Chapter 5- Situational Awareness for Chief Officer

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5-01 1999 年多佛海峽貨櫃船與客輪的碰撞

5-01 CPA 的正確性是 0.7 海浬， 漂流角是由 DGPS 計算

這條客輪是 213 度的真航向，對地速度是 14.5 節，多佛海岸防衛隊，記錄 VHF 頻道 16 收到一個無確認物件呼叫的時間， "右舷，右舷，右舷" ，是在凌晨 00 時 54 分 37 秒，這個很可能是兩條碰撞船隻，其中一條在即將碰撞之前，所發出的呼叫。

這個碰撞發生在 0055 時的多佛海峽，在 1999 年的案件，離現在已經有 20 年了，當時新的 DGPS 並不普遍，而航次資料記錄器 VDR 還沒開始安裝，阿帕是從 1997 年才開始要求，這是 20 世紀最黑暗的時刻，舊的目視瞭望技巧，並沒有傳承到新的雷達瞭望的世代，新的雷達瞭望技巧也沒有建立。而且阿帕的操作性能，還學著目視瞭望的邏輯，依照聯合國海事組織 1995 年 11 月 23 號採行的決議案 A. 823(19)，對阿帕的性能標準，要求如下

3.8.3 阿帕的設備，應該在 3 分鐘穩定的目標運動航跡計算裡，能達到下列所要求的準確值，也就是性能數值（95%的可能），如下表:

Data Scenario	Relative course (degrees)	Relative speed (knots)	CPA (nautical miles)	TCPA (min)	True course (degrees)	True speed (knots)
1	3.0	0.8	0.5	1.0	7.4	1.2
2	2.3	0.3	-	-	2.8	0.8
3	4.4	0.9	0.7	1.0	3.3	1.0
4	4.6	0.8	0.7	1.0	2.6	1.2

可接受的 CPA 準確值（95%的可能性）在 0.7 海浬以內，這是在 3 分鐘目標穩定運動狀態下，船隻的測繪計算結果，0.7 海浬就可以接受，換句話說如果目標的測繪，不足 3 分鐘，他的阿帕資料就是有可能有問題，或是要以當值船副個人風險自負，來使用這些資料。機器的製造商，並不負責計算結果 100%正確。

在實際的海上情景，當值船副只有選擇忽略阿帕的錯誤，而不會抱怨為什麼阿帕的資料，有這麼多的錯誤，就像他們不會抱怨為什麼？雷達的回跡在近距離的時候，經常會遺失不見。

碰撞的調查報告，在二十年前所做的已經過時了，他說要推薦的結論，也要重新檢視一遍。現在船上的瞭望，已經由阿帕的瞭望，進步到 AIS 的瞭望，在阿帕系統跟 AIS 裡面所輸入的參數，比 20 年前正確多了，因為有比較穩定的羅經船首向輸入，與更精確的 DGPS 船速的自動輸入。舊的航向航速輸入方式，已經不被接受，現代的船員，沒有經歷過電羅經倒掉的時刻，最重要的參數，對地的速度很容易受到水與風力的影響，對水速度才是在 20 年前，被要求輸入的

船隻航速，因為它不包括對未來風力流水速度的估計，也就是把流水的影響排除，想要得到目標船真正的視角，方便判斷是迎艏正遇，或是橫越等。現在對地的速度是由 DGPS 來取得，真正的碰撞，也是由對地速度造成，他的精確度已經到了 5 米或 10 米的船位，就算是靠碼頭使用，都不成問題，更別提我們現在已經有個人的導航設備 PPU personal piloting unit 來協助靠碼頭，他也不建議我們使用對水的速度，使用差分衛星導航系統的對地船速輸入，是正常的實務。流水與風力的影響，對本船的航向，是反映在我們的船首向，以及對地航向的差別，我們叫做船隻的漂流角 Drifting Angle。

5 – 01 Dover Strait: Container ship collided with cruiser 1999

5-01 CPA accuracy of 0.7 nm and Drift Angle from DGPS

The cruiser is on 213º True (T), speed over ground is 14.5 knots. The Dover Coastguard recording of VHF Channel 16 timed an unidentified call: 'Starboard, starboard, starboard' at 00 hours 54 minutes 37 seconds. It is likely that this was made by one of the two vessels immediately before the collision.

The collision happened in Dover Strait at 0055 on 24 August, 1999. 20 years ago, a time when new DGPS positioning is not universal yet and Voyage Data Recorder VDR are not available. ARPA just merged around the corner at 1997. It is the darkest time in the industrial when old generation visual lookout transit to new era ARPA lookout. However, the ARPA performance standard are more or less follow same logic of visual lookout. For example, IMO Resolution A.823(19) adopted on 23 November 1995 PERFORMANCE STANDARDS FOR ARPA.

3.8.3 An ARPA should present within three minutes of steady state tracking the motion of a target with the following accuracy values (95% probability values).

Data Scenario	Relative course (degrees)	Relative speed (knots)	CPA (nautical miles)	TCPA (min)	True course (degrees)	True speed (knots)
1	3.0	0.8	0.5	1.0	7.4	1.2
2	2.3	0.3	-	-	2.8	0.8
3	4.4	0.9	0.7	1.0	3.3	1.0
4	4.6	0.8	0.7	1.0	2.6	1.2

The acceptable CPA accuracy values (95% probability values) are 0.7 NM. This accuracy is plotted with 3 minutes of steady state target. In another words, if a target's tracking is less than 3 minutes, its ARPA data is quite questionable and should be used at OOW's own risk by this standard. In real sea scenarios OOW just ignore the ARPA performance. They don't complaint why ARPA data have so much error as they don't complain why radar echo are often missing in close range.

The collision investigation report made 20 years ago is outdated. The conclusions it recommended also need to be reviewed again. The lookout instrument had progressed from ARPA lookout to AIS lookout already. The parameters input to ARPA and AIS are more accurate than 20 years before (more stable gyro heading input and precise DGPS speed input, manual input in course and speed is not acceptable any more). The most significant one is the usage of speed over ground SOG which is easily subjected to current and wind force influences were been correct account for. SOG is not recommended to be input into ARPA 20 years ago as they are part of estimation for the future speed over ground SOG by past ship's position measurement. The major problem is ship's fix is not reliable. Now SOG can be obtained from DGPS with very high accuracy of 5 or10 meters position error which are good enough even this precision can be used in berthing operation. Nobody talks about when we use Personal Piloting Unit PPU to docking we should use speed over water SOW today. Using DGPS Speed input into ARPA is normal practice. Current and wind force influences on ownship's movement is reflected on SOG speed over ground and COG course over ground difference which we call it Drift or setting.

5-02 對所有船東的建議，需要修改

我們快速的檢視一下，在這份報告裡面，對所有船東所做的建議，

1. 當使用兩部以上的雷達，或是阿帕，我們建議的測繪，應該只在其中的一台上面使用。

⇒ 在本書，我們的建議是使用兩台雷達，10 公分雷達探測小型的目標，使用相對運動的尾跡跟速度向量線。3 公分雷達用來測繪大型的船隻，使用阿帕的自動擷取模式，作為快速的參考。

⇒ 只有用一種方式來做瞭望，是不健康的，當值船副應該使用視覺的瞭望輔助，針對小型目標，或是用第三台雷達探測，如果船上有裝三部雷達。

2. *使用阿帕的相對運動向量線來決定碰撞危機，只有相對運動線才應該使用。真運動的速度向量線，只能用來決定目標的視角。*

⇒ 我們在本書的建議是使用相對運動模式在 10 公分的雷達上，用在小型船隻，觀測小型船隻的尾跡，相對運動的雷達比較容易確認，小型目標可以適用于安全相對方位 SRB，和觀測相對方位的改變與 CPA 估計值的核對。

⇒ 使用真運動向量線在 3 公分雷達大型船隻的測繪上，利用真運動向量線判斷碰撞的位置，碰撞距離以及碰撞時間的技術，同時用來預測碰撞位置的改變，碰撞位置在兩條船的速度向量線上的變化。

3. *所有駕駛台的當值人員，應該提醒作為避碰測繪速度的輸入，在雷達跟阿帕上都是對水的速度，而不是對地的速度。*

⇒ 我們的建議是，使用微分衛星定位系統的自動船速輸入，重點並不是對水的速度，或是對地的速度，重點是船隻的漂流角。也就是本船船首向，跟對地航向的差距，在航行時，可能關係不大，但是在本船轉向的時候，就非常關鍵。

對客輪來說

4. *客輪的當值船副，在碰撞當時的值班人員，應該受更進一步的雷達使用的訓練，客輪的管理人員應該確保這一點，能夠儘快的在船隊中實施。應該確認其他的航儀，駕駛台當職人員是否完全瞭解，航儀使用的正確方法。*

⇒ 我們的建議，閱讀跟訓練，利用本書的教材來訓練目視跟雷達的瞭望技巧，關鍵的碰撞位置，碰撞距離，碰撞時間，安全相對方位，以及相對方位改變更與 CPA 變化的估計，現行的訓練 5 天是不夠的。

5. *客輪的船長，應該提出更明確的當值命令簿，以符合公司的程式手冊，澄清何時船副應該要求駕駛台的額外協助，客輪管理公司應該確保令人滿意的船長命令簿，都有完整的提交給所有船隻。*

