+Chapter 1: Knowledge and Situational Awareness for Rating

1-01 Knowledge, feeling and instinct for Rating

1-01 What is Situational Awareness? knowledge, feeling and instinct
1-02 Situational Knowledge
1-03 Situational Feeling:
1-04 Situational Instinct
1-05 Situational Awareness improvement at sea

1-02 Visual Lookout on bearing: Aspect, relative bearing, line of sight

1-06 Knowledge Awareness for Rating: Visual Lookout
1-07 Verifying target's portside or starboardside (aspect)
1-08 Target's aspect is not same as ownship
1-09 Lookout at sea: Aspect and Blossom effect
1-10 Finding collision risk by unchanged relative bearing.
1-11 Visual clues in lookout duty
1-12 How to verify target relative bearing changing? Using line of sight.
1-13 Principle of Line of Sight
1-14 Characteristics of visual marks
1-15 Why we need to set up line of sight for use
1-16 Target vessel is not at her original direction
1-17 Visual relative bearing on deck: first instinct in lookout

1-03 Visual Lookout of distance: Horizon, bow wave and wake current

1-18 How to tell target distance at sea？ Second instinct in lookout
1-19 Queries from duty AB: the calling from past sea generations
1-20 "Beyond the horizon": How Far Can You See at Sea?
1-21 The water line is the highest line where ship's vertical hull submerged
1-22 Target water line at horizon 13-4 N. Miles range: in precautionary range.
1-23 Target has bow wave at 4 N. Miles range: in action range
1-24 Vessel with no bow wave in close range may be a safe sign.
1-25 Target vessel with wake wave at 1 N. Mile range: activate range
1-26 Lost horizon is lost visibility and situation awareness
1-27 Sea Smoke is dangerous for small target

1-04 Nightfall at sea: Limitations, illusions, deceptions,

1-28 Nightfall at sea
1-29 Bridge Navigational Watch Alarm System, abbreviated BNWAS
1-30 Due diligent we need in night watch,
1-31 How can we judge target distance by night? First sight of fishing boats is at 7 NM.
1-32 Knowing small vessels distance by lights on deck at 4 nm
1-33 The blossom effect for ocean going vessel at 4 nm
1-34 Reflection on water: Vessels close to ownship at 2 nm range
1-35 Limitations of human eyes at night
1-36 Mistake for cone cells are not functional.
1-37 Eye's adaptation to darkness: 100,000 times more sensitive after 30 minutes
1-38 Night illusions can cause confusion and distractions
1-39 Bearing change at Night
1-40 Glare length on bridge

1-05 Situational Awareness for Rating: Visual Contact

Figure

1-1 Knowledge for Rating

1-2 Situational Awareness for Rating

Chapter 1: Knowledge and Situational Awareness for Rating

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1-01 駕習生的知識

1-01 何謂情境感識:知識,感覺與直覺。

情境感識或謂情境感知，還是情境想要，該名稱是由情況報告而來，我們是否能夠處理現在的狀況，取決於我們理性的知識，感性的想法，跟習慣性所造成的直覺。理性的知識是我們做決策時的線索，想像一下，我們坐在一個教室裡，參加數學的測驗，但是不知道要從何作答。感性的想法，設定我們對當時情況的優先順序，我們經常是依照我們的感覺來做決策。直覺的習慣性是決定我們接下來要如何做，是我們面對麻煩時的第二天性。說起來容易，就算我們在猶豫，我們還是會想辦法，或戰或逃，來改善我們的處境。不 知 道這樣做會付 出什 麼 樣 的 代 價？我們要如何增進情境感識，這也簡單，只要我們人在現場，我們就已經在狀況內，現場對實習生來說，是嚴厲的。如果你是甲班實習生這一章就是為你寫的。不管 我們做的對還是錯，下一次我們處境感識的看法想法做法，多少都會有進步，這就是為什麼職業海員，需要一年的海勤資歷，才能夠做一個當值船副。相對的就算我們是非常有經驗的船長，是否我們的知識與做法，就高枕無憂，令人喪氣的是，諺語：大海永遠不會停止對我們的試煉。我們需要在不同的情況之下，具有不同的優先順序。如果我們沒有這些情況的相對知識，我們不會感覺到危險。沒有危險的感覺，就不會採取任何行動，來處理我們的危機。當任何人問到我，我會如何最好的形容，我40年的海上經歷，我只能說沒什麼大事，當然，冬天有強風與風暴，或是下大霧這些情況，但是在我的經驗，我從來沒有任何意外，值得一提。這是愛德史密斯鐵達尼號船長在1907年的演講。

每個人都有冰山的知識，但是只有危險的感覺，能夠讓我們採取行動。當我們有了感覺，在我們標準作業的直覺，就會自動出現。或是派出新的瞭望或是對現有的瞭望編制，感到信心？

1-1 Knowledge for Rating

1-01 What is Situational Awareness? knowledge, feeling and instinct

Situational Awareness is a term derived from situation report. Whether we can handle the situation or not depends on our rational knowledge, emotional feeling and habitual instinct. The rational knowledge is to know what clues we need for decision making (imaging we are sitting in a classroom to take a mathematic exam but we have no clue how to answer it). The emotional feeling is to set out our priority by current situation (I do what my guts tell me). The habitual instinct is to decide what we will do next (our second nature when we have some trouble ahead). That's easy to say. Even hesitated, we will do something (to fight or to run) to improve our situation eventually. Don't know what cost we have to pay in this way? What we can do to improve our situational awareness? It's also easy **as long as we are at scene if we are in the situation already**. At scene is crucial for an apprentice. If you are a rating or cadet on bridge this is the chapter writing for you. No matter we are doing right or wrong with our knowledge, feeling or instinct there is a chance we will improve our situational awareness next time. This is the reason we professional seaman are insist of one year sea time before validated the OOW certificate. On the contrary, is our situational awareness bulletproof when we have been a very experienced Master with many years of sea time? The truth is sad to say "the sea never ceases the test on us" or we don't know. We need different Awareness in different Situation. Without situation knowledge we will not have the feeling of danger. No feeling of danger we will not make any change and yield no solution to our crises.

> *" When any one asks me how I can best describe my experiences of nearly forty years at sea I merely say uneventful. Of course, there have been Winter gales and storms and fog and the like, but in all my experience I have never been in an accident of any sort worth speaking about."*
> *by Captain ED Smith of Titanic 1907.*

Everybody has danger knowledge of iceberg but only the feeling can motivate our reaction. When we have the feeling already the instinct from our SOP (standard operational procedure) will appear automatically. Should we send extra lookouts for new threat of iceberg or have confidence of existing compliment in lookout squad?

1-02 情境知識或情境探測

我們在學校，或是公司通告得到的所有知識，都是屬於預防措施。這些注意事項，是我們在事件或意外發生之前，應該要做好的。這些公司和利益團體所綜合的知識，是在無障礙的環境做成的，當時指導者不在現場，他們的心智正常，也沒有任何的心理壓力。當事情發生後，我們讀到當局的調查報告，或是公司寫的通告，法庭的判決書等，他們都是坐在辦公室或法庭上，然後綜合一下，到底有多少條國際避碰規則被違反了。這些並不是我們的情境感識，或是我們的情境想要，那些只是責任的劃分，理性的知識並非是避免意外的所有答案，當情況在進行之中，我們也必須有所感覺，想要先做某些事情，來改善情況。人類的感覺，在潛意識裡是相互影響的，我們很容易被其他人，例如船長或是船副的恐懼焦慮所影響。這些負面情緒，會進入我們的潛意識，成為在我們日後遇到同樣情況之下的某種直覺。

1-02 Situational Knowledge:

All knowledge we learnt from school or company circulars are precaution measures. These precautions are things should be done before any incident/accident had happened. Those knowledges summarized by shipping company or relevant investigation parties after incident are based on unobscured condition where investigators are not at the scene and no mental pressure on their clear mind. After a collision happened, we read the investigation report or verdict written by officer or judge who sit in the office/court and summarize how many *COLREGS - International*

Regulations for Preventing Collisions at Sea rules had violated. These are not situational awareness, that is allocation of liabilities between parties. Rational Knowledge are not the answer to avoid accident. We also need to have the feeling to do something first when the situation is in progress. People's feeling is interacting unconsciously. We get affected easily by other's fear and anxiety at scene (Master or OOW). **These negative emotions can sink our memory of current scene into our subconscious level which will become part of our instinct to solve the case in the future.**

1-03 情境感覺或是情境想法

憑感覺作事，聽起來很不專業，每個人對事情都有他自己的感覺，我們的感覺大部分來自我們的潛意識，當我們伸伸腿，想要從床鋪上爬起來的時候，我們不會想想或是考慮第二次。一般情況之下，我們會把事情的優缺點，列表出來參考，這些是屬於知識層面。在緊急的狀況，我們沒有選擇，只能相信我們的感覺。我們也許具備魚骨圖上面的知識，根據不同的參數改變，或者是優先順序的變更駕駛台程式指南，或是駕駛台標準值更命令，對船隻避碰有很多先決的條件。這些資料與知識，寫的是很清楚，但是並沒有說，在不同的情況之下，第一優先是什麼？何者優先？這些注意事項都是對的，何者優先，卻要靠現場的感覺來決定。我們有的感覺，都是來自我們的潛意識。就像我們坐在考場裡面，面對空白的考卷，心裡面沒有任何頭緒，我們需要等待感覺來決定，什麼是合理的解答。就像我們帶著絕望的心情，走到 ARPA 前面，想要找出目前碰撞困境的解答，什麼是我們需要的線索？是否是目標的距離？我們又該如何取得？當我們有時間的時候，這些是我們用理性知識來決定的步驟。當我們沒有時間的時候，我們就會利用潛意識的感覺，或是直覺來領導我們，解決這些問題。

1-03 Situational Feeling:

Feeling sounds like very unprofessional. Everybody has his feeling about something. Our feeling is mostly come from our subconscious. We never think it twice when we stretch our legs to get up from the bed. We can do pro and con list in casual situation (knowledge base) **but in emergencies we have no option but to trust ours feeling.** We may have the knowledge of situations write in Fishbone Diagram according to parameters changed or priority different. Bridge procedure guide or standard standing order have many prerequisites in writing for collision avoidance. This information or knowledge are listed properly but did not say which one is in top priority in different stages of current situation. All precautions in writing are right but what is first priority now had to decide by our feeling at that time. The feeling we have come out from our subconscious. Like we sat in front of school desk and gazed at the exam paper without any clue. We are waiting the feeling to come to make sense of it. Like we approach to ARPA in desperate to find the way out from current collision situation, what clues are useful now (target distance?) and how can we get it? When we have time, it is our rational knowledge to decide the initial approach. When we don't have time, we depended on strongest feeling of our subconscious instinct to lead us to solve the case.

1-04 情境直覺

理性的知識，在現場也許沒辦法發揮功用。但是知識對於管理者，教師或者是我們本身，日後要增進自己對情況的感識，是非常重要的。當每件事情，都可以攤在桌子上檢討的時候，我們可以找出現場沒有注意到的線索，對於沒有足夠知識的人，有足夠案例可以學習是很重要的。這些線索也許當時被船長和船副的負面情緒所掩蓋，也許當時這些線索，大家都沒有注意到，這些線索就會被重新整理它的優先順序，並且設定為一個新的標準作業程式，就像駕駛台的程式指導書一樣。一般的實習生準備參加適任證書的考試，會把這些標準作業程式，當做一些通用的知識，但是並不瞭解這些程式的順序，是非常重要的。

本書的寫作，想要避免誤導我們的海員，他也許現在正在他們職業生涯上的不同領域，具有不同的知識跟經驗，讀者應該對自己成為一位船長，有所期許，本書最主要的目的，就是培養我們作為一位船長的直覺。在海上生涯的不同階段，我們應該要遵守公司的規章，對於年輕的船副，即使您已具備了近接避碰的知識，你還是需要，等待當你自己做船長的時候，才來應用。除非你遇到了非用不可的情況。我們這裡學到的知識，是用來培養我們的情境感識，是用來確認我們的看法想法與做法，我鼓勵各位利用你的潛意識，來養成正確結論的長期記憶。千浬之行始於足下，"科學不過是經過訓練與組織的常識，試著從每件事情裡學點東西，又從這點東西裡瞭解其他事情"。我們這裡要學

的東西，是其他海員沒有注意到的事情，本書的目的是尋找一些日常作業共同的規則，用來對日後其他事件，測試它的正確性。
對於管理級的船員，這裡的知識，是你每天在駕駛台所面對的，只是你可能並沒有特別的想法或是感覺，人類的天性就是尋找我們熟悉，或是感興趣的東西，其他的事情，對我們來講，也許只是讓人分心，本書的目的，就是讓你對這些事情感到興趣。如果可能，你會發現對你日常航行的實務，是非常重要的。換句話說，經由對在駕駛台一些常識的適當整理，這本書要培養我們的直覺。

1-04 Situational Instinct

Rational Knowledge may be useless at the scene. But it is a vital part for investigators, scholar or ourselves to improve out situational awareness afterward. When everything can lay on table to review, we can extract the unnoticeable but important traces to those have not enough knowledge. These traces may originally submerge by Master or OOW's negative emotion and go without enough knowledge to notice it. These traces then can be re-organized its priority and re-defined in a new standard operation procedures SOP such as bridge procedure guide. As usual cadet prepared for COC exam, we used to treat these SOP in general terms not knowing the working sequence of SOP are very importance.

I was trying to write this book and avoid mislead our fellow seafarers who are at different stage of their career with different knowledge and practice of their own. Reader should not expect themselves become a Master when they had finished reading this book although the layout of it is to cultivate our instinct to be a Master. Reader in different stages should take the actions required by your supervisor or company guidance. For young OOW, even you had enough knowledge of close quarter encounter you should wait for your time of command. The knowledge here is to cultivate our awareness of situations on our daily practice at sea. I will motivate your subconscious to implant correct conclusions into your long-term memories. The road to conquer thousand meters high mountain begins where we stand now.

> *"The science is nothing but trained and organized common sense. Try to learn something about everything and everything about something." by Thomas H. Huxley.*

Something here is unnoticed by experienced seafarers' common sense. This book here is to summerize the common rule we can sense in every watch keeping day and to test its correctness with everything we aware thereafter. For those management lever OOW, these knowledge are something you may had seen at bridge but means nothing to you before. It's human nature to look for something we interested and known. Other things in our eyes are distractions only. This book is to tell you **what you should be interested and find out its importance for your usage.** In another words, this book is to cultivate our instinct through properly arranged common senses at bridge.

1-05 改進海上的態勢感知

感知，這是我們由情境中所產生的知識，可以測試我們對於數分鐘後，優先順序的感覺與直覺。在本書出現的情境，是要檢討我們或多或少的知識層面，當我們需要的時候，感覺是對的嗎？什麼樣的直覺，能夠變得反應更好？態勢感知是經由我們的知識，感覺與直覺，累積而來的。並不只是單純的由我們的海勤資歷，所累積出來的。最便宜的教訓，永遠都是從書本上來的。在我二十年避碰主題的寫作中，我發現有兩件事，第一是新的知識，所總結出來的種種條目，容易被遺忘，或者是根本就沒辦法，被資深的海員有限的記憶力所記住。年紀大的人，總是不容易記住新的東西，對於年輕人來講，是沒有足夠的場景，可以把他從書本上讀到的知識，產生一個適當的連結。年輕人可以寫出你總結的條目，但是到了現場，卻不能認清楚情境的實質，因為這些場景不能讓他們產生足夠感覺。本書的寫作與一般教科書不一樣，主要是提供各種場景的感覺，以配合不同階級海員的需求，這種方式同時也反映出，我對人為因素研究的實際應用。現在就讓我們開始成為船長的旅程，不管你已經準備好了沒有。

1-05 Situational Awareness improvement at sea

Awareness is the knowledge you raised in scenario to testify your feeling of priority and your instinct of what will come in next minutes. The situations presented in this book are to review what is better or worse in your

knowledge. Did you get the feeling right when it needed? What instinct you can have better from now on? Situational awareness is improved by knowledge, feeling and instinct we can accumulate on our sea time. But, the cheapest lessons we can had is in paper. In my 20 years of writing in Collision Avoidance topics, I found out two things. One is rational knowledge of summarized rule 1 and 2 and 3 are easily left behind or never picked up by experienced seaman's poor memory. The old men have problem to remember new things. The other problem is young man did not enough scenario to connect the knowledge he read from book. Young man can write down the rules you had summarized but hard to recognise it at scene. They did not have the feeling connected with the scene. This book is different in common writing style by providing the feeling of the scenario to serve different lever of seafarers. This style is also reflecting fact based on my study of human factors. Now, let's start the journey to become a Master whether you are ready or not.

1-02 Visual Lookout on bearing: Aspect, relative bearing, line of sight

1-06 Knowledge Awareness for Rating: Visual Lookout

Visual lookout is the basement for collision avoidance: no matter you are a rating or Pilot.

1-02 目測方位：視角，相對方位，方位線

1-06 實習生:目視瞭望的知識

目視瞭望是避碰的基礎，不管你是一個實習生或是領港。

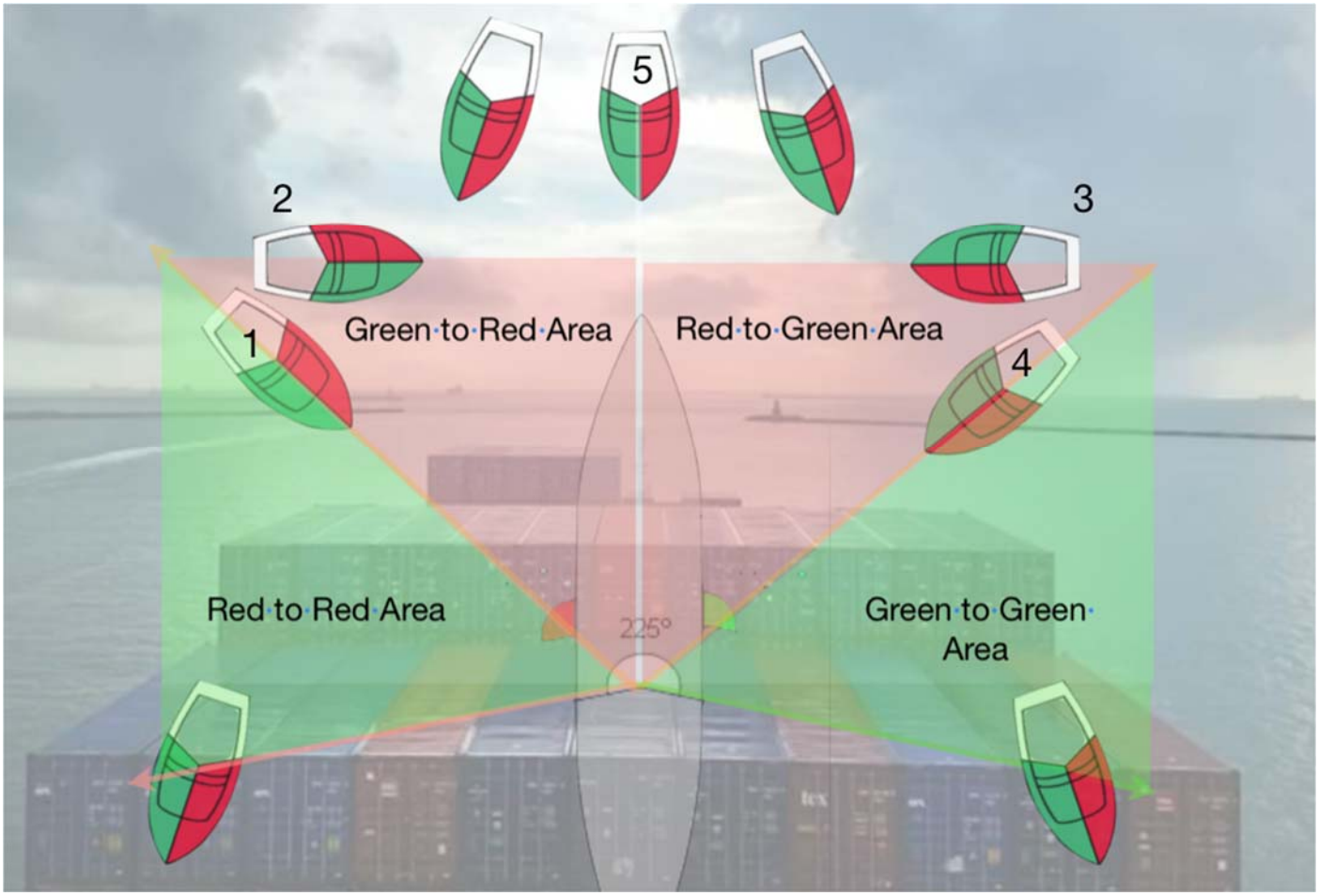


Figure 1-01: passing port to port, red to red, passing astern, lookout for first sign

1-07 確認目標的左舷或右舷，視角

在我們的海上生涯，一定在VHF的談話中聽到，船長或領港與它船的聯絡，要如何互相通過？紅對紅或者是左對左。當兩條船確認為紅燈對紅燈通過，它意味著目標船的左舷與本船的左舷，在通過的時候，會彼此相對，因為左舷的舷燈是紅色。當我們看到左舷有船隻，同時它船也是左舷對著本船，這就是左對左通過。如果兩條船都能保持左對左，對這兩條船來講，都是安全的。這就是避碰規則，所設定的通過方式。每條船都沿著航道的右側行駛，把本船的左舷留給他船通過。左對左通

過，保證了兩條船都能夠留在航道正確的一邊，對雙方都是安全的。在圖形1-01，我們可以看到左舷的一號船，二號船需要向右轉向，以保持左對左的通過。當兩條船是在左對左的情況下，這兩條船都被國際避碰規則九約束，這兩條船都必須保持同樣的視角。視角就是目標船面對本船的一側。如果目標船左舷面對本船，它的視角是紅色。一般來說，左對左通過，對在本船左舷船隻的安全，非常有用，如果他們願意左舷對著本船。

確認目標船的視角，是我們瞭望時，必須學會的第一個直覺。不管何時，只要我們確認目標的視角，是紅對紅，或是綠對綠，碰撞的危機就立刻解除，即使你是一個船長，也需要這種直覺。在我們成為船長的旅途中，我們還會遇到使用其他的方法，來確認碰撞危機，但是利用視角的訓練來確認，卻是我們所需要的第一直覺。這樣的直覺，可以為我們在駕駛台的瞭望，省下最寶貴的資源:反應時間。

1-07 Verifying target's portside or starboardside (aspect)

In our seatime, we must have overheard VHF conversation from Master / Pilot with outside party discussing how to pass each other "red to red" or "port to port". When two vessels confirm with each other pass "red to red", it means passing ownship portside by target vessel's portside when these two vessels are closing to each other. The red is portside navigation light color at night. It means when we saw one vessel on our Portside (red light side) and her portside red navigational light is also facing ownship. This is a "port to port" passage. It will be a safe passage to both vessels as long as both vessels keep this "port to port " aspect. This is a designed way of passing in COLREG. Each vessel sails along starboard side of fairway, channel or traffic separation scheme will leave her port side to passing vessels. Port to port passage guaranteed both vessels will stay at correct (starboard) side of fairway and their passage is safe to both vessels. We can see from the Figure 1-01. Port side No.1 or No.2 vessel need to alter course to starboard side to maintain "port to port" passage. When two vessels are in red to red situation both vessels are binding by COLREG rule 9 to maintain same aspect to each other. Aspect is which side target is facing ownship. If target vessel port side facing ownship it has a "red" aspect to ownship. General speaking, port to port passage is useful for our portside targets if they willing to show their portside red light side to ownship.

To identify target's aspect is the first instinct we have to learn in lookout duty. Whenever we identify target's aspect is "red to red" or "green to green" collision risk is eliminated immediately at the same time even you are a Master you will need this instinct in emergency. In the way to be a captain we will come across many other ways to identify collision risk but the training to identify the aspect of target is our first instinct (priority) in our lookout training. This instinct saves the most valuable resource on bridge, reaction time.

1-08 目標船的視角與本船不同

對在本船右舷的目標船，如果我們看到目標船的左舷，面對本船的右舷，就像３號船一樣，這是一個紅對綠的通過，此時對方船隻能否安全通過？就是一個很大的疑問？如果目標船的視角，與本船不同，就像３號船，２號船與本船不同，２號船是綠對紅。此時這兩條船的航線與本船，就會產生交點。在紅對紅，或是綠對綠的通航，本船航線與目標船不會有任何的交點。瞭解目標船與本船航跡所產生交點的性質，是非常重要的。在避碰章程的課程，對這個交點，沒有充分的討論，而且大多數海上航行的海員，對此也是未知。

這些碰撞的交點，是在開航港作航行計畫，畫航線時，就已經決定的。如果兩條船同一個時間，到達同一交點，實際上就是碰撞。

如果 3 號船比本船先到達這個交點，她的相對方位會通過本船的船首，他的相對運動，也是同樣的往本船前面移動。他的視運動，相對於我們眼睛觀測的運動，就叫做相對運動。他的方位，如果從本船船頭量起，就是他的相對方位。在這種情形下（3 號船比本船先到），兩條船的視角，不會改變是紅對綠，會保持到３號船橫過本船船首。

如果 3 號船比本船晚到達交點，他的相對方位會往本船船尾移動，他的相對運動同樣是會通過本船的船尾。在這種情況下，他的視角會慢慢的由紅對綠，改為紅對紅，此時我們的第一個直覺將被喚起，"**無論何時，當我們確認到目標的視角是紅對紅，或者是綠對綠，碰撞危機立刻就消除了**"。

交叉相遇的情況，在海上並不是永遠如此。交叉相遇的情況中，橫越船會在兩船相互的通過時，保持相同視角的，只有那些先通過交點的船隻。如果一條目標船對本輪顯示他的紅燈或是綠燈，就像 2 號船跟 3 號船，一開始在圖形 1-01 上面的顯示。過了一會，本輪又可以看到他兩邊的舷燈，這些船隻必定在本船的船尾，有一個航線的交點（通過本船船尾）。如果目標船的視角，正由不同的船舷改變成跟本船同舷，此時這兩條船就安全了。換句話說，**如果這條船兩舷的舷燈，都能夠被本船觀測到，就代表這條船的碰撞危機正在發生改變**。如果當值船副能夠借由其他的方法，得到相同的結論，這種知識似乎對當值船副沒什麼用。但是有了這一層瞭解，對我們的態勢感知會有很大的說明，想像當目標船正在轉向，而我們開始時，並沒有察覺到這條船已經很近了，就像１號船跟 4 號船如果保持原來的航向，就能像圖形 1-01 一樣，分辨出安全與危險的區域。綠色是安全區域，也就是紅色區域代表危險。劃分安全與危險區域的線條，就是這條船的相對方位線。

１號船跟４號船對本輪的視角，在這個相對方位是零。如果目標船在適當的距離外，對本輪顯示零視角，這會是一個安全通過的信號。如同目標船在圖形 1-02，是左舷面對本船的右舷，紅對綠，這樣的態勢可能是橫越或追越的情形。對橫越的情形，就像我們上面討論的，將會有兩種安全通過的態勢。第一當本船可以看到他船兩舷的舷燈，而且航線的交點在本船的後面。第二目標的視角在通過時會維持不變，如果兩條船的交點在本船船頭。兩條船會發生碰撞時，會同時通過交點，此時他們的視角也會維持不變。我們如果只用視角來判斷碰撞危機，到底是追越還是橫越，將會發生混淆。舷燈顏色在追越的過程之中，兩條船會維持不變，保持紅對綠，或是綠對紅。這些追越的情況，使得利用視角來判斷碰撞危機，產生了更多的困難，我們需要更精確的方法來確認碰撞危機，依照國際避碰規則，碰撞危機是由羅經方位來確認的。對一個實習生來說，如果兩條船的距離足夠（這樣才有足夠的觀測時間），我們需要更簡單的方法來確認碰撞危機。對迎艏正遇的情況，如同５號船在圖形１－０１中，兩船相遇時，如果航向相對（差１８０度）可以左對左，或是右對右相互通過，避碰規則的要求是左對左，所以兩條船都應該向右轉向。

1-08 Target's aspect is not same as ownship

For starboardside targets, if we saw target vessels portside facing our starboardside like No.3 vessel is a "red to green" passage. It will be a questionable passage whether collision risk exist or not. If target's aspect is not same as ownship like No.3 vessel or No.2 vessel, green to red in No.2 vessel. These two vessel's tracks are crossing ownship's track at some point. In "port to port" or "green to green" passage ownship's track will not have any intersection point with target vessel. Knowing the nature of intersection point of ownship and target's track is very important. In current collision avoidance course syllabus this point had not discussed throughout to most mariner at sea.

This intersection point of both vessels' track is decided when we made voyage planning and course line on charts in departure port. This intersection is actually a collision point if both vessels arrive at same time.

- If No.3 target vessel arrives the intersection earlier than ownship her relative bearing will move across ownship's bow. Her relative motion is also moving ahead ownship. Her apparent movement to our eye is called relative motion (movement). Her bearing measured from ownship's bow is her relative bearing. In this situation both vessels' aspect will not change. "Red to green" aspect is maintained before No.3 vessel crossed ownship bow.
- If No.3 target vessel arrives the intersection later than ownship her relative bearing will move across ownship's stern in some times later. Her relative motion is moving toward our astern. In this situation her aspect will change slowly from "red to green" to "red to red" as ownship passed her bow. Then we are safe by Our first instinct: Whenever we identify target's aspect is "red to red" or "green to green" collision risk is eliminated immediately.

The crossing situation is not always the same at sea. Those crossing situations maintained throughout both vessels passage is for those target vessels have intersection point ahead of ownship only. If one target vessel shows her red or green side light to ownship in the beginning like No.2 or No.3 vessel in Figure 1-01 then shows her both side lights (red and green) afterward at some distance away like vessel No.1 or No.4, this vessel must have an intersection point at ownship's stern by that time. If target vessel's aspect is about to change from different side to same side as ownship, both vessels will be safe from the moment side changed.

In another words, if target vessel's both side lights can be observed by ownship the collision risk is about to change at the same time, sometimes safe and sometimes not. This knowledge seems useless in crossing situation when OOW can get same conclusion through other means of lookout. But this understanding will help our situation awareness a lot when target vessel is changing her course without our notice in the beginning in close quarter encounter situation.

If vessel No.1 and No.4 keep their original course there is a line in Figure 1-01 divided safe and danger zone for No. 1 and No.4 vessel (safe zone colored green and red color for danger zone). It is target's relative bearing line measured from ownship's heading. No.1 and No.4 vessel is at their o degree aspect in this relative bearing. If target vessel shows 0 degree aspect to ownship at ample distance away it will be a safe passage.

If target vessel in Figure 1-02 has its portside facing ownship starboardside, red to green, this may be a crossing or overtaking situation. **For crossing situations** like we had discussed will have two safe passage situations:

1. A short moment when ownship can observe target's both side lights if the intersection is behind ownship.
2. Target vessel's aspect unchanged throughput the passage if the intersection point is ahead of ownship's position now.

When both vessels arrive the intersection point at the same time with a collision their aspect in crossing will maintain without change. We will confuse safe passage or danger collision by using aspect method only.

We can say **Crossing situation can not decide it is safe or not by knowing two vessels aspect only.**

For overtaking situations both vessels will maintain their original side light color to each other, red to green or green to red throughout a success overtaking passage. For a long time overtaking situation when two vessels have very close sea speed after they departure Suez or Panama canal from convoy arranged. In later situation both vessel's aspect will change from time to time because their setting from original course line will be different. So as their auto pilot set course to compensate the leeway they had. These overtaking situations will add more confuse to crossing situations above by judging target vessel's aspect only. We need more accurate way to ascertain the collision risk. The collision risk is ascertained by compass bearing change of target by COLREG. For a rating, we need a simplified version by using relative bearing method to ascertain collision risk. In the end, even most experienced seaman will need some relative bearing awareness in our chapters to come. It is the first and last resort a prudent navigator can depend on his career.

For head-on situations like vessel No.5 in Figure1-01. Port to port or starboard to starboard passage can be maintained for vessels have reciprocal course line, that is vessel coming from opposite direction of ownship's heading. In head-on situation, port to port passage is the norm of COLREG as both vessel have to alter course to starboard side for safe passage.

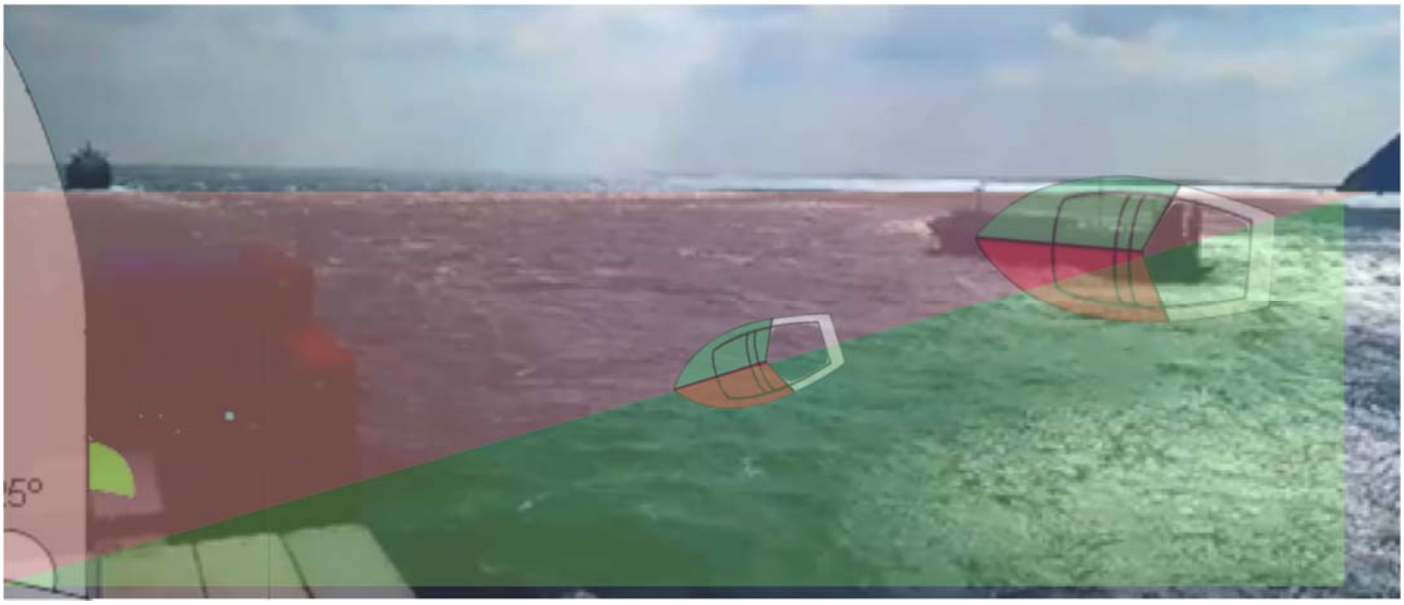


Figure 1-02: red to green passage whether it will pass ownship bow or stern or is overtaking now?

