of ownship we alter course to starboard is increasing collision risk as we discussed at section 2-24 of this chapter. This early day's suggestion "**alter course to starboard side** at least 30 to 60 degrees **for a vessel forward of the beam"** has its potential limitations. More details discussion is at chapter 4 for chief mate **(**Figure 4-12 Safety Relative Bearing for 1/3, ½ and 2/3 speed of target).

*(ii). an alteration of course towards a vessel abeam or abaft the beam.*

*向正橫前後的船隻轉向：*是愚蠢的事情，不要向正橫的目標船轉向。在圖形 2-24 下面，我們可以看到，是第一章圖形 19，桑吉輪在 1939 LT 時，鄭大嶼 03187 號在 40 度的相對方位上（黃線），這是一條速度比本船速度慢的魚船，現在的速度向量線是 9 分鐘的長度，碰撞時間就是 1939LT 加上 9 分鐘 948 LT，這黃色的圓圈圍繞鄭大嶼 3 187 就是他的可能位置在 9 分鐘後，使用它的原始的速度。這個概念就是如同圖形 2-23，如果本船向右轉向，我們的速度向量線位置，就代表本船未來的位置，與鄭大嶼號將會有重疊的位置，換一句話說，本船向右轉向，會增加與鄭大嶼的碰撞危機，**向慢速船的另外一邊轉向，是一個比較好的選擇**。在此例，如果本船向左轉向，除非鄭大嶼增加船速，不論任何航向，他在做改變或是行駛，根本船都不會產生碰撞點或是碰撞位置。

- an alteration of course towards a vessel abeam or abaft the beam *is a foolish thing to do obviously. Don't alter course to vessel abeam. In figure 2-24 below, we can see as chapter 1 Figure 19 SANCHI's X band radar display at 1939LT, ZHEDAIYU 03187 is at relative bearing about 40 degrees starboard side (yellow line) which is a fishing boat with slower speed than ownship. The speed vector is 9 minutes long. Collision time is 1939 LT + 9 minutes = 1948 LT. The yellow circle around ZHEDAIYU 03187 is her possible position after 9 minutes with her original speed. The concept is same as figure 2-23. If ownship alter course to starboard side our speed vector (ownship's future position) will have many overlapped positions with ZHEDAIYU 03187. In another words, ownship alter course to starboard side will increase collision risk with ZHEDAIYU 03187.* Alteration of course ***away*** a ***slow speed*** vessel abeam or abaft the beam ***is a better choice****. If ownship alter course to port unless ZHEDAIYU 03187 increase speed, any course she goes will not create collision position with ownship*
*對於從正橫附近方位接近的快速船隻，向他轉向，***也許並不是一個很好選擇***。就像我們在圖形 2-24 桑吉輪的案件，長峰水晶輪是在相對方位 20 度，右舷的紫色線條上，他可能的位置在 6 分鐘之後，就會在紫色的圓圈上面的一點。如果本船向左轉向來避免碰撞，左轉 10 度 20 度都不足以遠離紫色的圓圈，也就是長峰水晶輪 6 分鐘後的可能位置。本輪必須向左轉向 30 度，去避免右舷來船的碰撞，**除非已經確定碰撞不會發生**， 向左轉向是違背規則第 19 條（d）（i。

實際上，**在能見度受限制的情況下，是沒有直航船的**。目標船向右轉向，而本船向左轉向，會造成另外一個近接的情況。在這個桑吉輪的案件，桑吉輪可以向左轉向，至少 30 度去避免碰撞，在其他的情況，也許不會允許如此操作。除非呢，他已經確定了碰撞危機不會存在，向左舷地轉向，對一個船隻在正橫之前呢，應該是要避免，這次規則 19（d）（i）的要求。外國人我們就不講了，讀者至今，如果桑吉輪左轉 30 度，是否能確定碰撞危機不存在？