⇒ 我們建議是有清楚的指令跟命令，以確認船副們的適任，與適當的技術水準，就像本書的建議，來完成視覺，雷達，ARPA 跟 AIS 的訓練，一步一步來完成，並且船長的命令，要明確，由誰來處理不同風險區域，如開闊水域，沿岸航行，港區接近進出，都需要具有不同瞭望技術的當值船副來執行

6. 6. 船公司應該採取步驟，強制執行跟監督船隊的程式手冊裡面，明確何時瞭望的人員應該加強，與雙執照當值。

⇒ 我們的建議是要加強當值船副的瞭望技術，**雙重技術當值**，目視/雷達/阿帕，而不只是單純的增加人力，每個船副都只會做阿帕瞭望而已，只知道 CPA 多少，卻不知道如何避碰。

圖形 5-01 情境知覺，在多目標碰撞前 6 分鐘。

5-02 To All Shipowners recommendations revised

We will take a quick review of the recommendations made in this report: To All Shipowners

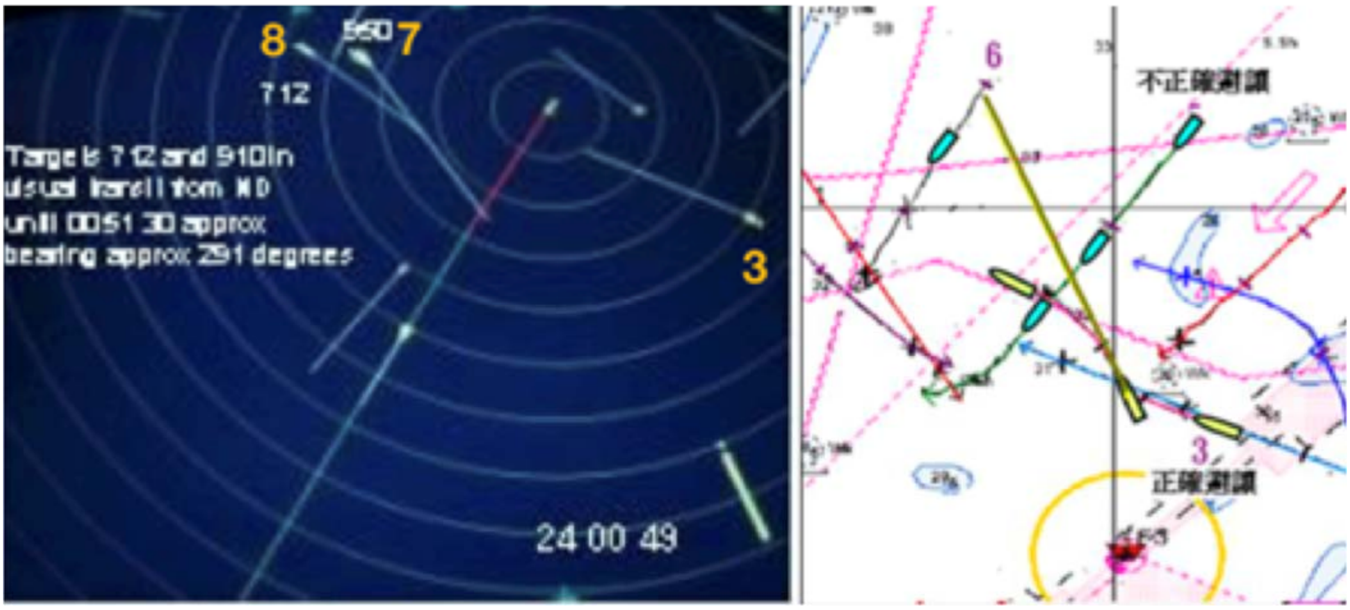
1. *When using more than one radar/ARPA, an anti-collision plot should be kept on only one.*

⇒ Our recommendation is to use two radars: 10 cm radar for small target in relative motion trail and 3 cm radar only for large vessel in true motion speed vector and set APRA auto requisition mode for quick reference. Only one mean of lookout is not healthy OOW should use visual lookout for small target and third radar for big vessel if available.

2. *To determine risk of collision using ARPA vectors, only the relative vectors should be used. True vectors should be used to determine aspect.* Our recommendation is
   - ⇒ to use relative motion trail in 10 cm radar and set speed vector in relative motion mode to estimate TTC for small target. Also, relative motion radar is easier to identify small target with her SRB and relative bearing change and CPA estimation visually.
   - ⇒ And to use true vector true motion for 3 cm radar's big target with our skill in judging collision position, distance and time. Further to predict collision point movement along both vessels' speed vector when both vessels take actions.
3. *All bridge watchkeepers should be reminded that the speed input for an anti- collision plot on radar/ARPA should always be speed through the water not speed over the ground.*
   - ⇒ Our recommendation is to use DGPS auto speed input for ARPA.
   - ⇒ The point is not Speed through water STW or Speed over ground SOG. The point is Drifting Angle between ownship's heading and Course over ground COG which is neglectable in navigation but is crucial when ownship is altering course to avoid collision.
   - ⇒ The heading of both vessels may still confuse each other. However, with plotting in speed vector of true motion, Collision risk is more easy to judge.

To Cruise Lines

4. *The OOW of the Cruiser at the time of the collision should undertake further training in radar usage. Cruise Lines should ensure that this is carried out as soon as possible, they should also ensure that other bridge watchkeepers within their fleet are fully familiar with the bridge equipment with which they will have to deal.*
   - ⇒ Our recommendation is to read and train as this book with visual and Radar skills in collision position, distance time, SRB, relative bearing change and CPA estimation. Current training in ARPA usage is overloaded with digital and audible alarm which means nothing in multiple vessel's situation if OOW cannot handle with their short term memory.
5. *The Master of the Cruiser should draw up more explicit Standing Orders in accordance with the Company Procedure Manual to clarify when the OOW should call for assistance on the bridge. Cruise Lines should ensure that satisfactory masters orders are drawn up for all of their ships.*
   - ⇒ Our recommendation is **explicit Standing Orders to verify their competent through proper skills level** as this book to complete visual, Radar, ARPA and AIS lookout step by step and **master's orders in bridge watch composition to handle different risky area like** open sea, coastal, harbour as required by different lookout skill level OOW to help.
6. *Cruise Lines should take steps to enforce and monitor the guidelines contained in their Procedures Manual about when watches should be doubled.*
   - ⇒ Our recommendation is to double OOW lookout skills with visual and radar rather than double manpower doing radar lookout only.



圖形 5-01 情境知覺，在多目標碰撞前 6 分鐘。

5-03 當訓練不足，情境感識就會消失

在圖形 5-01，7 號目標船航向是 145 度，航速 20 節，5 號目標航向是 213 度，航速 14.5 節。

⇒ 在這兩條船的速度向量線上，我們看到一個碰撞點，對 7 號目標船時間是 6 分鐘，而對 5 號目標船（紅色速度向量線）碰撞時間大約是 5 分鐘。

⇒ 5 號的目標船先通過碰撞點，時間早了 1 分鐘，

在 0049 時， VHF 頻道上面有聽到說，“郵輪接近 F 三浮標，航向 215 度，請回答。”這大約是在碰撞前 4 到 5 分鐘的時間，船隻相互確認了他們的身份，當回答的時候，當值船副看了看窗外，看到 7 號的目標船使用了日間信號燈的閃光信號，在右舷的正橫。

⇒ 在 VHF 通訊上，目標船間的正向確認，這是有絕對的必要，但卻是最困難的部分，當我們在多目標情況下，做 VHF 的通訊。

⇒ 在雷達螢幕上，我們可以看到 7 號目標船的距離是 1.7 海浬，碰撞的時間是 5 分鐘，這是現在對碰撞危機的知覺，當值船副不一定能有這樣的雷達認識。

⇒ 在目視瞭望船副可以看到他船在打閃光信號，右舷正橫，同時也應該看得到該船的住艙燈光，在他船的駕駛台附近，這就能夠協助我們確認他距離本船有多遠？這是避碰的第三階段，當值船副不一定能有這樣的目視認知。

如果，當值船副沒有被 VHF 的通訊所分心，已經能夠及早發現這項改變。

⇒ 這並非事實，當值船副不是被 VHF 所分心，而是被駕駛台其他的成員所干擾。

⇒ 如果 7 號的目標船沒有在 VHF 上呼叫，客輪可能會在船艏的部位被碰撞，因為當值船副對於橫越船會比本船晚到達碰撞位置，沒有概念。

七號的目標船要求這一條客輪向右舷轉向，繞過他的船尾，當值船副在這個時間點，似乎是被阿帕的測繪所迷惑，他說的是，他想 7 號船會在他的船頭 0.6 海浬前通過。

⇒ 當值船副對於真運動向量的碰撞點概念，並不熟系，

⇒ 如果當值船副誤解速度向量線，是相對運動的速度向量線，橫越船應該能夠在本船之前，1.2 海浬處通過，而不是 0.6 海浬（在 0049 時的畫面上）。

⇒ 當值船副並沒有目標的相對方位是否正在減少的概念，不會使用他的目視瞭望的技巧。

⇒ 碰撞距離是 1.2 海浬，這是在圖形 5-01 上面所看到的，固定距離圈的距離是 0.5 海浬。

他認為七號目標船會在 0.6 海浬前面通過本船。

⇒ 這是在雷達上觀測時，看一眼所得到的一個想法。這就是缺少適當的目視跟雷達瞭望的綜合訓練。

⇒ 當值船副已經具有兩年的海上資歷，雷達瞭望的技巧都還沒有上手，他複製了他知道的知識，但並不足夠形成本船附近正確的情境感識。

⇒ 如果當值船副使用了 10 公分的雷達來探測大型船隻，自動擷取目標，阿帕的資料，也許可以說明他看到 CPA 是多少，或是橫越本船船頭的距離是多少，也就可以避免胡亂的猜測。

⇒ 現在當值船副可以立刻知道碰撞距離，碰撞時間，利用 AIS 資料裡的真運動向量線，不必使用阿帕測繪。

5-03 Situational awareness lost when training is not enough?