1-09 海上瞭望：視角與花開效應

當兩條船在海上，互相競逐同一位置時，我們不容易發覺。大多數時候，船隻都是在他自己的航線上面，孤獨的航行，我們看到紅燈和綠燈來來去去，就好像日出日落一樣的平常，不會多加注意，這就是人的天性。一般來說，我們會有三種橫越的情況，第一種就是他成功的橫越本船的船頭，此時他的視角，在我們看起來並不會改變。第二種是他無法超越本船的船頭，會從本船的船尾通過，他的視角會從不同的船舷，變成與本船的同舷通過。第三種是對兩條船最不利的，就是他跟本船同時到達碰撞點，他的視角從頭到尾都不變，他的船體無法超越本船的船頭，也無法通過本船的船尾，這兩條船會在這交點的地方，發生碰撞。換句話說，兩條船都在同一時間到達同一地點，這就是碰撞。這個神秘的碰撞點，我們會再下一章當值船副的時候討論。當目標船成功橫越本船，他會比本船先通過碰撞點，如果他來不及通過碰撞點，但是本船已經通過碰撞點，目標船就會比本船晚通過碰撞點。所以現在到底是什麼樣的態勢，誰知道呢？我們無法從目標的視角來分辨碰撞危機，我們要從其他的方法來確認，橫越船的狀態。

就像三號船的視角，在圖形 1-01 是左舷對本船的右舷，或者說是紅對綠，這就是橫越的情況。2 號船在我們的左舷，他的綠燈對著本船的紅燈，綠燈對紅燈，這也是一種橫越的情況。橫越船是否有碰撞危機，需要用其他有系統的觀測來確認，我們沒有辦法確認他的碰撞危機，如果只是確認他與本船，現在不是同一舷相互通過。**所以當看到目標船跟本船並不是同舷航行，這是我們碰撞危機的第二個直覺**，又將被喚起。即使距離很遠，就發現目標船，具有不同視角，但這個情況稍後還是可能會改變。在海上目標船的視角會改變，有兩種可能性。

第一是他比本船晚到達碰撞點，此時他視角的改變是緩慢與穩定的。如果我們能分辨出目標的距離是否足夠，這將會是安全通過的保障。目標船的距離太近時，即使他的視角變的與本船相同時，仍然會有碰撞危機。

第二是目標船改變航向，並且讓路給本船，此時目標船航向的改變，視角的變化是巨大且快速的。目標船的視角改變，是否解除碰撞危機？他最對本船的距離，是一個關鍵的因素。目視瞭望時，我們需要對目標船的距離，有一定的瞭解。

有些船的碰撞，完全都沒有被本船注意到，目標船的羅經方位，會一直停留在同一個位置。也許他的羅經方位被駕駛台窗戶的柱子，或是海圖室的窗簾遮蔽，尤其是當瞭望懶得改變他在駕駛台站立的位置時，所以駕駛台的命令簿或是優良船藝，都建議我們要適度的勤勉，適時的改變你在駕駛台位置，以確保 360 度的景觀（目標），都能收入眼底。

如果你只是實習生，發現當值船副疏忽了橫越船隻，你應該通知他，讓他能夠採取行動去確認碰撞危機。這是我們的義氣，或者說是我們的主張，橫越船隻是哪一舷面對本船，如果在近距離時，並無任何神秘。我們可以用他的船頭浪，與他螺旋槳後的航跡流來判斷，在夜間可用他舷燈的顏色來判斷。目標船的距離很遠時，在白天目標船的視角，也許就很難決定，他是哪一舷面對本船？另外的一個概念，也許能夠幫忙我們確認碰撞危機，那就是花開效應，如果目標船的形狀變得越來越大，就像花苞開始盛開一樣。這就有可能，目標船距離本船，變得越來越近。目標船的形狀，變得或大或小，是我們對目標形狀的警覺。對於小型船隻，他們的船型，永遠是比本船小，不管怎麼樣，碰撞的警覺，對小型船隻，也是不可或缺的，也有可能小型船隻形狀還沒有變大，就跟本船發生碰撞。對於大型船隻，知道花開效應，可以提高我們對碰撞危機的警覺。知道花開效應和目標船的視角，跟他的形狀大小，即使是在遠距離，也可以幫助我們提高了聊望的警覺，雖然對碰撞危機的確認，並不充分。

1-09 Lookout at sea: Aspect and Blossom effect

When two vessels compete each other for *same location at sea we can not notice easily*. Most of the time each vessel sails along her course line without notice other vessel's movement as sailor said lonely sea. We see red light or green light come and go as sun rise or sun down. It is human nature. Usually, there will have three kind of crossing situations. First situation, she made *it* and pass ownship's bow. Her aspect won't change during the passage. Second situation, she did not make *it* and pass ownship's stern. Her aspect will change from different to same side as ownship. Third one is most unfavorable to both vessels, she made *it* at same time with ownship. Her aspect will remain the same throughout. Her vessel body will not pass on our bow as

first situation nor pass on our stern as second situation. These two vessels will collide each other in intersection point. In another words, both vessels made *it* at the same time is a collision. **This mysterious *it is collision point*** which we will discuss in later chapter for OOW.

When target vessel made *it* she will pass collision point earlier than ownship. When she did not make *it* but ownship make *it* already target vessel will pass collision point later than ownship. Who knows what crossing situation is now? we cannot tell it by target vessel's aspect only. We need another means to verify which crossing situation target vessel is now.

Like No.3 vessel's aspect to ownship in Figure 1-01 is portside to our starboardside, or red to green, it is a crossing situation. No.2 vessel on our portside has green side light (aspect) to ownship's red side light, green to red situation, is also a crossing situation. Crossing situations may or may not have collision risk but to ascertain we need other kind of systematic observation. We cannot ascertain the collision risk just by one look if target has different aspect. **To sense the target has different aspect with ownship should arouse our second instinct of collision risk**. We can notice different aspect of target far away but it may change at later stage. In real sea target vessel aspect may change due to two possibilities. One is she arrive intersection later than ownship. Her aspect change is slow and steady. If lookout can identify the target's distance to ownship is ample it will be a safe passage. If the distance is too close to ownship when target vessel aspect changes to same side as ownship the collision risk may still present. The other is target vessel change course and give way to ownship. Her aspect change is sharp and abrupt. Once again, the distance of two vessels are the dominate factor of collision. Whether aspect had changed or not the distance between two vessels is the decisive factor of collision. <u>As a visual lookout we need the ability to verify target vessel's distance to safe guard ownship.</u>

In theory of collision, vessels may collide without notice at all because her compass bearing remained the same until collision. Her compass bearing may obscure by bridge window frame or chart room curtains where lookout did not bother to change their standing position on bridge to verify any target is left unnoticed. In good seamanship due diligent is recommended by all guidance and procedures. Move your legs on bridge periodically to ensure an all-round view is examined by lookout person. If you are the rating and sense your OOW apparently overlooked crossing situation you should notify him so he can take measures to ascertain the collision risk (accountability or assertive of rating). Which side target vessel facing ownship is not a mystery to us if it is at close range. We can judge it by vessel's bow wave or her wake current after her propeller or her side light color at night. If the distance is far away or in daylight target vessel's aspect may be difficult to decide. Another concept may help arousing collision awareness that is **blossom effect**. <u>If the target's shape is getting bigger and bigger like a flower in blossom process the possibility of collision is increasing.</u> Our awareness of target's shape become bigger or smaller is part of situation awareness. For small vessels their shape is always small compared with ownship. Nevertheless, collision may still happen with small vessel even their shape had not grown bigger yet like one rowing boat at sea. For big vessel if we have the knowledge of blossom effect can raise our awareness in collision risk. Aware the Aspect of target vessel and their shape size change can help our lookout instinct a little but not complete.

1-10 利用不變的相對方位找尋碰撞危機

瞭解綠對綠，或是紅對紅，對兩條迎艏正遇的船，是安全的信號。當兩條船看到對方，並非是在同一視角下航行，本輪應該要有碰撞危機的警覺性。即使兩條船已經同意，相互通過的計畫是左對左，或是右對右，也要有目標船，很可能突然改變航向的警覺性。目標船可能會有某種機械故障，或是對其他小型船隻讓路，我們可能注意到目標船，並非與本船具有同樣的視角，但是否有碰撞危機仍然不明。我們需要有另外的一些警覺性，來說明我們確認目標的碰撞危機，對橫越船而言，有些是通過我們的船尾，有些是由船頭通過，我們已經知道那些通過本船船尾的，是因為他們比較晚到達兩條船航線的交點。

這些船的視角會改變，變的與本船相同，因而解除碰撞危機。那些視角不變的船隻，他們的碰撞危機，就沒有辦法確認，就像圖形1-02右舷的船隻，要讓本船瞭解他是否能及時通過，這將會非常的困難。對於橫越船隻的態勢，我們必須一而再，再而三的確認他的現在位置，是否可以通過

我們船尾。船隻可以通過的，會慢慢向船尾方向移動。就像圖1-03右舷船隻，以黑線的方向移動。相對運動是以本船為中心的合成運動，是以本船為中心的視運動，不論本船與目標船的航向航速為何。其他船隻在本船附近的視運動，就是以本船為中心的相對運動。

雷達的中心點，如果設為本船，目標船的相對運動，就會像我們用眼睛看到的，很容易地在雷達上面監測目標，我們第一次在海上看到目標的形狀與位置，大約在本船右舷的42度，由本船船頭量起。就像在圖形1-03上的紫色線是相對方位線，雖然他的距離未知。相對方位線由本船的船首向量到目標的中心點，第二次我們觀測的時候，目標船相對方位增加到右舷的50度，第三次它的相對方位，增加到右舷的76度，本船不知道他的前進方向與速度，但是他的相對運動是向本船的船尾移動，他的相對方位，每一次我們量取他方位讀數的時候，是持續增加。目標船的視角不會改變，直到他通過本船左船尾，從原來的視角是左舷對本船的右舷，到最後的視角是他的右舷對本船的右舷，這就是我們熟悉的場景，由不確定危險到解除碰撞危機。

1. 如果本船能夠安全通過目標船的左船艏，他的相對方位，會增加到我們右舷的180度。在相對運動的觀測中，如果他的相對方位是180度，目標船會在我們的船尾。對於那些相對方位不斷變大的船隻，給我們一種清晰的指示，他們的動態是不斷的本船尾移動。在圖形1-03連結右舷船隻的黑色線條，代表他的相對運動線，他的方向是204度，在這種態勢下，本船會比目標船先通過碰撞點，本船已經通過後，目標船仍然在向碰撞點前進中。目標船晚點到達碰撞點時，使得他的相對方位，落在本船的180度。我們說這些船是通過船尾，如果他們的相對方位是不斷的增加。

2.那些會通過本船船頭的目標船，每次我們核對他的相對方位時，看來總是不斷的接近本船的前桅。目標船的相對方位不斷減少，在我們看來是向前開，就像圖形1-03上，西航的船隻，他第一次的相對方位是在右舷的28度，他的相對方位線是綠色的線條，它第二次的相對方位是在右舷的18度，第三次就在本船的船頭，相對運動移動的方向是239度。他相對方位的數字不斷減少，直到他開到本船的左舷。這些船是向前開，如果他們的相對方位數字，在通航時不斷減少。但是他對本船的視角保持不變，反而是本船對他的視角，從右舷改成左舷，從右對左，變成左對左的態勢。同時碰撞危機也從不確定變成確定。

3.有時目標船的相對運動，不會向前或向後移動，從很遠的距離開始，只會固定在一個方向，這些相對方位不變的船隻，與本船就有碰撞危機。每一次我們觀測的時侯，相對方位固定不變，但是距離越來越近，當值船副如果不採取行動，改變目標船的方位，這些目標就會在一個方位，變的越來越大，最後就發生碰撞，這就是航空界的花開效應，目標的水準夾角，隨著目標距離接近時變大，如果我們知道目標長度，我們可以在航海對數表上，查出他與本船的距離。瞭望的人也許注意到目標變大了，但是並不知道碰撞危機，已經是非常緊急。沒有知識，就沒有警覺。這對在船上的任何人，都是很不利的情況，我們會喪失住艙裡的個人財產，跟那些我們還來不及賺到的薪資。也許我們的小宇宙，在今天也來到了終點，也許我們會在哪裡失去生命。目標船的相對方位，可能會固定在甲板上的任何方位，總的來說，目標相對方位的改變，就像他的視角改變，就會改變兩條船碰撞危機。差別是利用視角來判斷的時候，我們需要用眼睛確認，他是哪一舷面對本船，量取他的相對方位時，我們不必知道，他是哪一舷正對本船。用目視來確認是我們的警覺性，可以培養我們的直覺。相對方位需要有系統的觀測與紀錄，由相對方位的改變與否，才能夠決定剛才取得的方位，是否有用。不論何時，有機會使用目測的時候，就應該鼓勵實習生利用望遠鏡，確認目標船的視角，利用望遠鏡，以培養我們航行的直覺。

1-10 Finding collision risk by unchanged relative bearing.

Knowing that red to red/green to green is safe for two vessels to pass in head-on direction. When two vessels see each other sailed not in same aspect ownship should have the awareness that possibility of collision is present. Even both vessels have agreed an passage plan of “port to port” or “starboard to starboard”, target vessel may suddenly change her course due to some malfunction of her machinery in steerage or give way to other small vessel unvoluntary. Target vessels has different aspect as ownship her collision risk is unknown. We need another awareness that can help us to verify collision risk with target.

For crossing vessels without collision, some pass our stern and some pass our bow. We know those vessels passing ownship’s stern is because they arrive the intersection later than us. These vessels will change their aspect to same side as ownship without collision risk. For those vessels’ aspect did not change to same side as ownship their collision risk is unknow like Figure 1-02 starboard side vessel. It would be very difficult for ownship to

know "Can she make it?" in crossing situation at first sight. We have to check it once, twice, third and always as target getting closer to know what aspect of her now. Using aspect of target vessel to verify collision risk become an endless job to lookout personal.

In Figure 1-03 there are three target vessels their aspect remained unchanged with different outcome and ownship is in center of lower part. Two Starboard side vessel are in red to green aspect. One will pass astern, the other will pass ahead of ownship. However, the one on our portside had a collision with ownship. These vessels are hard to distinguish their collision risk by aspect only. But we can verify their collision risk by relative bearing method. Relative motion is the resultant motion centered in ownship no matter what speed and course ownship and target vessel had. The way other vessel apparent moving around ownship is her relative motion to us. By the use of radar centered in ownship, relative motion of target vessel is easy to detect just like we saw it with eye. Vessel heading NW when we first saw her shape at sea her position is about starboard side 42 degrees measured from ownship's bow which is the purple line in Figure 1-03, distance unknown. Relative bearing is the bearing of purple line measured from ownship heading to her center. The second time we check her relative bearing increased to starboard side 50 degrees. Third time its relative bearing increase to starboard side 76 degrees. We don't know what direction or speed she has now but her relative motion is moving toward our stern. The relative bearings are increasing each time we take her bearing reading. The aspect of target will not change until ownship passed her port bow. After that, from original aspect of "her port side to ownship starboard" change to final aspect of "her starboard side to ownship starboard side" (our familiar scene), from uncertain of danger to clear of collision risk.

1. If ownship can safely pass her bow her relative bearing will increase to 180 degrees in our starboard side. Target vessel will be at ownship's stern when their relative bearing is 180 degrees. For those vessels relative bearing getting bigger each time give us a clear indication of its movement is toward ownship stern. In Figure 1-03, The black line joined starboard side vessel's position around ownship is her relative motion line which has a direction of 204^0 (T). In this situation, ownship pass collision point earlier than target vessel. When ownship had passed target vessel is still on her way to collision point. Target vessel arriving collision point later make her relative bearing increased to 180 degrees. We said **these vessels are going astern if their relative bearing increased throughout the passage.** This vessel is said " going astern".
2. Those vessels will pass our bow appear closer to our fore mast each time we took her relative bearing. These target vessels' relative bearing decreased each time we observed are said "going ahead". Like the vessel heading west in Figure 1-03, her first relative bearing is starboard side 28 degrees as green line. Her second relative bearing is starboard side 18 degrees. The third one is at ownship's bow. Her relative motion is moving to our port side in the direction of 239 (T). The relative bearing numbers are decreasing each time we take her bearing reading until she sailed to our port side. **These vessels are "going ahead" if their relative bearing decreased throughout the passage.** Target vessel's aspect did not change (facing ownship with her port side) but ownship aspect to her had changed (from "port to starboard" to "port to port" situation). Same is the collision risk changed, from uncertainty to certainty.
3. Sometimes, target vessel relative motion did not go backward or forward but steady in one direction only from distant away. **These relative bearing unchanged target vessels have collision risk with ownship.** Their relative bearing is fixed but distance closer each time we observed. If OOW did not take action to change target's bearing these targets will grow bigger and bigger in one direction and finally collide. This is called blossom effect in aviation to address the horizontal angle of target shape getting bigger in close range. If we know target's dimensions, we can find out her distance related to her horizontal angle in nautical tables. The lookout may aware of the target shape getting bigger but not knowing collision risk is imminent. No knowledge, no awareness. It is not a favorable situation to anybody on board when we see something getting bigger. We may lose our personal belongings in cabin and those salary we do not have the time to spend. Maybe everything come to an end including our little universe in today. We lost our live there. The relative bearing where target is steady can be any direction on deck.

In summary, relative bearing changed target is safe as both vessel's aspect will change after a while. Target vessel's relative bearing to ownship is her aspect to ownship. Her aspect changing will change the collision risk and her relative bearing changing can also change collision risk to both vessels. Her aspect need our

visual confirmation which side she is facing ownship from time to time but her relative bearing can be taken without knowing which side she is facing us. Visual lookout can cultivate our awareness into our instinct. Relative bearing needs to be systematical observed and detect its bearing change before it can mean anything to us. Visual contact with target is recommended to confirm her aspect with binocular or her relative bearing change to cultivate our visual instinct in navigation.

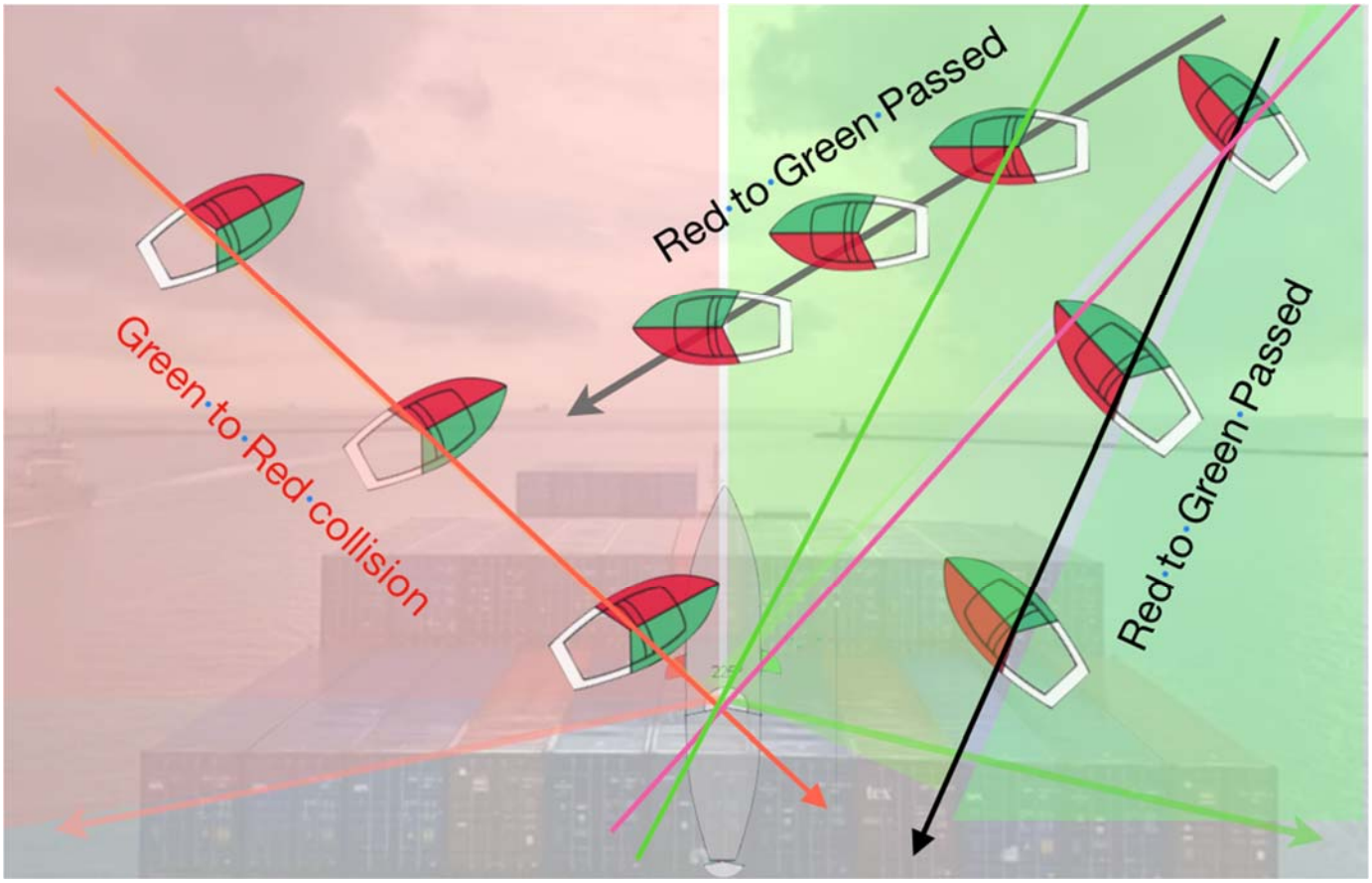


Figure 1-03: find out target relative bearing is changing or not?

1-11 瞭望的視覺線索

對大型船隻來說，如果在遠距離通過，他實際的大小，對我們是無法顯示的，並且他的相對方位也是未知。這些船隻是不受國際避碰規則約束，本船也沒有讓路的義務。對於大型的目標，近距離的時候，越變越大，或越來越高，我們才察覺到，這就是花開效應，是第一個危險的徵兆。要確認他們的碰撞危機，我們必須確認他的視角，或是有系統的觀測它的方位。對小型目標來說，即使在近距離，看起也是小，他們的視角很難確認，如果我們想用小型目標的尺寸大小，或是花開效應來判斷碰撞危機，是不太實際。必須用相對方位，來確認碰撞危機，下面請看，

1. 請比較圖形1-04上面的三條船，在本船右船頭，有著淡藍色船殼，他的形狀隨著時間改變，尺寸越來越小，因為他的速度快，當通過本船船頭的時候，他的形狀變小，距離增加，此時本輪是安全的，因為他的相對運動是向前移動，相對方位不斷的變少。但是在1-04之一的時候，我們並不知道，他的動向是否能夠安全通過。過了6分鐘之後，我們核對他的運動態勢，發現目標船變小了，其實他的相對方位並未有明顯的改變，圖形1-04之2，在這6分鐘之內，如果我們在駕駛台做一些其他的事情，對於他的相對運動。到底是向前或是向後？會有所懷疑，所以我們最好還是量取他的相對方位，就像我們上一節的敘述，稍晚時，我們才可以核對，目標船相對方位的數位是增加或減少？從他船的視角，我們知道不同的視角，是第二種危險信號。如果我們能系統的量取他的相對方位，我們就知道相對方位減少，就是安全的信號。不管我們對目標船視角的觀測，或者是相對方位改變的觀測，都是希望能夠得到目標船安全和危險的感覺，一般來說，有時間時，我會推薦對相對方位改變的觀察， 如果你沒有足夠的時間（只能看一眼），你就必須相信，你對目標船視角的觀測，知道你要看什麼？然後去尋求其他方法，或是稍晚再用相對方位來確認碰撞危機。

2. 看到圖形1-04之3，在左舷有一條4根吊杆的船隻，在104之1的圖形，我們根本就看不到他的影子。事實上，我們沒有必要去觀測眼睛看不到的目標，除非是在霧中，當能見度受限制的時候。我們必

須設定我們瞭望的優先順序，讓那些近距離的目標優先觀測，例如那些有花開效應的目標。在圖形1-04之1中，並不包括這條4根釣杆的船隻，當他在遠距離的時候。看圖形1-04之2，他很明顯的，在我們的左舷變大。左對左通過，這是安全的第一個信號，安全是因為我們能夠確認他的視角。我們也能夠確認他的相對方位，也是在增加中，這就是第二個安全的信號，參考圖形1-04之2到1-0 4之3。

3. 人類的直覺，就是使用目標的距離或大小來判斷碰撞危機，而不是使用視角和相對方位來判斷。我們如果檢視圖形1-04之1，對右舷淡藍色船隻，會有碰撞的感覺，但是同樣的這條船，在圖形1-04之3，感覺這條船就是ok的，只要他離本船適當的距離。事實上，在圖形1-04之1右舷的所有船隻，到了圖形1-04之3都變小了，因為本船因為正在減車，目標船都開到本輪的前方去了，大型的目標船，在近距離，船型變大是一種危險的信號，小型船在近距離的相對方位不變，也是一種危險的信號。不管目標船的大小，瞭望最好的說明，是確認目標船的距離，如果我們認為目標船有危險，確認目標船的距離，是目視的技巧。我們將會在本章後面討論。

圖形 1-04之1 目標船距離遠近的碰撞危機

圖形 1-04之2 目標船距離遠近的碰撞危機

圖形 1-04 之 3 目標船距離遠近的碰撞危機。

1-11 Visual clues in lookout duty

For large vessels, they may not show their actual size to us if it passing far away and their relative bearing is unknow. These vessels are those not under COLREG regulated and binding ownship by right of way. Large targets grow bigger and taller in close range. Blossom effect is the first sign of danger for large vessels. To make sure of their collision risk we have to verify their aspect or take their bearing systematically. **For small targets**, they look small even in close range and their aspect is hard to verify. It is not reliable if we judge collision risk by small target's size or blossom effect. Small vessel relative bearing changed have to be used to verify collision risk.

1. Please compare three vessels below in Figure 1-04. The vessel on our starboard bow with light blue ship's hull changed her size as times go by. Her size became smaller as she passing ahead because her speed is faster than ownship. So, her shape become smaller when her distance increased. This is an overtaking vessel. We are safe because she moving ahead in relative motion and her relative bearing is decreased look like passing ahead. We don't know if it is OK or not in the beginning as Figure 1-04-1. After 6 minutes we find target vessel getting smaller even her relative bearing did not change apparently as Figure 1-04-2. If we are doing some errands on bridge in this 6 minutes we may confuse this vessel's relative movement is ahead or astern by Figure 1-04-2. It would be better if we can take relative bearing of targets as we described in last paragraph. We can check target vessel relative bearing reading is increasing or decreasing to help our situation awareness.
   From first awareness of her aspect, we know she has different aspect (a sign of danger). From taking her relative bearing systematically, we know relative bearing decreasing is second awareness of safe. Whether it is safe or danger is decided by our feeling to trust target vessel aspect observation or her relative bearing change? In general, I will recommend to *trust your observation of relative bearing change if you have time* for series observation. If you did not have enough time to do series observations of target vessel's relative bearing and the aspect is adverse. Relative bearing change is like blossom effect will severely be influenced by its distance. Generally speaking, Relative bearing change is more prominent in close distance. We may not need 6 minutes to make sure of its change. Even 10 or 20 seconds continued observation can find target vessel's relative bearing change.

2. In portside we have this four cranes vessel coming as Figure 1-04-3. We have no idea where she is at first Figure 1-04-1 by our bare eyes. It won't be necessary to look for target cannot be seen by our bare eyes unless it is in fog where visibility is very limited. We have to set our lookout priority in those targets close by, i.e. those targets have blossom effect. This four cranes vessel burst out from Figure 1-04-1 when we cannot identify it at that time. It became apparent that she is growing bigger on our portside as Figure 1-04-2. **Port to port passing is first safe sign** for her aspect is certain to us. Her relative bearing is increasing. **Relative bearing increasing is second safe sign** from Figure 1-04-2 to Figure 1-04-3.

3. It is human instinct to detect collision risk by size and distance of target which is different from aspect and relative bearing method as we had discussed. By looking at Figure 1-4-1 we will have sense of collision with starboardside light blue hull vessel by her distance to ownship. This same ship looks OK in Figure 1-4-3 like other vessels at sea when she has ample distance away from ownship. Actually, all vessels in starboard side as Figure 1-4-1 became smaller in Figure 1-4-3 because ownship slow down and they all sailed ahead of us. Large target vessel's shape growing bigger and bigger is a sign of danger in close distance. Small target vessels relative bearing unchanged is also a sign of danger in close distance. Whether target vessel is big or small the best help in lookout is to report target's distance if we consider it is a danger. Verify target vessel's distance is a visual skill which will discuss later in this chapter.

Figure 1-04-1: collision risk by target vessel's distance -1

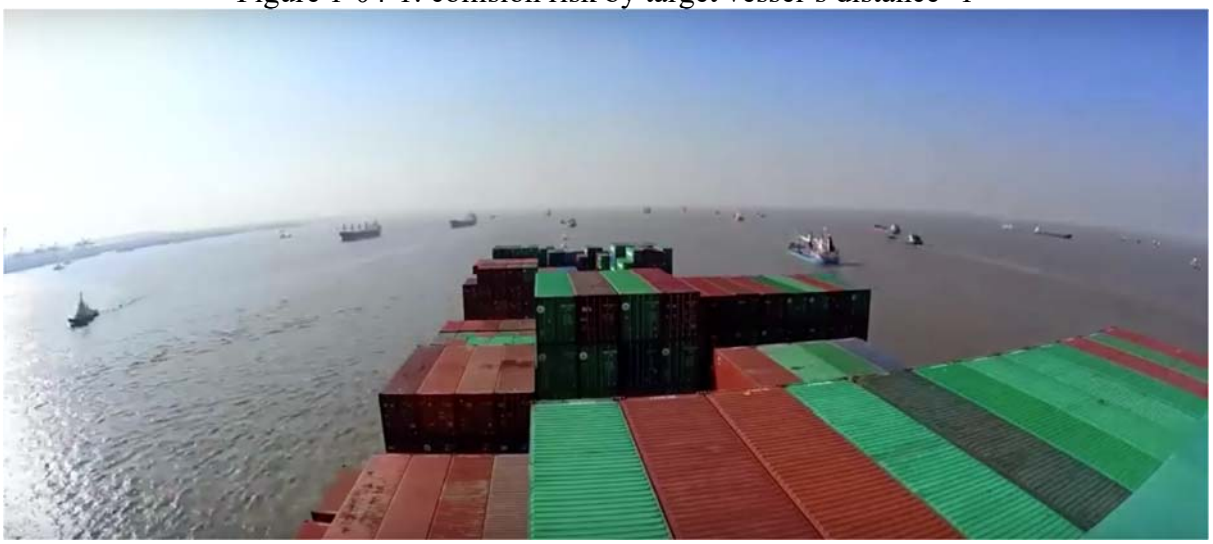


Figure 1-04-2: collision risk by target vessel's distance -2

Figure 1-04-3: collision risk by target vessel's distance -3

1-12 如何確認目標相對方位的變化，使用視線

如同圖形 1-04，海上有許多船隻，我們是否可能在船上，得到一些參考點來幫助我們瞭望。在船上要知道目標船的相對方位變化，對於確認碰撞危機是很重要的。本船在海上的航程，使用的是穩定的航向與速度航行，所以固定目標在船體之外，應該有同樣的速度，向後的視運動。目標船有他本身的航向航速，他們的相對運動，不會永遠向後移動。因為兩條船的合成速度和方向，例如圖形 1-03 顯示。

在碰撞的態勢下，目標船的相對方位不會改變，我們之前討論過。目標船的相對方位可以使用一個啞羅經或是固定的羅經盤，只要我們站在後方讀取。我們是否可能使用我們的視線，來取代目標的相對方位。如果我們能夠使用圖形化的視線，來代替相對方位的數字，我們就能夠忘記那些惱人的數字，每一次我們要核對目標的相對運動時。

圖形 1-05 目標的相對方位線就是看到它的視線

1-12 How to verify target relative bearing changing? Using line of sight.

There are many vessels at sea as Figure 1-04. Is it possible for us to get some reference on board to help our lookout? To know target vessel's relative bearing change is important to verify its collision risk. In sea passage, ownship sailed on sea speed and steady course thus **fixed objects** outside our bridge should have same speed apparent backward movements to a lookout personal. For target vessel with their own course and speed, their relative motion will not always moving backward due to resultant speed of both vessels as Figure 1-03 shown. In collision situation, target vessel relative bearing will remain unchanged as we discussed before. Target's relative bearing could be measured from a dead compass card if we standing behind the compass card. We can use the line of sight to replace relative bearing line? By using the line of sight we can forget about the annoyed digital relative bearing reading each time we check on target's relative movement.

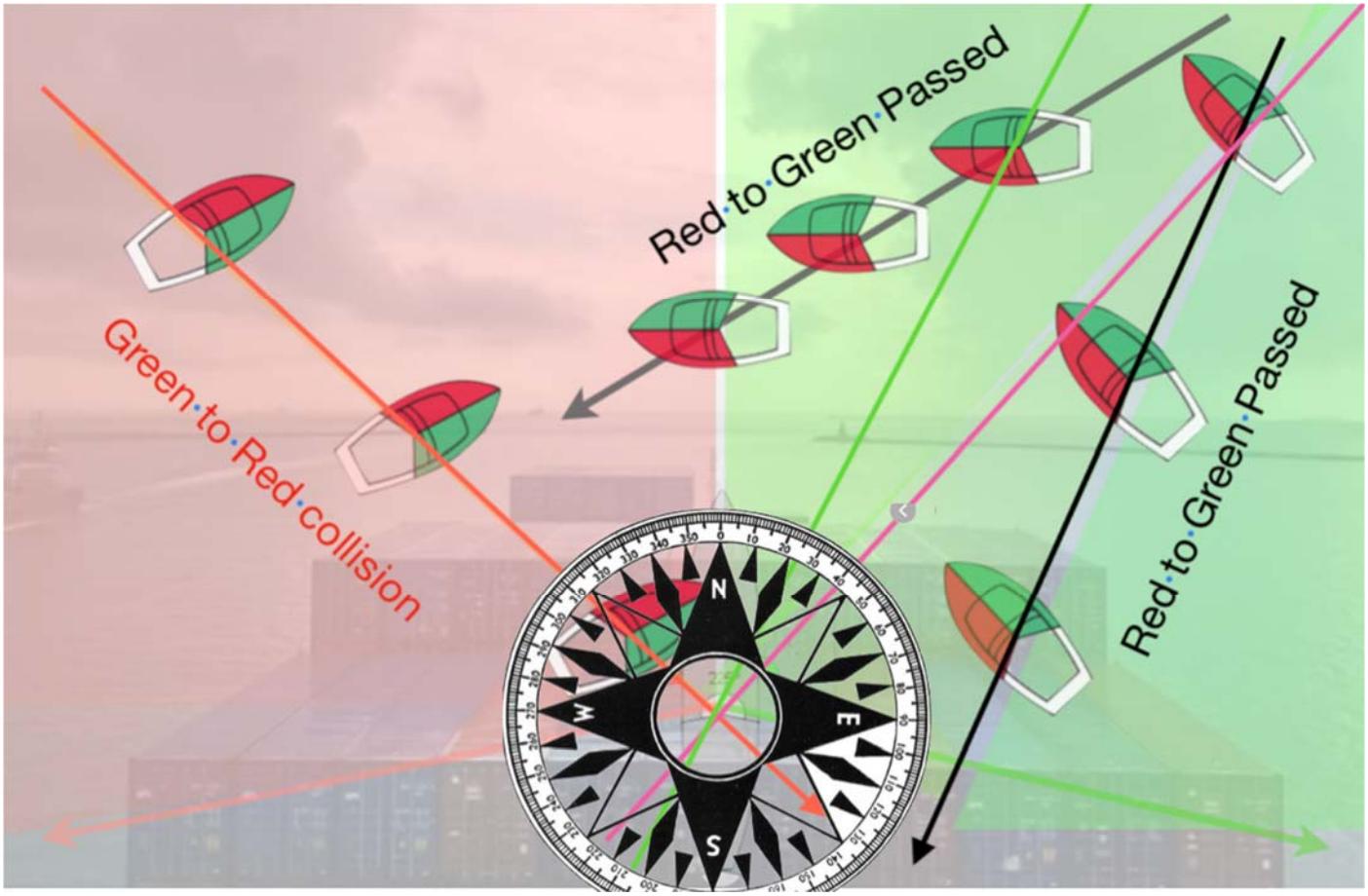


Figure 1-05: Target vessel's relative bearing line is their line of sight

1-13 視線的原理

目標船的相對運動線，是由兩點所建立的，羅盤中心點與海上目標。我們從羅經盤上讀取相對方位，是站在羅盤的後方，連結目標船與羅經盤中點，成一直線，然後用這一直線，在羅經盤上，讀取相對方位的數字，是多少？如同圖形 1-05，紫色相對方位線他的讀數是右舷 40 度，視線使用的是同樣的原理，但是有一個點不同，視線是使用我們的眼睛與目標的連線，來形成目標的視線。在這條視線上，我們會選出甲板上的標誌，作為視線參考點，我們在圖形 1-06 將會仔細討論。

相對運動線與視線，將會是同一條線，如果瞭望的人員站在羅經中點的後面。我們必須核對相對方位線的變化，是因為我們需要這一個工具，來確認碰撞危機。如果目標船與本船有碰撞危機，那他的相對方位讀數，在連續的觀測中，不會發生改變。這很容易記憶，如果只有 3 位數的羅經方位，牽涉到碰撞危機。目標船看起來就是，沿著相對方位線方向，向本船接近之中，如同圖形 1-05 左舷的目標船有碰撞危機，因為它的相對方位讀數是左舷 49 度，在連續的三次觀測之中，049 這三位數，是我們對這一條船碰撞與否的唯一關切。下一次等我們再度核對他的相對方位，如果他的讀數還是 049，我們就會採取必要的行動來避免碰撞。這沒有問題，如果我們的記憶容量，還記得住 049 這三位數。我們的麻煩來自，觀測目標船相對方位讀數的變化，就像在右舷的船隻，在他的第一個位置，相對方位是右舷 40 度，在第二個位置，相對方位是右舷的 50 度，在第三個位置，相對方位是右舷的 75 度。這時如果我們還有另外一條船，與此同時，他的相對方位是右舷 45 度，容易跟前一條船的方位，右舷 40 度產生混淆，等到另外一條船的相對方位，也發生變化的時候，例如相對方位變成右舷 49 度，目標船到底是在什麼樣的方位，變成現在的度數？實在是搞不清楚。羅經的複述器，其實是現代的航儀。想像 100 年前，如果船上沒有電羅經，如同鐵達尼號上，在前桅杆上瞭望的人員，就必須用他們的視線來判斷碰撞危機。必須用他們的視線，在甲板上找出一個標誌，來確認目標船是向前或者是向後移動。如果某個目標船有碰撞危機，我們用視線的方法，來監視這條船的動態，這船會沿著甲板上，我們所選定標誌的方向，來接近本船。在使用相對方位，來監視這條船，就像在左舷 49 度的船隻，就是沿著這一個相對方位線來接近本輪。看倌好奇的話，不錯，這個標誌的方向可能是左舷 49 度，如果我們在選標誌的時候，是站在羅經中點的後方。

使用相對方位時，必須站在羅經盤中點的後方，來讀取羅經方位度數。否則我們用眼睛很難準確的判斷，目標相對方位的讀數是多少？除非受過良好的訓練，反之如果我們使用的是視線的方法，我們使用的是甲板上的標誌，來做參考點。我們就不必站在羅經盤的後面，因為甲板上的標誌是沿視線上的某一點取出來的，視線的兩點，一是眼睛，一是目標船，與羅盤無關。我們只要維持眼睛的位置不變，就能夠偵測到目標船是否向前或是向後移動？眼睛總是跟著我們的雙腳移動，所以我們在使用視線來觀測時，我們要回到原來兩隻腳站立的地方，就像使用相對方位時，我們要回到羅盤的後方一樣，利用我們在甲板上所建立的標誌，來核對目標船的動態。如同圖形 1-06 之 2，瞭望是站在駕駛台的左舷，他的船首向是黑色線條，沿著貨櫃的邊牆前進，如果我們檢視 1-04 系列的三張圖形，我們可以注意到，瞭望眼睛的位置，在這三張圖裡面是一樣的，因為甲板貨櫃的形狀不變。我們沒有辦法控制目標船的移動，目標是不會等我們的。我們必須記得目標的第一條視線，來評估他的碰撞危機。在他的第一條視線上，我們需要選出一個參考點，由這個參考點與我們的眼睛來構成他的第一條視線。這個參考點必須是一個甲班板上的固定物，因為我們知道船體之外的物體，對我們都會有相對運動。

在圖形 1-06 之 1，我們找到了一個參考點，是以綠色箭頭標誌的，這是在右舷淡藍色船殼船隻視線上的一個參考點。在左舷用紅色箭頭標誌的一個參考點，這是為左舷 4 根吊杆船隻準備的，雖然他的距離還很遠。我們使用右舷船隻的船尾，作為綠色視線的第二點，綠色視線是我們所選定的第一條視線。我們用了綠色箭頭來標示第一條視線，他第一條視線的標誌，我們使用最外舷貨櫃的後櫃角，我們用綠色箭頭指著。與此同時，圖形 1-06 之 1 本船的左舷有一四根吊杆的船隻，不知道他是向什麼方向移動？我們在紅色的視線上，用紅色的箭頭標誌了一個參考點，是下一層綠色貨櫃的邊牆。這些標誌點，用綠色與紅色的箭頭指著，是我們選出來在甲板上，幫助我們記憶他們第一條視線的位置。比較圖形 106 之 1 與 10 6 之 2，我們可以看出，這兩個目標的視線已經改變，但是起點沒變，那就是我們的眼睛，這些參考的標誌還是在原地，如果我們還記得的話，這兩條目標船都已經離開了原來的位置。使用綠色與紅色箭頭的說明，這兩條目標船的動向，就比較明顯了，一條目標船向船頭移動，另外一條向船尾移動。結論就是，這兩條船都是安全的。

1-13 Principle of Line of Sight

Target vessel's relative bearing line is established by two points: from compass center to target at sea. We took out relative reading from compass card by standing behind compass center. Joined the line of target vessel and compass center with our eye then take out the reading from compass card between these two points as the purple relative bearing reading is "starboard side 40 degrees" in Figure 1-05. Line of sight use same principle but one different point: our eye. Line of sight is joined from our eye to target at sea. In between this line of sight, we pick a mark on deck for reference as in Figure 1-06. These two lines (relative bearing line and line of sight) are the same line if lookout standing behind compass center.