- *Alteration of course* away *a* fast speed *vessel abeam or abaft the beam* may not be a better choice. As we can see in figure 2-24 Sanchi's case CF CRYSTAL is at relative bearing 20 degrees starboard side as purple line on screen. Her possible position after 6 minutes will be as purple circle. If ownship alter course to port side to avoid the collision course change 10 or 20 degrees to port side is not enough to clear purple circle CF CRYSTAL's possible position. Ownship need to alter course at least 30 degrees (to port side) away from starboard side coming vessel to avoid the collision. Ownship alter course to port side is a violation to Rule 19(d)(i). *Actually, there are no stand-on vessel in restrict visibility situation.* If target vessel alter course to starboard side and ownship alter course to port which may become another close quarter situation. In this Sanchi's case MV SANCHI can alter course to port side at least 30 degrees to avoid collision. *In other case the situation may not allow for this maneuvering. Except where it has been determined that a risk of collision does not exist, an alteration of course to port for a vessel forward of the beam shall be avoided.* Rule 19(d)(i).

*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.*

船隻利用安全速度來避免危險，是利用減速 停車或反轉推進方式來做，對於正橫的船隻來講，不是一個很好的選擇，減速和停車是一個很緩慢的過程，需要幾分鐘才能夠完成，在圖形 2-24，如果本船減速或是停止主機，目標船還是會向本船緩慢接近，他們的紫色和黃色的圓圈，將會重疊到本船的速度向量線，而且碰撞危機會增加，這樣會使得在主機減速之後，所有的航向改變，變得毫無用處，因為呢減速後，本船還是沒有離開碰撞點，碰撞線，碰撞區域，而造成另外一種近接情況。

- *How about we avoid collision with vessel abeam by changing speed?* Ownship use safe speed to avoid danger by reduce, stop or reverse propulsion direction for abeam ship actually is not a very good choice for vessel sailed in sea speed. Vessel reduce or stop speed is a slow process which will need few minutes to finish. For vessel in maneuvering speed, main engine revolution is reduced quickly but vessel speed relaxed slowly. In figure 2-24 if ownship slow down or stop engine target vessel will approach ownship still the same. Their purple or yellow circle will overlap ownship's speed vector even more than moment ago which will make all our course change after engine reduced useless. (because reduce speed *result in another close-quarters situation.)*

很多當值船副在這裡，也許會混淆，下大霧的時候，是呼叫船長的時候，這邊討論的只是知識層面，資淺船副沒有必要，具有這一方面的技術，如果我們對當時的情況下，有任何疑問，呼叫船長是第一優先，這是船長的值更命令，也是公司的規範。圖形 2-24 就跟第一章的圖形 19 一樣。

- Many OOW may confuse here. No possible way out of danger as both vessels take action at same time. In dense fog is the time to call Master. In junior OOW level this is knowledge base only, not our skill base yet. If junior OOW has any doubt of the situation in fog call the Master is first priority as per standing order and company's guidance.