In figure 5-01, Target No.7 is about course 145^0 (T) speed 20 knots, Target No.5 course 213^0 (T) speed 14.5 knots

⇒ We saw a collision point on these two vessel's speed vectors in radar screen. Time to collision **TTC for No.7 target is about 6 minutes and for No.5 target (red speed vector) is about 5 minutes.**

⇒ NO. 5 target pass collision position one minutes earlier.

At this moment 0049 hours*, a message was heard on VHF, Channel 16, saying "Passenger ship approaching Foxtrot Freeboy [i.e. F3 Buoy] course 215, please". This was about 4 - 5 minutes before the collision. The ships identified themselves and, while replying, the OOW looked to starboard and saw No.7 ship flashing a light forward of his starboard beam.*

⇒ This is **positive identification of target in VHF communication which is a must-be and most difficult part in VHF communication in multi target situation.**

⇒ Inside the screen by Radar lookout, OOW can identify the target No.7 distance is 1.7 nm and TTC is 5 minutes to get an awareness of collision risk now.

⇒ In visual lookout, Does OOW can see ship flashing a light forward of his starboard beam has some accommodations lights around her bridge to verify her distance to ownship now?

- *but, had the OOW not been distracted by the call, he may have been able to detect this alteration earlier.*

⇒ This is not true. OOW was not distracted by VHF call but other people on bridge.

⇒ Distraction is not the reason of overlook the collision risk. OOW does not have necessary skill and knowledge to know immediate collision risk.

⇒ If no VHF calling by No.7 target, cruiser vessel may be collided in midship part as OOW have no idea of crossing vessel will arrive collision position later than ownship.

The No.7 ship asked the cruiser to come to starboard to pass around her stern. The OOW seems at this point to have become confused with the ARPA plot. He stated that he thought the No.7 ship would pass about 0.6 miles ahead of him.

⇒ OOW is not familiar with True vectors collision point concept in radar.

⇒ If OOW mistook these speed vectors as relative motion, crossing vessel should pass at 1.2 nm ahead, not 0.6 nm at 0049 hours.

⇒ OOW did not check target's relative bearing is decreased or not with visual lookout skills.

⇒ **Distance to collision point DTC is 1.2 nm as figure 5-01 one range ring on radar is 0.5 nm.**

- *He thought the No.7 ship would pass about 0.6 miles ahead of him.*

⇒ One thought by one look at radar. This is lack of proper training in visual and Radar lookout.

⇒ OOW has two years sea experience already but necessary radar lookout skills had not got yet. He duplicates only one thing he knows but not throughout enough to form a correct situation awareness around her vessel.

⇒ If OOW had used 10 cm radar for large vessel auto acquisition, ARPA data may help to clarify the CPA Or BCR Bow Crossing Range value without guessing

⇒ **Today, OOW can look at the radar screen and know DTC and TTC immediately by speed vector without ARPA data by our study.**

5-04 情境感覺消失，當被自己錯誤主導時

然後他就同意了 7 號目標船的要求，跟著在 0051 時轉向 7 度到 220 度的真航向，來增加通過的距離。請參考圖形 5-02，7 號目標在一海浬遠的位置，距離碰撞點的距離是 0.7 海浬，在 0051 的時候。

⇒ 當值船副需要多少度的轉向，才能夠對一海浬距離遠的目標避讓？應該要轉向多少度才足夠？當值船副並沒有任何概念，但是我們已經有了，應該是至少保留 10 度的水準夾角增大，當目標是 300 米長的船隻。請參考第二章 08 節，1852 m x 1 nm x Sin (θ0) = 300 meters (chapter 2-08). Θ=9.32 degrees 答案應該是 9.32 度

⇒ 對 7 號目標的真方位大約是 285 度，客輪必須從 213 度轉到 285 度，再加上 10 度水準夾角的增大，等於是 295 度，向右舷轉向 82 度，對一條客輪，要再 3 分鐘之內回轉這麼多角度，幾乎是不太可能。

⇒ 你是否有任何概念？因為近距離的花開效應，一條 300 米長的船隻，在一海浬的時候，你最少要轉向 20 度，才能避讓。

在一海浬的時候，向右舷轉向 7 度：是對迎艏正遇的或是小型船隻才足夠，對大型的船隻，這是絕對不足以繞過 7 號目標船的船尾。

7 號目標船的船尾：方位是 090 度，就像是雷達螢幕上面所顯示的，如果不使用右滿舵，在 3 分鐘的時間要回轉 90 度，幾乎是不可能。

⇒ 90 度的回轉是一個危險的動作，對船上的乘客而言。

⇒ 停止主機對現在這個情況，也沒有多大說明，再一次我們需要循環舵的技術，船長級的技術來減輕碰撞的的力度。

圖形 5-02 碰撞前 3 分鐘的情勢感知

5-04 Situational feeling lost when preoccupied by own mistake

He therefore agreed to No.7 ship's request. Accordingly, at about 0051 he altered course about 7 degrees to starboard to 220˚ (T) and (G) to increase the apparent passing distance. Please refer to figure 5-02. No.7 target is 1 nm distance away and Distance to Collision DTC is 0.7 nm at 0051 hours.

⇒ OOW has no idea of how many degrees course change is needed for a 300 meters long target at "one nautical mile distance"? But we have the idea. It's about 10 degrees horizontal angle for a target length 300 meters in one nm distance away. 1852 m x 1 nm x Sin (θ^0) = 300 meters (chapter 2-08). Θ=9.32 degrees.

⇒ And, this 9.32 degrees is 300 meters vessel's blossom effect (horizontal angle augmentation).

⇒ But how many distance had moved away by 7 degrees course changed by OOW in this case? 1852 m x 1 nm x Sin (7^0) = 225.7 meters,

⇒ To take another 300 meters distance for own ship's length into consideration (total 600 meter displacement of collision point) will need another 10 degrees course change to starboard side which will make 10+10 = 20 degrees course change to starboard side. (this conclusion is coincided with our discussion in Chapter 2).

⇒ OOW can take this as a general rule, ***For one NM target collision avoidance at least 20 degrees course alternation is minimum requirement.***

⇒ This course change has the effect to move original collision point to starboard side only.

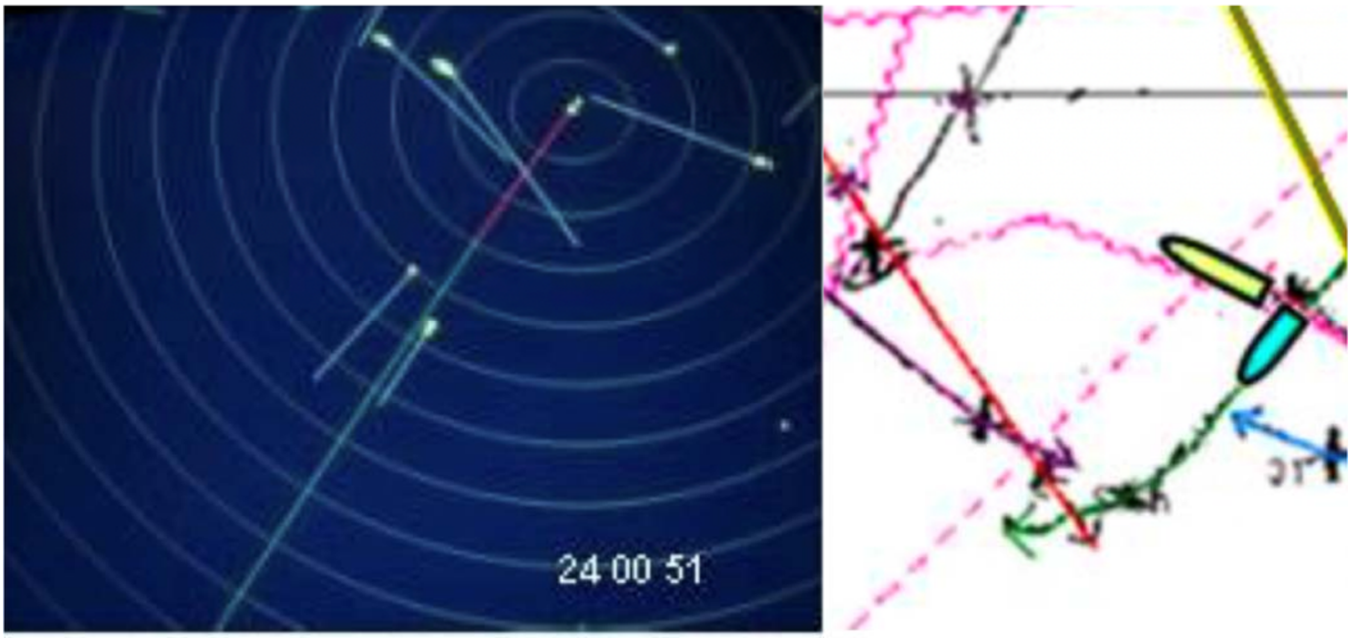
⇒ This course change had not considered of target vessel's relative bearing is about 70 degrees to ownship's starboard side.