We need to check relative bearing change is because we need this tool to ascertain the collision risk. If target vessel has collision risk with ownship their relative bearing reading will not change in consecutive observations to come. It is easy if only 3 digits bearing reading need to remember concerned of collision risk. Target vessel seems moving along the relative bearing line toward ownship in collision course. For example, in Figure 1-05 the target in port side has collision risk because her relative reading is "049 degrees port side" in three consecutive observations. 049, these three digitals are our only concern of this vessel's collision risk. Next time we check her relative bearing in compass the reading is still the same "049". We can take necessary action to avoid the collision without any problem as our memory capacity are capable of three digitals. The problem comes when target vessel has different consecutive relative bearing reading like the vessel on starboard side with "starboard side 040 degrees" in her first position, "starboard side 050 degrees" in second position and "starboard side 075 degrees" in its third position. If we have another vessel relative bearing "starboard side 45 degrees" at the same time, with the target vessel "starboard side 40 degrees", we will easily confuse these two vessels bearing reading change when we have more target bearing reading of "starboard side 49 degrees" to remember.

The compass repeater is a modern technology. Imaging one hundred years ago, we have no gyro compass on board. The lookout in the crow nest of fore mast at "Titanic" have to use their line of sight to verify collision risk. They have to pick up a reference mark on deck to verify target is moving ahead or astern. For one vessel has

collision risk, this target will approach from direction of this mark we picked. Like in relative bearing method, "049 degrees port side" vessel seems moving along this relative bearing line toward ownship.
Take bearing have to stand behind the compass without fail because starting point "center of compass card" is fixed there. However, the line of sight is easily changed by movements of our eye position. Our eyes' position is the starting point needed to set up line of sight which always moves with our legs. **The line of sight used for collision risk assessment need its starting point "lookout's eye position" to be fixed** like relative bearing line's starting point in compass card's center. With target's movement outside the bridge its relative bearing line is constantly changing. It is the same for using line of sight to verify relative bearing change of target. We can control our eye's position by standing in fixed position at bridge. Like Figure 1-06-2 the lookout is standing at port side of bridge. The heading line for him is the black line goes along the container side wall, straight forward. If we look at three 1-04 series Figures we can notice that the position of lookout's eye is the same as Figure 1-06-2.
We cannot control target movements outside. Targets won't wait. We have to remember target's first line of sight to access collision risk. We can pick up a reference point from our first line of sight. This point has to be fixed on board as we know everything outside have relative movements. We find one point marked by green arrow for starboard side light blue vessel in Figure 1-06-1 and one point marked by red arrow for port side four cranes vessel (still far away with small shape). We use starboardside vessel's stern as second point for its green line of sight. The mark for her first line of sight we picked is outer row container's aft corner fitting which pointed by green arrow. At the same time (Figure 1-06-1), ownship's portside has one four cranes vessel did not know which side she is going. We pick one reference point on red line of sight marked with red arrow which is side wall of green container in lower tier. These points marked with green and red arrow are reference points we chose on deck to mark first line of sight. Comparing the Figures of 1-06-1 and 1-06-2, we can see both targets' line of sight (or relative bearing) had changed by comparing reference marks we had assumed. These reference marks are still there (**only if we could remember**) but both targets had left. With the help of original green and red arrow the difference of these two targets' relative motion around ownship is obvious. One target is moving ahead and the other is moving astern. Both targets are safe. Period.

1-14 目視標誌的性質

只要我們還能記得，甲板上有人留下了標誌記號，方便我們記憶，如同圖形1-07，貨櫃船的甲板貨，在每個碼頭裝卸後，都會改變，就沒有辦法如此的方便，要在視線中選出1個標誌，需要相當的技術。問題是，我們要記得這些標誌，需要一些訓練。瞭望需要一些察覺，當我們使用視角時。當我們看著圖形1-06之一，我們會選擇那一個標誌，做為這兩個目標第一條視線的參考點，我們沒有這麼多的標誌可以選擇，我們需要一些想像來說明我們記憶，例如綠色跟紅色的貨櫃，裡面或是外面的貨列，貨櫃的前面櫃腳，還是後面等等，哪些船隻，甲板有著特殊機具的形狀，特殊設備等等，都可以作為參考點的標誌。如果我們使用1個貨櫃，“在甲板上的最外沿，貨櫃也許是橘色的，貨櫃也許比旁邊那一列的貨櫃低1尺的高度“，目標船也許位元在這個貨櫃前面櫃腳的方向。這個貨櫃”櫃角的前後，貨櫃顏色，位置高低“等，就構成了一副鮮明與縱合的視覺印象，作為目標船的標誌，這些對於一個年輕人來講，也許不太容易記憶，或者稍後要核對時，會發生困難。需要在船上做一些練習，才能夠掌握這一項技術，來尋找參考點標誌。
圖形的記憶較數位的數字的記憶，效果要好，如果我們試著去比較記憶外擋，橘色，低些這些記憶，與數字作為比較。視覺的資料處理在我們的大腦，比數文書處理的容量要大的多，尤其是在白天。這主要是大腦對於圖形的聯想，較數位為多，橘色讓我們聯想到橘子或工作服的顏色，比較低可能聯想到河川或是懸崖，外沿可能是球場的邊線，但是對於數字049，除非我們今年剛好49歲，我們可不容易記憶，況且二月也並沒有49天。所以數字能產生的聯想比較少，大腦就比較容易遺忘，這是人類的天性。當然我們使用圖形的記憶，最主要是要擺脫對數位記憶的束縛，也擺脫了對羅經盤需求，讓我們在駕駛台的任何地方，都能做有效的觀測。現在的船，經常是60公尺寬，要找到羅經還要一段時間。但是過多的圖像記憶，也是會像數字記憶一樣，在我們的腦海裡面，產生超載的

情況。我們需要和成圖像記憶，最好是說，我們需要對於目標船相對方位線上的甲板標誌，選出來有效的口訣，例如菊低外，來代表橘色，較低與外擋，來幫助我們記憶。

1-14 Characteristics of visual marks

Only if we could remember: If somebody can leave some marks on deck for our lookout reference it will be a great help as Figure 1-07. Container vessel deck containers stowage are changed in every port did not have this benefit. To pick a mark for line of sight need skill and the problem is to remember these marks. Lookout needs some training in our visual awareness. When we look at Figure 1-06-1 what reference we can choose to mark these two targets' first line of sight. Not so much reference are available. Sometimes we need some imagination to help in remembering green and red container, inner or outer row, for or aft corner post etc……. For those ships have deck containers, the specific deck cargo's shape, color, corner post, etc., may serve as characteristics to remember for reference marks. For example, we took reference mark on a container positioned in outer row of certain bay forward may have remark it by : **orange color**, one foot **lower** than the row next to it, etc. and target vessel is located on this container's **fore corner post** direction. These characteristics of colour (orange), lower (different height between containers), and position (fore-end of the container) comprised a vivid and compound visual clues for target's relative bearing mark which may not be easy for a rookie to remember and check with. So, it needs to practice their routine on board to master this skill.

The graphic is more easy than digital reading from gyro compass to remember. Try to remember "outer, orange, lower" three words to compare with digital memory of 049 zero four nine. Visual data processing occupied biggest parts in the brain for most animals living in daylight while digital is few. We can easily associate orange color with a fruit or our working suit. Lower may associate with some river or waterfall. Outer may associate with a ball field boundary. For 049 zero four nine we cannot remember any classmate of this number or in his seat number and nobody is born at February 49. More associations vitalize more parts in our brain cells. However, visual data may still overflow in our memory as digitals bearing. The mariner needs to chunk visual data into more meaningful words if his photo memory is not so well. The mark been chosen along the relative bearing line can sort out its specific characteristics like colour, height, and position, etc. for easy memory.

1-15 為什麼要設定視線

經過這麼多的麻煩，為什麼我們要使用視線？它在任何時候都可靠，無論我們在駕駛台的站立位置，第一只要我們還站得上去，我們就不必站在羅經盤後面，去觀測目標。對一個實習生或是瞭望，比較方便去評估碰撞危機，即使船長也可以使用視線的方法，評估現在的狀況，不會忽視掉駕駛台操作的其他細節。

第二個是人類的大腦無法處理超過7位元的數字，相對方位的用處，只有在我們能夠正確的記憶的時候有用，大部分的人要記住一組7位數的電話號碼，都有相當的困難，更不要說在駕駛台，還要有他的工作要去操心。

第三視線最重要的，不只是方便，如果我們訓練的夠好，還是我們目視瞭望與我們避碰的直覺。

第四在近距離方位的變化，可以立即觀測到效果，不必記憶任何的數字，這是駕駛台最緊張的時候。

第五 目標的視角，可以持續的觀測，以免他航向改變時，本船沒有注意到。

第六 目視接觸的連續性，可以保持，所以目標船的距離，也可以同時連續性的觀測，以避免可能的碰撞。

第七 我們夜間的視力，不會因為去讀取羅經盤上面的數字，而受到阻礙，或是因為雷達或阿帕上面的數字，亮度太亮，妨礙到我們夜間的視覺。

相對方位是由我們船頭，向右舷船隻或是左舷船隻量取，我們可以試著用相對方位確認目標船的動態，在這一章前面圖形1-06之1淡藍色船殼的船隻，在方位右舷055度，圖形1-06之2，他的相對方位是右舷048度，很快的，我們就會發現缺點，就是難以記憶方位讀數是多少？所以就很難去決定，讀數是增加？還是減少？尤其是當有階級更高的船副，站在羅盤旁邊，我們沒有辦法取得目標船讀數

的時候，我們沒有辦法判斷碰撞危機。在近距離或是夜間，使用視線較任何的數位資料的操作，來的有效與快速。

圖形1-06之一，使用甲板貨核對目標動向，圖形106之2使用甲板貨核對目標動向

1-15 Why we need to set up line of sight for use

With all these troubles there are many reasons why we need to set up line of sight for use.

1. It is available any time any place on bridge as long as we have a standing place, not only behind compass card. It is more convenient for a rating or cadet to assess collision risk. Even a captain can use line of sight to assess the situation without overlook other details on bridge when vessels' traffic are heavy.
2. Second reason is human brain cannot handle over seven digitals bearing reading. The relative bearing reading is only useful when we can remember it correctly. Most people have problem to remember one set of telephone number in our daily life and we have to take care everything at bridge.
3. *Most importantly, Line of sight is not only handy. It is part of our visual lookout and collision risk instinct if we trained ourselves well.*
4. In close range the bearing change of target can be observed visual immediately without remembering any digital bearing reading.
5. Target's aspect can be monitored constantly for any possible course change.
6. Keep eye contact with target continuous without fail. So, target's distance can be monitored at the same time for possible collision avoidance.
7. Our night vision won't be compromised by compass or Radar/ARPA illumination.

Relative bearing is measured from ownship's bow (black line at Figure 1-06-2) to starboard side target's green or port side target's red bearing line. We can try to use relative bearing to verify target vessel's movement. In this paper back Figure 1-06-1 light blue colored vessel relative bearing is 055 degree green (starboard side). In Figure 1-06-2 her relative bearing is 048 degree green. Soon we may find its handicaps, hard to remember original digital reading, hard to decide it is increasing or decreasing, no way to take bearing when other superior colleagues are standing beside compass repeater. In close range or night time using line of sight is far more effective than use any digital operation of compass or Radar/ARPA.

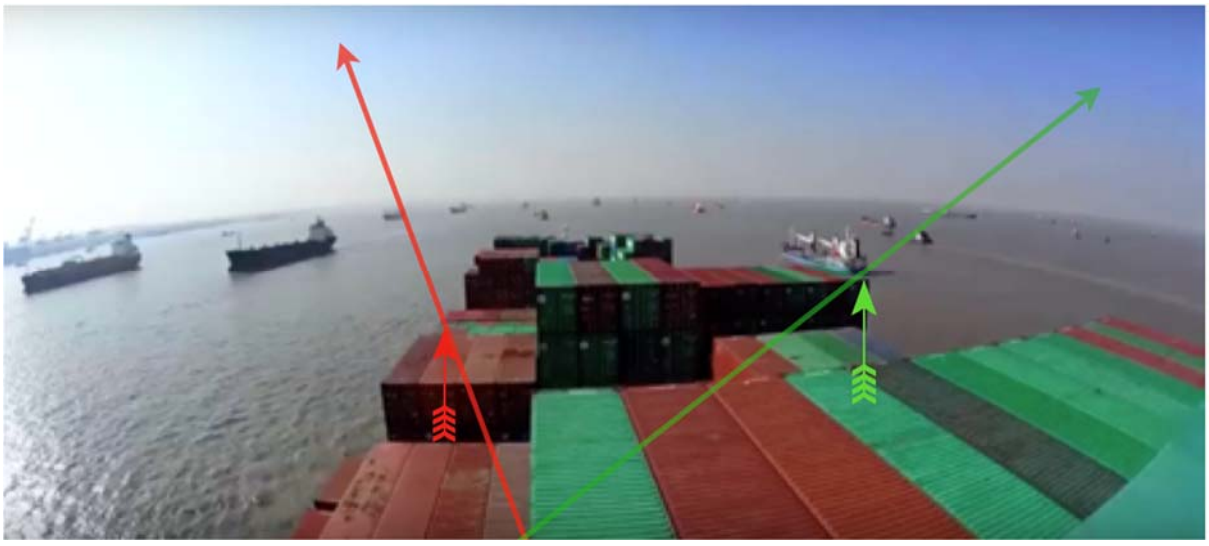


Figure 1-06-1: use deck cargo as reference mark for movement check

Figure 1-06-2: use deck cargo as reference mark for movement check

1-16 目標船不在原來的位置

在圖形1-06之2，我們建立了第一條視線，使用眼睛原來的位置跟甲板上參考點，來核對目標的動態。兩條船已經不在他們原來的方位，但是我們怎麼知道呢？在右舷的淡藍色船隻是向前移動，比原來綠色箭頭的標誌向前，見圖形1-06之一，更接近本船的船頭，相對方位減少，相對的船型，隨著距離增加而變小，這個就是第二個安全的視覺線索。他對本船來說是安全的，左舷4根吊杆的船隻，向船尾快速移動，越接近本船的船尾，它的相對方位越大，增加的越快。看到他的左舷面對本船的左舷，左對左，這又是安全通過的第二個保證。如果我們再重複核對他紅色箭頭的標誌，就更加確定他的安全通過，沒有問題。

1-16 Target vessel is not at her original bearing

In Figure 1-06-2, we establish first line of sight by original eye position and reference marks on deck to check target vessels' movement? Both vessels are not at their original line of sight now, but how can we know? Starboard side light blue vessel is moving ahead of green arrow (original mark on deck in Figure 1-06-1), closer to ownship's bow, relative bearing decreased. Her shape is getting smaller as distance increased. This is second visual clue of safety. She is OK with ownship. Portside four crane vessel is moving astern quickly, closer to ownship's astern, relative bearing increased. We sought her portside facing our portside, first assumption is "port to port". Second assurance of safe passage. If we can double check its red arrow marks which is ahead of its new line of sight. We are OK with her by double check with two concepts.

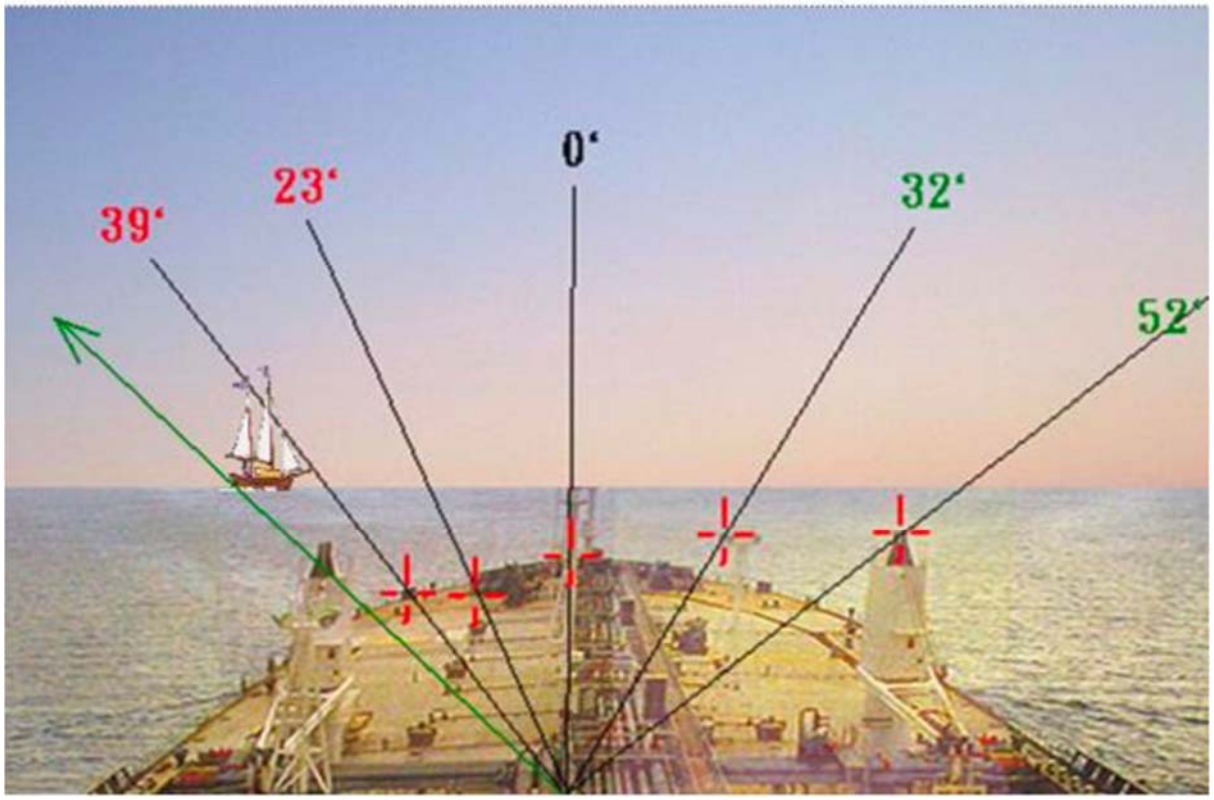


Figure 1-07: use tanker fixed deck fittings as reference mark for bearing checking

1-17 目測相對方位是瞭望的第一直覺

有甲板貨的船隻，在甲板上比較容易取得參考點，但是你也許不知道，在港跟港之間，他們的甲板貨形狀經常在改變。對於在圖形1-07上的油輪來講，我們有的甲板標誌比貨櫃更有效，可以用來核對來船的方向，是否改變？對那些船隻沒有甲板貨的，那些甲板上的機具，其相對方位是永遠都不變的。像前桅杆的相對方位都是零，如果我們在船中線上面來取的話。主甲板與前船艏樓接緣處，他的角度是23度相對方位，這在兩舷都不變的。在船頭帶拖船的纜繩出口，是在相對方位39度。右舷吊杆的杆頭，他的相對方位大約在52度左右。這個觀念就是，這些參考點的羅經方位，度數多少？並不重要，重要的是這些甲板機具對本船船頭之間的相對方位，永遠都是一樣。所以他們可以用來當作我們的視覺標誌，來確認目標的方位變化。如果我們知道每一個甲板機具的相對方位，就可以很快的估計出，目標傳的相對方位大概是多少？而不必再去核對羅經盤上的讀數，我們可以向當值船副報告的更精確，更能夠說明他們確認目標船的動態，效率更好。這些甲板機具同時也提供了視覺的參考，讓我們對目標保持視覺接觸，換句話說，你可以幫助減少當值船副的焦慮，尤其在近距離的時候，近距離又有很多的船隻。現在你學會視覺方位觀測，這些甲板機具的相對方位，也可以說明我們標誌安全的相對方位（關鍵字，你還不懂的），成為一個當值船副，你一定要記得這些23 39 52度數的甲板機具，現在假設有一條從左舷接近的帆船，你能夠估計出他的相對方位，而不必使用羅經的幫助嗎？

1-17 Visual relative bearing on deck: first instinct in lookout

You may think container fleet are lucky who have deck containers to refer to but their deck containers on deck are constantly changed due to different stowage plan from port to port. As a tanker OOW in Figure 1-07 we have something more useful to mark approaching target’s direction. For those vessels without deck cargos, deck fitting’s relative bearing is always the same. For instance, the fore mast's relative bearing is always zero if we take it from the ship's centerline. The sheer deck plate on the break of fore castle may be 23 degrees relative bearing to each side from fore mast, and forward tug line chock may be 39 degrees to each side, head of starboard side crane may be 52 degrees, etc. The concept is that, the compass bearings of reference points (fore mast, break of fore castle…) on deck is not important, their relative bearing to the ship's bow is always the same. And, they can be used as visual marks to ascertain the bearing change of the targets. If we knew each deck fitting’s relative bearing readings on board we can have a quick estimation of approaching vessel’s relative bearing readings without

reading from compass card. We can use these reading memory to estimate target's relative bearing without reading the compass card. We can report to OOW more precisely and help OOW to identify which targets vessel we are addressed more quickly. These deck fitting also provide visual reference to establish visual contact of target vessels for OOW. In another words, you can help to reduce OOW anxiety when lots targets around ownship in close range. Now, you got its relative bearing visually. These deck fittings relative bearing also help marking the Safety Relative Bearing when you became an OOW. Do remember these 23, 39, 52 degrees' reference point for future usage. Now, there is a sailing boat coming from port side did you know her relative bearing without using compass?

1-03 目測距離：水平線 船頭浪與航跡流

1-18 如何分辨目標的距離，瞭望的第二直覺

好吧，在陸地上沒有人教我們如何判斷距離？在陸地上，人們知道的里程數是由路邊的路標讀出。我們可以在雷達上分辨出目標的距離，如果我們使用可變距離圈去量取，或者是從阿帕資料區上，直接讀取他的距離數字。擷取距離與確認海上的目標，是我們避碰時安全的參考。如同圖形1-05之1，近距離的船隻，總是給我們比較多危險的感覺，最危險的目標，永遠都是距離本船最近的，這有幾個原因，首先是因為我們沒有時間去擷取 判斷與回應他的碰撞危機。再來避碰的水準角度，近距離時，大部份都被他封死了。我們需要知道些什麼？第一檢查他是左舷或右舷對著我們，也就是他的視角是否是左對左，第二接近的方位是否有改變，也就是相對方位是否有改變？偏偏這兩個方法在近距離避碰的時候，都不管用。這些避碰的方法，需要適當的距離外才有用。對遠洋船隻，要一海浬的安全距離，近岸的小船需要半海浬的安全距離，這些距離就是我們為了安全所保留的。話說，以安全的距離通過，是在國際避碰規則裡面的第八條，避碰的行動，需要產生全的通過距離。安全的通過距離，也是船長的值更命令簿與公司的駕駛台操作程式需要規定的事項。如果我們不能保持安全距離，船長要避碰的時候，就會產生很大的麻煩。當值船副在當班時，需要保持這些安全距離，來做避碰的操作。

1-03 Visual Lookout of distance: Horizon, bow wave and wake current

1-18 How to tell target distance at sea？ Second instinct in lookout

Well, nobody teaches us how to judge distance in land. We just read distance from road signs beside the highway. We can also read target distance on RADAR if we know how to use Variable Range Marker to measure or read it from ARPA. Target distance can read by ARPA data area if we know how to acquire and positive identify target at sea. The distance of target gives us safety reference in collision avoidance. As Figure 1-06-1, close distance vessel always gives us more dangerous feeling. The most dangerous target is always the closest target to ownship for many reasons: we have no time to acquire, judge, response to her collision risk and she occupied the horizontal angle we need to get away. What signs we need to look for

1. check she is portside or starboardside to us (her aspect) in the first sight? or
2. Does the approaching direction changed (relative bearing change) at second sight?

These two awareness are useless in close range to avoid collision. These two awareness are useful only at ample distance *away*(one nautical mile for ocean going vessel or half nautical mile for coastal vessels). These distances we reserved for safety are **"safe passing distance"** in International Regulations for Preventing Collisions at Sea (COLREGS). In Rule 8 (d) "**Action taken to avoid a collision with another vessel shall be such as to result in passing at a safe distance**." This safe passing distance is also the Master standing order of company's bridge procedure guide's requirement. If we cannot keep this safe passing distance Captain will have big trouble to avoid collision with these target vessels. In OOW duty hours, we should maintain these safe distance in collision avoidance actions to take.

1-19 AB 的詢問，來自過去世代的呼喚

由圖形1-04之1裡面，我們要檢查一下右舷淡藍色船隻，使用視覺的技巧，我們現在知道如何確認目標的相對運動，這是我們有機會，就應該多加練習的技術。當我還是見習船副的時候，當值AB問我，這條船是向前開的嗎?我想他是在問，這船是怎麼開？往哪裡去？但是我不知道，他其實問的是我知

不知道這條船有碰撞危機？這條船是否有碰撞危機，在避碰規則裡面有行為的準則，但是我們不知道碰撞危機，其實是由距離來界定的。是否有碰撞危機？同樣的相對方位變化，在不同的距離子下，是有不同的碰撞危機。
5度的相對方位變化，在5海浬的時候，是ok的。但是在一海浬的距離，5度的方位變化，就是一個危險的信號。我們也許知道如何用阿帕上面的CPA判斷碰撞危機。但是在實際的海上，我們需要知道在這樣的CPA，只有在近距離時才有危險。雷達目標的距離，很容易在接近本輪的時候遺失，與此同時，他的CPA也不見了，這也是我們最需要他資料的時候，關於這一點，我們會在下一章，才會再討論。
在21世紀的當值船副裡，不會目測距離的，是很普遍的事情，因為我們已經過度依賴雷達與阿帕，而且從來沒有系統性的介紹，要用什麼東西或技術來目測距離，這是學校裡面沒有教的。在海上我們的世代，也沒有足夠的導師，AB他們也許對於自己沒受過科學訓練，感到羞恥，因為在２０世紀，每個人都相信科學可以解決任何事情。很幸運的，我們還可以在這裡充分的討論，這些問題。
除了核對目標方位變化，當值船副也需要有能力核對目標的距離。
比較圖形1-06之1與 1-06之2上綠色方位線的船隻位置，在圖上可以看到，在1-06之2的圖上，綠色方位線的船與本船，還有一些水域，在圖形1-06之1這個距離並不足夠。這些水域介於本船與目標船之間，可以用來確認兩船之間的距離。好吧！判斷距離用兩船之間的水域，需要一些經驗，而且是每條船都不一樣，我們需要一些共同的參考來比較，從遠到近來幫助我們判斷距離。讓我們回應他們的詢問，去確認目標船的距離，從遠至近來確認目標船的距離，從最遠的，例如水平線之外。

1-19 Queries from duty AB: the queries from past sea generations

Light blue hull vessel on our starboardside closest to ownship in Figure 1-04-1. Now we know the technique to verify relative movement by eyes which should be practiced whenever we have the chance. When I was an apprentice OOW duty AB ask me “Sir, is this ship going ahead?” I though he is checking which way this ship is going. I don’t know he is asking “is this ship has collision risk?”. In COLREG we have conduct code if we have collision risk. But, we don’t know collision risk is defined by distance of two vessels. *Same amount of relative bearing change in different distance represent different lever of collision risk*. 5 degrees bearing change (relative or true) in 5 nautical miles distance away is OK. But, in one nautical mile distance away these 5 degrees bearing change is not enough to avoid collision (we will demonstrate in later chapters). We may know how to read collision risk in ARPA with close CPA. But, in real world we need to judge target distance by our own eyes. We should be able to read this CPA distance by visual. Radar targets are easily lost in close range when we need their distance most. This point will demonstrate in this chapter later. No skill of visual distance judgement is common among 21 century OOW as we had over relied on RADAR/ARPA and no systematic introduction of what techniques can be used in visual by academy education at school. At sea, our generation has no mentor as they are shamed with their unscientific approach by human sense while last century everybody trust science can overcome everything. Luckily, we will fully discussed here later. Beside the ability to check bearing visually we need the ability to verify target’s distance visually too. Comparing starboardside vessel position at Figure 1-06-2 and 1-06-1, we can see some sea room in 1-06-2 but no sea room in 1-06-1. These sea room between ownship and target vessel can be used to verify the distance. Well, judge the distance by sea room need some experiences and is different from ship to ship. We will need some more common reference from very far away to very close distance to help us in judgment target’s distance. Let’s answer their calling to verify target's distance from very far away, like to say **“beyond the horizon”**.

1-20 水平線之外，在海上你可以看多遠？

當我們聽到有人在呼喚，“看見陸地”的時侯，那是在帆船時代，那時候地球是圓的，人類是渺小的，我們只能用我們的眼睛看到水平線，DB的距離或者某一目標高出水平面時，再加上DL的距離（DB +DL），對每個人來講，水平線的距離都不一樣，那是由我們眼睛的高度所決定的。某人如果位於船上的桅杆上面，另外一個人在燈塔頂端上，如果兩人可以看到的水平線是同樣的，加總起來，就是我們可以看到的總距離，如圖形1-08距離DB+DL=DBL.

水平線是我們每天從駕駛台窗戶看出去，最可能看到的景象。水平線同樣啟發了地球是圓的靈感。在我們腳下的海平面是最低的，但是當海面向天邊延伸的時候，海平面反而上升到天空的高度。天空在我們頭上無限高的，當天空延伸到水平線的時候，水平線就是天空最低的地方，水平線也是海平面最高的地方。水平線就是人類眼睛的極限嗎？那可不一定，我們不可能低於地球，不可能高於天空，這是人類的錯覺。水平線的距離由我們眼睛的高度決定。哪些站的比較高的人，可以看到比較遠，越高越遠，就像比較高的燈塔看守者，看得比低的帆船上面的瞭望距離更遠。(DL>DB)

1-20 “Beyond the horizon”: How Far Can You See at Sea?

"Land Ho!" is heard on boat when someone made landfall in sailing boat times. The earth is round and human are small. We can only see from our eyes to horizon (D_B) or an object erected up over the horizon (D_B+D_L). The distance to horizon is different for each observer depends on our position and elevation. The one on the mast head of ship (D_B) and the one on the light house top (D_L) saw same horizon position. Together the distance we can see are the summary of these two eye height as Figure 1-08 D_{BL} = D_B Plus D_L. ($D_B$$D_B$ + D_L = D_{BL})

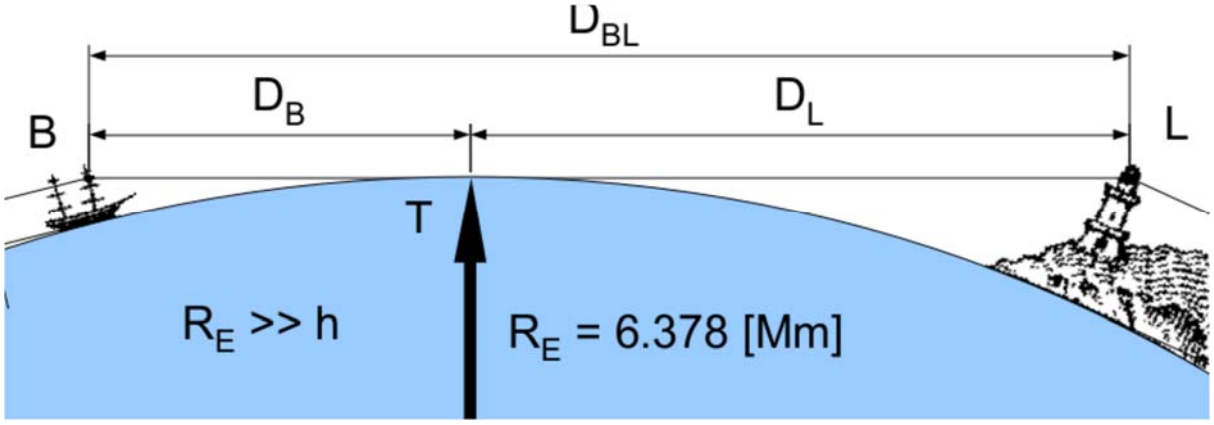


Figure 1-08 from Wikipedia, Horizon: How Far Can You See at Sea?

Horizon is the most likely scene we see when we look out bridge windows. This is the line that inspired the idea 'the earth is a sphere'. The sea level beneath our feet is lowest but when it extends to horizon the sea level elevated to reach the sky. The sky is infinite high above our head when it extends to horizon become as low as sea level. Even the sun is lower than sea lever before sunrise. We are no higher than the ground and no lower than the sky in distance of horizon by human illusion. Horizon distance depends on the height of our eye. Those who stand higher can see more distance away. The higher the further. Like the distance of horizon of light house keeper is more than sail boat lookout (D_L > D_B above).