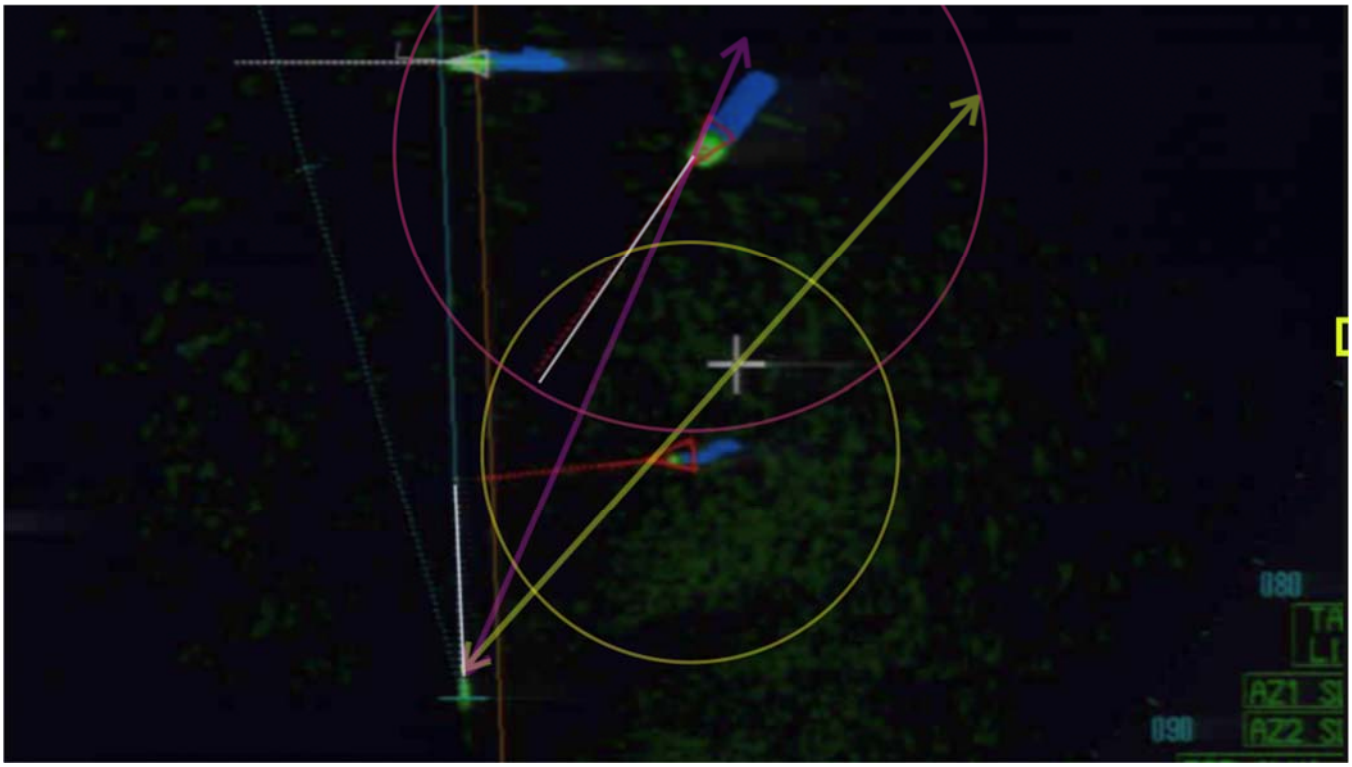


FIGURE 2-24: AS CHAPTER 1 FIGURE 19 SANCHI'S X BAND RADAR DISPLAY AT 1939LT

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

*- 除非已經確定危機並不存在，這是用雷達阿帕來確定，無法使用目測的技術來決定。在霧中，沒有這種目測技術，一定要使用儀器來，確定碰撞危機。*

- 聽到另外一條船的霧號：當聽到另外一條船的霧號，只有一到兩海浬遠，這已經是第三階段，兩船都需要採取避碰行動。圖形 2-22 實際上，在能見度受限制的時候，是沒有直航船跟讓務船的區分。兩條船都必須採取行動，來避免碰撞。在實際的海上，我們仍然使用三階段避碰義務規則，像圖形 2-22，即是使用雷達瞭望的技術。

- 聽到另外一條船在他的正橫之前：另外一條船的接近方位，沒有辦法目視，最危險的情況是迎艏正遇，這個要向右舷轉向，向右舷轉向，會增加右舷船隻的碰撞危機，就像圖形 2-24。優良船藝，要為最糟糕的情況做最好的準備。並且把碰撞危機減到最低，我們需要把本船的速度降到最低。

- *Except where it has been determined that a risk of collision does not exist:* By RADAR lookout or ARPA plotting data. Not by visual lookout skill to *determine a risk of collision does not exist.*

- *hears the fog signal of another vessel:* When heard fog signal from other vessel the distance is only one or two NM distance away. It is the third stage of COLREG as two vessels need to take avoidance action at the same time as in Figure 2-22. Actually, there are no stand-on vessel in restrict visibility situation. Both vessels need to take action to avoid collision. In real sea we still follow three stages of collision obligation rule as Figure 2-22 by radar lookout skills.