⇒ For target no.7 true bearing is about 285^0 (T) Cruiser have to alter course from 213^0 (T) to 285^0= 72 degrees to starboard side if by junior OOW standard operation in collision avoidance.

⇒ Which have to add 10^0 degrees more for blossom effect 213^0 (T) to 295^0 (T) = <u>85 degrees more to starboard side</u>. It is almost impossible for a Cruiser to finish the turn in 3 minutes.

⇒ Have you any idea? ***At least 20 degrees course should change for blossom effect of a 300 meters vessel in one nautical mile.***

- ⇒ *altered course about 7 degrees to starboard:* is for head-on situation or small fishing boat, not for a crossing big vessel and it is not enough to go around No.7 vessel's stern in last 3 minutes before collsion.
- ⇒ *No.7 vessel's stern:* located 90 degrees starboard side abeam as by radar screen. It is almost impossible to alter 90 degrees without hard over rudder to accomplish within 3 minutes.
- ⇒ 90 degrees turn is a dangerous move to passengers on board.
- ⇒ Stop engine cannot help in this situation. In this situation, C-3 almost impossible to avoid collision in last three minutes.
- ⇒ If we want to try to mitigate the collision, we will need rudder cycling skills in Master level to help the situation.



圖形 5-02 碰撞前 3 分鐘的情勢知覺

5-02 客輪雷達瞭望的最後一堂課

5-05 碰撞前 3 分鐘，需要的情境直覺

在 0051 這個時刻，是碰撞前 3 分半鐘，*當值船副瞭解到兩條船已經非常接近，所以快速的行動是需要的，當值船副將主機的控制器拉到全速倒車，然後舵角改為右滿舵。*

- ⇒ **無論如何緊急，碰撞距離都是需要先確認的東西**，因為碰撞的距離，決定了我們避碰行動的有效性，(改變航向需要的水域，或是主機停止時間是否足夠)。
- ⇒ 離碰撞的時間，可以在雷達螢幕上做確認，7 號目標的碰撞時間是 3 分半鐘，5 號目標（紅色的速度向量線）是 3 分鐘。
- ⇒ 當值船副將舵角放在右滿舵，碰撞的前 3 分鐘
- ⇒ 在這個情況下，舵效會減少，因為沒有螺旋槳的排出流作用舵板上。
- ⇒ 這就是所謂的鐵達尼效應，當鐵達尼號的當值船副，看到冰山在船頭，他就直接拉了全速倒俥的車令。
- ⇒ 在回轉的第一階段，船尾需要螺旋槳的排出流，將舵板推出，以便增加船體的阻力，協助在往後階段的回轉。（請參考第四章第二節回轉的三階段）
- ⇒ 每條船都有不同回轉與停車曲線的特性。船隻動態的真實反應，只有船上的當值船副跟船長清楚。

在這 0052 到 0053 時，碰撞的前兩分鐘，*客輪已經向右舷回轉，但是主機的動態對減低船速的效果有限。*

- ⇒ *客輪往右舷回轉*：航向從 213 度轉到 235 度，這有 22 度的轉向，這是由圖形 5-01 真運動向量的畫面，所量取的。

⇒ *船上的碰撞位置改變*：從客輪的右舷，轉移到客輪的船頭，在最後的兩分鐘時間，這樣就救了數千條人命，很多人命。
⇒ 想像原來船上的碰撞位置，是在右舷正橫前相對方位 20 度左右（來船方位）。
⇒ 在船副將舵角改為右滿舵以後，客輪轉向的 20 度，碰撞位置在船上，也從右舷正橫前 20 度轉移到客輪的船頭，客輪駕駛台位於船頭的位置。
⇒ *但是主機的動態對於減低船速，效果不大*：在減速的這一個階段，主機只有切斷燃油供應，主機的轉速 RPM，可能還是非常高，參見第三章第六節的警急倒車說明。

***在 0054 時碰撞前的 1 分鐘**，客輪碰撞 7 號目標船的左舷，以大約 90 度的角度。*

⇒ 在客輪轉向了 20 度到 235 度，碰撞的位置轉移到客輪的船頭。
⇒ 7 號目標船的航向是 145 度，加上 90 度等於 235 度，就是 5 號目標（客輪）在碰撞時的船首向。
⇒ 經過客輪 20 度的轉向之後，讓我們做一個碰撞位置位移的大約估計。
  - 客輪 20 度的航向改變，依照我們之前的研究，船隻是在第二階段的回轉。
  - 客輪在第二階段的回轉，他的前進距離大約是本船船長的兩倍，也就是 229.84 乘 2 等於 459.68 公尺。
  - 客輪的船頭離開原來的航線的正橫距離，459.68 x sin (20) = 157.2，碰撞點的橫向位移等於 157.2 公尺。

⇒ 碰撞點的橫向位移，為 7 號目標船帶來了惡運，因為他的左舷船舯被撞，貨櫃起火，在海面上燃燒了 10 天，在英吉利海峽不能進港，並造成危險的 40 度傾側。
⇒ 這表示客輪比 7 號目標晚到碰撞位置，碰撞點從客輪的右舷轉到它的船頭。
⇒ 這對有幾千條人命的客輪，是一種幸運，因為客輪的前後左右都是客艙。
⇒ 原來客輪是比 7 號目標先到達碰撞點，就像我們在圖形 501 跟 502 所看到的。
⇒ 七號目標船並沒有用目視的方法，檢查客輪的避碰行動，用客輪的視角變化，或是用相對方位的變化。
⇒ 同樣的 7 號目標船也沒有核對客輪避碰的能力，也不具備雷達瞭望的技術，對可能的碰撞位置，碰撞距離與碰撞時間不知道，不會利用速度向量線來估計。

當值船副很快的就瞭解到，他的轉向是沒有效果，在船隻穩定在新航線航向之前，將舵角增加到右滿舵，並且將主機的控制拉到全速倒車。

⇒ 客輪在第二階段的回轉，需要兩分鐘的時間，0051 時加兩分鐘等於 0 0 5 3 時，*舵角搬到右滿舵，同時俥鐘拉到全速倒車*，但這個已經太晚了。

圖形 5-03 雷達瞭望與目視瞭望對碰撞的直覺

5-02 Last mile before collision in Cruiser radar lookout

5-05 Situational instinct needed in last three minutes: DTC, course, collision position changed

***At this moment 0051 hours, 3 1/2 minutes before collision** The OOW realised that the two ships were very close and that rapid action was needed. The OOW put the engine combinators (i.e. bridge controls of main propellers) to full astern and the helm hard to starboard.*

⇒ **No matter how emergency, DTC distance to collision is first priority to identify** because DTC defined effectiveness of our avoidance action (sea room to alter course or stop engine is enough or not?)
⇒ TTC Time to collision can be verified at RADAR screen also. TTC for No.7 target is about 3 and half minutes and for No.5 target (red speed vector) is about 3 minutes.
⇒ *The OOW **put the helm hard to starboard:*** 3 minutes before collision.
  - In this case, rudder effect is reduced by *put the engine combinators (i.e. bridge controls of main propellers) to full astern* due to no propeller expel current on rudder plate.
  - This is what they called Titanic Effect when OOW on Titanic saw iceberg ahead he pulled full astern engine.
  - In 1st stage of turn the rudder plate need propeller expel current to push sideward to increase ship's body's resistance to assist the turning in later stages.

- This turning angle cause by rudder plate in 1st stage is also very helpful in reducing the speed ahead.
- Please refer to chapter 4 – 02 Four stages of vessel turning.
- Every ship has different characteristics in his turning and stopping curve.
- Actual reaction of ship's movement while turning only knew by on board OOW and Master.

At this moment 0052-0053 hours, 2 minutes before collision *The cruiser was swinging to starboard, but the* ***engine movement was ineffective*** *in reducing the vessel's speed.*

- *The cruiser was swinging to starboard:* course changed from 213^0(T) to 235^0(T), this course changed is measured from figure 5-01 right side's vessel track picture.

⇒ **Collision position on board had changed** from ownship starboard side to ownship's bow on Cruiser which save lots of passengers' life by this course change.

⇒ Imaging original collision position on board is 20 degrees to her starboard side (relative bearing changed by 20 degrees course change).

⇒ After *OOW put the helm hard to starboard and* cruiser alter course 20 degrees, the collision position on board shifted from starboard 20 degrees to ship's bow because cruiser vessel has their bridge at their bow position. (Chapter 3-05 Collision position changed by ownship's action)

- *but the engine movement was ineffective in reducing the vessel's speed:* Engine is cutting fuel oil supply in this stage. Engine revolution per minute RPM may still very high now. (Chapter 3-06 Situational awareness of Crash Astern)

At this moment 0054 hours, one minute before collision *The cruiser hit the port side of the No.7 target approximately at right angles.*

⇒ After cruiser alter course 20 degrees to 235^0 (T) the collision position ahead of No.7 target shifted to No.7 target's bow. (No.7 target arrive collision point half minute later than cruiser vessel in original situation)

⇒ No.7 target course is 145^0 (T) which plus + 90^0 (T) *approximately at right angles* collision = 235^0 (T) (course of cruiser vessel in collision).