1-21 水線是船體下沈最高的位置

一條船的桅杆是最先從水平線下升起來的部位，水平線可以當作確認距離的最好參考，如果我們知道眼高，眼睛的高度。在晴朗的天氣下，眼睛的高度如果是42米，水平線的距離大約13海浬。如果一條船的水線跟水平線重合，也就是他的水線就在我們眼睛看到的水平線上，也就是在海面最高的地方看到，如果我們的眼睛高度是42公尺，他的距離就是13海浬。水線就是船體沉在水裡面，跟水面交界的那一條線。如同我們看到圖形1-08，左舷通過的船隻，船邊的水線是有一條白線。水線是判斷一條船與本船距離的一個很好的標誌。圖形1-09低於水平線，這條船是多遠？在圖形1-09上有三條船，具有不同的大小與形狀，如果我們判斷距離，用船隻的大小跟形狀，就很容易犯錯。在本輪船頭的船隻，他的水線是在水平線上，我們可以看到這一條船的距離大約是13海浬，因為我們的眼睛高度是42米。事實上，這一條船的距離，我們不可能確定，因為沒有人的眼睛，可以看到這麼遠的水線，13海浬，20公里之外的白線。對瞭望的人來講，如果我們做這樣子的距離假設，是ok的，

因為就算是避碰規則，在這麼遠的距離，也還沒有啟動，也還沒有強制本船跟目標船的行動。在這麼遠的距離，任何船都可以自由行動，沒有直航或讓路船的差別。

1-21 The water line is the highest line where ship's vertical hull submerged

A ship's mast appears first when she comes from the horizon. The horizon can serve as a great reference for distance verification if we knew our height of eye. In clear weather, with height of eye of 42 meters, the horizon lies about 13 nautical miles away. If a ship's water-line is coincided with horizon her distance is the same as horizon, that is 13 NM by 42 Meters eye height. The water line is the highest line where ship's vertical hull submerged as we can see the white line along ship hull of portside passing vessel in Figure 1-09 lower part. A ship's waterline is a sure sign of her distance to ownship.

Figure 1-09: "below the horizon" How far this ship is?

On Figure 1-09 upper part, there are three ships with different shape and size. If we judge distance by size and shape, we will mistake easily. The ship at ownship bow in Figure 1-09 upper part, her water line is on the horizon. Although her shape is big her distance is further. We can see the distance to this vessel is about 13 nm because ownship eye height is 42 meters. In fact, we cannot say this for sure, because nobody's eye can see the waterline of target so far away. For lookout purpose, it is OK for us to make this estimation because COLREG had not been activated yet. Ownship and target vessel are *both at free to move stage at distance of 13 nautical miles*.

1-22 水線越低的船，距離越近

就像在本船右舷的帆船，它的水線就低於水平線。如果我們仔細的觀察這三條船的水線，我們會發現三條船，水線越低的船隻，距離本船越近。水平線與目標水線的垂直夾角，可以用六分儀來測量。使用這個垂直夾角的讀數，我們可以利用航海對數表，找出目標的距離 。我們可以確認目標船的距離，如果使用水線與水平線的垂直夾角。比較這些船隻水線的垂直夾角，這些船到底是低於水平線多少，不論這些船隻的尺寸大小，找到低於水平線最多的船，就是距離本船最近的目標船。利用水線，就是判斷遠距離船隻距離，最好的參考。遠距離就是 4 到 13 海浬的距離之間。這個距離的船隻，在海上是屬於注意階段的船隻，需要去確認目標船的方位變化，是否足夠。

圖形 1-10 船頭浪是船體推進產生的

1-22 Target water line at horizon 13-4 N. Miles range: in precautionary range.

If the target is closer, like the sailing boat at ownship's starboard side in Figure 1-09 upper part its water-line will descend under the horizon. If we look closer to these three vessels' waterline, we will found the vessel has lower water-line under horizon is closer to ownship. Actually, the vertical angle of horizon and target vessel's water line can be measured by sextant. With this vertical angle reading we can find target's distance by nautical tables. We can verify target vessel's distance by her waterline descend below the horizon (original purpose of this table is to determined light house distance to observer). By comparing the water-line position of these ships under the horizon, we can pick up the vessel closest to us regardless the target's size or shape. The small boat inside the breakwater at ownship starboardside is closest target although her shape is smallest. The lower target water-line to the horizon, the closer distance to ownship. This is the technique for verifying long range vessel (4-13 NM). Targets at sea of this distance range is in precautionary stage we only need to verify target vessel's bearing change in this stage lookout duty.

Figure 1-10: bow wave produced by ship's propulsion on sea water

1-23 目標船在四海浬，有船頭浪

目標船接近本船的時候，目標船的水線，會有些變化，尤其是近距離的時候。不然他對我們來講，也不過是海面上的另外一個小點，對，他正在產生花開效應。多數的船隻遠距離的時候，我們都不會注意到，如果我們已經能夠注意到，它船頭位置的水線有些變化，或是突然見到他在海裡面推進所引起的船頭浪，如同圖形1-10。我們可以看到他的船頭浪，大約是在四海浬的距離，雖然這距離，會隨著與他船頭的形狀與顏色，與海水顏色的對比，而有不同。這仍然是很重要的一個信號，當我們白天在瞭望的時候看到船頭浪，這應該要引起我們對狀況的察覺，引起我們的情境感知，這狀況就是行動的距離，4到6海浬。在這個距離，讓路船與直航船依照國際避碰規則，都要動作。在這個4到6海浬的距離，任何船從右舷接近本船，如果有碰撞危機存在，本船應該讓路。直航船應該保持原航向航速不變，直到碰撞危機解除。

1-23 Target has bow wave at 4 N. Miles range: in action range

Target vessel will undergo some changes as it approaches ownship. Yes. Its shape will bigger when coming to us otherwise she will remain another small spot at sea. She is in blossom effect when closer to ownship. Most vessels are sailing without our notice of their presence in far-away distance. If we happen to see their waterline shape at bow undergo some change, it is her "bow wave" produced by her propulsion on sea water as Figure 1-10. We can see some white wave form in target's bow at about 4 n. miles away in calm sea, although this depends on target's bow shape and the contrast of water color against her hull color. **This is an important sign in daylight lookout which can raise our situational awareness and signify an action range (4-6 N. Miles)** to both give-way and stand on vessels as required by COLREG. At this action range 4 - 6 N. Miles, any vessel coming from starboardside ownship should give way if collision risk exists. At the same time stand on vessel should keep course and speed if collision risk exists.

1-24 近距離船隻，沒有船頭浪是安全的信號

不要再找藉口，去上廁所，如果有必要的時候，瞭望人員應該準備手操舵。所以表現一下你的老練，站到舵輪的後面。

- ï 如果你是駕駛台唯一的瞭望，叫一下船副，寶貴的時間，不能再去做其他的事情浪費掉。當值船副在駕駛台，代表船長讓路給直航船，這就是他的航行義務，不是乙級船員的工作。
- ï 在甲板上選出適當的參考點，設定目標的視線，如果在稍早的時候，你還沒有這麼做，來確認碰撞危機。
- ï 是的，就算操舵的時候，我們也可以評估目標船的動向，能夠在繁忙的時候，得到你的幫助，對於一個船副，或是資淺的見習船副是寶貴的。
- ï 選出最危險的目標，利用目標船的距離訊號。
- ï 目標船頭水線的形狀，是一個需要注意的重要標誌。
- ï 當目標的船頭浪，變得越來越明顯，例如越來越白，或是越來越白，表示目標距離越近。
- ï 各目標之間的距離，可以用船頭浪加以比較。如同圖形 1-10，可以看到船頭浪越低於水平線，就是越接近本船，如同圖形 1-11。
- ï 當我們看到船頭浪的時候，我們需要注意。
- ï 當我們看到船頭浪時，可以用來當做目標船的水線，比較目標船他們間距離的遠近。
- ï 近距離的船隻，沒有船頭浪的時候，是一個安全信號。表示他沒有對水的速度，就沒有碰撞危機，不會橫越，這如同我們情境感識的一部分，如在圖形 1-12 的右舷船隻一般。
- ï 我們對於行動要求的察覺，是隨著目標的距離而改變。對於船頭浪的警覺，不是我們人類的天性。但是有一天，如果我們沒有常加練習，我們會失去這種警覺，這就是我們對一個適任瞭望的要求，多加目測。

目標船的船頭已經有白浪花，這表示他的距離，已經到一到兩海浬。在圖形 1-10 裡，我們看到三條船的船頭，有白色的浪花。

1-24 Vessel with no bow wave in close range may be a safe sign.

Make no excuse for toilet whenever lookout saw bow wave of other vessel. This is the time lookout should prepare himself for hand steering. Following procedures might take into consideration:

- ⇒ Show your competence (knowing collision risk by bow wave) to stand before the wheel. Or
- ⇒ Give a call to OOW if you are sole lookout at bridge. Precious time must not be wasted to do other errands. OOW should represent Master on bridge to give way to stand on vessels. It is his watch, not rating.
- ⇒ Set up line of sight and pick up reference mark on deck now, if not taken earlier, to ascertain the risk of collision. Yes, once we can do it behind the steering wheel you may assert on what movement target is to OOW or junior OOW then you can be an useful help to them in rush hour.
- ⇒ Pick up most dangerous target by this distance sign.
- ⇒ The water form at the target's bow is a vital sign to aware.
- ⇒ When target's bow wave becomes more vivid (whiter or bigger), this means target is more close.
- ⇒ Bow wave form can be used to compare to other vessel for distance verification as Figure 1-10. We can see vessel with lower bow wave below horizon is closer to ownship by Figure 1-11.
- ⇒ We need to aware when we sought bow wave.
- ⇒ Bow wave can be used as target vessel's waterline to compare with another vessels' distance.
- ⇒ **Vessel with no bow wave in close range may be a safe sign:** have no speed on water, no collision risk or not at crossing situation. Part of our situational awareness as starboard side vessel at anchor in Figure 1-12 while we have trouble to recognize its anchor ball sign.

The action awareness according to target distance should accompany us in our sea time. To aware bow wave at lookout duty is not human nature. We will not have this awareness if we have no knowledge of it. Without practicing bow wave observation lookout will not recognize it immediately. This is part of our situational awareness for a competent lookout. The most dangerous distance is when white splashes are seen around target

vessel's bow, which means the distance is closer to one or two nautical miles only. In Figure 1-10 we see three vessels have white splash around her bow.

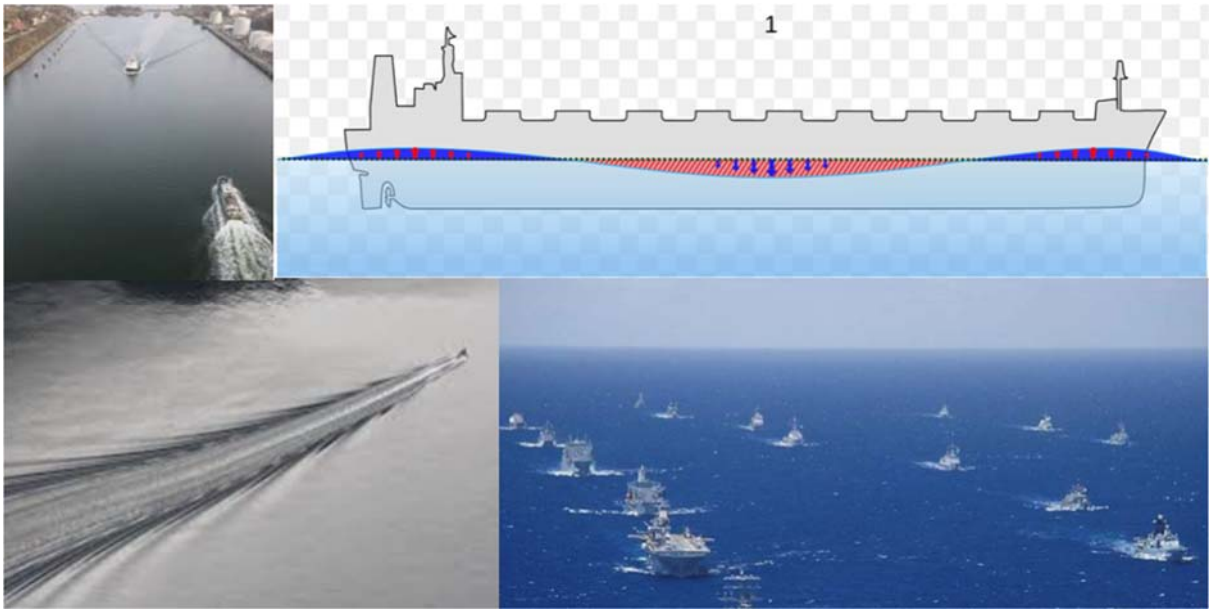


Figure 1-11: ship’s wake current aft and white splash forward

Figure 1-12: ship’s wake current and vessel has no bow wave

1-25 在一海浬目標船的航跡流，快速反應階段

目標船的航跡流，當他向前移動時候，就會產生，就是在船隻尾部的白色浪花。在近距離時，這個白色的浪花在船頭看到時，是他的船頭浪，白色的浪花在船尾看到的是船尾浪，如果看不到目標船的航跡流，就表示它沒有對水的速度。如果看到目標船的航跡流，他現在對本船的距離就很近，我們必須使用目視和雷達確認，他現在對本船的距離，是否能安全通過，或是當值船副，是否已加以注意，否則我們就應該通知他。船隻的航跡流，在一海浬之外，很難看到，是因為我們人類的視覺的角解析度，在一海浬之外，很難分辨三十公分大小的目標，如同圖形 1-11 所示。有很多漁船同時

接近，但是只有在近距離，近到一海浬左右，才能夠看到他的航跡流，一海浬左右的漁船，也許很難看到他的船頭浪，航跡流可能會更清楚一點。航跡流也可用做目標的距離與航向的同時顯示，任何時候，我們看到航跡流，前面章節，你學到的相對方位的技術，就能用來確認，目標船是向前或是向後移動。

海水顏色可能使得航跡流，很難偵測，如圖 1-04 或是在曙光時間看不到，如同圖形 1-13。陽光的水面反射，可能太強，讓我們無法直視。SOLAS 裡面規定，要確保駕駛台有一個清晰的視野，並避免強烈的陽光折射，駕駛台所有窗戶都需要一個最淺顏色的遮陽板，這個遮陽板應該可以很方便地取下，不可永遠固定。

瞭望人員應該具有一副抗紫外線的太陽眼鏡，這是當班的必要設備，我們瞭望的職務，不應受環境因素而減損，例如陽光的影響。在駕駛台 4 到 8 的當值瞭望，是最大的挑戰，即使他已經有了多年的海上經驗。適度勤勉的瞭望，不是隨便講講，這是我們在海上每天的日常業務。這就是造成船員，較其他職業來的強韌的因素，太陽。

圖形 1-13 日出日落時，瞭望的挑戰

圖形 1-14 失去的水平線，能見度受限

1-25 Target vessel with wake wave at 1 N. Mile range: activate range

Ship's wake current is the white splash after target vessel when she moving ahead. In close distance if we cannot see target vessel's wake current she may has no speed over the water. In another words, the white splash we sought at target bow is her bow wave and at her stern is her wake current. If we sought target vessel's wake current she is in very very close distance to ownship now. We have to make sure by visual or radar is this vessel safe or been attended by OOW? Otherwise you will have to inform OOW to take action accordingly. Ship's wake current is hard to detect out of one nautical mile due to human eye's angular resolution as we can see from Figure 1-11. Many fishing vessels approaching in same time but **only those in close range about one nautical mile can see its wake current.** These vessels are too small that we can see it bow wave and stern wave at the same time. Wake current can be an indication of target range and sailing direction at same time. Whenever we sought target's wake current we know it is very close. If you had the skills learnt from previous pages you can help to check her relative bearing goes ahead or astern. The water color may make wake current hard to detect as in Figure 1-04 or in twilight time (sunrise or sunset) in Figure 1-13. The reflection of sunshine on the water may be so strong that you should not or cannot look into it directly. IMO 5.1.1.2.6 specified: "To ensure a clear view and to avoid reflections in bright sunshine, sunscreens with a minimum color distortion should be provided at all windows. Such screens should be readily removable and not permanently installed". One UV protection sun glasses is a necessity for a qualified lookout. Our lookout duty cannot undermine by the circumstance factor like Sun. 4-8 duty on bridge is always the most challenge to a lookout even he has many years sea time experience. Due diligent of lookout is not just talking. It is daily practice at sea which make seaman tougher than any other occupation.

Figure 1-13: lookout's challenge in sunrise and sunset.

Figure 1-14: lost horizon in restricted visibility.

1-26 失去水平線，就是失去能見度

如果清晰的水平線，無法分辨，我們已經失去判斷距離的大部份能力。我們也許無法看到目標船，直到他忽然冒出來。如同我們看著圖形 1-14 的船隻，雖然距離很近時，我們仍然可以看到他的船頭浪與航跡流，還是害怕他船出現的時候，距離已經太近，我們無法確認碰撞危機與採取適當的避碰行動。看到他的左舷和右舷的出現，也許能夠緩解一下我們的焦慮，因為左對左，就是安全通過的信號，這又比使用相對方位的變化判斷是否安全，來的快速一點。不良的能見度，對駕駛台當值是惡夢一場。如果水平線看不到，我們知道某部分的海域，已經不在我們監控的範圍內。我們可能永遠不知道，在霧中，霧雪暴雨，沙塵暴或者其他的濃煙等等氣象現象的後面，是否有什麼樣的船隻？我們更不知道他的距離有多遠？這在航運界的術語是“能見度受限”，目標能否清晰的看見，或者目標在多遠的距離，才能清晰的看見？國際避碰規則對受限制的能見度的定義是，任何情況

下，受限制的能見度是指能見度下降，因為受到下霧，雪，暴雨，沙塵暴或者其他相類似氣象因素所造成的。
能見度受限的規則，適用於船隻不能互相看見時。在海上我們可能永遠不知道，本輪是否在能見度受限的狀態（可能兩船之間有一霧牆，但是本輪不知道），直到本輪進入到這些氣象現象中，或是看到其他船隻的部份在霧區，或是暴雨，沙塵暴裡面。當我們發現的時候，他可能是有一半或者部分船體，在能見度受限制的區域內，那時可能已經太晚，去確認碰撞危機與去做避碰的行動。
根據避碰規則，能見度受限的時候，是沒有直航船與讓路船的區分，所以我們永遠都必須準備，對那些你眼睛看不到的船避讓。失去水平線就是失去了能見度。失去水平線就要準備霧中的程式，當我們看不到清晰的水平線的時候，霧中的程式包括：
#通知當值船副
#啟動航行燈與霧號
#打開駕駛台的門，準備聽他船的霧號
#尋求協助或是新的瞭望
#在舵機後面待命
#應該以安全的速度，備便主機。
也許現在你瞭解到，看不到水平線的時候是多麼嚴肅的事情，所以應該向當值船副報告，你看不清楚水平線的時候，這時也是雷達需要啟動，來判斷船隻的距離，與我們用目視所判斷距離的差距。我們看到的第一條船的距離，就是我們的能見度。核對他在雷達上面的距離，可以幫助你瞭解本船現在的能見度，但是能見度是隨時在變的，霧跟雨雪都是有時濃，有時淡。能見度只是一個短時間的參考，隨著氣候的類型在變。如果船隻在霧區裡面，船頭浪與航跡流，仍然是它船距離的很好參考。正確的評估它船或其他目標的距離，需要用到雷達。

1-26 Lost horizon is lost visibility and situation awareness

If a clear vision of the horizon is lost, we actually lose most of our ability to judge the distance. We may not be able to find a vessel at sea till she come out of the mist. If we look at Figure 1-14 we can still tell which vessel has bow wave or wake current in close range. We are afraid when we saw target vessel coming it is already too late to ascertain collision risk and take avoidance actions in time. Seeing her port side or starboard side appear may help to relieve our anxiety if we have aspect awareness. Bad visibility is a nightmare on bridge. If the horizon is not in sight we know some part of the sea is missing in our visual lookout range. We can never know what target is behind the fog, mist, falling snow, heavy rainstorms, sandstorms or any other similar causes like the fire or smoke from inland. We cannot know whether any target is behind these meteorological phenomena needless to say how far it is. In these situations, we have a nautical term "**restricted visibility**" where visibility is "how clearly objects can be seen, or how far you can see clearly, usually because of the weather conditions". In COLREG **Restricted visibility** is defined as ""**"restricted visibility" means any condition in which visibility is restricted by fog, mist, falling snow, heavy rainstorms, sandstorms and any other similar causes.** " **Restricted visibility** rule applies to vessels not in sight of one another.
At sea, we never know does we are in "restricted visibility" status or not unless ownship already inside these meteorological phenomena. We don't know does other vessels are inside these fog, mist, falling snow, heavy rainstorms, sandstorms or else. We just cannot see these targets by eyes until we saw it. In top left picture we can see heavy rain fall behind the vessel but we cannot know whether there is a vessel inside the rain fall. When we find out she is half or part inside restricted visibility like lower right picture in Figure 1 - 14, it may too late to react. Further by COLREG rules, there will be no 'stand-on' or 'give-way' vessels in restricted visibility. Always prepare to give way to ships you cannot see. Lost horizon is lost sense of distance judgement and lost visibility because visibility is defined by the distance we can see a target vessel. Be prepare fog procedures when we cannot see clear horizon. Fog procedures:

⇒ Inform the OOW.
⇒ Turn on navigational lights, fog signal
⇒ Open bridge door
⇒ Call for help or new lookout
⇒ Stand by on the steering gears all the time

⇒ Call the Master

⇒ Every vessel must *proceed at a safe speed* with its *engines ready for immediate maneuver*. (by COLREG)

Maybe now you understand how serious when we lost sight of horizon. So just report to OOW when you cannot tell or see where is the horizon. These are times when radar need to be turn on to evaluate the approaching vessel's range against the distance we thought. In a foggy day, the distance of first vessel we see is our visibility: how far you can see clearly is your visibility now. Check her distance on radar may help you understand our situation better or how wrong we are in visibility judgement and it should be verified all the time. The visibility you have now is a reference distance only for short period. Remember fog density is not fixed all times, so the visibility may be varying by the weather pattern from light mist to dense fog or rain. If target vessel in fog come into our visibility range, the bow wave form (4 N.M.) and white splash (1 N.M.) is still a useful sign of our distance judgment. More exact assessment of the visibility may be possible when radar is used to determine the distance of vessels or other objects in the vicinity.

1-27 海煙

有時候我們能夠看到，清晰的月亮或太陽，大型船隻的航行燈也看得到，卻看不到雷達上，海面上的其他小型船隻與漁船，海面位置高的目標可見，但是比較低的目標，卻看不到。仔細看著海面，上面可能會有一層輕霧。毫無例外的，這時水平線看不到，高度較高的目標雖然清晰可見，宛如漂浮在天空，幽靈船來了，那就是海煙。這在寒冷或者極區比較可能發生，它的成因是因為暖空氣流經溫暖的海水表面，就像是我們煮開水的時候一樣，熱水蒸氣直接蒸發到上面的冷空氣裡，凝結成一層白煙，漂浮在水面上，這是海霧生成的第一階段，如果再有微風吹拂，海霧的高度越來越高，就會形成大範圍的平流霧，我們在這裡要討論的理由是，此時小型船隻或是漁船，很容易被疏忽掉，根本看不到，對只依賴目視瞭望的船副，是尤其危險。

圖形 1-15 夜幕低垂，星空滿天，海煙來了

1-27 Sea Smoke is dangerous for small target

Sometimes, we can see the sun or moon clearly on the sky. Other ship's navigational lights are also visible but we cannot find the sight of small vessels on water. *The object taller are visible but lower target are out of sight.* Look on sea surface there is a layer of mist floating on it. No exception, the horizon is missing although higher object is clearly visible. These are sea smoke or smog which happened in Arctic or cold air area. It happened when very cold air float over warmer water just like the air over boiling water. We can see some vapor evaporate direct from hot water been boiled. The vapor condensate to small dripple and form a thin layer of white smoke over the water surface. The reason we discuss this phenomenon here is because fishing boats is easily overlooked in sea smoke when we departed Busan port Korea.

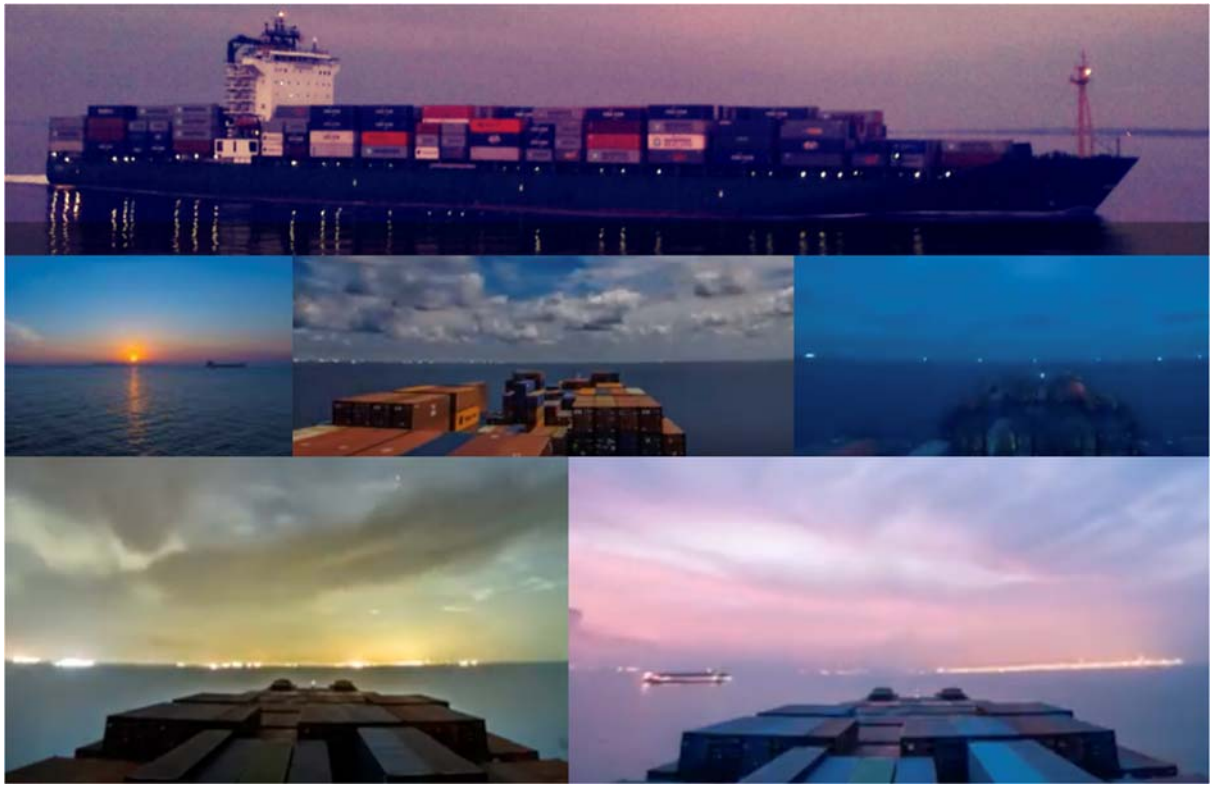


Figure 1-15: Nightfall at sea, Starry night

1-04 夜幕低垂，星空滿天

1-28 夜幕低垂

在夜間，我們需要花一點時間，來達到我們最佳的夜視能力，水平線仍然可以看得到，這可能需要 30 分鐘。當滿天星空或滿月光芒的時候，水平線都清晰可見，任何氣候現象能夠影響到白天的能見度，下雨下霧下雪，到晚上的時候，因為光線不足，情況只會更糟。加上我們人類眼睛的視覺限制與錯覺，我們需要對我們想像看到的東西，要更加小心。發現可能最接近本船的船隻，是利用他船上的燈光，不一定是航行燈，可能是其他的住艙，或者是走道的燈光。航行燈的設置，是依據國際避碰規則的規定。這些航行燈的設置，在在近距離的時候，對我們瞭望的任務，不是很恰當。當他船航行燈被背景燈光遮蔽，或來自岸上，其他船隻或本船燈光的散射，會讓我們產生很多的誤導。航行燈在適當距離之外是很有用的，只要它沒有跟漁船的甲板燈，工作燈混淆，漁船的燈光數量，遠遠多於避碰規則規定的商船航行燈數量。漁船燈光對商船來講，往往構成航行障礙，商船在海上就是利用阿帕的計算能力，也沒有辦法把這些漁船區分出來，我們需要有目測碰撞危機的能力，在夜間比日間更需要。圖形 1-16 橫越船 追越船 迎艏正遇的航行燈

避碰規則對於航行燈的規定，在日落到日出時間都要遵守。在這段期間，其他的燈光不得顯示外露，除非不會被誤認為航行燈，或者不會減少航行燈的能見度或是特性，不會干擾到夜間瞭望的任務。我們能夠利用避碰規則來判斷目標船的艏向，動力船隻在航行中，應該顯示第一較低的白色前桅燈，第二白色後桅燈，在較高的後桅上方，第三左舷紅色的舷燈，第四右舷綠色的舷燈，第五白色的船尾燈，如果這條船超過 50 公尺。較高的後桅與較低的前桅燈，讓我們可以對於他的船首向，有一個大概的估計，如同圖形 1-16，同時紅色舷燈能夠幫助我們判斷他的船首向，這條船看得到紅色舷燈，對著本船的綠舷燈，紅對綠，不同的視角，就像我們前面學過的，它船可能會有危險。舷燈的能見度是 3 海浬，前後桅燈的能見度，避碰規則的規定是六海浬，這就是為什麼，我們不能只依靠舷燈，來給我們他船船首向的指示，有時我們可以看到前後桅燈，但是舷燈在哪裡？卻沒有看到，只因為還沒有進到舷燈能見距之內。如同圖形 1-16，有一條船在近距離，可以看到他前後的桅燈，但是綠舷燈，卻不知道在哪裡？

1-04 Nightfall at sea: Limitations, illusions, deceptions

1-28 Nightfall at sea

During night time, horizon may still be visible if we spare some time to achieve our best night vision (30 minutes maybe by essays) when starry or moon light are available. All weather phenomena can impair our visibility in daytime will worse in night. We need to be careful in what we sought. The water-line position of target and her profile is not visible to our eye. The way we can use to know target vessel distance is by her lights on board. Navigation lights are set up by COLREG to indicate vessels movement. These navigation lights are not very good for lookout purpose in close range as the presence of background light such as from shore, other vessels or from back scatter of her own lights which could cause a lot misleading for us. Navigational lights are useful in some distance away as long as it not mixed with fishing vessels deck or working light which are outnumbered those status lights of COLREG. Fishing boat light in the sea is the way they want which might form another navigational hazard to merchant marine. Very often, fishing boat cannot be solved by ARPA capabilities. We need the ability to visualize collision danger in night time is more desperate than daytime.

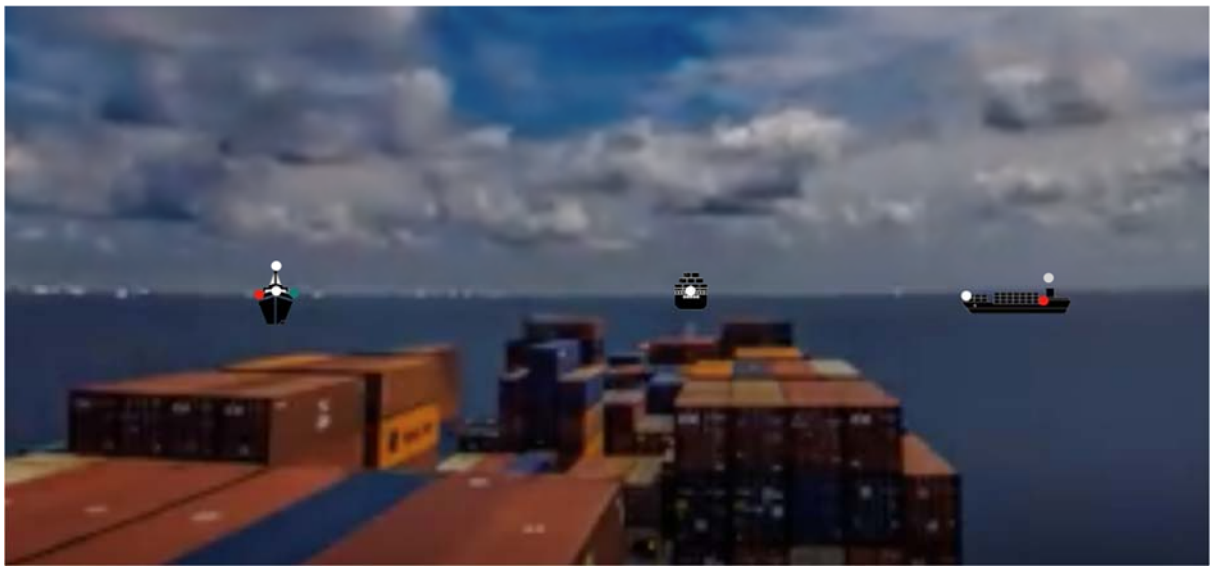


Figure 1-16: Navigational lights in crossing, overtaking and head-on situation

The rules of COLREG in navigational lights shall be complied **from sunset to sunrise, and during such times no other lights shall be exhibited, except such lights as cannot be mistaken for the navigational lights or do not impair their visibility or distinctive character, or interfere with the keeping of a proper look-out**. We can judge target vessel heading by rules of COLREG. A power-driven vessel underway shall exhibit: (i**). a lower white masthead light forward; (ii). a second white masthead light abaft of and higher than the forward one; (iii). Red sidelights on port side; (iv). Green sidelights on starboard side; (v). a white sternlight in vessels of 50 meters or more in length.** From higher aft masthead light to lower fore mast light, we can have a rough idea of her moving direction as starboard side vessel with red side light in Figure 1-16. Red side light can also help us in judging her heading. For this vessel red side light against ownship green side light i.e. red to green different aspect as we learned before. We may have a collision risk with her. The side light visibility 3 nm in COLREG is less than masthead light 6 nm. That is why we cannot only count on side light to give us indication of her heading as Figure 1-16. One vessel is in very close distance ahead. We can see her mast head lights for and aft, but the green side light is hard to identify.

1-29 駕駛台航行警報系統

航行燈的使用是日落到日出，其他燈光不准顯示外露，除非不會被誤認或妨礙干擾到航行燈的能見度與燈光特性。如同圖形1-16。從圖形1-15下面右邊的照片，我們可以看到，很難說其他的燈光，不會被誤認為航行燈，或沒有干擾到航行燈的能見度，不會被誤認為航行燈的特性。這是因為當值船副開啟甲板燈，以填補前後桅燈之間的黑暗，並希望這些燈光，沒有干擾到其他船隻的瞭望。這些

前後桅燈，給我們它船船首向與動態的感覺，他們是一種虛假的安全感，尤其是當看到大船上航行燈的時候，我們不知道他是什麼樣的船隻？一條大船可能會被誤認為兩條小船，一條迎艏正遇的大船，可能會被視為橫越船，一條大船的尾燈可能會被誤認為小型船隻的桅燈，反之亦然。船舷寬的油輪從船頭開過來的時候，會誤認為一條橫越的小船，兩條船的桅燈，會誤認一條船的航行燈。總之，犯錯是人類的天性，尤其是在夜間，因為白天的工作，當我們感到非常疲勞，加上人眼睛的限制。在夜間瞭望的任務，我們需要非常專心。就算在日間，人的注意力只有10分鐘的時間，當超過10分鐘以後，我們就沒有辦法專注，就會失去情境感知。我們的大腦會產生胡思亂想，由我們的潛意識干擾到，我們對駕駛台外面世界的注意力。現在船上都有裝設航行警報系統，該裝置就是試著，要把我們的注意力，引回到當值的任務。圖形1-17當值人眼視線的限制是1分，人眼視線的限制：角解析度。

1-29 Bridge Navigational Watch Alarm System, abbreviated BNWAS

These five navigational lights regulation shall be complied from sunset to sunrise in COLREG, no other lights shall be exhibited, except cannot be mistaken as in Figure 1-16. In Figure 1-15 lower right side picture, we can see it is hard to say other lights exhibited cannot be mistaken for the navigational lights or do not impair their visibility or distinctive character of this vessel. This is because OOW turn on deck working lights to fill up the darkness between its navigational lights in hope that such lights will not interfere with other vessel's look-out. These masthead lights may give us a sense of her heading or movement, but it is a false sense of security especially when navigational lights in big vessel. For we don't know what kind ship she is, sometimes one big ship may mistake as two small vessels, or head on vessel mistake as crossing vessel. A big vessel's stern light may mistake as small ship's masthead light, vice versa. Wide beamed tanker coming from bow may mistake as a crossing small boat. Two vessel's lights may mistake as one vessel's navigational light, etc. To mistake is human nature especially at night when we are tired of daytime's work together with human eyes restriction. We need undivided attention in our lookout duty at night. It is hard for human nature to concentrate anything over 10 minute time. *After 10 minutes, we lost our situation awareness easily*. Our brain will create some scenario in our subconscious to distract our attention in outside world. Now there have Bridge Navigational Watch Alarm System, abbreviated BNWAS to bring us back.