- *hear another vessel forward of her beam*: another vessel's approaching bearing is unknown. Most dangerous situation is head-on which need to alter course to starboard side. Alter course to starboard side will increase collision risk with vessel from starboard side relative bearing as figure 2-24. Good

seamanship prepares for worst scenario and minimum the collision risk by *shall reduce her speed to the minimum.*

**-** *應該減速到最低，僅能維持舵效:*這是一種速度,本船可以沒有困難的維持現在航向，這隨著風浪的情況而定。如果風浪很大的時候，這個最低速度也是相當高，最小的可操舵速度，這是避碰的第一階段，*當本船聽到在我們正橫之前的另外船隻的霧號。*

*- 船隻的霧號，僅是一種警報，其他船隻的動向，必須使用其他的方法確認，例如雷達阿帕或是 AIS。*

*如果有必要全速停車：*應該停車或鳴放霧號，兩長聲在不超過兩分鐘時間內，去減少碰撞危機，這是第二階段，當本船聽到本船之前其他船隻的霧號，接下來要怎麼做？並不是由避碰規則所規範，*無論如何，我們都應該要小心駕駛，直到碰撞危機過去。*

**-** *shall reduce her speed to the minimum at which she can be kept on her course:* a speed ownship can steer without difficulty to maintain present course. Minimum steerage speed. This is first stage when ownship *hear apparently forward of* our *beam the fog signal of another vessel*.

- *fog signal of another vessel*: is a warning only. Other vessel's movement have to make sure by another means like, RADAR ARPA or AIS.

**-** *if necessary take all her way off*: ownship shall stop speed and sound fog signal at intervals of not more than 2 minutes two prolonged blasts in succession to minimum collision risk. This is second stage when ownship *hear apparently forward of* our *beam the fog signal of another vessel*. What to do next is not specified by COLREG. *In any event navigate with extreme caution until danger of collision is over.*

讀者應該記得在這條規則 19，雖然現行的情況跟環境是能見度受限制，這個受限的情況是隨時在變化，其優先順序是：

對規則 19b 我應該以安全速度前進，這是規則 6

規則 19c，符合第一節的規範（規則 4 到 18，在能見度受限制時，仍然管用）。

規則 19d 雷達探測到其他目標的存在，本船應該決定？是否近接的狀況或是碰撞危機存在，如果是，本船應該採取適當時間的避碰行動。本船應該避免下列事項：

（1）相對正橫之前的船隻，左轉

（2）向正橫附近的船隻轉向，

規則 19e 本船聽到正橫之前，其他船隻的霧號。無法避免與其他船隻近接的情況，本船應該減速到僅能維持舵效。本船應該全速停車，而且在任何時間，無論如何小心謹慎航行，直道碰撞危機已經過去。

Reader should bear in mind, in this rule 19 although "**prevailing circumstances and conditions of restricted visibility" are changing all the time,** the priority are

- ⇒ rule 19 (b) *Every vessel shall proceed at a safe speed*. **Rule 6**
- ⇒ rule 19 (c) *complying with the Rules of section I of this part* (**Rules 4-18** is still useful in restricted visibility).
- ⇒ rule 19 (d) only when *detects by radar alone the presence of another vessel. Ownship*
  - *a. shall determine if a close-quarters situation is developing and/or risk of collision exists*
  - **b.** *If so*, Ownship *shall take avoiding action in ample time*
  - **c.** Ownship *so far as possible the following shall be avoided:*:
    **(i**)*. an alteration of course to port for a vessel forward of the beam*
    *(ii). an alteration of course towards a vessel abeam or abaft the beam*
- ⇒ rule 19 (e) Ownship *hears apparently forward of her beam the fog signal of another vessel or which cannot avoid a close-quarters situation with another vessel forward of her beam,*

**(i).** Ownship *shall reduce her speed to the minimum at which she can be kept on her course.*
**(ii).** Ownship *shall if necessary take all her way off and*
***At all times,*** *in any event navigate with extreme caution until danger of collision is over.*
這些航向的建議，（避免向左轉向，對於在正橫之前的船隻），或者減速 停車，應該降低他的速度到最低，直到他僅能維持他的航向，這些都是等於在雙方可以互見的時候的第三階段，也就是兩條船都需要採取行動，去採取最佳的避碰行動，（就像圖形 2-22 船隻的避碰是由他的距離來決定），或是在非常近的距離，當你沒有頭緒，目標船是從哪裡來的時候？你都要小心謹慎航行，過直到碰撞危機過去。