⇒ Let's make a rough estimation of the collision position displacement after A/C 20 degrees:
  - 20 degrees course change in our study of turning we know: ship is at second stage of turning.
  - Ship is at second stage of turning: her advance distance is 2 times of ship's length = 229.84 x 2 = 459.68 meters (Cruiser bow advanced original course line after alter course)
  - Displacement of collision position 459.68 x sin (20) = 157.2 meters

⇒ The collision position at sea originally is 157 meters ahead of No.7 target's bow. Collision point shifted about 294.13 meter backward after Cruiser course changed course, this bring No.7 target in bad luck who had burned for 10 days in English Channel and had a dangerous list 40 degrees.

⇒ This means cruiser arrived collision point later than No.7 target and shifted the collision from cruiser vessel starboard side to her bow.

⇒ This is a good luck for thousands lives on board for passenger's cabins are all over ship side.

⇒ Originally, Cruiser will pass collision point earlier as we see on figure 5-01 and 5-02.

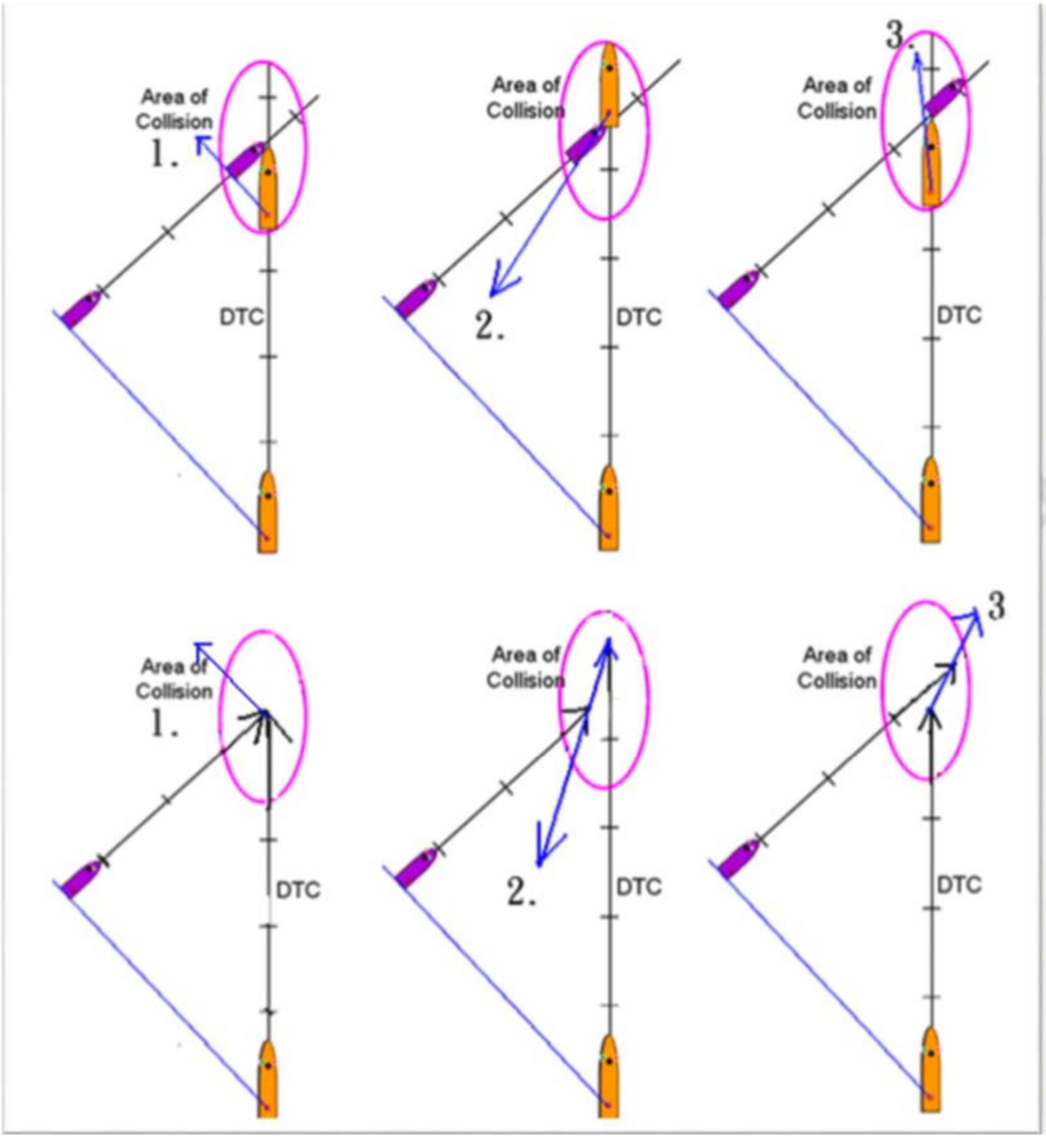
⇒ No.7 target had not checked Cruiser's avoidance action by Cruiser's aspect or relative bearing change in visual. (who had a North Sea pilot on board)

⇒ Also No.7 target had no Radar and visual lookout skills to identify approximate collision position, distance and time by both vessel's true motion speed vectors.

- *The OOW very rapidly realised that his alteration was ineffective and before the ship settled on her new course he put the helm hard to starboard and the combinators (i.e. bridge controls of main propellers) to full astern.*

⇒ Cruiser course in second stage need two minutes to finish her turning. 0051 hours + 2 minutes = 0053 hours. *He put the helm hard to starboard and the combinators (i.e. bridge controls of main propellers) to full astern.*

⇒ This is too later.



圖形 5-03 雷達瞭望與目視瞭望對碰撞的直覺

5-03 目視瞭望與雷達瞭望的碰撞知覺

5-06 誰撞誰的線索，本船那裡會被撞

圖形 5-03，本船橘色是向北航行，紫色目標船的船尾相對方位是藍線，在上半部目視瞭望有三種情況， 視覺線索誰撞到誰：檢查目標船的船尾相對方位線，也就是藍線，

a. 如果目標船船尾的相對方位不變，表示將會與本輪同時到達碰撞點。

b. 目標船船尾相對方位線往本船船尾方向移動，目標船到達碰撞點比較晚，將會撞上本船。也就是本船先通過碰撞點，目標船隨後才到，目標船會來撞本船。

c. 目標船船尾的相對方位向前移動，表示目標先到碰撞點，將會被本船撞上。

無論如何，這樣子誰撞誰的，是對資淺船副而言，作為一個資深船副，我們應該關切的是本船的安全，從這些視覺的線索，來找出本船的哪一部分會被撞上？

a. 目標的船尾相對方位不變，表示本船跟目標船可能是船邊撞船邊。

b. 目標船的船尾相對方位，向後移動，表示本船的船邊或船尾，會被目標船撞上。

c. 目標的船尾相對方位，向前移動，表示本船用船頭去撞目標船的船身。

在圖形的下半部，有三個雷達速度向量線所產生的情況，只要連結兩條船速度向量線的端點，端點代表兩條船的船頭，從本船速度向量線的端點連結到目標船的速度向量線的端點，就可以看出來（代表）目標船的相對方位，是落後或超前，在圖上是用藍線表示這些相對方位線的指向，有三種情形

a. 速度向量線端點對端點，表示兩條船會同時到達碰撞點，這個相對方位線藍線指向目標，也許是船邊對船邊的擦撞，或是直接的對撞。
b. 本船的速度向量線端點，在碰撞點之後比較長，相對方位線連接著兩條船速度向量的端點，指向本船的船尾，本船的船邊或是船尾會被碰撞。
c. 目標的速度向量端點在碰撞點之後比較長，相對方位線連接著兩條船的速度向量線端點，指向本船的前面，這表示本船的船頭會去撞目標船的船身。

碰撞角度可能可以用速度向量線（用我們的經驗）來做估計，只是筆者還沒有總結，有興趣的船長大副，可以自己歸納一下（不難吧）。

5-03 Collision awareness from visual and Radar lookout

5-06 Clues of who hit by who, which part of ownship will be collided

In figure 5-03 ownship colored orange is north bound, the relative bearing of target vessel's stern are those blue lines. In the upper part there are three situations with

1. visual clues of who hit by who: Check target vessel's stern relative bearing line (blue line)
    1. relative bearing unchanged means target is about to collision with ownship at the same time.
    2. relative bearing moving astern means target arrive collision point later and is about to hit ownship.
    3. relative bearing moving ahead means target arrive collision point earlier and is about to be hit by ownship.

However, these usual rules of who hit by who are for Junior OOW level. As a Senior OOW, we should care about ownship's safety first from these visual clues: which part of ownship will be collided.

1. target's stern relative bearing unchanged means ownship will collide side to side with target.
2. target's stern relative bearing moving Astern means ownship will be collided at shipside or stern. (by target's bow)
3. Target's stern relative bearing moving Ahead means ownship will collide at Bow.

It is obvious that ***Hit by target at our ship side is most unfavorable.*** The consequence is to sink ownship or disable ownship's maneuvering. Thus, it is worth to remember:

Target's stern relative bearing moving Astern slowly is a dangerous sign always.