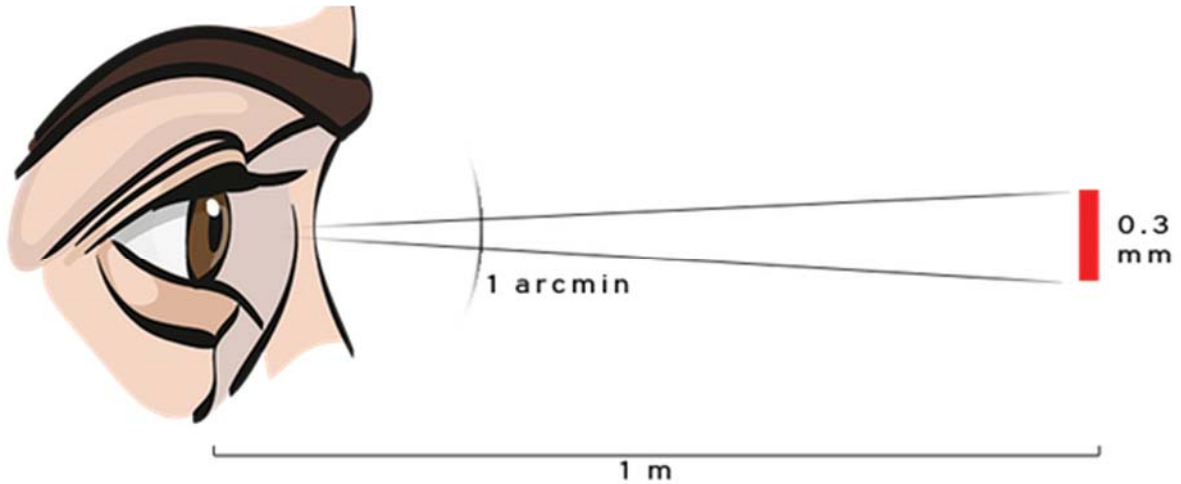


Figure 1-17: Limit of human vision is 1 ´ (one arc minute) of angular resolution

1-30夜間當值 需要的努力

#我們需要更多的耐性，尤其是在做決策的時候。
#我們的眼睛需要30分鐘，才能夠進入最佳的夜視模式。
#因為視覺的缺陷，在我們判斷的時候，要搜集更多相關資料。
#光使用望遠鏡，確認它船船首向是不夠的，要利用雷達與AIS的資料，多做確認。

#只要多看一眼，視覺 雷達與自動識別系統AIS的資料，對我們瞭望的品質，就會有很大的幫助。另外一個，在晚上改善情況的方法是，觀測目標的距離。在白天當班的時候，距離是避碰的關鍵，不管是在避碰規則上，或是在海上。

1-30 Due diligent we need in night watch,

⇒ Take more patient in our decision making because our eyes need 30 minutes to set in night vision mode.

⇒ Collect more supporting evidence in our judgment because malfunction of night vision.

For example, make sure target heading by binocular is not enough. We need to verify in RADAR echo or AIS data again. Just one more look by cross checking in visual or RADAR or AIS will make a big difference in our lookout quality. Another way to ascertain situation at night is judging target vessel's distance. We know in daytime duty that distance is the decisive factor in collision avoidance either in COLREG or in reality.

1-31在夜間，我們如何判斷目標距離

夜間我們看到漁船燈光的距離，是七海浬左右。在日間，我們已經知道目標船的花開效應，變大或變小，當他距離本論越近或越遠，在夜間，花開效應同樣能夠說明我們區分目標船之間的距離，一條漁船在七海浬的距離，他的航行燈 住艙燈 工作燈，我們都只能看到一個白燈，如同圖形1-18，遠距離的小船，顯得就像一盞小白燈，或小段水準的光帶。雖然有些人視力比較好，但是一般我們能接受的人類視力限制是1分的角解析度，表示我們只能分辨三十公分的物體，在1公里的距離外。在七海浬，人的眼睛只能區分到四公尺大小的物體。這還是在日間在能見度良好的情況下。夜間遠距離船隻的船首向，我們必須接受，無法僅憑他的航行燈，就能看出它的動向，如同圖形1-18，必須利用他的相對方位變化，來判斷他是向船頭移動，還是向船尾移動。除了一些特殊的魷魚船，有很強的集魚燈，其他的漁船的光度，在七海浬之外，就很難發現。在七海浬之外，就算我們在雷達螢幕上，可以清晰地打到漁船的回跡，我們眼睛也看不到燈光，我猜這是因為他們的工作燈，沒有很好的亮度。漁船超過7海浬的距離，對我們而言，跟我們航行安全無關，是沒有碰撞危機的。我們可以等到這些船，接近到四海浬的時候，再來確認他的方位變化與碰撞危機。

1-31 How can we judge target distance by night? First sight of fishing boats is at 7 NM.

In daytime, we already know blossom effect of target vessel will appear bigger or smaller when distance become closer or further. In night time, blossom effect can also help to distinguish the distance of target vessel. But how? If one fishing vessel locate at 7 nm away her navigational lights may appear as a white spot only as we can see in Figure 1-18. Vessels at sea appear as small white spot or a small horizontal light belt. Although some people have sharper vision, general accepted limitation of human eye is 1′ (one arc minute) of angular resolution. That means we cannot distinguish articles smaller than 30 cm at a distance of 1 km. At 7 nm, our eyes can only distinguish objects more than 4 meters apart. This is in daylight and visibility is very good condition. At night and long distance away, we have to accept the reality that we cannot distinguish which way the fishing vessel is heading by her navigational lights along as Figure 1-18 below. We have to use their relative bearing change to ascertain their moving is ahead or astern. Beside some squid boats have strong gathering lights other kinds of fishing boats light is hard to find more than 7 NM even we can see its echo in radar screen clearly. I guess this is because their working light did not have very good visible range more than 7 NM. For collision avoidance purpose, fishing boats in 7 nm away are irrelevant of safety. No collision risk in 7 NM. We can wait till they are 4 nm away and check their relative bearing change for that distance.

Figure 1-18: Enhanced image of night vision, targets in distance away

1-32 使用甲板燈光 區分4海浬小船

在長距離能見度良好的夜間，我們仍能比較船隻的航行燈，相較於水平線的高低，而區分他們的距離。因為我們看不到它船的水線，只好以航行燈的高度，來做個大約估計。但是這是很不準確的，因為每條船的航行燈，設置的高度都不一定，航行燈高低常常差很多，無論如何，7海浬的小船，對我們是無所謂，不需要去注意。那些在近距離的小船，才需要去注意，當這些小白燈，在它的甲板上開花成兩盞，三盞燈，我們就要提高警覺。在四海浬左右的距離，我們就可以看到他的部位燈，和工作燈，而不只是小白點而已，他花開成兩，三個甲板的燈光，我們就要開始評估它的碰撞危機了。在晚上，小船開花，讓我們提高警覺，4到6海浬也是我們對於大船，必須要採取行動的距離。對於大船應該是在4到8海浬觀測，然後4到6海浬的距離，採取避碰行動。我們可以一邊監測這些漁船，同時考慮到對大船，要採取什麼樣的避碰行動。

1-32 Knowing small vessels distance by lights on deck at 4 nm

In long range if the visibility is good we can still compare height of target vessel's navigational light with sea horizon to estimate their range because we cannot see her water line at night. However, this is very unreliable due to different ship navigational lights has different size and construction on board. Small vessels at 7 nm away are "no me importa" not important or I don' t care. Small vessels in closer range need to lookout by using blossom effect. When their white spot become two lights or three lights separately, **this is about 4 nm away as we can see her station light or working lights on deck are not one spot only which had blossomed into two or more lights on deck.** This distance is important because we have to evaluate collision risk of these small targets at this range. *This is an important sign at night to raise our situational awareness when saw more than one lights on small vessel.* 4-6 N. Miles is also our action range to give way as request by COLREG for ocean going vessel. We may take avoidance action at same time for small and ocean-going vessels. If we can monitor the movement of these fishing boats at this distance can save our trouble of panic by relative bearing change.

1-33 The blossom effect for ocean going vessel at 4 nm

Same effect of blossom in ocean-going vessels is not like smaller one. For **ocean-going vessels in 4 nm distance, we shall check** with binocular **if her accommodation or stairway or deck lights** can be seen beside her navigational lights on board. If we look at top vessel of Figure 1-15 we can see this ocean going vessel have more lights on board than navigational lights only. Some vessels may light up main deck alleyway light on purpose, some just leave it unnoticed. In either way if we can see their deck lights, she is about 4 nm away from ownship. 4 nm is visible range of these household lights. In lookout, closer target needs more urgent to evaluate its collision risk. If we can judge target vessel's distance correctly, we won't waste time to ascertain collision risk with wrong vessels.

This is our situation awareness in lookout. Another effect of lights on water can be used to verify target even closer than 4 nm. As we know most target rarely close to ownship in 2 nm range at open sea.

Figure 1-19: Enhanced image of night vision, targets with reflection on water

1-33 大型船隻 4 海浬的花開效應

對於大型船隻來講，在四海浬的花開效應，不像小型船隻那樣開花。我們會看到大船住艙燈光或室外工作燈或下面的走道燈，這些都不是避碰規則所規定的航行燈，如果使用望遠鏡，也許更清楚。我們看看圖形 1-15，上面圖形的船隻，可以看到這條遠洋船上面的燈光數量，遠遠多於避碰規則的要求。有些船也許故意把甲板燈打開，有些船可能只是沒有注意到，這兩種情況下，當我們可以看到他的甲板燈光時，距離就是差不多四 4 海浬。住艙燈可見的距離也就是差不多 4 海浬。近距離目標需要更迫切的瞭望，來評估碰撞危機，如果我們可以目測，判斷目標船的距離，就不會浪費時間在錯誤的船隻上，這就是我們瞭望的情境察覺。燈光在水面反光的特性，可以用來判斷距離少於 4 海浬的目標船。大洋上，大部份的海上船隻，很少接近到本輪 2 海浬的距離。

圖形 1-19 目標船具有水面反光

1-34 水面反光：少於兩海浬的船隻

即使是一個浮標在水面，如果距離夠近的話，也會有反光。例如圖形 1-19，這個是我們在海上經常看到的，但是我們沒有把它當作一種提高警覺的信號，要訓練自己，當看到反光就必須使用雷達確認目標的距離，過了一陣子，等我們對這些評估，具有相當的經驗以後，我們就會對這些反光產生直覺反應。我們的警覺性，在瞭望的時候，會從沒有感覺，改變成只要我們看到它的時候，就會加以注意。就像我們從不注意附近有沒有狗，直到有一天，其中一隻狗對你大吼大叫，下一次在街上遇到狗，當它們接近你的時候，你就會生氣或是恐懼，你就有警覺性。

我們需要的警覺性是，當看到水面的反光，就知道這些目標，是在非常近的距離，這些目標是在 1-2 海浬左右的距離，在海上，不管目標船是大還是小，在這距離都要注意他們的碰撞危機，然後採取必要的避碰行動。水面反光的警覺性，對大型船隻或小型船隻都有必要，在圖形 1-13，瞭望在日出日落時候的挑戰，日出日落夕陽雖美，但是水面會產生強烈的陽光反射，陽光把海水的顏色改變，造成目標船隻的形狀，船頭浪，航跡流等等消失不見，在惡劣天氣裡，這些小型船隻也會在波谷裡面消失，從我們的眼前完全消失，就像他們的雷達回跡，在螢幕上也會消失不見，讓我們很難注意到他的存在。曙光時間可能從 15 分鐘到幾個鐘頭，是由本船的緯度所決定。你應該要知道瞭望的限制，尤其是在曙光時間瞭望的限制，去想辦法克服它。在夜間我們的瞭望，品質不好，我們卻不自知，因為人類視覺的限制。

1-34 Reflection on water: Vessels close to ownship at 2 nm range

Even a light buoy have reflection on water at close range as green buoy on portside of bottom Figure 1-19. This is a common scene at sea but not a situation awareness if we did not know or use it as a sign. To train ourselves, we can look for reflection of lights and verify its distance with radar in the beginning. After we had some experience of these assessments, we will have some instinct in these reflections. Awareness in lookout changed some things we see from no feeling to pay attention when we first saw it. It's like we did not notice any dog around until the day one of these creatures barking at you fiercely. Next time in the street you will aware these dogs with anger or fear when they come close to you again. This is **the awareness we need when we see reflections on water: these targets are at very close range of 1-2 nm.** Any ship no matter big or small in this distance need to be aware of collision risk and take actions to avoid it immediately no matter what side she is. *Awareness of Reflection on water need our proper actions both in big and small vessels.*

In Figure 1-13: lookout's challenge in sunrise and sunset is its twilight. It is beautiful but hard to lookout at due to strong sun light reflection directly into our eyes. The color of the sea changed by reflection of sun in almost horizontal direction can easily cover target vessel's shape or any trace like bow wave and wake current on water. In rough sea, those targets in the trough of sea will disappear from our view like target disappear from radar screen in close range make it hard to notice. Twilight time can last from 15 minutes to many hours depend on your latitude. We should know our limitations of lookout in twilight time and prepare to overcome it. But in night time, our lookout duty is deteriorated by human limitations without our awareness due to no knowledge of it.

1-35 人眼的夜間限制

圖形 1-20 錐狀與柱狀的感光細胞

我們眼睛的感光細胞有兩種，其中 10%是圓錐狀，圓錐狀感光細胞位於我們眼睛瞳孔中間的後面，這些圓錐狀的感光細胞，適合於探測物體的顏色，質地跟其他比較細微的特性，這些圓錐形的感光細胞，需要亮度夠強的環境，才能夠發揮功用。其他 90%圓柱狀的感光細胞，圍繞著圓錐狀細胞，這些圓柱狀的細胞，對光線的明暗，亮度的對比與物體的移動非常敏感。但是呢，這是在我們潛意識裡面，做物體運動的監測，我們並沒有特別去注意或記憶。我們並不知道在背景中移動物體的細節，確實的形狀，或是顏色。柱狀細胞感覺到的，可能只是不同層次的灰色與黑色。實際上，視網膜收到的視覺刺激呢，只有 10 趴能夠到達我們的大腦（誰在潛意識過濾？）。在白天的時候，這兩種細胞共同工作，圓錐狀細胞集中在精細的工作，圓柱狀的細胞，監測物體的移動，警覺性比較高，這就跟我們呼吸心跳一樣，是在潛意識裡面運作。在白天亮度夠 光源足，我們可以看到東西，而且知道是什麼東西，但是到了晚上，我們只能看到物體移動，確實是什麼東西在動呢？不知道，尤其當光源受到限制，也就是光線亮度不夠，圓錐狀細胞就會失去他的功用，類似視覺限制，會讓我們覺得不方便嗎？不，在我們夜間一切行動如常，但卻不知道眼睛看的東西，已經產生了很多的錯誤。

1-35 Limitations of human eyes at night

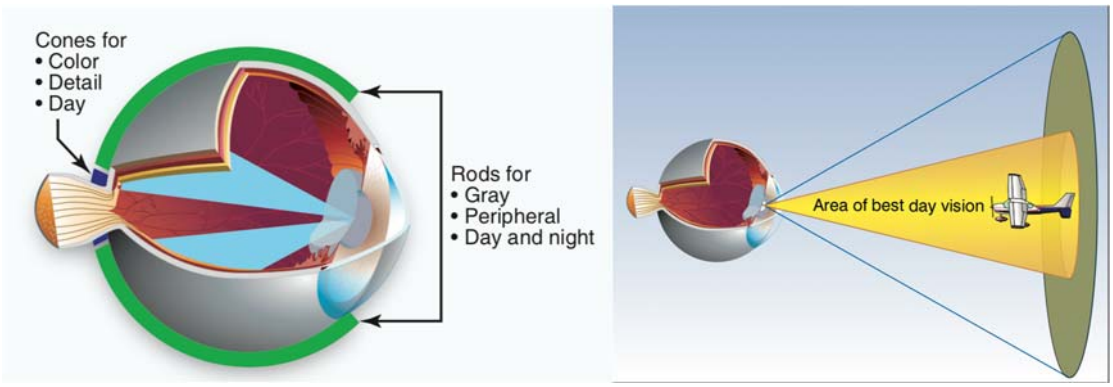


Figure 1-20: light-sensitive nerves "cones" and "rods" in daylight

Light-sensitive nerves "cones" and "rods"

We have two kind of light reception cells called “cones” and “rods” shape which are located at the back of the eye. 10 percent of our light reception cells are Cones shape located in the center of the retina which is good to detect color, texture, details, and far away objects. These cones shape cells need highly illuminated environment to function properly. Other 90 percent are Rods shape cell located around the cones which are sensitive to the light, contrast and shadow movement. The rods shape cell detects objects, particularly those are moving in our subconscious we did not pay any attention. We don’t know these background objects’ detail or color—only shades of gray in our subconscious. Actually, only 10 percent of visual stimulus received from our light cell can reach our brain. These two cells work together in daytime, the cones cell concentrate on the dedicated job and the rods cell is vigilant on any object's movement in our subconscious. We can see and know what it is in daytime. But **in night time, we can see their movement but don’t know what it is.** When light resources are limited cones shape cell will lose its function. Does this bother anybody? No, we just act the same at night without knowing we may make mistake in our visual data.

1-36 圓錐感光細胞造成的錯誤

在白天只要我們直視著一個物體，它就能夠被清晰地看見。但是在晚上，圓錐狀感光細胞沒有作用，在視網膜的中央，留下一個黑點。在夜間，從駕駛台的窗戶往外望，我們是努力的保持良好瞭望，以保護本輪以及在船上的同仁。實際上，圓錐視細胞沒有功用，因為亮度不夠，我們仍然能夠感覺到目標燈光的移動，這是依靠我們圓柱視細胞的功能，我們也許會想，有保持良好的瞭望，但是我們很容易，因為圓錐狀細胞沒有功用，產生錯誤，這就是為什麼目標船的桅燈，也會給我們它船艏向與動態的印象，由於虛偽的安全感，造成錯覺，我們卻不知道，是什麼樣的原因。有時候大船會被誤認為小船，大船的船尾燈被誤認為小型船隻的桅燈，反之亦然。一個船身很寬的大船，在迎艏正遇的時候，會被誤認為小船，兩條小船的燈光，被誤認為一條船的航行燈。要解決這些視覺的錯誤，我們必須用望遠鏡，來增強光線的亮度，或是用望遠鏡再仔細觀察，讓眼睛能夠適應黑暗。話說在晚上，我們需要比白天更多的努力，來做瞭望的工作。

1-36 Mistake when cone cells are not functional.

During daylight, one object can be seen best by looking directly at it, but **at night Cones shape cell is a blind spot in the center of our vision**. In the night time, we looking outside the bridge window thought we do our best to safe guard the ship and our friend on board. Actually, the cones shape cell is not working because the illumination is not enough. We can still sense some target's movement through the function of rod cell. We may think we are still keeping good lookout, but we are prone to make mistake for cone cells are not functional. That’s why masthead lights may give us a sense of her heading or movement, but it is a false sense. We don’t know what kind ship she is; sometimes big ship may mistake as a small one. A big vessel’s stern light may mistake as small ship’s masthead light, vice versa. Wide beamed tanker coming from head may mistake as crossing small boat. Two vessel’s lights may mistake as one vessel’s navigational light, etc. The solution is to receive more light by binocular or take a second look to make sure. In another words, we should take more precaution in night time.

1-37 眼睛的感光性，30 分鐘後增強十萬倍

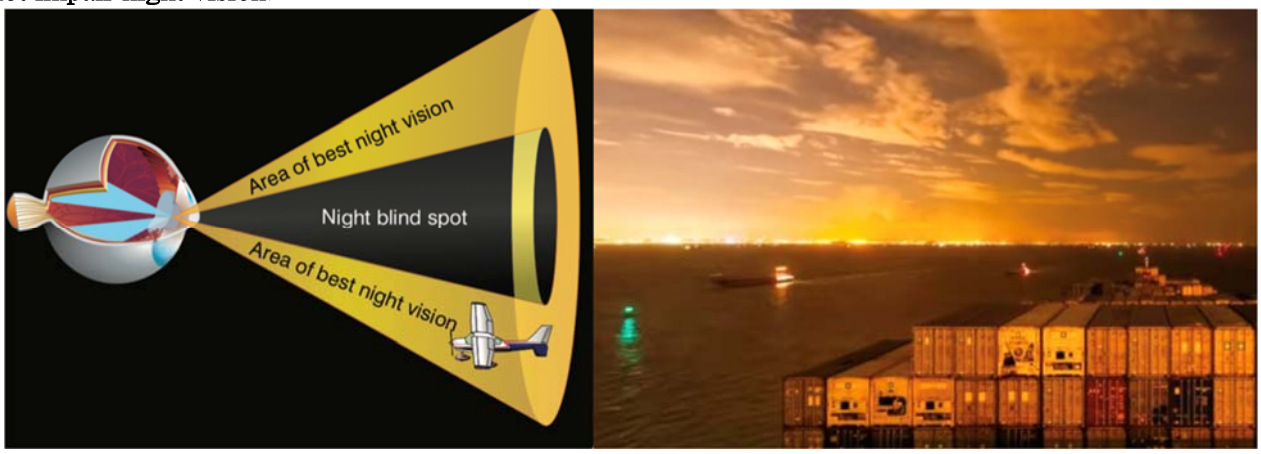
眼睛要能適應黑暗，是我們夜間瞭望很重要的一個課題。夜間當我們進入黑暗的駕駛台，眼睛很難看到任何事情，要看到，要等到眼睛可以適應黑暗。多數的人都有這樣子的經驗，當他進入漆黑的電影院。在這個過程呢，眼睛的瞳孔會放大，以接收更多的光源，經過 5 到 10 分鐘，我們的圓錐狀視細胞回復功能，調整到微光的狀態，視力增強 100 倍，經過再多的時間，大約 30 分鐘，會讓我們的圓柱形感光細胞適應這個黑暗，當圓錐圓柱細胞都能夠工作的時候，我們的眼睛的視力增強十萬倍。

當然在適應期過了以後，必須避免對黑暗已經適應的眼睛呢，再暴露在強光之中，只要超過 1 秒鐘的白光，就會讓我們的眼睛暫時的失明。我們的眼睛對光線的適應是獨立的，當我們曝露于光源的時候，只要閉上或是遮住一個眼睛，就可以保留這一隻眼睛夜間視力的敏感性。現在我們知道為什麼，海盜頭子都帶一個眼罩出場，遮住的那一隻眼睛，就是他在夜間做炮火指揮時用的。在夜間，

我們需要一隻可靠的手電筒，這也是我們除了太陽眼鏡之外，夜間當班的標準配備之一。這些手電筒能夠產生紅光是最好的，紅光不會影響到我們夜間的視力，基本上，人眼對紅光是比較無感的。

1-37 Eye's adaptation to darkness: 100,000 times more sensitive after 30 minutes

Adaptation to darkness is another important factor of night vision. When we entered a dark room, it is difficult to see anything until our eyes had adjusted to the darkness. Almost everyone had experienced this when entering dark movie theater. In its process, the pupils of eyes enlarged to receive more available light as possible. After approximately 5 to 10 minutes, our cone light cells adjusted to the dim light and our eyes become approximately 100 times more sensitive to the light before we entered. Much more time, about **30 minutes**, is needed for the rod light cells to adjust to darkness, but when it did, these rods are about **100,000 times more sensitive**. After the adaptation process is complete, *avoid exposing dark adapted eyes more than one second to any bright white light* (in toilet) as that cause temporary blindness. Remember that each eye adapts to the dark independently. By closing or covering one eye when exposed to light, some night vision acuity is retained in the closed eye. At least one reliable flashlight is recommended as standard equipment on all night watch on bridge. A reliable incandescent or light-emitting diode (LED) flashlight able to produce red light is preferable. Since **the red light is non-glaring, it will not impair night vision.**



1-38 夜間錯覺引起的混淆與分心

只依賴視覺瞭望的當值船副，夜間最危險的情況是，把大型船隻的航行燈，誤認為魚船的部位燈，就像桑吉輪的案件，損失了全船 32 條人命。或是大船的船尾燈被誤認為小型目標的桅燈，這種燈光混淆或是幻覺，也許是來自我們過去航行的經驗，也許是習慣導致，我們對自己的判斷滿意，自滿會減低我們對危險的警覺性。也許警覺性減低，源於夜間身體的疲勞造成，但我們並不自覺，最後造成嚴重的事故。要解決我們自滿的問題，就是要用良好的習慣，使用望遠鏡去確認目標，用望遠鏡再多看一眼，使用夜間的視覺，我們必須注意人類視覺的限制，以及可能的錯誤。要減輕問題，最好使用交叉比對，我們需要適當設置的阿帕，或是有一個適任的當值船副，去確認自動辨別 AIS 的資料，使用阿帕或是雷達，都不能告訴我們，目標的大小。但 AIS 的資料可以。

即使 AIS 可以告訴我們，目標的大小，目標船可能沒有開啟 AIS，就像是軍艦有時候不願意使用 AIS，或是某些近岸船隻，對航行的細節，很少多加注意。作為一個駕駛台的瞭望，我們必須使用視覺核對目標動向。不能使用電子航儀，似乎是一種損失，或是障礙。能夠培養我們的視覺航行技能，包括良好的判斷距離航向，我們使用望遠鏡的習慣，其實不是海上的損失，這對我們一生的事業，產生重大的功用：直覺，對船長來說，各種各樣的緊急狀況，永遠都是等待著他的直覺來解決。

圖形 1-22：駕駛台窗戶的鋁栓與夜間視窗

1-38 Night illusions can cause confusion and distractions

The most dangerous situation for OOW rely on visual lookout is the confusion of ocean-going vessel's navigational lights with the fishing boat's station lights like in SANCHI's case lost whole ship 32 souls. Small target confused with *big target* or the stern light of a big vessel may deem as a small target's mast light by OOW. These kinds of illusions may come from past navigation watch which led us to over-complacent on our judgment.

The complacency will reduce the awareness of danger. It may not come from night illusion only. Sometimes we just tired at night and our awareness is lost without our notice of it. Hence our vigilance is lost too and we don't know until it led to a disaster finally. **The solution for our complacency is to overcome with a good habit.** Use the telescope to verify the target's size and heading by second look. Using the visual in the night time, we have to beware of the human visual limitation and illusion. To ease the problem by cross checking, we may need proper setting of ARPA or have a dedicated OOW to verify these targets by AIS data. Even the ARPA/radar cannot tell us the target's size/ heading immediately, but AIS can. Even the AIS can tell us the target's size/ heading immediately, but target vessel may not turn on AIS as naval vessel reluctant to use and some coastal vessels did not care about navigation watch. As a rating, we have to check target by visual. Cannot using electric navigation instruments seems a loss or handicap for rating, but it is not. If we can cultivate our visual navigation skill including good judgement and habit without fail it is essential to our entire career at sea, especially for ship's master when all kind of emergencies are waiting him to solve in the future.

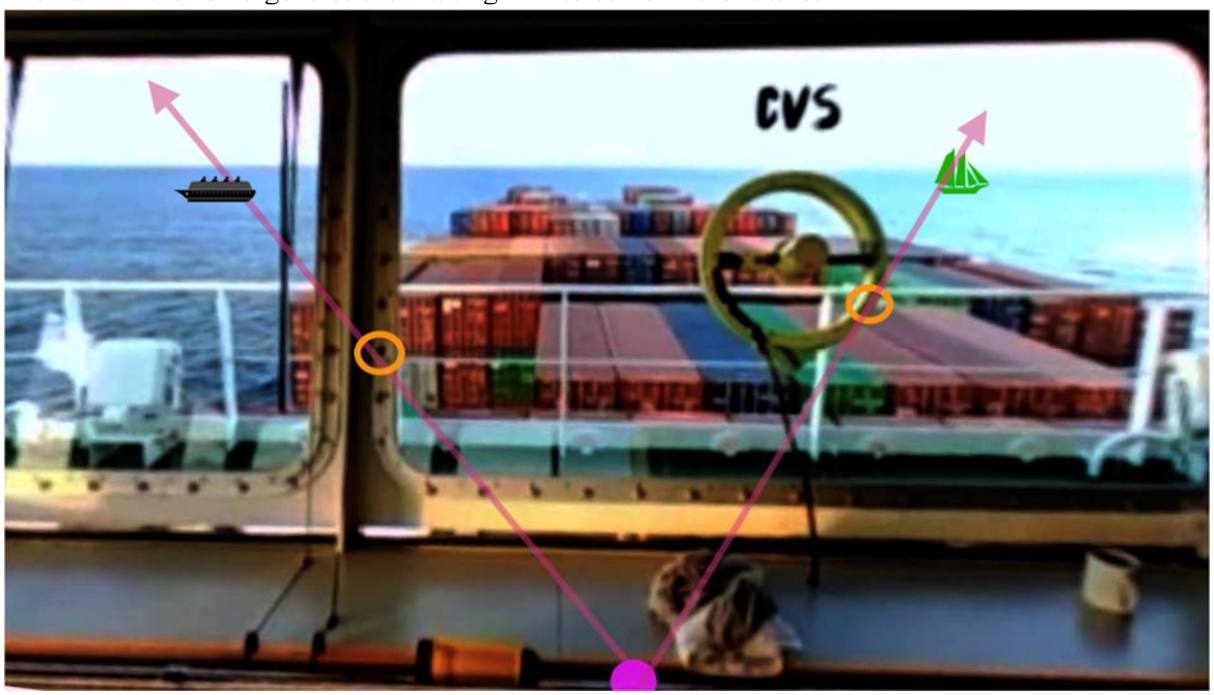


Figure 1-22: Alumni bolts location on the window or clear view screen edge in night time

1-39 夜間的方位變化

目標船的羅經方位沒有明顯改變，碰撞危機應視為存在。碰撞危機的第一件事，就是他的方位沒有明顯改變。第 2 件事就是知道他的距離，是否正在減少。

在夜間的目標，知道方位的變化，需要建立視線。晚上甲板的參考標誌，沒有辦法像在白天一樣，那麼清楚。但是在晴朗的夜裡，還是可以看到，當作方位變化的甲板參考點。但是只要有一點點的霧氣，就會很嚴重的影響，我們看到本船甲板機具的能力。在駕駛台裡面，雷達 風向風速計 時鐘面板的微弱燈光，或是駕駛台航儀的形狀，都可以說明我們觀測目標的方位，如同圖形 1-22 駕駛台窗戶的鋁質螺栓，可以作為左舷目標的方位標誌。除雨雪鏡的邊緣，可以用來說明標誌右舷的目標，在完全黑暗的夜，駕駛台內部的航儀就能幫助瞭望。

如果下大雨，那我們也看不到目標，就不必做目測。在岸邊 港區附近，雖然甲板上不准有燈光外露，但是岸上的目標 ，燈光，背景光線或是天空的餘輝，能照亮本船的甲板，如同圖形 1-19。向窗戶外面瞭望是一個很重要的習慣，不應該隨便放棄，如果我們還有選擇。

1-39 Bearing change at Night

Risk of collision is deemed to exist if the compass bearing of an approaching vessel does not appreciably change. First thing in collision risk verification is to know her bearing does not appreciably change. The second is to know her distance is decreasing. To detect bearing change of target at night, we need to establish line of sight. At night time, reference mark on deck may not be able to see clearly as daylight. In clear night we may use deck fittings for bearing reference marks as daylight. But, even a little haze will seriously affect our ability to see ownship deck

fittings. Those fainted shape of bridge instruments like radar or ARPA or windows etc. may be used to mark the target bearing. **By using alumni bolts on the window like Figure 1-22 can help to mark portside target bearing and CVS clear view screen edge can help to mark the starboard side target.** Use the reference mark inside the bridge in total darkness at open sea while vessels are few is possible. In coastal area although no naked light is allowed to shine on deck while underway other vessel's light or shore light or glare on the sky can help to illuminate ownship's deck cargo or fittings as upper picture of Figure 1-19. Look out the windows is an important habit we should not give up if we have the choice.

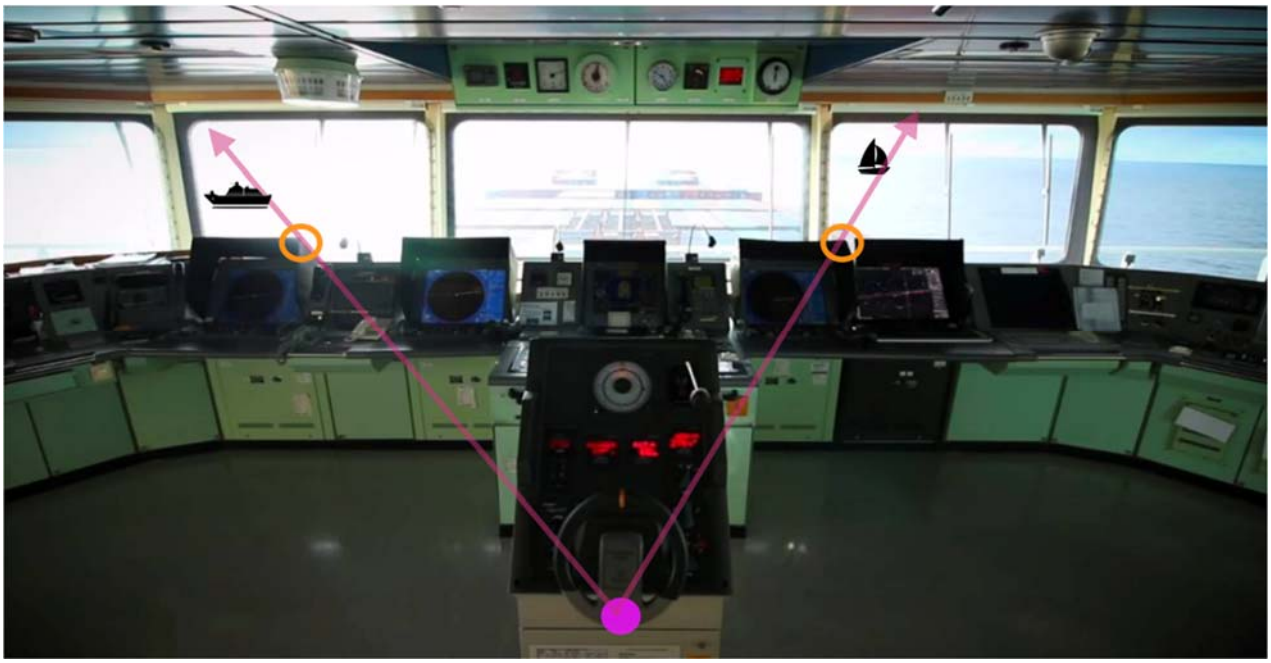


Figure 1-23: Navigational equipment's shape help marking target bearing at night time

1-40 駕駛台的餘輝長度

紫色位置就是乙級船員站的位置，也是他核對目標方位時的位置。在圖形 1-23，我們使用第二部雷達的邊角，說明我們標誌左舷目標的方位，使用雷達與電子海圖中間的間隙，標示右舷目標。在夜間一個近距離目標的燈光，會在駕駛台的玻璃上，產生一些餘輝，就像圖形 1-24，很明顯的餘輝，跟他燈光的亮度有關，一般來講，大型船隻的燈光亮度比較一致，他燈光的亮度與它的距離有關，距離越近的目標他燈光的餘暉，就會越長，距離越遠的目標，他燈光的餘暉越短，我們可以用這個現象，來核對目標距離。餘輝像我們看到的水面反光一樣，在很近的距離才會發生。當光線的強度夠的時候，才會發生。我們還可以用來當作，近距離目標的早期警報。利用玻璃餘輝來核對距離，開始時，我們就可以使用雷達來核對自己估計的距離，餘輝的長度，是隨著本船結構與它船燈光特性而變。多注意幾次，我們就能掌握其訣竅。

1-40 Glare length on bridge

The purple spot is where a quartermaster standing while checking bearing of target. In Figure 1-23 we use the corner of second radar to help mark port side target bearing and the gap of radar and ECDIS to mark starboards side target at night time. In night time a close-range target's light will generate some glare on bridge window like Figure 1-24. It is obvious that the closer the longer of these glares. We can use this phenomenon for distance checking. Usually glare only visible in night time like daytime reflection on water in very closer range. If the reflection on water is not available the **glare length on bridge window can be used for warning sign of close-range target.** How many distance away when we saw light glares in different length on glass depends on ownship's structure and target vessel's property like squid vessel glare on sky can be seen even beyond the horizon. Night time lookout should use radar to verify the distance of target's light glare at sea. The distance judgement by light glare depends on our experience and diligent.