These course recommendation (*avoid an alteration of course to port for a vessel forward of the beam***)** or reduce, stop speed (*shall reduce her speed to the minimum at which she can be kept on her course*.**)** are for third stages in sight of one another "two to move: both vessels to take actions best aid to collision avoidance" (as Figure 2-22: vessels obligations in collision avoidance varied by both vessel's distance) or at very close range when you have no clue where this target come from.
2-45 從 VHF 港務台或是領港站,得到的航行指示
如果不論本船利用任何方法，追蹤到目標船的動向，利用 VHF 港務台或是領港的指示，本船應該採取有效的行動來避免碰撞，依照這些指示，與規則 4 到 18，也就是操舵與航行規則，在兩條船可以互見的時候。
這些單位的 VHF 港務台和領港指示，是具有公共服務的性質，所以他的傳達或廣播，是經由空中廣播或是他們私人的裝置傳達，他們是適當的主管官署，對於航路的安全有責任監管，避碰規則即本規則不應干涉主管官署的特殊規定，不過呢這些主管官署可能會犯錯，所以本輪還是對航行安全，負最後的責任。不論任何原因，當你追蹤到目標的動向，經由本船的航儀雷達阿帕等等這些資料，是屬於私人的性質，只對本船有效。當碰撞危機牽涉到其他的目標，而你能見度受限制的時候，看不到他船，本船就應該要採取第 19 條的規定行駛，但書就是你確定不會有碰撞危機發生。
2-45 Sailing instructions received from VHF, VTS vessel traffic service or Pilot Station
If by any means you can track the target by VHF, VTS vessel traffic service or Mr. Pilot instruction ownship should take effective actions to avoid collision as their instructions with regards to rule 4-18 as in sight of one another. These party's VHF, VTS vessel traffic service or Mr. Pilot instructions has public service properties which are propagating through air or their private communication devices. They are proper authorities to regulate the traffic safety by paramount clause of COLREG Rule 1 (b) *Nothing in these Rules shall interfere with the operation of special rules made by an appropriate authority for roadsteads…….*
However, these authorities also can make mistake ownship is still responsible for ownship's collision avoidance safety. If by any means you can track the target by ARPA, AIS…. etc.,. these data are gotten from our equipment which are available only to ownship. When the collision risk involved with another target we cannot see in restricted visibility ownship shall take actions as this rule required as above.

## *總結資淺船副的知識面*

### 太空船：是碰撞危機的區域，在速度向量線的最後 3 分鐘的空間。

對見習船副來說，在第一章是我們視覺瞭望的知識，包括找出甲板參考點，作為目視方位線，在白天夜間，找出目標船距離所需要的線索。我們已經討論過，如何目視來確認碰撞危機，作為基礎的情境感知。目標的方位距離對我們不具任何意義，除非我們知道他的碰撞危機。
使用有系統的觀察，當我們看到目標的時候，只要等幾分鐘，對於目標方位距離的改變，會啟動對碰撞危機的直覺，從而決定我們要採取什麼樣的行動？這才是是我們需要的，目視瞭望的直覺，或是情境感知。

在這一章，對資淺船副而言，如果超過一個目標有碰撞危機，在這個同時呢，我們應該知道哪一條船是最危險的，我們討論過駕駛台操縱位置，所會牽涉到的盲區，就是當值船副無法目視監測的盲區，等於是當值船副無法控制本船動向的區域。盲區就是無法控制的區域。當我們還是 1 個實習生，使用天文，雷達，GPS，在海圖上面，定位出一個點來認定本船，現在我們應該把本船放大到我們的盲區範圍，因為我們回轉的時候，需要前進一段距離，因為使用的舵角不同，有時候就會像“圖形 2-08 前進距離的盲區”。盲區就像紅船一樣大，瞭望的時候，資淺船副應該要記在心裡，而不是視同海圖上單純的一個點。無論如何，這一條紅船變的更大，在圖形 2-14 阿帕螢幕，3 分鐘的真運動向量。本船變得更大，這也是一個想像的危機區域。這是想像的碰撞危機區域，就是速度向量線上，最後 3 分鐘的區域，我們又叫這個區域為太空船。