In the Lower part there are three situations with Radar speed vectors crossed. Join two vessels speed vectors' ends (represent both vessels' bow) from ownship to target to see what direction this relative bearing line (blue line) point to.:

1. Speed vectors crossed end to end: two vessels arrive collision point at same time, side to side scratch maybe or collision.
2. Ownship's Speed vectors pass cross point first: ***relative bearing line (blue line) point astern of ownship, ownship's side or astern will be collided.***
3. Target's Speed vectors end pass cross point first: relative bearing line (blue line) joined two vessels speed vectors' ends point ahead of ownship, ownship's bow will be collided.

Angle of blow may be estimated from our experience. Author had not summarized yet.

The difference of visual and radar lookout in this regard is

- Visual lookout needs some time to evaluate the situation or use our instinct of relative bearing change.
- Radar lookout can read the situation immediately from true motion speed vector.
- Visual lookout is usually used by Master or Pilot with extraordinary experiences.
- Radar lookout is for junior OOW had proper radar lookout skill.

5-07 誰將會是犠牲者

在這麼近的距離，瞭望時的另外一個考量，是船隻實際的大小，相對運動線指向是向前，或是向後移動，哪一條船會是犠牲者是很清楚的。當相對方位不變，就像在圖形 5-03 裡面的 1 號情境，小船會是犠牲者。實際的犠牲者可能 VLCC 或是 LNG 的大型船隻，船上有爆炸或火災危險貨物，像桑吉輪在碰撞 3 分鐘之後，駕駛台就被大火吞噬。我要鼓勵當值船副，仔細的研究上

面圖形，所提供的資訊，然後想像實際情境，試著自己來解釋圖形所代表的意義（尤其是在雷達瞭望時），這樣你就能夠在緊急的時候，得到正確的認識。

1 號情況是兩條船幾乎是在同時到達碰撞點。

- ⇒ 碰撞可能是左舷對右舷，或是右舷對左舷，也就是船邊對船邊的擦撞。
- ⇒ 視覺線索是目標船的船尾，相對方位幾乎不變。
- ⇒ 雷達線索：速度向量端點連線的指向，指向目標，在圖上，我們對同樣的時間間隔做了記號，讀者可以連結同樣的時間間隔，兩條船所在的位置，來確認這兩條船相對方位的指向，是向前或是指向後方。

2 號的情況是本船先到碰撞點，本船船上的被碰位置，是在我們的左舷。

- ⇒ 像上一個例子所提到的，7 號目標船的情況在 0054 時，或是在桑吉輪是右舷被撞到，桑吉輪就是先到碰撞點，長鋒水晶輪後到，撞到桑吉輪的右舷。
- ⇒ 視覺的線索是，所看到的是，目標船的船尾相對方位，是在增加，從 42.5 度增加到 156 度的相對方位。無論如何，目標並沒有足夠的距離來避免碰撞，有可能目標的船尾方位，移動到本船尾之後，但是他的船頭還是撞到本船的船舷。
- ⇒ 雷達線索：速度向量線端點連線的相對方位線，指向船尾，代表本船的船舷或船尾會被撞到。

3 號情況是目標早到達碰撞點，在本船是船頭去撞對方。

- ⇒ 視覺線索是目標船的船尾相對方位的方位，是在減少中。（從 42.5 度減到 5 度）因此，他的船尾還沒有通過本船的船頭，如果他的船尾相對方位線通過本船的船頭，可能碰撞是可以避免的。
- ⇒ 雷達線索：速度向量端點的連線是指向前方，目標船是往本船的船頭前方移動，但是我們還是會撞到他。

5-07 Who will be the victim?

Another consideration in lookout in this close range is vessel's actual size. When relative bearing line pointing or moving ahead/ astern which vessel will be the victim is clear. When relative bearing is unchanged like No.1 situation in figure 5-03, small vessel will be the victim. Actual victim may be the VLCC or LNG vessel who has explosive and flammable cargo on board like Sanchi engulfed by their cargo fire three minutes after collision. I am encouraging OOW to study the massage from the figure above which might save your own life sometimes. Look at it and figure it out and make wordings to explain by yourself, you will get the correct sense when you need it in an emergency.

- ⇒ No. 1 situation is two vessels arrive collision point almost at same time. Collision is port side to starboard side or starboard side to port side.
  - o Visual clue is Target vessel's stern relative bearing line almost unchanged.
  - o Radar clue is Relative bearing by joining their speed vectors ends is pointing to target.
  - o I have marked of same time interval in figure 5-03, reader can join same time interval position of these two vessels to feel their relative bearing change.
- ⇒ No. 2 is ownship arrive earlier, collision point on board is at ownship's port side which can be verified by reader in No.7 target at 24 00 54 hours in last example and for MV Sanchi who been collided at starboard side.
  - o Visual clues is target vessel's stern relative bearing line is increasing (in figure 5-03 is from 42.5 degrees to 156 degrees port side). For a clear pass, target vessel's relative bearing have to increase to 180 degrees as quickly as possible. However, target did not have enough distance to clear the collision.
  - o Relative bearing of Speed vectors' end is pointing astern means ownship will be collided at shipside or stern.
- ⇒ No. 3 is target arrive earlier: collision position is at ownship's bow.
  - o Visual clues is Target vessel's stern relative bearing line is decreasing (in figure 5-03 is from 42.5 degrees to 5 degrees port side). However, it's stern had not passed ownship's bow yet.

- Relative bearing of Speed vectors' end is pointing ahead. Target vessel is moving ahead of ownship bow. We will hit it.

5-08 避碰的最佳措施，是使用相對方位變化來判斷

知道船上會碰撞的部位，有多嚴重？這是生死關頭，去撞或是被撞，代表著在碰撞時，本船的生存機率，活下來的機會。就像是長鋒水晶輪存活，桑吉輪卻失去機會。

到現在，我們還有著一些疑問

第一個疑問是為什麼？方位變化如此明顯，還是發生了碰撞，這個原因就是花開效應，如同圖形 2-09 水準夾角增大與接近船隻的相對方位改變。如果我們能夠判斷碰撞的部位，運用速度向量在雷達上的顯示，就能夠知道如何才是最佳的避碰行動，或使用目視的相對方位變化去判斷。

⇒ 情況 1，相對方位幾乎不變，或是速度向量端點連線指向目標。兩條船同時到達碰撞點，兩個方法，向右舷轉向，平行來船的航向，增加他的相對方位，或是停止主機來減少他的相對方位。與目標的航向平行，可以避免碰撞，如果時間允許的話。我們這邊討論的都是第三階段的避碰，也就是兩條船都必須採取行動。時間距離還夠的話（第二階段的避碰），本船應該依照避碰規則的要求，來採取行動，該讓路的讓路，該直航的直航，只有在逼不得已的時候（第三階段的避碰），就是在非常近的距離，才會使用最有助於避碰的行動。

⇒ 在情況二，相對方位變化向後，或是速度向量端點連線指向本船船尾，本船先到碰撞點，向右舷轉向去平行來船的航向，去增加來船的相對方位，現在我們的建議是因為，在圖形 5-03，本船橘色是向北航行，而目標船是紫色的目標船，由本船左舷接近，所以我們建議是向右舷轉向。

⇒ 情況三相對方位向前，指向船頭，目標船先到碰撞點，本船應該停止主機，減少相對方位。這意思是說，目標船的相對方位，如果有增加的趨勢，就要讓他增加的更快。如果有減少的趨勢，就讓他減得更快。只要目標過了我們的船頭或是船尾，我們就通過了碰撞的考驗。

總結的來說，由相對方位改變，來判斷避碰的最佳行動。如果目標的相對方位減少，就加強減少相對方位的趨勢。如果目標的相對方位增加，轉向到目標船的另外一邊，來加快來船相對方位增加的趨勢。

5-08 Best aid to avoid collision in advance: use relative bearing to judge

How serious these collision spot will be? " To be or Not to be?" which is equivalent to " To collide or to Be collided?". To be is "CF CRYSTAL" who survived. Not to be is "SANCHI" who sacrificed.

We have some questions so far.

⇒ First question is why bearing change is obvious collision still happen? The reason is blossom effect as figure 2-09 Horizontal angle augment and RB change of approaching vessel.

If we have collision awareness from true motion speed vector in radar lookout we will know how to react to

best aid to avoid collision in advance: use relative bearing to judge

⇒ In situation one: Relative bearing almost unchanged or point to target, two vessels arrive in same time, A/C to starboard side to parallel oncoming vessel's course to increase her relative bearing or stop engine to decrease her relative bearing.

⇒ In situation two: Relative bearing moving or pointing astern, ownship arrive earlier, A/C to starboard side to parallel oncoming vessel's course to increase relative bearing. Don't stop engine for ownship will stay on collision point longer than original situation.

⇒ In situation three Relative bearing moving or point ahead, target vessel arrive earlier, stop engine to decrease relative bearing more quickly.

In summary, ***judging from relative bearing change to decide what to do is best aid to collision.***

- If target relative bearing decreased, stop engine to reduce relative bearing quickly.
- If target relative bearing increased, alter course to other side of the target to increase relative bearing quickly.