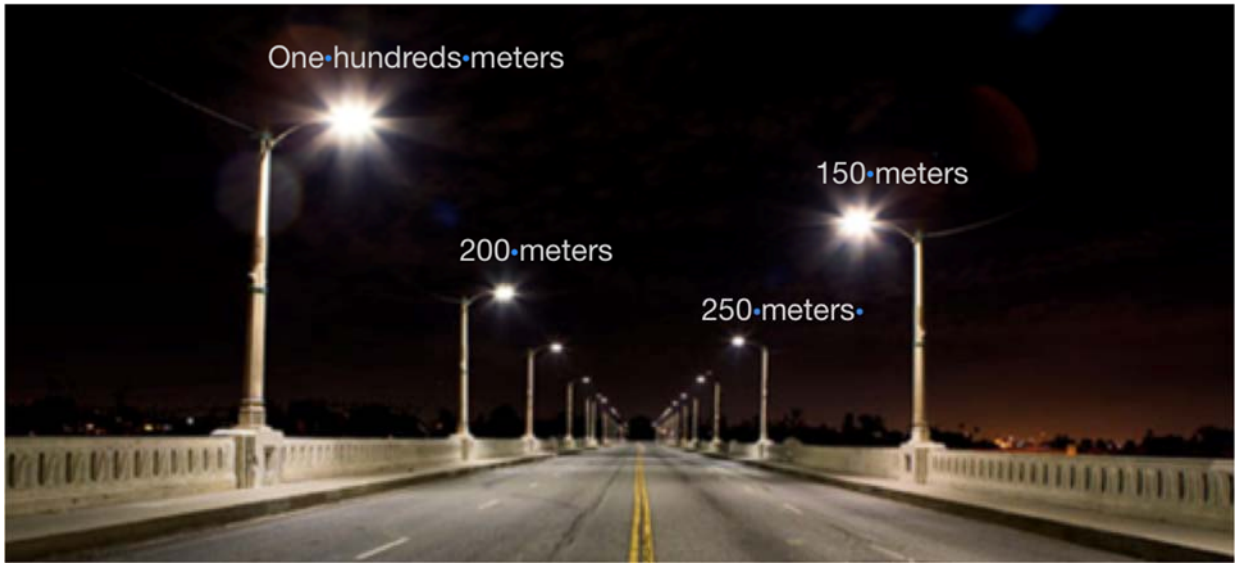


Figure 1-24: Glare on window of car at night time

1-2 甲板當值的情境感知

讓我複製一段過世瞭望與當值船副的對話，在悲傷的 2018 年 1 月 6 號發生的碰撞，這是官方的調查報告。

1-05 甲板當值的情境感知：視覺接觸

1-41 C-15：瞭望應該通知三副，這是一條大船

在當地時間，1935LT,C-15 碰撞前 15 分鐘，桑吉輪對地航向 358 度，對地航速是 10.4 節，雷達的游標放在長峰水晶輪上面，長峰水晶輪的回跡，並沒有被擷取，沒有阿帕的動態資料，而且這條船的自動識別系統，也沒有啟動。

瞭望提到：在方位 023 的雷達螢幕上，有一條船，他看到了紅燈跟綠燈，如同圖形 1-17。

根據瞭望的這個敘述，我們可以參考圖形 1-01， 4 號的船隻是朝向本船航行，我們可以同時看到它紅色與綠色的舷燈。

瞭望做的事是：他報告看到了目標船，報告它的方位是 023 度，此船是朝向本船航行，

情境感知：#瞭望用目視，知道這條是大船，但是三副不知道。

#瞭望應該通知三副，要馬上在駕駛台採取需要做的動作。

在 1935 當地時間，長峰水晶輪的距離是 5.4 海浬，方位是 023 度，瞭望應該繼續監測這條大船的方位變化，這條船將會哪一舷面對本船？這是我們的警覺。

是否是右對右舷通過？它不是紅綠燈都對著本船顯示？這是我們的直覺。

1-2 Situational Awareness for Rating

Let me copy the conversation of both deceased lookout and OOW on M. V. Sanchi in the sad date on 6 January 2018. (Report on the Investigation of the Collision between M.T. SANCHI and M.V. CF CRYSTAL on 6 January 2018)

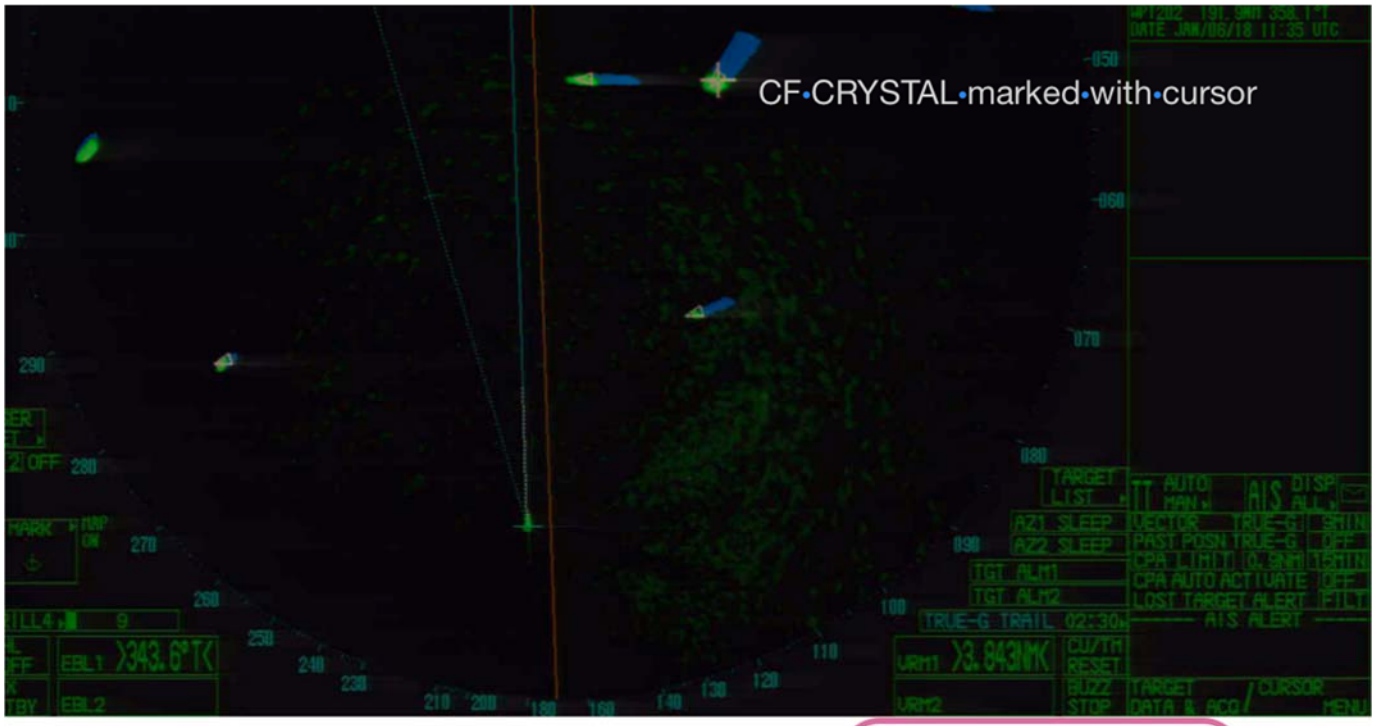


Figure17-SANCHI's X Band Radar Display at 1935：45LT（cursor on CF CRYSTAL）

1-05 Situational Awareness for Rating: Visual Contact

1-41 C-15: Lookout should inform 3/O this is a big vessel

At about 1935LT C-15 (15 minutes before collision), SANCHI's Course over Ground COG 358° and Speed over Ground SOG 10.4 kts. The cursor of X-band radar was marked on CF CRYSTAL. On the X-band radar, the echo of CF CRYSTAL was not acquired and AIS target was not activated either. **Lookout mentioned a vessel at a bearing of 023°** on radar screen and showing red & green lights. (Figure 17-)

According to this voice recorded of lookout, we can refer to Figure 1-01: vessel no.4 is heading toward ownship so we can see her green and red lights at the same time.

Jobs done by lookout: lookout had sighted target vessel and report target's bearing 023°, also the vessel is heading toward ownship.

Situational Awareness:

- ⇒ Lookout knew this vessel is big by visual but 3/O might not know. (sight awareness)
- ⇒ Lookout should inform 3/O this is a big vessel **which should be verified right now. (action needed)**
  At 1935LT, CF CRYSTAL's distance was about 5.4 nm and bearing was about 023°(T).
- ⇒ *Should lookout continue monitoring this big target vessel's bearing change or which side going to face us? (awareness of aspect or bearing change)*
- ⇒ *Is this starboard side to starboard side passage possible after few minutes as she is heading to ownship now? (instinct on work to be done)*

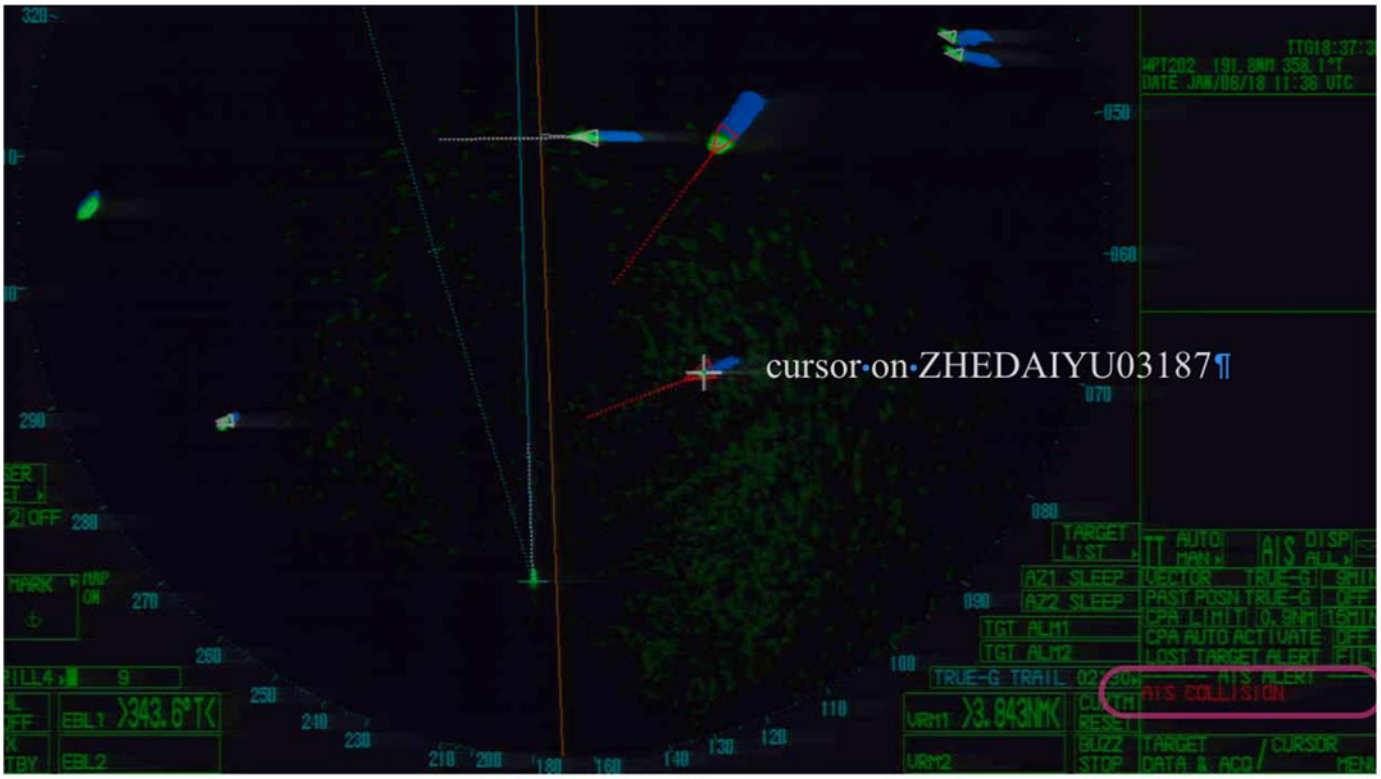


Figure18：SANCHI's X Band Radar Display at 1936LT（cursor on ZHEDAIYU03187）

1-42 C-14 ：現在瞭望應該知道，它船是左舷對我們的右舷

在 1936 當地時間，碰撞前 14 分鐘，圖形 1-18 桑吉輪的航向航速不變，長峰水晶輪距離 5.3 海浬。在漁船上的當值人員呼叫桑吉輪，使用特高頻頻道 16 VHF Ch.16，在這一時間，桑吉輪三公分雷達的遊標放到漁船的回跡上，過了一下子，AIS 的視覺碰撞警報，長峰水晶輪與漁船的，在桑吉輪的雷達上面，同時顯示。兩條船的回跡上面，都帶著紅色三角形的符號，這是兩條船 AIS 的碰撞訊息，在雷達的右下角顯示。如同圖形 1-18。
瞭望工作：遼瞭望並沒有報告這條方位 039 的漁船。
情境感知：它是距離最近的船隻，也許它是一條小船，應該優先處理。（警覺）。
瞭望沒有監控它的方位變化，與本船之間的距離，這是瞭望職責的一個疏忽。（行動）
現在瞭望用眼睛應該看到，並且知道，這條船是左舷對本舷右舷，並不安全，應該對這條船的方位變化，做一個確認。（警覺）
用來核對碰撞危機。（直覺）
瞭望是否能確認這兩條船的距離，使用他們燈光的位置，或是燈光高於水準線的高度，使用我們夜間判斷距離的技術。

1-42 C-14: Now lookout should know by visual this vessel is portside facing ownship starboard side.

At about 1936LT C-14 Figure 18: SANCHI's COG and SOG unchanged. CF CRYSTAL at a range of 5.3 nm. The watch keeper of ZHEDAIYU 03187 started calling SANCHI on VHF channel 16. At this time, the cursor of X-band radar was shifted to ZHEDAIYU 03187 (attention changed) and shortly afterwards visual AIS warning signals of collision of CF CRYSTAL and ZHEDAIYU 03187 were displayed on SANCHI's X band radar at the same time. *The triangle symbols of both targets turned red and the message "AIS COLLISION" appeared in the right lower corner of radar display.* (Figure 18)
Jobs done by lookout: lookout had not report this vessel with bearing 039°.
Situational Awareness:

⇒ Maybe it is a small vessel but it is the closest one should be taken care first. (awareness of collision priority)

⇒ Lookout did not check its bearing change or distance close to ownship. This is an overlook of lookout duty. (action had not taken)

⇒ Now lookout should know by visual this small vessel is portside facing ownship starboard side *which have to verify her bearing change (awareness) for checking collision risk. (instinct)*

⇒ *Can lookout verify these two vessel's distances by their light's composition or lights height against the horizon by our night distance skill? (skill)*

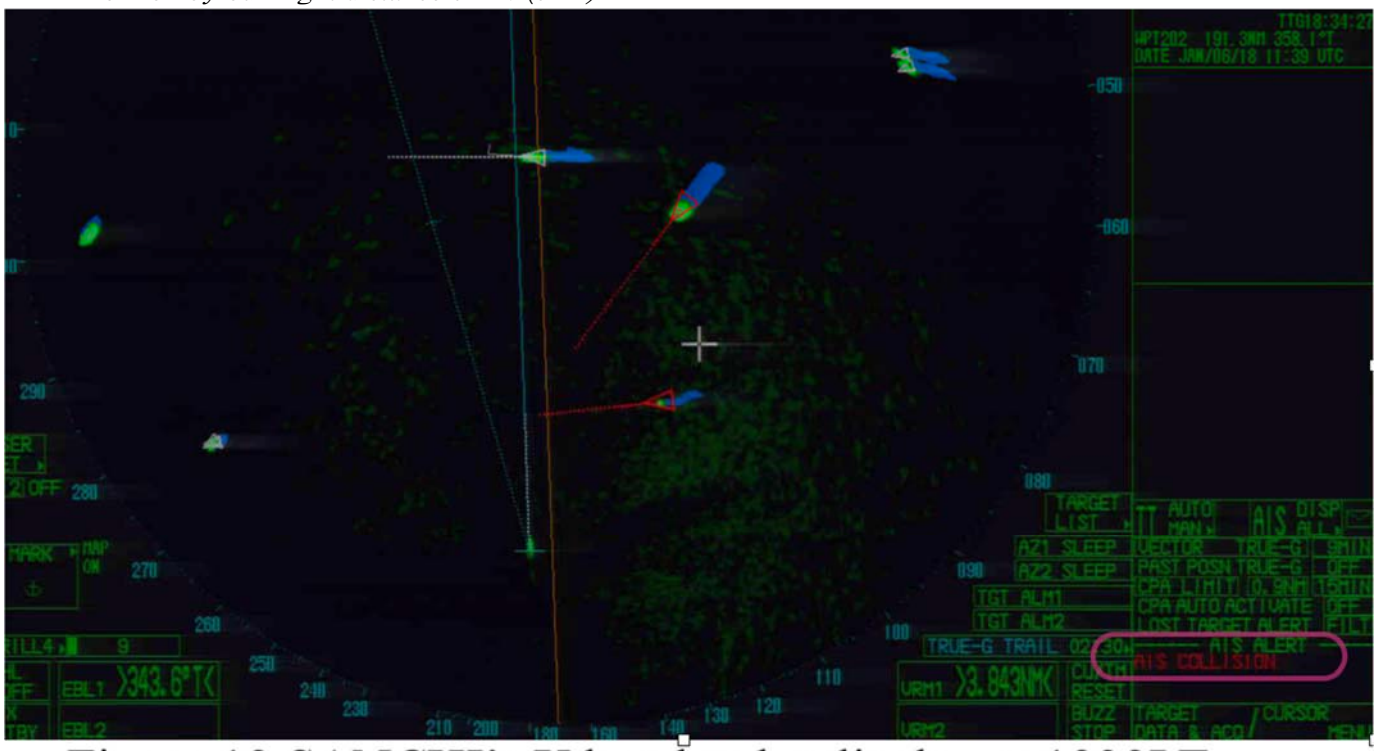


Figure 19 SANCHI's X band radar display at 1939LT

1-43 C-11:如果你不回答，他就要自行避讓

在 1939 當地時間，碰撞前 11 分鐘，3 分鐘後桑吉輪的對地航向 358（T），對地航速 10.4 節，維持不變，漁船繼續在 VHF 上面呼叫，桑吉輪三副說道：他在跟別人講話，知道嗎？不要回答這些呼叫，因為如果你不回答，他就不 ok 去行動，不覺得安全去行動，如果你回答，他就會認為，已經跟你確認他要採取的行動，所以他就會去行動。無論如何，他無線電裡面說什麼呢？搞不清楚，但是如果你不回答，他就會被迫去採取行動避讓，讓他自己可以通過。

AB 回答:這並不符合規則，那就是我們必須……，只因為我們不瞭解他們的語言嗎？

在這段時間，瞭望做的工作：

#AB 知道航路的規則，並且對船副詢問？

#瞭望沒辦法採取任何行動，依照他對這些小型船隻的經驗，碰撞警告來自於 AIS 的資料區，在雷達螢幕上面顯示了 3 分鐘。

#三副不願意回答這些無線電的呼叫，然後採取任何行動，希望呢這條漁船會被迫採取行動，讓他自己清爽。

#沒對目標做阿帕的擷取，三副會失去對這條船的警覺性。

#三副跟瞭望只是在等待，沒有採取任何行動。

#是否瞭望對碰撞有所目測，並沒有使用雷達和阿帕的資料，

#是否瞭望核對了這兩個危險目標船的方位變化，在這 3 分鐘的時間內，使用視覺的參考點。（直覺）

#三副是否知道，如何在 9 分鐘之前，設定第一個碰撞危機的視覺信號？（觀測方位變化的技術）

1-43 C-11: But if you don't answer, he shall be forced to take action to make himself clear.

At about 1939LT C-11 three minutes later, SANCHI's COG 358° and SOG 10.4 kts remained unchanged. ZHEDAIYU 03187 kept calling SANCHI on VHF radio. (Figure 19)

3/O said: "Oh, he's talking to another one. You know, never answer these calls. Because if you don't answer, it is not OK to action. But if you answer, he seems ... he confirms with you about his action. So, he takes action, whatever he said in the radio and you don't understand. But if you don't answer, he shall be forced to take action to make himself clear, *understand?*"

AB: "And this is not complying to the rules that I must oblige..... Because we don't understand their language?"

(Jobs done by lookout: AB knew the rules to give way and challenged at 3/O. This is assertation or his accountability to bridge team.)

Situational Awareness:

- ⇒ Lookout cannot take any action by his experience with these small vessels, collision alert by AIS data is on radar screen 3 minutes before. 3/O don't want to answer these calls and take any action in hoping this vessel will be forced to take actions to make himself clear. (complacency due to past success)
- ⇒ No ARPA target acquire of this vessel by 3/O. 3/O will lost situation awareness of this vessel. (no awareness of his status obiligation)
- ⇒ **Lookout and 3/O just wait. (no action)**
- ⇒ *Can lookout have collision estimation without radar or arpa? Does lookout had checked these two dangerous target vessel's bearing changes with visual reference mark for collision risk in these three minutes time? (no training no instinct)*
- ⇒ Does 3/O remember first visual sign of collision risk of large vessel 9 minutes before? (skill of bearing change)

1-44 C-9 我們能否使用水面反光，來知道漁船的距離？

在大約 1941 當地時間，碰撞前 9 分鐘，漁船的距離大約是 1.8 海浬。三副要求瞭望使用摩斯信號燈，對漁船發射注意信號。當值船副注意到漁船，已經開始向左轉向。

瞭望做的工作：AB 使用摩斯信號燈發射摩斯信號給漁船，遵照 3 副的指示。

情境感知：漁船開始向左轉向，通過本輪的船尾，因為他是在我們的右舷，1.8 海浬對三副來講，他仍然覺得安全。（警覺）

#繼續監視漁船的方位變化，或是他的視角，是不是變成右舷對右舷通過，在這麼近的距離通過，安全距離可能並不足夠。（行動）

本船比較幸運的是，先通過碰撞點，如果漁船比本輪先通過碰撞點，那他可能會進入本船的盲區，當有 AIS 的碰撞警告的時候，我們會找不到漁船在那裡？（直覺）

我們能否知道漁船的距離，使用他在水面的反光，或是駕駛台玻璃上的光線餘輝長度，這是在 1.8 海浬的距離。（技術）。

1-44 C-9: Can we know the fishing vessel's distance by her reflection on water?

At about 1941LT C-9, ZHEDAIYU 03187 was around 1.8 nm away. The 3/O asked lookout to give ALDIS signal to ZHEDAIYU 03187. The OOW noticed that the fishing boat started altering its course to port side.

Jobs done by lookout: AB give ALDIS signal to ZHEDAIYU 03187 by 3/O order.

Situational Awareness:

- ⇒ Fishing boat started altering its course to port side to pass ownship's stern for she is on our starboard side starboard to starboard). 1.8 nm away is comfortable distance to 3/O for fishing boat. (awareness)
- ⇒ **Continue monitoring fishing boat bearing change for starboard to starboard passing. Safe distance may not enough in this close range. (action)**
- ⇒ *It is lucky that ownship is ahead of collision point before fishing boat when she had alter course to portside. What happen if fishing vessel is ahead of ownship and inside ownship's blind sector when this AIS collision alarm activated?* (instinct)

⇒ Can we know the fishing vessel's distance by her light's reflection on water or her lights glare on window glass which is at 1.8 nm now? (Skill)

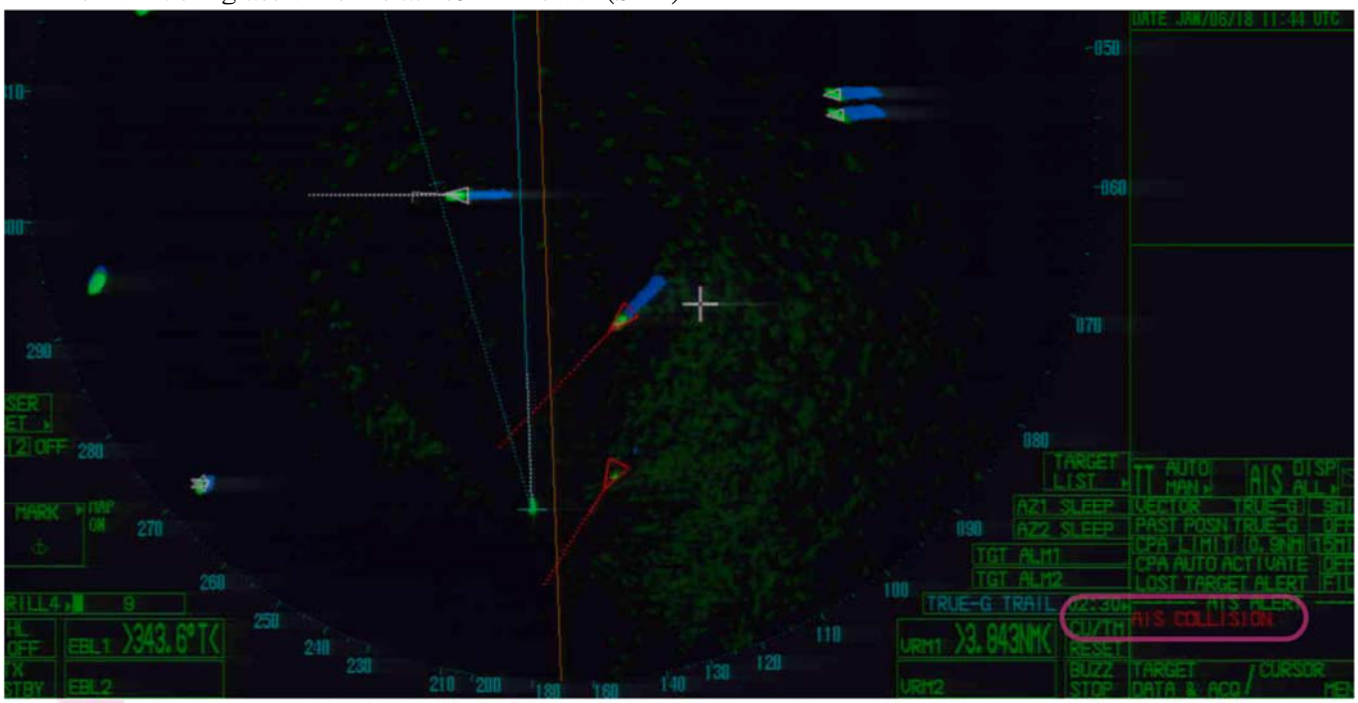


Figure 20 SANCHI's X band radar display at 1944LT

1-45 C-8 長峰水晶輪的雷達回跡，在近距離變小

在大約1 942當地時間，碰撞前8分，水晶論的衛星定位在30度52.4分北緯，124度59.2分東經，對地航向225度，對地航速13.2節，當值船副調整航向到225度完畢。桑吉輪在3.1海浬的距離，方位205度。大約在1944，碰撞前6分鐘，桑吉輪的對地航向358度，對地航速10.5節，如同圖形20。

三副說到這是一個困難的情勢。

情境感知：#AIS碰撞警報在雷達螢幕顯示，漁船會右對右，通過我們的船尾，這是我們的第一個警覺。

#另外一條大船在方位023度，這是由瞭望在1935時報告的，仍然是紅燈對綠燈，紅對綠，這是一個危險的徵兆，這是我們第二個警覺。

#大船的相對方位在過去9分鐘並沒有改變，這是我們的第三個警覺。

#長峰水晶輪的對地航向是225度(T)， 桑吉輪的方位是大約在205度，桑吉輪的方位是大約在長峰水晶輪的左舷20度。（碰撞危機的警覺）

#長峰水晶輪的雷達回跡，在近距離變小，這會造成三副錯覺，把它當作一條小型漁船的回跡。（很大的錯誤）

#兩條船為了安全，都需要監測他船方位變化。（直覺）

#我們能否分辨這是大船，使用視覺的線索，我們可以核對他的住艙，或是走道甲板燈等，或是駕駛台玻璃上，它航行燈的餘輝長度，更或者就簡單的使用望遠鏡，來觀察它的側影大小。（技術）

#三副是否知道，就在6分鐘內有碰撞危機，使用雷達的航速向量線的交點？（使用向量線的技術）

1-45 C-8: Radar echo of this vessel CF CRYSTAL became smaller in close-range.

At about 1942LT C-8, CF CRYSTAL's GPS position was 30°52′.4N/124°59′.2E, COG 225° and SOG 13.2 kts. The OOW completed the course adjustment to 225°. SANCHI was about 3.1 nm bearing 205°.

At about 1944LT C-6 6 minutes before collision, SANCHI's COG 358° and SOG 10.5 kts as Figure 20. The 3/O commented that it was a hard situation when he found CF CRYSTAL.

Situational Awareness:

⇒ AIS collision alert is on radar screen in Figure 20. Fishing boat is starboard side facing ownship's starboard side, starboard to starboard passage. Ownship will be OK with her. (first awareness)

⇒ Another big vessel at bearing 023° as aware at 1935 hours reported by lookout still have port side red light to ownship green light, red to green passage. (second awareness) This vessel relative bearing had not changed over 9 minutes. (third awareness)

⇒ CF CRYSTAL's COG is 225°(T) and SANCHI bearing is about 205°(T), SANCHI relative bearing is 20 degrees port side to CF CRYSTAL. (awareness for collision risk)

⇒ Radar echo of this vessel CF CRYSTAL became smaller in close-range **which cause illusion of 3/O regard it as a small fishing vessel's echo. (Big mistake both in Radar presentation and 3/O awareness.)**

⇒ *Both vessels need to monitor other vessel bearing change for safety.* (instinct)

⇒ Can we tell how big this vessel is by visual clues? By verifying her accommodation or stairway or deck lights or the glares of her COLREG navigational lights or simply use binocular to check her profile at night. (skill)

⇒ Can 3/O know collision risk is within 6 minutes now by speed vectors intersection point? (skill by speed vectors in next chapter)

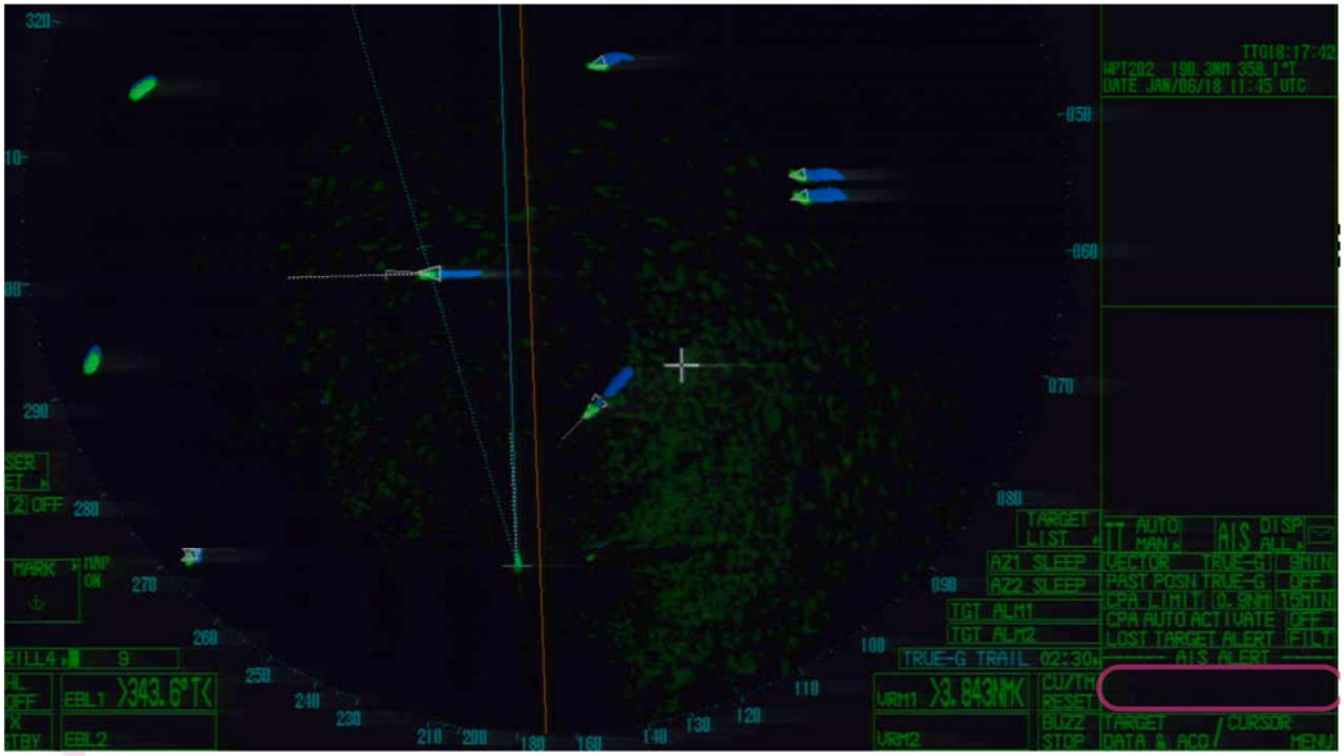


Figure 21 SANCHI's X band radar display at 1945LT

1-46 C-5 沒有對漁船保持視覺接觸，僅使用雷達瞭望會盲目。

在大約 1945 分鐘，碰撞前 5 分鐘，桑吉輪航向航速不變，358 度，10.5 節，漁船已經通過他的右正橫，長峰水晶輪的航向 223 度，航速 13.4 節，桑吉輪大約是 2 海裡的距離，方位 205 度，當值船副要求 AB 發射摩斯信號給長峰水晶輪。

瞭望做了工作：

#AB 對長峰水晶輪發射摩斯信號，因為三副的指示，沒有跟三副詢問應該採取什麼行動。

情境感知：右邊正橫這個漁船的雷達回跡，在雷達上不見了，也不知道這條漁船的船首像是哪裡？（大問題）

如果我們沒有對漁船保持視覺接觸，只有使用雷達瞭望，會對他的行動盲目無知。（警覺）

#漁船回跡馬上消失，讓三副心理壓力增加，不知何處可以轉向，用來安全的避碰？此時 AB 也沒有辦法幫助他，就算告訴他漁船的視覺方位。（直覺）

這樣大的船在 1.8 海浬的距離，雷達回跡的大小，並沒有比遠方漁船的回跡大。（雷達造成的錯覺）

#它是一個缺失，三副必須使用視覺瞭望來克服。（警覺）

#三副應該對大船小船，同時做視覺瞭望，保持我們對情況的感知。
#更糟糕的是，AIS 碰撞警報完全沒有了，這表示阿帕失去了 AIS 目標的資料。
#現在沒有紅色三角形，或是紅色速度向量線，錯誤的雷達回跡。（警覺）
#他們的住艙和甲板燈光，在這個距離，2 海浬，應該是可以目視得到。應該對他們的方位變化，持續的監控，確認他的碰撞危機，碰撞危機是立即的。（直覺來自於視覺的知識）
沒有碰撞的警報，與失去速度向量的雷達目標，這對當值船副是嚴重的缺失，法庭上應該被用來追溯它的責任，因為寶貴的人命，因此喪失。在現代的技術，這是可以輕易的客服的事，只要增加探測波發射的次數，使用電腦運算的能力，來確認目標回跡的強度跟尺寸。海運界從來沒有抱怨過雷達的缺失，不要說國際海事組織也是一樣。這就是為什麼，我們需要一直保持目標船視覺接觸，不能有所疏忽。
“任何船隻在任何時候，都應保持視覺瞭望”，我們不能只依賴雷達或阿帕，做為唯一的瞭望，造成目視瞭望能力的喪失。

1-46 C-5: If we did not have visual contact with fishing boat we will blind of her movement by RADAR lookout only.