## *Knowledge Base Summery for Junior OOW*

### Space Ship: collision risk area in last 3 minutes of speed vector

In the first chapter for cadet officer, we have discussed the knowledge of visual lookout including how to pick up a reference point for visual bearing line and the clues need for our instinct of target distance at day and night. We had discussed how to verify the collision risk by visual as basic situational awareness. Otherwise, target bearing and distance means nothing to us if we don't know it collision risk. The moment we saw a target by eye and waited for few minutes our feeling of its bearing and distance change will decide what action we will take. In this chapter for junior OOW, if more than one target has collision risk at the same time we should know which one is most dangerous? We had discussed blind sector from bridge conning position which is the closest distance OOW can monitor visually. Blind sector area is exactly the same as OOW has no ability to control ownship's movement (OOW disable area). Blind sector area= No control area. Ever since we are a cadet we fix ship's position by celestial, radar, GPS as a point in the chart or ECDIS. Now we enlarge ownship to include our blind sector because head reach (advance) of our turning circles with different rudder angle will as big as red ship in "Figure 2-08 Distance of Advance included blind sector". This red vessel should bear in mind for junior OOW in lookout. However, this red ship getting even bigger in "Figure 2-14: ARPA screen, 3 minutes True motion speed vector" which is also marked an imaginary collision risk area. This imaginary collision risk area in last 3 minutes of speed vector is what we called Space Ship.

**太空船是一個象徵，代表每條船最後 3 分鐘在真運動速度向量線上的區域**，在圖形 2-14 我們看到太空船在 6 分鐘速度向量線的尾端，而且本船跟在我們右船頭的船隻，有碰撞危機，在 6 分鐘後有碰撞危機在。在圖形 2-15 的阿帕畫面，我們把真運動的速度向量減到 3 分鐘，太空船的長度呢，就是剛好跟每條船 3 分鐘速度向量線的長度一樣，我們發現在圖形 2-15 中，沒有船與本船發生碰撞危機。但是由速度向量線的交點。我們可以估計跟目標船的碰撞時間是 6 分鐘後。我們並沒有完全討論如何去操作本船，在多船隻遭遇的情況，使用速度向量線，這個太空船用來避免與各船的碰撞，與本船在操作避碰時，所面臨的限制。這個太空船會被證明是非常有用的。在多船遭遇的情況，當我們在阿帕上面使用雷達瞭望。

**Space Ship: An iconized ship to represent each ship last 3 minutes advance in her True motion speed vector.**

In Figure 2-14: we see space ship in the end of 6 minutes speed vector where ownship has collision risk with the vessel on our starboard bow after 6 minutes. In Figure 2-15: ARPA screen, we reduced true motion speed vector to 3 minutes space ship length which is exactly the same as every vessel's 3 minutes speed vector length. We found in Figure 2-15 no vessel has collision risk with ownship within 3 minutes. By intersection point on speed vectors, we can estimate the collision time with target vessel after 6 minutes. We have not discussed fully how to maneuver ownship in multi -ship encounter situation with speed vectors in this chapter. This space ship will be used to avoid collision with each ship has its own limitations of maneuvering. Speed vector will prove to be very useful in multi-ship situation when we use radar lookout in ARPA.