5-03 新加坡水道：油輪航行衝突區域

5-09 超大型油輪與超大型貨櫃船 2016 年碰撞的省思

一條一萬四千 TEU 的超大型貨櫃船 VLCS ，與一條超大型油輪 VLCC 發生碰撞，在當地時間 23 點 55 分，2016 年的 8 月 3 號在新加坡水道裡面，大概在 Sebarok Island 3 公里東南方，這兩條船都是巴拿馬旗，超大型油輪 VLCC 是向西南航行，船頭遭受損害，超大型貨櫃船 VLCS 的損害是在他的左船尾，由這裡的敘述，我們知道 VLCC 超大型油輪較晚到達碰撞的地點。這一條超大型貨櫃船剛由新加坡港開出來，要橫越西南向的航行巷道，轉入東北航向的航行巷道，船隻總長有 365.8 米，最大寬度有 52 米，吃水 12 米，能夠裝載 14000TEU，在分道航行制西南向的航行巷道裡面，VLCS 必須做一個 90 度的轉向。

VLCC 西行，沿著西南向的航行巷道。32 萬噸的載貨量，16 萬 4 千噸的總噸位，這條船是從中國開往伊朗，在壓艙的情況下航行，全長 333 米，最大船寬 55 米，最深吃水 17.8-21 米，油輪比較短寬，是圓船，相對於超大型貨櫃船。油輪設計的目的是增加他的載貨量。超大型貨櫃船是一條尖船，設計考量的是快速。

在意外發生之前，航道交通管制台提供了資訊給這兩條船，警告大型油輪，有一條大型貨櫃船將會橫越西南向的航行巷道。

超大型油輪的船頭受損，超大型貨櫃船的左船尾受損，有 6 個空櫃落海，這是碰撞的後果。如果油輪可以把速度減下來，碰撞可能可以避免，但是實際的情況是：

圖形 5-04 在新加坡水道的碰撞位置

14 點 56 分 47 秒，我們知道新加坡時區是正 8，所以當地時間是 22 點 56 分 47 秒。

5 – 03 Singapore Strait: maritime bunker power conflict zone

5-09 After myth of VLCC collided with VLCS 2016

A 14000 TEU Very Large Container Ship (VLCS), was in collision with a Very Large Crude Carrier (VLCC) at approximately 23.55 LT (local time) on 3rd Aug 2016 in the Singapore Strait, about 3 km South-East of Sebarok Island. Both are Panama-flagged vessels. ***VLCC westbound sustained damage to her bow whilst VLCS sustained damages on her port quarter hull.*** By this statement, we know VLCC arrived collision position later. *The container ship VLCS just sailed from the Port of Singapore to cross westbound lane and join the eastbound lane of the TSS which has overall length of 365.80 m, molded beam of 52.00 m and maximum draft of 12.00 m. The vessel has capacity to carry 14,000 TEU.* VLCS have to conduct a 90 degrees turn inside the TSS.

The VLCC westbound sailed along SW traffic lane had deadweight of 319,999 DWT and gross tonnage of 164,241 GRT. The ship was en route from China to Iran under ballast. Length Overall x Breadth Extreme: 333 m x 55 m. Deep Draught 17.8 m / 21.1M. VLCC is shorter and wider than VLCS, a round ship for more cargo loading. VLCS is a sharper ship for speeding

Prior to the incident, VTIS provided traffic information to these two vessels and alerted VLCC one VLCS was crossing the traffic lane. VLCC sustained damage to her bow whilst VLCS sustained damages on her port quarter hull and 6 empty containers fell overboard. By the collision consequence, if VLCC can slow down the collision might be avoided. But the truth is:

圖形 5-04 在新加坡水道的碰撞位置

圖形 5-05 這兩條船的碰撞位置，14 時 56 分 47 秒到 14 時 57 分 47 秒，

Time 14:56:47 UT1:

5-10 貨櫃船將撞到大型油輪的右船尾，由速度向量線的交點來判斷

向量線是 3 分鐘的長度，這條的速度向量線就是我們的太空船：可能的碰撞區域。

⇒ 大型貨櫃船船速 9.5 節，航向 129 度，顯示紅色速度向量線，3 分鐘的長度 0.48 海浬，這是他探測碰撞危機的碰撞線，或是他的金箍棒。

⇒ 大型油輪的船速是 15 節，航向是 248 度，顯示綠色的速度向量線，3 分鐘速度向量線的長度，是 0.75 海浬的距離。
⇒ 碰撞點是在黃色的圓圈，依照他們速度向量線的方向，產生的交點。
⇒ 大型貨櫃船是直航船，在橫越的情況，應該保持它的航向跟航速，這是避碰規則第二階段的要求。
⇒ 橫越船 VLCC 是在深水航道，航向 248 度，速度 15.0 節。

如果兩條船保持他們的原來的航向航速，由 14 時 56 分 47 秒圖形
⇒ 西南航的船隻 VLCC 會先通過碰撞點，在 4 分鐘之後，也就是 23 點 00 分 47 秒
⇒ 而直航船超大型貨櫃船將在 5 分鐘之後，才通過碰撞點，在 23 點 01 分 47 秒才會到。
⇒ 1 分鐘的時間差距，並不足以清爽的通過。
⇒ 以超大型油輪現在的船速 15 節，1 分鐘時間，他可以前進 463 米。
⇒ 超大型油輪全長 333 米是少於 463 米，所以超大型郵輪有機會通過超大型貨櫃船的船頭，463 米的這個距離，要看原來的超大型油輪的碰撞點是在哪裡？這個呢資料不夠，我們沒有辦法在這邊討論。
⇒ 一般呢我們會保留兩倍船長的距離，做為避碰的安全距離，對 333 米的船隻來說，需要的是 666 米，兩倍的船長，現在只有 463 公尺，還是不夠的。

但是，對後到的一萬四千 TEU 的超大型貨櫃船，駕駛台到船頭可能就有 200 米的長度，這樣就會先橫越大型油輪的航線，造成碰撞。當西南向的大型油輪通過碰撞點的時候，大型貨櫃船的船頭，可能也到了碰撞點。在大型油輪全部的船長，尚未通過碰撞點的時候，造成碰撞。大型貨櫃船的船頭可能撞上大型油輪的船身，當大型油輪正在他船頭通行的時候。

實際的情況是大型油輪撞上的大型貨櫃船，大型油輪的船頭撞上貨櫃船的左船尾，這跟我們 22 點 56 分 47 秒看到的不同，是什麼原因？
⇒ 這就是東南向的大型貨櫃船加速，在四分鐘的時間從 9.5 節增加到 12.1 節。
⇒ 西南向的大型油輪並沒有轉向，也許是考慮到它最大的吃水 17.8 米，使他無法離開深水航道。
⇒ 西南向的大型油輪在 22 點 56 分減速，從 15.0 節到 11.7 節，這並不足夠，但是可以有額外的時間評估與大型貨櫃船可能的碰撞情勢。

At this Time 14:56:47 UT1:

5-10 VLCS will hit VLCC starboard quarter judging by speed vectors crossed point

Speed vector are three minutes. This 3-minutes speed vector is our space ship: possible collision area.
⇒ For VLCS speed 9.5 kts / course 129^0 in red color, her red speed vector in three minutes is 4.8 cables in length. This is her collision risk stick ahead.
⇒ For VLCC speed 15.0 kts / 248^0 in green color, her green speed vector in three minutes is 7.5 cables in length.
⇒ Collision point is in the yellow circle according to their speed vectors direction.
⇒ "VLCS" is Stand-on vessel in crossing situation who shall keep her course and speed.
⇒ Transit vessel VLCC is in deep water route course 249 degrees speed 15.0 Kts.
⇒ If Both vessels maintained her course and speed,
  - Transit Vessel VLCC will pass collision point earlier (after 4 minutes 14:56:47 + 4:00 = 15:00:47) and
  - Stand-on vessel "VLCS" will pass collision point one minute later (after 5 minutes 14:56:47 + 5:00 = 15:01:47).
  - One minute distance run in 9.5 knots is 293 meters in VLCS which might be enough for VLCC to pass.
  - One-minute distance by VLCC speed now is 15 Kts x 1 Minute = 463 Meters.

- o VLCC has 333 meters length over all which is lesser than 463 meters. VLCC may have the chance to clear of VLCS's bow by these 463 meters. It depends on what time both vessel's bow arrived original collision point.

Actual case is VLCC westbound collided VLCS with her bow and VLCS sustained damages on her port quarter. This is not what we had seen in 14:56:47 drawing, why?

- ⇒ SE bound VLCS increased her speed from 9.5 kts to 12.1 kts in 4 minutes time.
- ⇒ SE bound VLCC did not alter course because the consideration of her max. draft 17.8 meter is too deep for her to sail outside TSS SW lane.
- ⇒ SE bound VLCC reduced speed at 1456 hours from 15.0 kts to 11.7 kts is not enough but this reduce may have more time to access the situation with VLCS.