At about 1945LT C-5 **5 minutes before collision**, SANCHI's COG was 358° and SOG 10.5 kts unchanged. ZHEDAIYU 03187 was almost abeam SANCHI's starboard. CF CRYSTAL's COG 223° and SOG 13.4 kts. SANCHI was about 2.0 nm distance away and bearing 205°.The OOW of SANCHI asked AB to give ALDIS signal to CF CRYSTAL. (Figure 21)
Jobs done by lookout: AB give ALDIS signal to CF CRYSTAL by 3/O order. No argue with 3/O for what actions should take. (against obligations of give way vessel to take action)
Situational Awareness:

- ⇒ Fishing boat is almost abeam our starboard. The echo of fishing vessel in radar is invisible now and no indication of where this fishing boat is heading. **Big problem.** If we did not have visual contact with fishing boat, we will not know her movement by RADAR lookout only. (awareness)
- ⇒ *The echo of fishing boat disappeared on radar will give 3/O mental pressure for not knowing where is safe direction to avoid collision? AB also cannot help him by give him visual bearing of target in this situation.* (o awareness no instinct)
- ⇒ For this big vessel 1.8 miles away now, her radar echo is no bigger than a fishing vessel far away. (illusion of target size in radar)
- ⇒ This is not acceptable to OOW but it is a reality has to overcome by OOW visual lookout skill. (awareness)
- ⇒ OOW should keep visual contact of both targets at starboard side to keep his situation awareness (using line of sight skill)
- ⇒ Even worse the AIS alert of collision is complete gone? (ARPA lost AIS target information)
- ⇒ **No red triangle and red speed vector of danger target now. Wrong radar echo size may cause serious Radar illusion. (lost APRA collision awareness)**
- ⇒ *Could* CF CRYSTAL *accommodation or alleyway lights can be visible from this range, 2 nm. Its bearing change should be monitored constantly for collision risk is imminent.* (instinct followed our visual awareness)

No collision alert and speed vector of radar target are serious deficiency which should be sued at court for human lives lost. In modern technology this can easily overcome by verifying target’s echo strength and size by computer calculation ability. Marine industries never complain of this deficiency nor IMO. That’s why we need visual contact all the time without fail. “**Every vessel shall at all times maintain a proper look-out by sight**”. We cannot rely on radar or ARPA as sole lookout means and lost our visual lookout abilities.

1-06 情境感知：右舷已滿

1-47 但是在這個情況，我能做什麼？右舷已滿

#碰撞前 5 分鐘，三副向瞭望說，在右舷我們有一條船，應該採取行動，但是在這狀況，我能採取什麼樣的行動？
#為什麼右舷是滿的，這兩個目標船有 1.8 海浬遠的距離。（這需要使用速度向量線的技術）。
#從一般的值更命令簿上面的需求，過洋船在大海上，最小的 CPA，應該是 2 海浬，近岸的時候（離岸 12 海浬），減少 CPA 到 1 海浬，保持 2 海浬這個距離呢，對過洋船隻來講，右舷是滿檔，但是在實際的海上，並非如此，CPA 不必這麼大，就像我們以前討論的。（警覺）
#我們可以創造一個左對左的情況，只需要把船頭轉向它船的船尾避讓。（行動）
#向右轉 25 度，（還記得三副曾經被告知，目標的方位是 023 度），就會改變兩條船的通航態勢，左對左。（直覺）
#從當值命令簿來看，應該減速來避免近接的狀況，如果改變航向，不能保持需要的 CPA。（警覺）
#每一個當值船副需要警覺，與確認減速是避碰的方法之一。（技術）
#對於船上的乙級船員，你可能需要大叫：“前面會碰撞，長官，撞船”，如果你能利用望遠鏡，知道目標船的距離，它船的大小。（直覺）
#本輪可以一直轉向到右舷 90 度，漁船在正橫位置。（目視的警覺，不是雷達）
#事實上，本輪只需要向目標船轉向 25 度，轉到目標船的船尾。（技術）
#右舷已滿，是的，從 000 到 025 度右舷是滿的，只要轉向超過 25 度，就可以自由轉向到 90 角度，這是我們應該具有的知識。

1-06 Situational Awareness: Starboard side is full

1-47 But what action can I take in this situation? Starboard side is full.

3/O spoke to the lookout (5 minutes before collision)：*...we have this one on our starboard side. We should take action.* But what action can I take in this situation? Starboard side is full.

⇒ Why starboard side is full? These two targets have 1.5 nm distance away. (awareness before take avoidance action)

From general standing order requirement: Final CPA with a target should be: - Ocean Passage: Minimum CPA 2 nm or - Coastal Waters (12 nm from land): Minimum CPA 1 nm. It is full from CPA requirement by standing order for ocean passage. Not in the real world, actually as we can see from above discussion,

⇒ we can create a port to port situation by turning our bow to CF CRYSTAL stern for avoidance. (action)

⇒ *Alter course 25° degrees to starboard side (remember 3/O been told target bearing is 023 degrees(T) on our starboard side few minutes before) will change two vessel's passing aspect to port to port. (instinct)*

⇒ Once again from standing order: Reduce speed to avoid close-quarter situations if alter course alone cannot provide the required CPA. (awareness of distance)

⇒ Every OOW must be aware and confident by reducing ship speed to avoid collision. (skill)

⇒ For rating on board in this situation, you may need to shout out loud "collision ahead, collision Sir "*if you can judge the distance of this vessel and know her size and type by binocular already.* (assertation or accountability)

⇒ Ownship can alter course up to 90° degrees to starboard side for fishing boat is at our beam now. (awareness by visual, not radar)

⇒ In reality, ownship only need to alter course to target's stern 025° (T). (skill)

⇒ Starboard side is full from 000 degrees to 025 degrees. After altering course 025 degrees, starboard side is free to go which is not full at all. (knowledge)

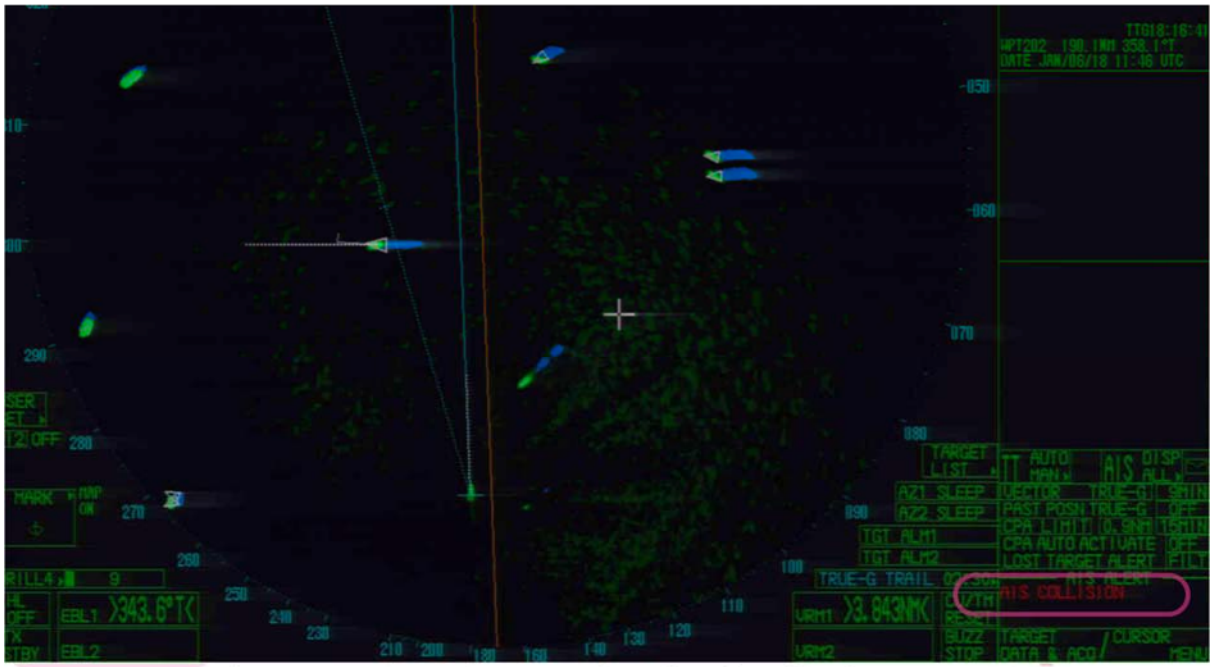


Figure 22 SANCHI's X band radar display at 1946LT

1-48 C-4:大副沒有向窗外或雷達裡面望望，就交班給三副

在大約 1946 當地時間，碰撞前 4 分鐘，桑吉輪的航向航速不變，漁船已從桑吉輪的船尾通過，向長峰風水晶論發射了連續的閃光摩斯信號燈，吸引他的注意力。
長峰水晶輪的駕駛台內，對地航向 225 度，對地速度 13.4 節，大副交班給三副時說，海面交通狀況是清爽的，沒有把另外一條船的狀況，向三副報告。接班的三副沒有看到桑吉輪的摩斯信號燈光。因為三副同意接班，大副不久就離開了駕駛台。
大副離開不久，過了一會，接班的瞭望來到駕駛台，交班的瞭望交代航向是 226 度，使用自動舵航行，然後就離開駕駛台。
長峰水晶輪瞭望沒有做的事：
#交班 AB 沒有看到桑吉輪的摩斯信號燈光，或是沒有交代。
#大副交班給三副，沒向窗外跟雷達裡面確認，而且他說交通狀況是清爽的。（這不是事實）
#而且並沒有把另外一條船的狀況，向三副會報。（沒有瞭望）
#交班的瞭望沒有向接班的瞭望，提到船隻的動態，大副也沒有。

1-48 C-4: C/O handed over the watch to the 3/O without looking outside window and inside radar.
At about 1946LT C-4: **4 minutes before collision**, SANCHI's COG 358° and SOG 10.4 kts unchanged. Fishing vessel cleared from SANCHI's stern. Signals to CF Crystal (5 short flashes by ALDIS Lamp) to attract attention. (Figure 22)
Inside the bridge of CF CRYSTAL COG 225° and SOG 13.4 kts. The C/O handed over the watch to the 3/O and he said the traffic was clear and did not mention the situation of another vessel. The 3/O did not see ALDIS signal of SANCHI. Then with the consent of the 3/O, the C/O left the bridge.
Shortly after the departure of the C/O, the 3/O's lookout came to the bridge to take over his watch from previous lookout who advised him of the steady course 226° and autopilot condition before leaving the bridge.
Jobs not done by CF CRYSTAL lookout:

- ⇒ AB did not see ALDIS signal from SANCHI or he did not speak. (no accountability)
- ⇒ C/O handed over the watch to the 3/O without looking outside window and inside radar. **(no visual lookout)**
- ⇒ and he said the traffic was clear (not true)
- ⇒ and did not tell the situation of other vessel. (no lookout)
- ⇒ relief lookout did not mention traffic around ownship nor chief mate. **(no visual lookout)**

1-49 在桑吉輪駕駛臺上

AB:查理已經過去了,是嗎? 向右一點? (不知道 AB 是否在下令，雖然乙級船員不應該下命令，AB 因為這個事件，已經犧牲了他的生命，他應該有權要求三副去做些事情。查理：中國人或共產黨）

三副：向右？為什麼？（可能感覺到 AB 在命令他）

AB： CPA 是多少？CPA 是零，零啊。（那為什麼你就不知道？是零，零）

1-49 Inside the bridge of SANCHI, AB: Charlie is passed, right? A little to starboard? (is this command mode), although rating should not give order. This AB had wasted his life in this incident so he is entitled to ask 3/O to do something.)

3/O: *Starboard? Why?* (sense the command)

AB: *What's the CPA? CPA is ... zero, zero.* (why you don't know? ... zero, zero)

1-50 C-3 碰撞前三分鐘，三副繼續說話，來緩解他的焦慮，壞習慣

在 1947 當地時間，碰撞前 3 分鐘，桑吉輪的三副，"這是條小船，對吧？"（小船應該向大船讓路，對吧？）

瞭望：不！大船。（醒醒，是大船）

三副：那為什麼他要這樣子行動？（三副並不知道來船，並沒有看到本輪的摩斯信號燈光，三副繼續自言自語，來減少他的對碰撞焦慮，壞習慣。）

桑吉輪瞭望做的不錯的事：

#向長峰水晶輪發出摩斯信號燈光，依照三副的指示。

#要求三副採取避碰行動。

#通知三副老共已過，暗示右舷漁船已經清爽。

#提醒三副向右邊一點，提醒轉向右舷 25 度，就足夠長峰水晶輪的相對方位。（這就是他在 1935 當地時間，向三副報告的，右舷 23 度的方位，有一條大船）方位不變？

#AB 向三副挑戰，提醒他一個簡單的事實，"CPA 是多少?CPA 是零，零嘢"。

#瞭望回答三副有關於來船大小的問題，"不！這是大船"，這是個很精明的瞭望。

1-50 C-3: 3/O keeps talking to ease his anxiety of collision. it is a bad habit.

At about 1947LT C-3, SANCHI 3/O: ...*It's a small vessel, right?* (complacency…. small vessel should give way to ownship, right?)

Lookout: *No, big vessel.* (wake up, it is BIG.)

3/O: *So why is she intending to take action like this*? (The SANCHI 3/O did not know coming vessel did not see ownship's ALDIS signal. 3/O keeps talking to ease his anxiety of collision. it is a bad habit.)

Jobs well done by SANCHI lookout:

- ⇒ AB give ALDIS signal again to CF CRYSTAL by 3/O order.
- ⇒ Ask 3/O to take avoidance action.
- ⇒ AB waited till "Charlie is passed, right?" which imply starboard side is clear and
- ⇒ advised "A little to starboard?" Alter course 25 degrees to starboard side will be enough as CF CRYSTAL relative bearing (Another big vessel at bearing 023° as aware at 1935 hours reported by lookout) had not changed.
- ⇒ AB challenged 3/O and reminded him the truth "What's the CPA? CPA is ... zero, zero."
- ⇒ Lookout answered to 3/O's small vessel question "No, big vessel." **Smart lookout.**

1-07 情境感知: 說服的公式

1-51 AB 對三副下達指示，如果你知道如何說服

桑吉輪的駕駛台內，情境感知：

#長峰水晶輪的雷達回跡大小，就像一個小型的漁船，也沒有紅色速度向量線的警報，雖然呢，AIS 警報呢在雷達螢幕上，再度出現。（螢幕上提供了錯誤的參考）

#三副沒有參考雷達上面的碰撞危機。（沒有碰撞目標的速度向量線）
#碰撞目標的回跡，給三副一種錯誤的資訊，因為三副說，“這是一條小船，對嗎？”（就是因為參考到了，錯誤的回跡大小）
#目標船距離是 1.5 海浬，他們的住艙及走道燈光，應該看的到，或許會在水面產生反光，在這 1.5 海浬的距離。(沒有目測距離的訓練，就會缺乏目視的直覺）
#三副沒有採取任何行動，他有需要的每一項資訊，已經超過兩分鐘了。（三副沒有碰撞時間的警覺性，這需要雷達瞭望的技巧，這我們會在下一章討論）
#沒有目測距離的訓練（實習生），或是雷達截取目標資料的能力（當值船副），三副失去了他所需要的情境感知的能力。（只有聽說 AB 的言語，三副無法立刻做出決定性的行動避碰。
#避碰行動所需要的航向改變，不是稍微向右轉一點，像值班 AB 說的，至少需要轉向 23 度。（這是目標的雷達相對方位），在這麼近的距離，（目標距離只有 1.5 海浬），（我們改變航向的直覺來自於我們對航向改變的知識跟警覺）。
C-3 碰撞前 3 分鐘被認為是避碰的最後時機。（請參考第九章）
#這個危急的情況，是否應該再次通知（命令？）三副。來船隻有 1.5 海浬的距離，瞭望應該對三副，大叫些什麼來警告他？（這是我們做主張時的直覺，如何有效的溝通？）。
“這是大船，三副，轉向或者是立刻減速，我是不是該打電話給船長？”（這些敘述給了三副全部的事實，但是並沒有多大的功效）。
應該改成下麵的講法：
“是否該叫船長？”（先提到船長，提醒三副，因為三副受船長監督，被認為是船長的代表，會讓他恐懼，同時也表達了我對情況的評估）
“前面就要碰撞，”（加上這一個事實，加上另外一個三副不敢想，也不願意提的事實與恐懼，到他的腦海，這還是在理性的階段）
“我害怕”（再加上新的感覺，AB 對於碰撞的感覺，強迫出三副內心害怕的感覺，這是在感性的層面）
“你需要轉向或立刻減速。”（這是提醒三副應該要採取的行動，這是同時也是對三副的命令。）
如果你瞭解說服的公式就是：事實+ 事實+ 疑問 + 命令。這是一個很大的題目，我沒有打算在這本書裡面，加以說明，可以參考我在ＹOUTUBE 的講座。）

1-07 Situational Feelings: Persuasion formula

1-51 An instruction of AB to 3/O if you know persuasion formula.

Situational Awareness (Inside the bridge of SANCHI):

- ⇒ CF CRYSTAL ‘s radar echo size is like a small fishing vessel with no red speed vector although red AIS alert is on screen again. (wrong awareness and presentation of target size provided by RADAR)
- ⇒ SANCHI 3/O have no reference on radar screen about collision risk. (awareness: No speed vector of collision target)
- ⇒ **This echo gives a wrong information to 3/O who said “It's a small vessel, right?” (use error reference of echo size on radar screen)**
- ⇒ *Target vessel is 1.5 nm distance away. Their accommodation and alleyway lights should be visible from this range. Navigational lights may have reflection on water at 1.5 nm too. (lack of visual training so lacks of instinct from visual)*
- ⇒ **3/O had not taken any action when he knew every information he needed over past 2 minutes.** (3/O has no awareness of collision time from radar lookout which will be discussed in OOW chapter.)
- ⇒ **No visual skill of distance judgement (rating level) and ARPA acquired target data (OOW level), 3/O lost situational awareness he needed.** (by hearsay of AB, 3/O cannot make decisive action immediately)
- ⇒ The course change needed for avoidance is not only “A little to starboard?” as Duty AB said. Ownship have to alter course to 023° (target’s bearing at radar) in this close quarter situation (target’s distance *1.5 nm* from radar). (instinct from course change knowledge and awareness which will be discussed later)
- ⇒ **C-3: is 3 minutes before collision which is considered as last chance to avoid collision. (Refer to last chapter 9.)**

⇒ *Should AB remind 3/O again of this critical situation (1.5 nm distance away)? What lookout should shout to warn 3/O again? (instinct in assertiveness: effective communication)*

It's a big vessel. 3/O, alter course or reduce engine right now. Should I call Master now? (these statements had given whole truth but not effective)
Should I call Master? (mentioned Master first to remind 3/O: add new fear factor in 3/O consideration he is supervised by Master, also express my evaluation of situation now)
Collision Ahead. (add the truth: another fear word didn't mentioned and 3/O didn't want to admit in his mind. All in rational ground)
I am afraid. (Add new feeling: AB's own feeling of collision "I am afraid" and compulsive feeling beside all fear factors provided to 3/O already and bring "I am afraid" out of 3/O mind. Add emotional ground)
You need to "alter course or reduce engine right now". (actions need by 3/O, it is also an instruction of AB to 3/O if you know persuasion formula of "truth + truth + question + instruction")

1-52 這條船的BRM 文化

在長峰水晶論的駕駛臺上，航向226度，航速13.5節，瞭望通知三副，雷達上目標CPA只有0.2海浬，船副也注意到了雷達目標，然後心想這是一條小船。（再一次真正的危險，被雷達回跡混淆）
長峰水晶論瞭望做好的工作：瞭望提醒三副目標CPA只有0.2海浬，由雷達上AIS系統的資料。
情境感知：瞭望從雷達取得AIS資料裡面的資訊。在雷達上目標只有一個回跡，並沒有目標的尺寸，容易被誤認為小船。（警覺的錯誤）
#三副假設近距離的目標，就是一個小目標。（這是錯誤假設，內心的第一個想法，是習慣性錯誤，現在沒有目標的視覺線索）
#三副應該要求瞭望，去核對窗戶外面，到底是什麼樣的船隻？三副分派工作給瞭望，這同樣暗示這是你的工作。（作為一個瞭望，應該確認目標的性質。）
#瞭望應該幫忙確認目標性質，如果他夠熟練，不是只有等待三副的命令。（這就是這條船的BRM文化）
#三副應該監控目標的距離跟方位，從雷達的螢幕上，或是從窗戶外面的目視線索，這要依賴於他的夜視能力的調整。（直覺）

1-52 BRM culture of this ship.

Inside the bridge of CF CRYSTAL's COG 226° and SOG 13.5 kts. The lookout reminded the 3/O that the CPA of SANCHI's AIS target on radar was around 0.2 nm. The OOW also observed the target by radar and thought it was a small vessel. (once again same as SANCHI's 3/O, the real danger is confused by radar target's echo size)
Jobs well done by CF CRYSTAL lookout:

⇒ The lookout reminded the 3/O that the CPA of AIS target on radar was around 0.2 nm.

Situational Awareness:

⇒ Lookout get target information from radar / AIS target data. (in radar, target is only an echo regardless the size. Wrong Awareness from radar)
⇒ 3/O assume short distance target is a small target first. (first thing in mind is habitual error, no visual clues of target at this moment)
⇒ **3/O should ask lookout to check outside the window. "What kind of ship?" (action to assign workload to AB on bridge, it also implies that this is your job as a lookout should verify target's property.)**
⇒ *Lookout may help in verifying visual clues of this target if he is prudent, not just waiting 3/O order. (*BRM culture of this ship*)*
⇒ *3/O should verify AIS target distance and bearing from Radar screen and visual information outside the window depend on his night vision adjustment skill. (instinct as chapter 1-36)*

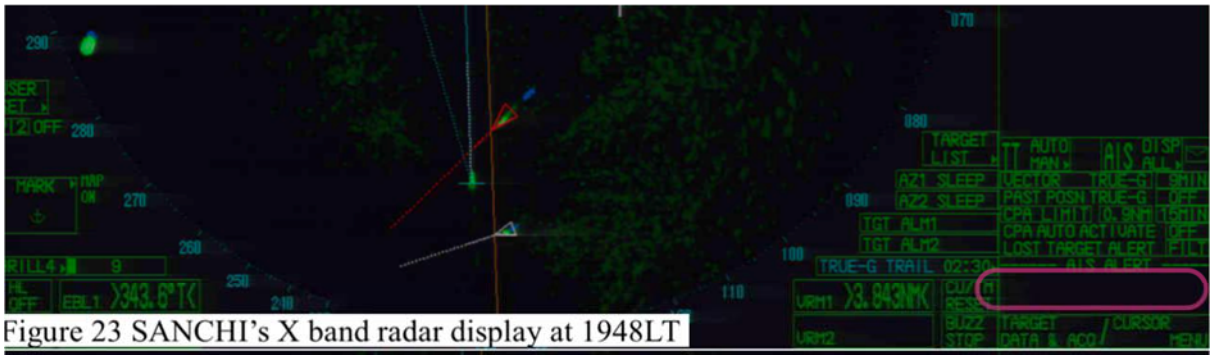


Figure 23 SANCHI's X band radar display at 1948LT

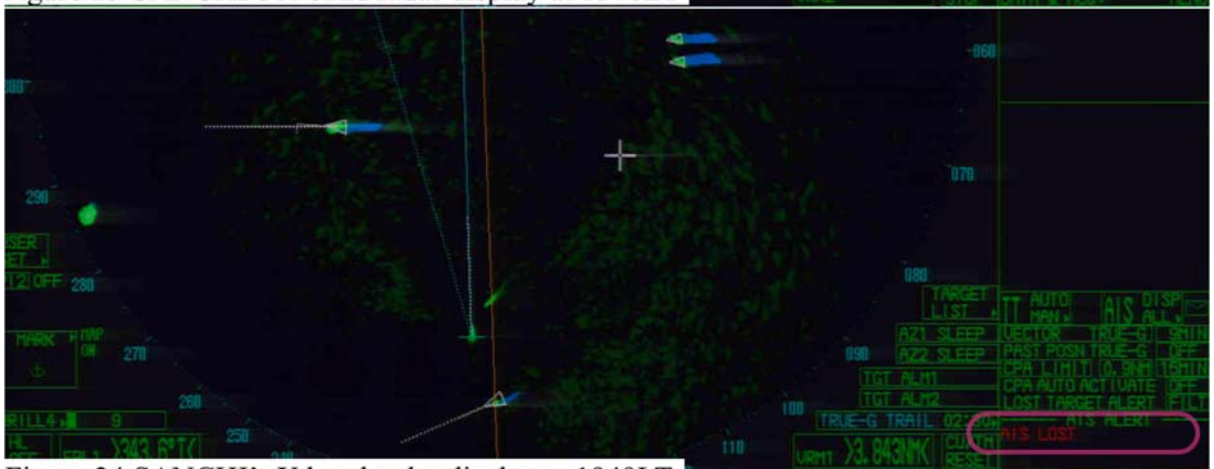


Figure 24 SANCHI's X band radar display at 1949LT

1-08 情境感知：立即的碰撞危機

1-53 C-2 優先錯誤或推給權威的天性

大約在 1948 當地時間。碰撞前兩分鐘，在桑吉輪的駕駛台，衛星定位的位置是北緯 30 度 50.7 分，東經 147 度 57.6 分，對地航向 358 度，對地航速 10.5 節不變。三副打電話給船長說到，"右舷有一個目標，CPA 為零， 距離很近，他是條大船。"

桑吉輪瞭望做的工作：瞭望提供所有資訊後，並沒有要求三副採取行動。

#瞭望在等待行動指示。

#瞭望沒有說話，只有等待。（沒有說出那些他希望講的話，那些他永遠沒有機會對任何人說的話，他的生命 5 在分鐘後，即將結束）

情境感知：長峰水晶輪的雷達回跡，像剛通過的小漁船一樣大，但紅色三角形危險標記，紅色向量線的記號，已重新出現，雖然紅色的 AIS 碰撞警報，又再度遺失。（雷達提供的警覺性不夠）

#雷達的這個回跡，對於當值船副是錯誤的示範，如果他沒有保持視覺的接觸。(警覺喪失)

#在這麼近的距離，兩分鐘內都沒有航向改變，或是減速，（1.5 海浬，也許三副在緊張與強大的心理壓力下，以至於他不曉得應該怎麼做？）

#三副決定打電話叫船長，而不是由他自己先採取行動避讓。（這是一個錯誤的優先順序，或是來自他推給權威的天性。）

#呼叫船長也是好的，但是可以由 A B 來打電話。（三副可以繼續對目標做評估，或立刻採取必要的行動避讓。）

#三副不能對現在的情勢，做一個簡單的結論，來向船長簡報立即的碰撞危機。（不知道該怎麼做的心理壓力，會減慢他決策的能力）

#船長從現在的雷達畫面裡，又能夠得到什麼樣的資訊？（直覺？）

#船長剛上駕駛台，並且他的眼睛還沒有辦法適應夜間的視力。並且他必須為船上 32 條人命，立即做決策？（快速決策？）

#船長出了寢室，應該有一隻紅光手電筒，避免視力受燈光影響。

#雷達螢幕上，速度向量線，紅色三角形與碰撞警報的文字，這三者來來去去，忽隱忽現。（看不看得到是運氣？）

#三副把所有關鍵性資料，都在電話裡，告訴船長，他自己卻無法採取明確的行動。（第 16 條沒有及早實質的避碰行動，第二條無法避免立即的危險）

#三副也沒有保留足夠的時間，給船長去評估情勢。（三副知道情況嚴重，但是他不知道還剩多少時間？）
#兩分鐘的時間，也不足以解決碰撞危機。（這要在以後章節裡討論）
#從碰撞前 4 分鐘到碰撞前 2 分鐘的時間，都被三副浪費掉了。
#三副在碰撞前兩分鐘，才通知船長。
碰撞前三分鐘，才是避碰的關鍵，卻被三副浪費掉，因為缺乏相關的訓練與知識。（參閱本書第九章）

1-08 Situational Instincts: collision risk is imminent

1-53 C-2: Wrong priority or defer to authority by human nature

At about 1948LT C-2 two minutes before collision, Inside the bridge of SANCHI, GPS position was 30°50′.7N / 124°57′.6E, COG was 358° and SOG 10.5 kts. (Figure 23) the 3/O called the Master and said: ... ‘*We get a target on starboard side and CPA is zero. Distance is very short. It's a big vessel.”*

Jobs done by SANCHI lookout*:*

- ⇒ Lookout did not ask 3/O to take further action after give all information.
- ⇒ Lookout just waits for instruction.
- ⇒ Say nothing just wait. Those words he may want to say never have the chance to say to anyone. His live finished after 5 minutes.

Situational Awareness:

- ⇒ CF CRYSTAL ‘s radar echo size is like small fishing vessel ZHEDAIYU 03187 just passed with red speed vector and triangle mark appear again although red AIS alert is missing again. (awareness in radar)
- ⇒ This echo gives a wrong presentation to OOW if he didn’t have visual contact. (awareness)
- ⇒ **Two minutes later without any course change and speed reducing in close quarter situation (1.5 nm away, 3/O may immobilize and shock by the situation and have no clues of what to do in very short distance).**
- ⇒ **3/O decide to call master two** minutes before collision **rather than take action first. (**wrong priority or defer to authority by human nature**)**
- ⇒ **Call the Master is good. It can be done by AB. (3/O can continue his assessment of situation or take necessary actions immediately)**
- ⇒ **3/O cannot get a simple conclusion with current situation and brief to Master” collision risk is imminent”. (Mental pressure of not knowing what to do will slow down the decision ability.)**
- ⇒ *Image what information Captain can get from this RADAR picture?* (Instinct: when he just arrives and his eyes still cannot adopt to night vision and he has to make decision for 32 lives on board immediately? A prudent captain will use his own red LED flash light to maintain his night vision after leaving his cabin on the way to bridge.)

With all these three: speed vector, triangle danger mark and AIS alert come and go interrupted.

- ⇒ 3/O had given some information captain need for decision making in telephone. (awareness)
- ⇒ 3/O did not act as captain’s behalf to execute collision avoidance action immediately. (lost situation awareness in COLREG 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* and no instinct of correct collision avoidance according to Rule No.2 “*make a departure from these Rules necessary to avoid immediate danger*”)
- ⇒ 3/O did not give enough time to Captain to evaluate. (3/O knew this but did not know how much time left for captain?)
- ⇒ 2 minutes before collision may not enough for captain to solve this risk. (3/O did not know this, we will discuss later)
- ⇒ 3/O had further waste 2 minutes in waiting master to come. (3/O did not know this, from four minutes before collision C-4 till now C-2)

⇒ 3/O called Captain 4 minutes before collision. (awareness)

C-3: 3 minutes before collision is the last chance for safety which is wasted by 3/O due to lack of training by Master and knowledge of this kind. (please refer to chapter 9)

1-54 碰撞只能發生在一個地點跟一個時間

大約在1948當地時間，碰撞前兩分鐘，在長峰水晶輪的駕駛台裡，它的對地226度，對地航速是13.5節，AB提醒船副目標的CPA只有0.1海浬遠。

長峰水晶輪瞭望做的事：

#也許AB是從雷達上面，讀到目標船的資料。

#AB並沒有完整的向三副報告，該目標的方位與距離。（AB不能使用雷達的游標與電子方位線）

#一般的雷達測繪，使用3分鐘或6分鐘的速度向量線，來推測他船的航向航速，特別是雷達和阿帕上，需要等到另外一條船，在新的航向穩定了以後，才能測繪。

#當目標還在5 或6海浬遠的距離，這測繪時間的延遲，可能需要等待將近3分鐘。當目標在碰撞前4分鐘或3分鐘的時候，這種3分鐘的延遲，就沒有辦法接受，因為碰撞可能馬上就要發生了。航向變更也需要用3分鐘的時間完成，以免碰撞。

情境感知：

#三副仍然在研究，1分鐘前瞭望給他的資訊。（碰撞前3分鐘到碰撞前兩分鐘，三副都沒有採取任何行動避碰）

#三副沒有打給船長，檢查完桑吉輪的距離後，他也沒有做任何事。（沒有近接情勢的警覺性：避碰規則第十七條：不論任何原因，當船隻需要保持航向航速，發現本輪已經太接近碰撞，碰撞無法由讓路船的單獨行動解除，應採取最佳的避碰行動。）

碰撞只能發生在一個時間跟一個地點。每一個人都認為，這麼大的船，長峰水晶輪的碰撞會隨時隨地的發生。事實上，避碰並不難，只要改變你的速度向量線，改變你的航向航速，碰撞點的位置就會馬上改變。如果我們知道關鍵時刻是，碰撞前三分鐘，在這三分鐘前改變航向或航速，碰撞的情勢就可以避免，或消除。

1-54 Collision can happen at one place and one time only.

At about 1948LT C-2, Inside the bridge of CF CRYSTAL's GPS position was 30 ° 51′.5N / 124°58′.1E, COG 226° and SOG 13.5 kts. The AB reminded the OOW the CPA of one target was 0.1 nm.

Jobs done by CF CRYSTAL's lookout:

⇒ AB reminded OOW the CPA of one target was 0.1 nm. (maybe AB read it from RADAR)

⇒ AB did not report fully about the distance and bearing of target. (AB cannot use radar cursor and EBL)

Usual radar plotting use 3 minutes or 6 minutes as a unit to derive other vessel's speed and course, especially radar or ARPA plotting has to wait another vessel had steady on their new course. These time lag of 3 minutes to wait for necessary data is acceptable when target is far away, 5-6 n miles. In C-4, C-3 situation this 3 minutes lag is not acceptable due to collision may happen just after radar/ARPA plotting finish. Also, **3 minutes time C-3 is needed to complete one course change to avoid collision**. (discuss later)

Situational Awareness:

⇒ 3/O still study the information of lookout since last minutes. (no action been taken in C-3 and C-2 situation)

⇒ 3/O did not call master nor he did anything after check the distance of SANCHI. (no awareness of close quarter situation: COLREG Rule No.17 "*(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.* ")

Collision can happen at one place and one time only. Everybody thinks collision of this big vessel CF CRYSTAL can happen any place and any time. Actually, the escape plan is easy. If you can change your speed vectors which is set up by your current course and speed from your current collision situation the collision risk

will change in the same time. If we know the critical time is last 3 minutes and try to change something in speed or course 3 minutes before, the collision situation may be avoided or mitigated by our decisive actions.

1-55 C-1 不同大小船隻的回轉特性

大約在 1949 當地時間，碰撞前 1 分鐘，桑吉輪航向航速不變，
三副說道”為什麼他不採取行動，他，是瞧不起我們嗎？”
情境感知：
#三副仍然希望他的摩斯信號燈光，能發生一些效果。
#駕駛台的瞭望試著告訴三副的是，“依照避碰規則，本船有讓路的義務。“
#但是三副使用他自己的“大小船因 VHF 通話，產生義務轉移的理論”，來打斷瞭望警告的話。
#三副的長期記憶，受到壓縮，因為近距離的大目標，過去沒有經驗過。
#三副認為別的船隻是在測試他的耐性，或是認為別的船隻是在瞧不起他，“在這種情況下，沒有考慮到本船的大小“。
#三副忘記他在碰規則裡面，讓路的義務。
#三副仍然陷在他自己，小船要讓路義務的場景裡面，雖然值班的 AB 已經修正他，來的不是小船。
#三副把這個情況推給船長，在這麼近的距離裡。
#三副說道“向左舷走，全速向左轉，噢！天啊！右滿舵，右滿舵，滿舵，滿舵，求求你”
情勢感知：三副想要向左轉，當大船從右舷接近，這似乎是正確的。依照規則第二條，“違反本規則的必要行動，以避免立即的碰撞”
#向左走，全速向左，（不幸的，轉向須已經晚了 3 分鐘，左滿舵在 3 分鐘前，碰撞前 3 分鐘有用，但是現在已經沒用。有效改變航向的時機點，需要瞭解船隻的回轉性能，這會在以後的章節討論）
#全速向右，右滿舵，滿舵，滿舵，請你。（當三副看到本船的船頭通過來船的船頭，決定避免本船的船中部分，被來船撞到）
#在 19 點 49 分 28 秒，船長來到駕駛台，（碰撞前 30 秒，在這麼短的時間裡，他沒有辦法做任何事情來改變碰撞，但是可能可以減輕碰撞的力道。）
#三副說道“船長他沒有採取任何行動”（本船也沒有採取任何行動，也沒有任何回轉的動量，表示本船也是在最後一刻才用舵）
#船長說道“右滿舵，右滿舵”。（船長可能不知道本船船頭的位置，跟來船頭的位置，他可能只是隨著三副的舵令，這是他的直覺）
圖形 1-25 大小船的回轉特性
情勢感知：桑吉輪的船長
#桑吉輪在回轉的第一階段，實在沒有辦法脫身，不管用的是左滿舵或右滿舵。
#停止主機可以減輕碰撞力道，在這麼近的距離，是唯一選項，而且也是避碰規則 8 的義務，“如果有必要避免碰撞或允許更多的時間來判斷情勢，船隻可以減速 停車，使用停止或反轉推進的方式。

圖形 16 是我們從 MAIB 的調查報告裡面拷貝的，我們可以看到船隻回轉，需要最少 1.5 倍本船長度的前進距離，才能開始離開原來的航線。（這是由本船的全長來決定）
#要避免碰撞，當使用了滿舵以後，貨櫃船需要最少 3.5 倍本船長度的距離，油輪散裝船需要 1.5 倍本船全長的前進距離，回轉才能生效。
#當使用了滿舵以後，油輪或是散裝船需要比較少的前進距離，回轉避碰。
#船長沒有辦法知道，本船的船頭位置，船頭前桅的綠色操舵燈，也許有幫助，所以我們在他船接近的時候，應該要把操舵燈打開，以備緊急時的使用。

1-55 C-1: Turning characteristics of different size container vessels.