## 2-46 目視瞭望的技術：是駕駛臺上最佳的備援

小型船隻需要多少的方位變化，才足夠清爽的通過？我們能夠利用阿帕去確認他的 CPA。當 CPA 的資料是在阿帕的螢幕上，立即可得，我懷疑有多少當值船副會注意到目標的方位變化？會依賴阿帕，似乎對資淺船副是一個合理的行為，不過呢，如果資淺船副只有使用阿帕來確認碰撞危機，就會失去目視的警覺，事實上，現在的船副，根本不知道什麼是目視瞭望，尤其是在避碰的時候。對於一個帥氣的當值船副，交叉參照永遠是一個必須，當他想要去改善他的能力。是的，當值船副可以用 AIS 的資料，或是 VHF 的通訊去達到同樣的目的，但是這些人工的方法，同樣需要對目標船，在目視上面做一個正向的確認，這在近距離的時候，是最困難的部分，如果當值船副嚴重依賴雷達的資料。

在近距離，當值船副最需要雷達資料的時候，目標回跡會在阿帕 雷達上面消失，消失在海浪回跡或雨雪雜斑裡面。在桑吉輪的案件裡面，阿帕目標的回跡，速度向量線，或是碰撞危機的警報字樣，時常會消失，因為呢海浪與雨雪雜斑，遮蔽了雷達的回跡，即使是長峰水晶輪，這樣的大船。在近距離，當值船副所有的選擇，就只剩下了目視瞭望的技巧，來確認目標的方位改變，在近距離，如果他能夠先確認目標，然後及時採取行動，在未來的日子裡，這種目視方位改變的感覺，會變成我們駕駛台瞭望直覺的一部分，方位改變的察覺，對目標船的方位線的察覺，在我們海上生涯不同的階段，都是我們最基礎，也是在避碰時最後的技術依據。在圖形 2-05 你看得出來目標的方位是否改變了，從圖形 2-04 的位置。

## 2-46 Visual lookout techniques: best backup lookout skill on bridge

How much small target bearing change is enough for passing clear? This can be done by using ARPA to verify its CPA. When CPA data is immediately available in ARPA screen I wonder how many OOW will notice the bearing change of target. Reliance on ARPA seems reasonable for junior OOW. However, OOW using only ARPA to verify collision risk will lost visual awareness in collision avoidance. Cross reference is always a must-be for a smart OOW if he wants to improve his ability. Yes. OOW can use AIS data or VHF communication to achieve same purpose. But these artificial means also need positive identification of target vessel in visual. This is the most difficult part at close range when OOW relied on radar data too much. Target APRA or RADAR echo may lose in sea/rain clutters in close distance detection. We had seen in Sanchi's case, target's echo or speed vector or collision risk alert lost from time to time due to sea/rain clutters. In close range, the option left for OOW in lookout is **visual lookout techniques: to verify the target bearing change at close range if OOW could and to get positive identification of target so as to take effective action in time.** In the days to come, this feeling on visual bearing change will become part of our instinct on bridge lookout. Bearing change awareness of target vessel bearing lines difference in different time is our basic and ultimate skill in collision avoidance. In Figure 2-05 can you see target bearing had changed from Figure 2-04?

## 2-47 對阿帕太過信賴，並不是一件自然的事

過度依賴一樣電子航儀，有些潛在的風險，因為這些儀器在探測的時候，會遇到的限制，這對有經驗的海員來講，是不成問題，如果他會目測，但是對於人為因素所受到的限制，人們在使用這些儀器的時候，並不知道有問題？最大的問題就是人類的短期記憶，受限於 5 加減 2 的數位容量，這些短期記憶是沒有辦法處理，阿帕提供所有數位資料的缺陷，當班的時候，這是連船長都不清楚的事，每個人在駕駛台，都只是來來回回的在檢查雷達或阿帕上面的資料，去取得資料一遍又一遍，我們只是單純的認為，同樣的儀器，我們查兩次就是 double check，或是認為呢，檢查又檢查是一個海員勤勉的表現，due diligent 。而且實際上呢。並非如此，如果在最後一分鐘，失去了目標船回跡的資料，你可能會認為過 1 分鐘後，我再去檢查，就會沒問題。但這幾乎有 50%的機會，你會發現那些你需要的資料呢，仍然沒有出現在螢幕上，**即使我們非常勤快的去檢查阿帕的資料區，沒有保證會得到任何確認的回報**，整個航運界呢，都沒有質疑雷達或者阿帕的缺陷，就像在桑吉輪的案件，無人重視雷達回跡失去的問題，此時可能已經是在當值船副喪命前 5 分鐘的事，我們呢會怪罪於當值船副早期的瞭望疏失，他們沒有採取行