At about 1949LT C-1 one minute before collision, Inside the bridge of SANCHI's, COG was 358° and SOG 10.5 kts unchanged. (Figure 24)
3/O: *Oh, why is she not doing anything? Oh man, he's judging.*
Situational awareness:
⇒ 3/O still hope his ALDIS light will have some effect.

⇒ The lookout on bridge try to tell 3/O is “ownship is obliged to give way vessel in COLREG”.
⇒ but cut short by 3/O obligation shift theory between ownship and small vessels in VHF communication.
⇒ 3/O long term memories of past experiences are compressed by mental pressure of close quarter target and
⇒ he thinks other vessel is testing his patience in this situation or disregard his vessel’s size at sea.
⇒ 3/O forget his duty of give way vessel in COLREG.
⇒ 3/O still stuck in his own small vessel obligation shift scenario although duty AB had corrected him it is not a small vessel.
⇒ 3/O refer this situation to Captain in this close distance.

3/O: *Go to port side, full port side. Oh, man! Full starboard side, full starboard side. Full, full, please.*

Situational awareness:

⇒ 3/O go to port side when big vessel approaching from starboard side in close range may be correct according to Rule No.2 “*make a departure from these Rules necessary to avoid immediate danger*”.
⇒ *Go to port side, full port side.* (Unfortunately, course altering time is 3 minutes late. *full port side* will work 3 minutes ago C-3, not now. The timing to alter course will need the understanding of vessel’s turning characteristics which will discuss later.)
⇒ *Full starboard side, full starboard side. Full, full, please. (*when 3/O saw ownship’s bow already passed approaching vessel’s bow, he decided to avoid ownship’s midship section been hit by approaching vessel.)

Captain comes to bridge at 19:49:28LT (30 seconds before collision: in this short time interval nothing Captain can do to change collision situation but to mitigate the impact a little.)

3/O: *Captain, she did not take any action. (*ownship did not take action neither. Ownship did not have any turning momentum)

Captain: *Hard to starboard, hard to starboard.* (maybe Captain have no way to know ownship’s bow position related to coming vessel when he first comes to bridge. He just follows rudder order of 3/O. Instinct)

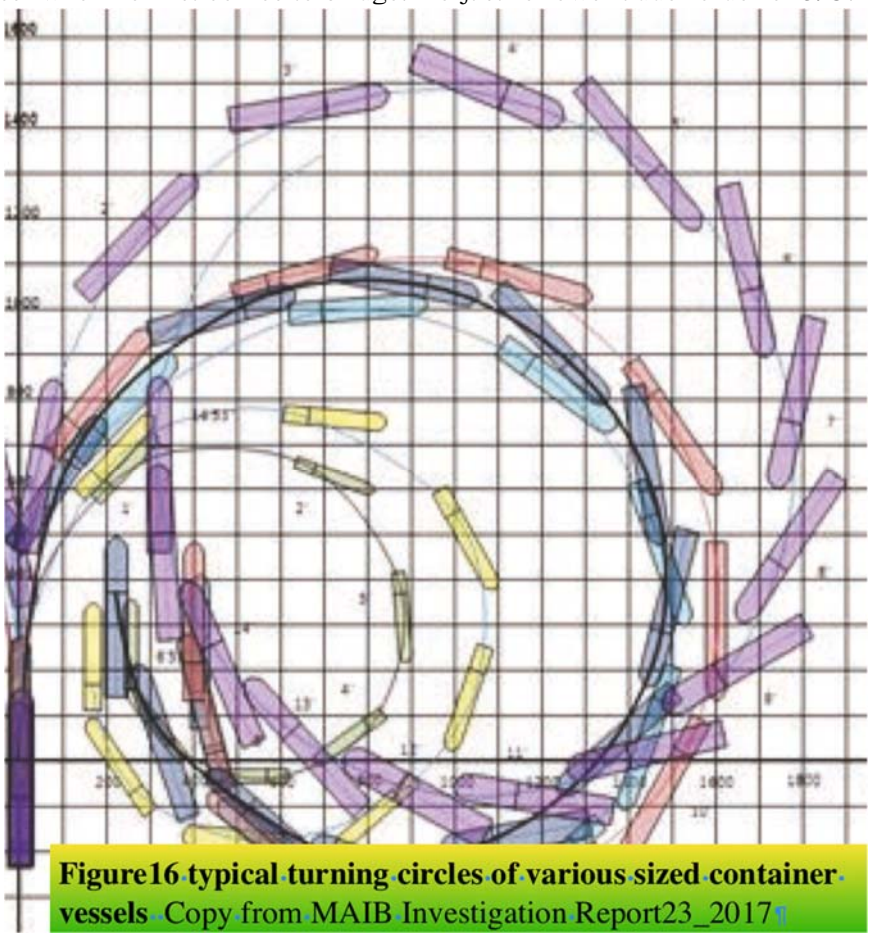


Figure16 typical turning circles of various sized container vessels Copy from MAIB Investigation Report23_2017

Figure 1-25: Turning characteristics of different size container vessels

Situational awareness for Master of SANCHI:

⇒ Vessel is in first stage of turning. No way out now. (ownship will go straight even wheel over for one minute. See all vessels will go straight at beginning of turn in Figure 1-25 above.)
⇒ Neither full port side nor full starboard side rudder can get away.
⇒ Stop engine is only an option to mitigate collision impact force and part of COLREG obligation as Rule 8 Action to Avoid Collision *(e) If necessary to avoid collision or allow more time to assess the situation, a vessel may slacken her speed or take all way off by stopping or reversing her means of propulsion.*)
⇒ In the Figure 16 copied from MAIB investigation report we can see
  - Vessel turning need at least 1.5 ship's own length advance distance to start the turning. (depends on ownship's length over all)
  - To avoid the collision, container ship needs at least 3.5 times ownship's Length distance ahead by hard over rudder.
  - Tanker or bulk carrier need less advance distance than container ship. (discuss later)
⇒ Captain have no way to know ownship's bow now. (Fore mast steering green light may help in this situation. It is recommended to turn on steering light when other vessel is in close range for emergency use.)

1-56 C-1 駕駛台安全文化最大的弱點：無目視瞭望知識 技術 與直覺的訓練

在大約1949當地時間，碰撞前一分鐘，在長峰水晶輪駕駛台裡，航向226度，航速13.6節不變，瞭望再一次提醒當值船副，雷達上AIS目標的CPA,只有0.1海浬，瞭望沒有注意到這目標就是桑吉輪。當值船副要求舵工將舵機由自動舵改為手操舵，然後下令右舵，沒有給出明確的舵角，當舵角到達右舷20度，瞭望向船副報告。
長峰水晶輪瞭望做的工作：
#第三次提醒船副，雷達裡面的目標的AIS CPA 是0.1海浬，但是沒有給他目標的任何細節。（瞭望也沒有取得目視資料，只有提供雷達現成的資料）
#在這兩分鐘的時間內，目標沒有正確識別。（簡單的向駕駛台外面看看，確認目標，保持視覺接觸是非常重要的，因為雷達的顯示在近距離，非常的不可靠）
#這是駕駛台安全文化的最大的缺失，沒有目視的知識，技術與直覺的訓練。（這是舵工，船副，大副都不行不會的）
#舵機由自動舵改為手操舵，然後操到右舵。（現在三副終於下定決心轉向）
#三副指示右舵，但是沒有給出明確的舵角。（三副被自己的想法所限，或者是對他的行動產生猶豫，害怕轉向會將本輪船中部分暴露給來船）
#瞭望向船副報告，當舵角來到右舷20度。（瞭望理解是緊急情況，然後他就使用，他覺得還能控制的最大舵角。）
一般來說，滿舵的舵角在日常的操作，並不平常，除了船長與引水人，船副對於操滿舵，並沒有足夠的經驗。

1-56 C-1: Weakest link in safety culture on the bridge. No visual lookout training, practice, skill and instinct.

At about 1949LT C-1, Inside the bridge of CF CRYSTAL's GPS position was 30°51′.4N/124°57′.9E, COG 226° and SOG 13.6 kts. Lookout reminded OOW again that CPA of AIS target was 0.1 nm, but not aware the target was SANCHI. Then OOW asked his lookout to change autopilot to hand steering and ordered to starboard rudder without giving a specific rudder order. The lookout reported to OOW when rudder angle was starboard 20.
Jobs done by CF CRYSTAL's lookout*:*

⇒ Lookout remind 3/O third times CPA of AIS target was 0.1 nm but did not give any details of the target. (lookout by radar AIS warning only, no visual contact of bearing or distance)
⇒ No positive visual identification of collision target in 2 minutes time. (simply looking outside windows to identify the target to establish visual contact is crucial as radar display is not reliable in close range)

⇒ This is a weakest link in safety culture on the bridge. No visual lookout training, practice, skill and instinct. (both in chief mate, 3/O and lookout)

⇒ Change the autopilot to hand steering and steer starboard rudder by 3/O order. (3/O finally made up his mind to alter course now)

⇒ 3/O ordered to steer starboard rudder without giving a specific rudder order. (3/O is occupied by his own thought or hesitate on his actions: fearing alter course to starboard side will open up ownship midship section to target vessel.)

⇒ The lookout reported to the OOW when the rudder angle was starboard 20. (emergency situation reckoned by lookout and with the rudder angle he is comfortable with day to day practice.)

General speaking, Hard over rudder turning is not usual in daily maneuverings. Beside the Master or pilot on board, most OOW did not have enough experiences with Hard over rudder turning.

1-57 當碰撞發生後，錯誤的直覺

大約在1950當地時間，桑吉輪的船長：我們被撞了，左滿舵，左滿舵。

情境感知：

#此時船長感覺已經發生碰撞，（經由船體的震動，可以感覺到撞船，雷達的顯示，此時已經毫無用處）

#船長下令左滿舵，對本輪是右邊船殼被碰撞的船隻，不太合適，（可能的破洞會大量進水）。

#左滿舵，左滿舵。船長接受碰撞的事實，而且試著減輕碰撞的力道。（但是這是錯誤的直覺，顯示碰撞的場景，沒有在船長的心裡面演練過。）

長峰水晶輪的船頭撞擊到桑吉輪的右舷，撞到第二與第三右舷壓水艙之間，造成貨艙也破裂進水。（桑吉輪先通過碰撞點，這比長峰水晶輪危險的）

#桑吉輪上面的大火，因為他的貨物是凝析油，是可燃液體，船長指示啟動滅火幫浦。

三副將本船的命運，交給海上的其他船隻，只因為他自己的“使用VHF 後權利義務轉移的理論”，他期望：

#如果你不回答他的VHF 呼叫，漁船將被迫採取行動，讓他自己能夠清爽。

#也許三副的理論，對漁船是有用的，因為他們比較容易轉向跟減速，他們會自行採取行動，以避免碰撞。

#現在的情勢，在開始的時候長峰水晶輪，沒有回答本船摩斯信號燈光的警報。

#有可能長峰水晶輪，並沒有注意到本輪的信號。

#本輪被迫讓路，因為是國際避碰規則的規定，即使目標船已經注意到本輪的摩斯信號。

#在這麼緊急的時刻，目標船也許還在等本輪採取行動。

#在近距離的情況，大型船隻沒有能力去對本輪讓路，就像小船或小漁船那麼容易。請參考圖形1-25。

#在非常近的距離，要等大型船隻讓路，是沒有用的。大型船隻無法做到讓路，就像本輪也沒辦法一樣。

#因為長峰水晶輪船頭的火災，船長到駕駛台後，下令全速倒車，以拯救他的船隻。

#碰撞引起凝析油的洩漏，與後續的火災與爆炸。

#桑吉輪船長要求，開啟所有的甲板燈，命令舵工操左滿舵。

#在繁忙的區域或兩船近接的情況，走道燈光不會干擾到航行燈，不會干擾到適當聊望的燈，應保持開啟，方便他船參考本船動向。

#這不是一個違反避碰規則的動作，而且是必須的。但是什麼樣的甲板燈光？什麼樣的部位燈？適合在這種緊急的情況下使用，應該在駕駛台控制台上做記號，並由合適的船副來選定並管理。

#避碰規則第20條，在日落到日出之間，其他的燈光不得外露，除了不會被誤認為則所特定的燈光，或是不會妨礙其能見度或是燈光特性。

#船長也許希望能夠避免目標船引起火災或爆炸。（保持目標船的安全）

#風向如果不利，會把火勢 煙霧跟爆炸，引到本船的駕駛台。（起火時應有的警覺）

#船長應該操船，把火勢，煙霧改到下風方向，儘量遠離本船的駕駛台，這是保護本船船員安全的知識與技術。
#桑吉輪船長要求發送遇難信號。（對外發送求救之前，應該同時啟動通用警報器，連續的鳴放，喚起所有船員注意，這個要比對外通訊，更為優先）
#航次紀錄器資料，記錄了碰撞摩擦和碰撞時，還有當值時舵工，在1950碰撞時的聲音，顯示出劇烈的情緒波動（在碰撞前15分鐘，舵工就已經盡到他的責任，但是對三副是完全的失望，所有他的耐性在經過這麼長的時間，最後被一場碰撞與火災所終結，所以他有很強烈的情緒反應）
#碰撞發生時，長峰水晶輪航向 226，桑吉輪航向 358 度，碰撞角在這兩條船之間，大約是在 48 度。這與這兩條船損害檢驗的時候，資料一致。（所有的右滿舵，或左滿舵，在碰撞前 1 分鐘的時間，所使用的滿舵都是沒有用的，要完成一次完整的轉向，我們需要 3 分鐘的時間，這我們以後會討論）

1-57 Wrong instinct when collision already happened

At about 1950LT, SANCHI Captain: we are being hit. Captain: Hard to port. Hard to port.

Situational awareness:

- Master sense collision happened in this moment. (Vibration of ship's hull felt. Radar presentation is useless now.)
- Master order "Hard to port" is not recommended for ownship have collision hole on starboard ship's hull
- "Hard to port" again. Captain accepts the collision reality and try to mitigate the collision force on board. **(but this is a wrong instinct when collision already happened. This action of Master reveals the truth that collision scenario had not practiced in Master's mind before.)**

CF CRYSTAL's bow hit SANCHI's starboard side between No.2 and No.3 starboard ballast tanks and breached her cargo tanks, (SANCHI passed collision point first, more dangerous than CF CRYSTAL)

- Fire on board SANCHI because her cargo condensate oil is flammable liquids. Captain instructs fire pumps starting.
- 3/O leave ownship's fate to other vessels at sea with his obligation shift mindset theory, expecting:
    - *But if you don't answer his VHF call, he shall be forced to take action to make himself clear.*
    - Maybe 3/O is right about fishing vessel with easy course and speed change ability, so he will take action to make himself clear.
    - The situation now with CF CRYSTAL is: target vessel did not reply to ownship's ALDIS warning in early stage.
    - There is a possibility that target vessel CF CRYSTAL did not notice ownship signal or
    - Ownship is obliged to give way by COLREG even target vessel noticed ownship ALDIS warning or
    - target vessel may wait ownship to take action in this critical moment.
    - In close quarter situation, large target vessel has no ability to give way to ownship as easy as small fishing vessels. (refer to Figure 1-25)
    - It is useless to wait large vessel to give way in very close range. Large vessel cannot do it as ownship can't either.
- Fire on Bow of CF CRYSTAL. Captain came to the bridge and order for full stern to save his own ship.
- Collision resulting in the leakage of condensate oil and a consequent fire and explosion.
- The SANCHI captain requested to switch on all deck lights and ordered helmsman to steer "hard to port".
- Deck alleyway lights if not interfere with navigational lights or the keeping of a proper look-out should be switch on through dense traffic area or before close quarter situation for easy reference.
    - This is not a violation but a necessity. Which deck lights are suit for this emergency purpose should marked on lights switch board beforehand by proper OOW supervision.

- COLREG rule 20(b): *and during such times no other lights shall be exhibited, except such lights which cannot be mistaken for the lights specified in these Rules or do not impair their visibility or distinctive character, or interfere with the keeping of a proper look-out.*
- Captain may want to take fire and explosion away from target vessel. (keeping target vessel's safety)
- Unfavorable wind direction will bring fire, smoke and explosion to ownship bridge. (awareness of wind direction in fire)
- Master should maneuver to take the fire and smoke to lee side away from ownship bridge. (precautions to protect ownship's crew safety, skill)

- Then SANCHI captain asked 3/O to send distress message. (SANCHI need to sound general alarm continuously to awake all crews before calling for help from outside.)
- The VDR of SANCHI recorded the sound of collision and deflagration, as well as the voice of duty crew in bridge at 1950 LT, which reflected the dramatic emotional changes. (this good man has done his part ever 15 minutes before collision but totally disappointed by 3/O actions on bridge. All his patience in this long period had ended up with a collision and fire.)
- When the collision occurred, CF CRYSTAL was heading 226°, and SANCHI 358°. So, the angle of blow between the two ships was about 48°. This was consistent with the damage inspection of both vessels. (all hard port or hard starboard rudder are useless within one minute time on both vessels, 3 minutes is the time needed for a complete turn. discuss later)

1-58 修正避碰規則的航行燈規定，以方便瞭解目標船的動態

在大約 1951 當地時間，碰撞後一分鐘，桑吉輪船長命令啟動滅火幫浦，與 GMDSS 全球海事遇難安全系統。

在大約 1952 當地時間，碰撞後兩分鐘，爆炸與火勢吞噬了桑吉輪駕駛台，接著就是窒息的聲音。（本人深深的哀悼，對 32 位死亡與失蹤的船員，為了紀念他們的犧牲，我建議要修正航行燈的規定。使用新的 LED 甲板燈，方便我們瞭解目標船的動態，如同附錄一）

在大約 1953 當地時間，碰撞後 3 分鐘，桑吉輪的 GMDSS 信號中斷。

1-09 在長峰水晶輪的駕駛台

長峰水晶輪的雷達資料，因航行資料記錄器的資料被複寫，沒有被保存下來。

在 1944 當地時間，碰撞前 6 分鐘，長峰水晶輪三副由 AIS 的符號，認為桑吉輪是一條漁船，而且沒有碰撞危機的顯示。（三副的口頭敘述，當時 3 副剛到駕駛台，準備接大副的班）

在 1945 當地時間，碰撞前 5 分鐘，長峰水晶輪的航向 223 度，航速 13.4 節，桑吉輪方位 205 度，距離 2 海浬。

在 1946 當地時間，碰撞前 4 分鐘，長峰水晶輪航向 225 度，航速 13.4 節，長峰水晶輪大副交班給三副，他說附近船隻清爽，並沒有交代其他船隻的動態。三副沒有看到桑吉輪發的摩斯信號燈光，大副離開駕駛台，因為 3 副的同意他的說法。這是不好的交班習慣，交班的船副要向窗戶外面，多看一眼，確認自己的觀察，就會發現 2 海浬的大目標。

在大約 1947 當地時間，碰撞前 3 分鐘，長峰水晶輪航向 226，航速 13.5 節，瞭望向三副提醒桑吉輪的 CPA 在 AIS 目標的資料裡面，只有大約 0.2 海浬，當值船副同樣注意到，雷達的目標，因為沒有建立視覺接觸，認為他是一條小船。

大約 1948 當地時間，碰撞前兩分鐘，長峰水晶輪航向 226，航速 13.5 節，AB 提醒當值船副，有一目標的 CPA 是 0.1 海浬。

在 1949 當地時間，碰撞前 1 分鐘，長峰水晶輪航向 226，航速 13.6 節，瞭望第三次通知三副，某一目標的 CPA 在 AIS 資料上，只有 0.1 海浬。當值船副要求瞭望，把舵機改為手操舵，轉向右舵，但是沒有給出明確的舵角，當舵角到了右舷 20 度，瞭望向當值船副回答。

在 1950 當地時間，碰撞發生時，長峰水晶輪船頭撞在桑吉輪的右舷，第二與第三壓水艙之間，破裂延伸到貨艙。

瞭望做的工作：

#提醒三副三次，CPA 距離在 AIS 是 0.1 海浬。

#大副班的瞭望，並沒有交代附近有任何船隻的動態。

情境感知：
三副和大副都沒有任何視覺的接觸，所有瞭望的工作，目標船所有的資訊，都是在雷達螢幕上完成，即使有 AIS 資料，都沒有好好利用。
#認為桑吉輪是一條漁船，使用 AIS 的符號，碰撞前 6 分鐘。
#三副並沒有看到，桑吉輪輪發的摩斯信號燈光，這是在碰撞前 4 分鐘。
#三副看到雷達的目標，認為他是一條小船。碰撞前 3 分鐘。
#當值船副並沒有回應 AB 的詢問，有一個目標的 CPA 是 0.1 海浬，這是碰撞前兩分鐘。
#AB 第三次通知有一個目標的 CPA 是 0.1 海浬。

1-58 Amend navigational lights in COLREG for easy refence of target vessel's movement.

At about 1951LT C+1 one minute after collision, SANCHI Captain instructed fire pumps to be started and GMDSS activated.

At about 1952LT C+2 two minutes after collision, explosion and fire engulfed SANCHI bridge accommodation, followed by suffocation sounds. (my deepest condolence to 3 diseased and 29 missing seafarer, To memorize their sacrifice I suggest to amend the navigational lights set up in COLREG for easy refence of target vessel's movement with led lights on deck as annex I.)

At about 1953LT C+3 three minutes after collision, SANCHI GMDSS signaling stopped.

1-09 Lookout in CF CRYSTAL bridge

No radar Figures are available from CF CRYSTAL for Voyage Data Recorder is overwritten.

At about 1944LT C-6, CF CRYSTAL's 3/O thought SANCHI was a fishing vessel by the AIS symbol and there was no risk of collision. (by oral statement, 3/O just arrive bridge for relieving C/O)

At about 1945LT C-5, CF CRYSTAL, COG 223° and SOG 13.4 kts. SANCHI was about 2.0 nm bearing 205°.

At about 1946LT C-4, CF CRYSTAL, COG 225° and SOG 13.4 kts. The C/O handed over the watch to the 3/O and he said the traffic was clear and did not tell the situation of another vessel. The 3/O did not see the ALDIS signal of SANCHI. Then with the consent of the 3/O, the C/O left the bridge. (bad relieving practices without looking out of the windows and finding 2 nm big target)

At about 1947LT C-3, CF CRYSTAL, COG 226° and SOG 13.5 kts. **The lookout reminded the 3/O** that the CPA of SANCHI's AIS target on radar was around 0.2 nm. The OOW also observed the target by radar and thought it was a small vessel. (no visual contact established)

At about 1948LT C-2, CF CRYSTAL, COG 226° and SOG 13.5 kts. **The AB reminded the OOW the CPA of one target was 0.1 nm.**

At about 1949LT C-1, CF CRYSTAL COG 226° and SOG 13.6 kts. **The lookout reminded the OOW third times that the CPA of the AIS target was 0.1 nm.** Then the OOW asked his lookout to change the autopilot to hand steering and ordered to steer starboard rudder without giving a specific rudder order. **The lookout reported to the OOW when the rudder angle was starboard 20.**

At about 1950LT collision time, CF CRYSTAL's bow struck the starboard side of SANCHI between her No.2 and No.3 starboard ballast tanks.

Jobs well done by lookout: **The lookout reminded 3/O three times with CPA distance in AIS.** The lookout in chief mate duty did not report any vessel traffic around.

Situational awareness: 3/O and chief mate did not have any visual contact with target vessels. **All lookout jobs are done by Radar screen, even the AIS data is not used:**

1. thought SANCHI was a fishing vessel by the AIS symbol (1944 hours, C-6)
2. The 3/O did not see the visual ALDIS light signal of SANCHI. (1946 hours, C-4)
3. OOW also observed the target by radar and thought it was a small vessel. (1947 hours, C-3)
4. OOW did not response to AB the CPA of one target was 0.1 nm. (1948 hours, C-2)
5. The lookout reminded the OOW third time. (1949 hours, C-1)

1-10結論

1-59 STCW 發證的課程與當值船副

這兩條船的瞭望工作，都做的不完整？為什麼簡單的視覺瞭望，在五十年之後，變成駕駛台神秘事件？這個原因，就是沒有學院化的訓練，與系統的討論。對於目視瞭望這一部分，船上的海員也是絕口不提，當他們看到雷達 阿帕 AIS 對碰撞危機的計算，可以得出CPA 距離方位等等， 各式各樣的資料, 真是太神奇了。沒有人瞭解，人類的短期記憶，所受到的局限，人的短期記憶，只能處理7位元數位，只要處理一條目標船的數位資料，都會造成當值船副的記憶超載。當值船副所能發現的解決方案，去克服自己的記憶困難，就是double check，再度核對，一次又一次重複，當然弄的他精力衰竭，非常疲勞，非常的累，另一方面，當值的瞭望需要跟當值船副，競爭雷達阿帕AIS 的資料，這不是一條船，二條船，而是更多船的問題，這就是現在的駕駛台文化，雖然當值瞭望沒有正式的操作訓練證書，但是他只要喵一眼，就勝過於自己的任何判斷，沒有人教過他目視瞭望的技巧，確認碰撞危機的方法，潛在惡化的原因是，多國籍船員的安排，因為他們是不同的國籍，瞭望失去傳承的下一個世代，這在當初，駕駛台什麼航儀都沒有的時代，根本就是無法想像的，當值的船副，一定會教當值的瞭望，如何使用目視，判斷來船是否有碰撞危機？

因為他們是不同的世代，同樣的現在做STCW訓練發證的航儀證書下，當值船副不知道他們缺少了目視的訓練？當值瞭望可以做的目視觀測，不被重視，因為他們有電腦輔助的設備在手，像雷達 阿帕跟AIS ，他們更傾向于信任儀器。

船上管理級的船員與公司管理船隊的經理，都相信駕駛台資源管理的訓練，可以減少人為的錯誤與失誤，但最近的美軍碰撞事件，對我們證明了BRM ，並不是解答。優良船藝也因為沒有學術理論而受到貶抑，我們的當值船副在這一點上，如果只依賴STCW發證的訓練，我們並沒有比那些海院的教授，和航運公司副總 處長等優秀。我們目視瞭望在這一章，得到的知識 經驗 技術 教訓，跟坐在辦公桌上，紙上談兵的教授跟公司的副總是不一樣的，即使我們只是駕駛台上面的一個實習生，目視瞭望的能力，只有透過有意義的練習，才能夠得到提高加強。在我們實習生的階段，也許不能看到目視瞭望的好處，但是我們可以看到桑吉輪/長峰水晶輪，雷達 阿帕瞭望的實務不好，引起的碰撞火災 爆炸的慘境。這將會是我們下一章的主題跟情境感知，使用雷達阿帕瞭望的技巧。

附記：親愛的朋友們，可能會抗議，這一章不光只是為了實習生或乙級船員所寫，這是正確的事實，我能夠對同一海事案件，針對三種不同的年資對象，寫三種練習的主題，讓他們可以尋找適合自己的能力去閱讀。你可能沒有這樣的耐性，去讀三次，我最後決定，為所有階級都寫一遍，以免遺失太多的細節，只因為配合讀者的程度。貓一套，狗一套，每個人都有一套。這是老船員的覺悟，認為自己能力夠的，可以跳的讀，尋找自己需要的主題，我認為這樣會失去太多細節，剩下的只有時間能印證。

公司的海技管理人員與船上管理級船員，可以自行決定他需要那樣的主題，去教導他的同僚。乙級船員沒有證書，我們知道，但是看看在這個案件發生的情形。我們需要瞭望去確認，做些什麼目測？除了AIS的資料，CPA是多少？來船是由船頭過，或是船尾過？答案就在這一章裡面，目視瞭望的資料確認。

1-09 Summary

1-59 STCW certified training course and OOW

The lookout duty on these two vessels are not complete. Why an easy job of visual lookout in thousands years ago still a mystery at sea? There is no academic trainings or discussions of visual lookout in school at all. The old man just shut up when they saw what RADAR/ARPA/AIS can do in verifying collision risk with all details of CPA, range, bearing … etc. Nobody understands human limitations of short term memories only capable of 7 digitals. Only one target's digital data will overflow OOW ability to remember. The solution OOW found to solve his memory problem is to double check over and over again which exhausts OOW energy in his duty. Duty AB competing the radar and AIS data resources with OOW in modern bridge culture. This is not just one ship, two ships, or more here or there. This is a safety culture problem in ours industrial. The undermined reason deteriorated the situation is multi-nation crew arrangement on board. Precious visual lookout techniques lost its heritage to next generations with different nationality. Also, out of arrogance induced from modern STCW

certified navigational equipment training and academic education OOW don't know what they had missed. What an AB can do is not respect by OOW because they have computer aid equipment at hand like Radar, ARPA and AIS.
They are management lever on board and in fleet believe in Bridge Resource Management training can reduce human mistake and error. Recent cases of US navy collision had proved BRM is not the solution. Good seamanship is compromised by academic theory. At this point, if we OOW relied on STCW certified requirement only, we are no better than those maritime professor or company senior vice presidents. What we have now in this chapter is the way to practice ever since we are a cadet on bridge. Our competency in visual lookout can only be refined through meaningful practice. We may not be able to see what benefit visual lookout can bring in this stage. But we do see what a bad Radar/ARPA lookout practice can lead us to: collision, fire and explosion. It will be our next chapter topic: knowledge and situational awareness of Radar/ARPA lookout for Junior officer.

P.S. My dear fellow friend may complain this is not for rating only. It is correct. I can write the case study three times for three ranks to study. You won't have the patience. I finally decide to write it for all ranks, not to miss too much details for another rank. Every company management or personal can decide by himself what topic he/she want to know better or to teach to their colleagues. Rating have no certificate we know but look what happened in this case. What we should ask lookout to report beside the AIS data they saw in Radar screen? The answer is here.

1-60 Annex I: Consider installing alleyway lights

1-60 致 Seaways 編輯者信件

馬克船長的文章，“今日世界的避碰規則”，應該受到讚揚。我願意加上 2 點，有關於航行安全的建議，現行航行燈的位置分配，使得利用它來建立目標船視覺確認，有著相當的困難，尤其是在有強烈的背景燈光，或是在轉換航向的時候。我有兩個技術性的建議，可以更清楚的識別目標船的動態，
1.現成船的航行燈，不易變動，改裝不易，其最大的缺點，就是數量不足與亮度不夠，如果加裝高強度 LED 發光二極體的走道燈，這些走道燈設置在船舷邊，以固定的距離，例如 10 公尺，或是該輪肋骨間距設置，在夜間，他船就可以從它們排列的形狀，間距的大小，由其船舷邊的數目，就能夠判斷來船的大小與方向，就不會像桑吉輪與長峰水晶輪的視而不見，豪無來船大小方向的概念。左舷走道燈建議使用紫紅色的燈光（讓路燈），右舷建議使用黃色的燈光（注意燈），這樣子在第一眼看到，某一側舷燈，就能夠認出他是左舷還是右舷，這在我們討論視角 Aspect 時 有提到，認的出他是左對左，還是右對右，就知道是否能安全通過，就是本船安全的一個保障，這是一眼就能決定的，比確認相對方位變化更快。
對於那些甲板高度非常低的油輪散裝船等，可以使用防水的 LED 燈，裝在玻璃纖維管內，沿著它的輸油管和液態貨管線，延伸到他船頭船尾的甲板，防水的的等級，應該不成問題。
2.這些 LED 的燈光，可以跟回轉速率相連結：船隻在轉向的時候，有回轉速率時，就可以看到這些 LED 燈光在閃爍，閃爍的燈光數量跟他的回轉速率成正比例，本船 1 分鐘轉兩度時，閃爍一顆 LED 的走道燈，一分鐘轉 10 度的話，閃爍從船頭開始的五顆走道燈，回轉速率達到 30 度的時候，閃船頭前的 15 顆走道燈。回轉速率的重要性是，如果回轉速率已經太高，基本上，這條船已經無法改變航向，或是失去控制。
3.走道燈也可以考慮與船速相結合，第十顆閃爍表示十節的船速，第 20 顆閃爍表示 20 節速度。也可以安排 一顆燈逐次向後或向前熄滅，代表前進或後退方向等等。
4. 羅經甲板上面的摩斯信號燈，應該可以用大型的 LED 看板來取代。在 LED 看板上，直接在上面打上，本船在左轉，或右轉，或是操縱失靈等等的國際信號代碼圖形，或是明白的文字，我要領港等等，這都不是問題。
利用現有科技，如紅外線感測等，這些新式助航儀器的時候，應該要考慮到人類的心智慧力。也就是我們的短期記憶，是非常有限的。不能使用太多的數位，或是文字來表示本船的狀態，最好是可以一目了然的畫面，就像前面以 LED 燈的數量，來代表回轉速率的大小。

對於自動避碰雷達的設計理念，也應該要改變，因為現行的自動測繪是以數位，提供數位化的資料給當值船副，數字量超過人的短期記憶能力，因為以前電腦對圖形顯示能力的不足，現在的電腦的圖形顯示，都不成問題。數位化的資料對人員的記憶，造成很大的負荷，所以實際上，阿帕的裝設，沒有減輕航行當值人員的工作負擔，現在最主要的幾個缺失的有
1.目標回跡的大小，隨距離而任意改變，這是很不應該的。目標的回跡，應該能夠反應目標現在的距離，猶如目視一般，在近距離時候，在螢幕上占的方位距離要更大，在遠距離的時候變小，以符合真正的航行威脅等級。
2.使用符號代替接收到的回跡大小。因為回跡的大小，隨著雷達回跡的距離而改變，使用符號顯示，可以消除海浪回跡的影響。
3.近距離要有要速度向量線的自動顯示。因為這跟避碰的操作，息息相關的。
4.要在螢幕上，顯示出兩船的碰撞地點。這種避碰的操作，牽涉到擱淺的危機。
5.要把目標的方位，在方位圈上標示出來，方便瞭望直接讀取目標方位，方便目視瞭望。
6.直接標示出本船與目標船，在三分鐘或六分鐘的船位，取代以前的 trial maneuvering 的操作，可以對於碰撞的態勢，更清楚的瞭解，以上謝謝。

Letter to the Editor Seaways
From Captain Gilbert Lee MNI

Captain Mark Bull is to be congratulated for his feature, *Colregs for todays world* Seaways June 19.
I would like to add two ideas concerning masthead light signals which can vary in terms of physical separation making it difficult to establish visual identification from strong background lights and changes of heading in a consistent way. I have two technical suggestions.
1 suggest installing alleyway high luminated LED lights at set intervals along shipside to be visible by its alignment and numbers related to her length as currently used by high freeboard container ship now, violet for port, yellow for starboard (some fishing vessels use green lights) and on large low freeboard vessels a similar arrangement could be arranged by water proof LED lights strip or fibres reinforced glass tube on deck along cargo line or fore aft hatches line to amplify the effect of the steaming lights.

2 These lights could then be linked to a rate of turn instrument and could flash in sequence to indicate the speed and direction of vessel rotation to give an unmistakable indication and the possible consequences of her manoeuvre.

3 On a related theme, is it not time that conventional Signal Flags code on compass deck which are rarely used should be replaced by high illuminated TV screens we sought in Khalifa Tower or along the highway. Who knows we can even send twitter on it to indicate own ship intentions.

Beside the use of modern technology, properly tested, which can be more adaptable than fixed installations, we should also be thinking about the deficiency of all our navigational and control equipment and signalling methods which cannot integrated with our mental capability. Human is bounded by his short-term memory to handle ever changing situation. We should not overflow navigator by endless digital numbers on each equipment which we can handle only 5 more or less in 20 seconds interval. It is truth ARPA is not acceptable or reluctant to use in dense traffic which we saw in many and cost 32 human life in Sanchi case.

Like the alleyway lights to aid in visual lookout of other vessel's movement, our navigational equipment RADAR ARPA AIS ECDIS need to change the presentation of data into graphical comprehensible. Digital data have its importance by is undependable in human memory and emergency usage. I proposed Dynamic Radar Presentation system in my own research which are available in my YouTube video. Main features of it which are missed in ARPA:

1. Target echo received should discriminate how many bearings and ranges it covered
2. Used symbol and its size to present the Echo received, to eliminate sea clutter
3. Automatic speed vector showing in close range
4. Indicate the collision spot(red) on screen, most important
5. Show target bearing(pink) in azimuth ring to facilitate look out the windows

6. Show target and own ship position after 3,6 minutes or more at request

Captain Gilbert Lee MNI