動，沒有正向確認。而不是在我們最需要資料的時候，儀器的缺陷，人犯錯是自然的，但是沒有技術，就是愚蠢的，有阿趴的證書，但是得不到阿帕回跡的資料，這難道不是儀器殺人。你的勤勉並不是適任，做的多並不表示你做得好。當值船副的責任，是要會使用目視瞭望，去確認碰撞危機，這是因為儀器的功能不完善，我們的自救措施。
在實際的海上，雖然領港的工作，可以得到很好的報酬。但是有一位領港，依賴雷達，只會單獨使用雷達資料導航。從他還是一個資淺船副，到後來做領港的工作，還是一樣，不得不呢提早離開工作崗位，這對我來講呢，並不意外。他的淡出呢是對於雷達所遭遇的不確定性，感到疲倦，這些雷達的缺點，是不能用我們的努力，或是 30 年的使用經驗來改善，目標的回跡，說消失就消失，你呢完全沒輒，那這樣呢也可能是你在駕駛台上面的畫面。如果你沒有目視瞭望的技術，你就必須給你自己一個機會，放棄使用這些重重覆覆來來回回的阿帕資料，而去試著使用目視的直覺，當你還是一個資淺船副的時候。

## 2-47 Too many faiths in ARPA is not nature.

Over reliance on electrical navigation equipment will have some potential risk due to their limitations in detection which are known by experienced mariner. But, the limitation in human element to use these equipments are not known to public. Human short term memory limited to 5 ± 2 digits which cannot handle all data provided by ARPA. This deficiency is not recognized by OOW, master and pilot, everyone just going back and forth to check and re-check on ARPA data area again and again. We simple assume same equipment check twice is double check and check/double check is due diligent of seamanship and. Actually, it is not. **If ARPA lost target data in last minute and you though I check again later it will be good by then.** There are 50% chance you find those data you need are still missing in later time. How frustrate this can be when our diligent is not paid out? Whole industrial did not question its deficiency in RADAR and ARPA like in SANCHI's case. We ignore target lost problem SANCHI's OOW had faced 5 minutes before their death. We blame for their "no action" or lack of "positive identification" in early stage, not equipment deficiency. To err is nature. But lack of skill is foolish. Your diligent is not competent. The competent OOW can use visual and radar lookout to verify collision risk.
In a real case, despite lucrative payment of a pilot job in Taiwan. One pilot relied on RADAR data solely (ever since he is a Junior OOW) to do piloting in harbour area had asked early retirement. This is not surprise to me. His retirement is tired of those uncertainty accompanied with Radar usage and those restrictions in RADAR cannot overcome by our diligent or 30 years experiences in using. This could also be your picture at bridge if you did not have visual lookout techniques. So, you need to give yourself a break in using these winding and hunting data in ARPA for a change of visual instinct while you are still a junior OOW.

## 2-48 瞭解避碰規則：使用圖形的資料，以消除疑問

在我們事業的這一個階段，我們並沒有許可權去挑戰避碰規則，我們能做的事，只是去瞭解他的條文跟規則，並遵守公司及船長的值更命令，或是夜令簿，我們對避碰規則的運用，會留到資深船副的時候，再去討論，這裡我們提供一些圖形的資料，來消除一些疑問，這些參考，還沒有提到其他的論文或是主題裡面，沒有更仔細的學術研討，如果你有機會讀研究所的課程，或是海上的當值船副，我們有這樣的許可權，現場去測試他的正確，要不，怎麼會清楚自己的想法做法是否正確？

## 2-48 Knowing COLREGS - some graphic information to clear the smoke

In this stage of our career we did not have the authority to challenge COLREG. What we have to do is to understand it by the clause and rules and follow company and Captain standing/night order. We put away its application to senior OOW to discuss later. Here we provide some graphic information to clear the smoke a little. These references had not provided in other article and subjected to more academical study if you have

the chance go to graduated scholarship. We are the OOW at sea. We have the privilege to test its correctness at scene.

End of chapter 2