5-11 對目標船的船尾轉向，永遠都是避碰時最佳的選項

如果大型油輪希望向右舷轉向，他必須創造出 659 米的距離，讓大型貨櫃船通過，這是貨櫃船 9.5 節的速度，一分鐘跑的距離加上貨櫃船的全長，等於 293 米加 366 米的長度，總共就是 659 米。

- ⇒ 大型油輪 15 節的船速，1 分鐘可以跑 463 米，離碰撞的時間還有 4 分鐘，以他 15 節的船速，現在他**離碰撞點的距離還有 1852 公尺**，大型郵輪如果要向右邊轉向，**1852 sin(Ø) = 659, Ø = 21 degrees**，就必須要轉 21 度。（這是由速度向量線的觀察來計算的）
- ⇒ 在現在的狀況，就必須要轉 21 度，由 248 度轉到 269 度，經過大型貨櫃船的船尾。
- ⇒ 比較圖上大型貨櫃船的真方位，現在是 280 度，大型油輪想要繞過大型貨櫃船船尾，她必須轉向到 280 度，這個比我們計算的 269 度要多，讓路給大型貨櫃船，用目視避碰轉向，轉向要多 11 度。
- ⇒ 所以以目視轉向，如果我們選擇向來船的船尾方向轉向，這是比我們計算的 269 度，具有更多的安全。

對於慢速的大型貨櫃船，如果想要讓路給 333 米的油輪，他距離碰撞點是 9.5 節乘上 5 分鐘等於 1466 公尺，1466 公尺要轉幾度？才有 3334 米的正橫距離，1466 sin(Ø) = 333, Ø = 13 degrees.答案是 13 度。這是從兩條船速度向量線來計算的。

- ⇒ 大型貨櫃船轉向左舷，要從 129 度轉到 116 度，來讓大型油輪先通過碰撞點。
- ⇒ 大型郵輪的目視方位是 100 度，所以呢使用目視來船的船尾方位轉向，比較安全，比我們計算所需要的度數還要多。

單純的計算轉向產生的正橫距離，是沒有考慮到花開效應與三階段轉向時，所造成的正橫距離效果，**所以近距離轉向避碰，還是要以目視為主**。

5-11 Alter course to target's stern is an invariant best option to avoid collision

If VLCC want to alter course to starboard side she has to keep out 659 meters abeam distance for VLCS to clear. (<u>one-minute distance run of</u> <u>VLCS 7.4 knots speed plus VLCS length over all = 293 meter + 366 meter = 659 meters</u>).

- ⇒ One minute distance run for VLCC 15 knots = 463 meters.
- ⇒ By Distance to Collision DTC is 463 minutes (read from collision point) x 4 = 1852 meters, 1852 sin(Ø) = 659, **Ø = 21 degrees.**
- ⇒ VLCC have to alter course 21 degrees to 269^0 (T) to pass VLCS stern in current situation. (calculated from speed vectors observation)
- ⇒ Compared with VLCS true bearing now is 280 degrees(T). If VLCC try to go around VLCS she will have to alter course to 280^0 (T) which is more than necessary in our calculation 269 degrees(T).
- ⇒ Alter course by visual to 280^0 (T) have more safety allowance than our calculation 269^0 (T).

For slower vessel VLCS, want to alter course to give way to VLCC 333 meter long.

- ⇒ By Distance to Collision DTC is 7.4 Kts x 5 minutes = 1142 meters, 1142 sin(Ø) = 333, **Ø = 13 degrees.** (calculated from speed vectors observation)
- ⇒ VLCS has to alter course **13 degrees** to port side from 129 degrees to 116 degrees (T) to let VLCC pass first.

⇒ Visual bearing of VLCC in traffic lane is 100 degrees(T), by using visual skill we don't need to know relative bearing is how many degrees.

5-12 超大型油輪避讓時的考量，停車或轉向

總的來說，**對目標船的船尾轉向是避碰時，最好的選項。如果距離碰撞的時間還有 3 分鐘**，因為一次完整的回轉，需要 3 分鐘的時間。

⇒ 使用碰撞位置的規則來判斷，在 56 分 47 秒當時的情勢，速度向量線的交點，對超級油輪來講是 4 分鐘，而對超大型貨櫃船來講是 5 分鐘。所以大型油輪會提早到達碰撞點，這樣就不應該減速，因為減速不一定具有效果，本船的處境又會比較危險（船邊會被撞），所以選擇轉向比較有利。

⇒ 大型貨櫃船正確的做法，就是先停車，讓油輪先通過，油輪是在西南向的分道航行巷道，沒有辦法避讓，航行巷道外的水深不足，沒辦法繞過本船的船尾。我們說過碰撞點應該是在航道裡面，才是正常的。

⇒ 只是避碰超大型貨櫃船，才開出航道之外，因為避讓還未進入碰撞點的船隻，就像是超大型貨櫃船還沒進入航道，超大型油輪就必須將船隻，開到他的船尾方向，就有可能會開出分道航行巷道而擱淺，所以在這種情形，應該是考慮使用循環舵的技術來減速，這個以後我們再討論。

⇒ 距離碰撞還有 4 分鐘的時間，對一條大型油輪具有 15 節的船速，這是他的全速，除非他向右舷轉向來讓路，超大型油輪減速，並不是一個有效的避讓方法。超大型貨櫃船本來就是晚 1 分鐘到達碰撞位置，減速也無法避免碰撞，反而讓貨櫃船追上，要加車更是不可能。

⇒ 對超大型油輪而言，向右舷轉向，需要 659 米的正橫距離，才能到達大型貨櫃船的船尾，大約是 0.36 海浬的長度。

超大型油輪的船位，將會在航行巷道的邊緣，轉向對著超大型貨櫃的船尾避讓，如果船長沒辦法把他的回轉，控制得很好，開出航道去擱淺的可能性，就會增加。

⇒ 對超大型油輪這樣深吃水的船隻（圓船），回轉速率是很難停止的。

⇒ 碰撞的距離 DTC 在 22 時 56 分 47 秒是 4 分鐘的時間，乘上 15 節等於一海浬的距離，對這一條超大型油輪來講，這是他 5.6 倍船隻的長度，所以超大型油輪仍然具有向右舷轉向避讓的選項。

⇒ 但是超大型油輪選擇去減速，超大型貨櫃船卻選擇去加速。這兩條船都做了錯誤的事情，這就是因為沒有具備雷達瞭望的知識跟技術，所以他們也沒有雷達瞭望的直覺可以用。

右圖時間 22 時 57 分 47 秒，過 1 分鐘後，船隻的碰撞是船頭對船頭

5-12 Considerations of VLCC to give way, stop engine or alter course?

In summary, **alter course to target's stern is an invariant best option to avoid collision if TTC more than 3 minutes** (make A turn complete needs 3 minutes).

⇒ Use "collision position" rules to judge the collision situations in 14:56:47. The crossed point of speed vectors is 4 minutes ahead VLCC and 5 minutes ahead VLCS current position. VLCC will pass collision position earlier who should not reduce speed if possible.

⇒ The correct way for VLCS is to reduce engine and let VLCC pass first who is in SE traffic lane and may not have enough water depth to give way or go around ownship outside TSS.

⇒ There are 4 minutes TTC time to collision, for a big vessel VLCC with 15 knots (almost her full speed) unless it alters course to starboard side to give-way, **VLCC reduce speed is not an effective way to give way.** Originally VLCS is to arrive collision position one minute later.

⇒ For VLCC A/C to starboard side needs 659 meters abeam distance which is about 3.6 Cables distance.

⇒ VLCC's position will be at edge of traffic lane by altering course to give way .

If VLCC master **cannot control the turn very well the possibility to go aground is increased.** For VLCC this kind deep loaded vessel (round ship) the rate of turn in turning is very hard to stop. The DTC (distance to collision) of VLCC at 14:56:47 hours is 4 minutes run x 15 Kts = 1 nm (1852 Meters) which are 5.6 Ship's Length. VLCC still has the option to alter course to starboard side to clear VLCS.

But, VLCC choose to reduce speed and VLCS choose to increase speed.

Both vessels had done the wrong thing. They have no radar lookout knowledge and skill. So, there is no radar lookout instinct for them to use.

Time 14:57:47 (one minute passed) vessels collide side to side scenario

5-13 AIS 瞭望的一個好處

在圖形 5-05 的右圖，我們看到直航船超大型貨櫃船的航向是 132 度，這是從 129 度轉過來的，當時的速度是 10.3 節，從 9.4 節的船速，在一分鐘之內所增加的。碰撞點的位置幾乎是不變，在圖上顯示是黃色的大圈，橫越船超大型油輪的航向 247 度，是從 249 度轉過來的，速度是時 14.3 節，從 15 節船速緩慢減下來的。

⇒ 如果兩條船保持現在的航向航速，會在 3.5 分鐘之後發生碰撞。
⇒ 兩條船的羅經方位不變，180 度對 100 度，這就是碰撞的確兆，但是碰撞的情勢已經改變了。
⇒ 這就是雷達瞭望使用速度向量線的好處，但是速度向量線上的船速輸入，是由 AIS 資料來的，所以應該講這是 AIS 瞭望的好處。
⇒ 可能的碰撞情勢是油輪船頭撞船邊，或是超大型貨櫃船的船頭會撞到超大型油輪的船中部位，因為超大型油輪早 1 點到達碰撞點，事實上，碰撞情勢很難確認，因為這兩條船 AIS 發射的船位座標，可能並不一樣，兩船的船速，也是隨時在變。

超大型油輪船上的碰撞位置，從他的船尾移動到他的船中部位，碰撞位置向前移動，是因為貨櫃船增加了他的船速。我們知道本船速度如果降下來，可以將碰撞的位置往船頭方向移動，總的趨勢，就是油輪碰撞的位置往船頭方向移動。（請看第三章 30 節碰撞位置移動的安全知覺）

⇒ 再過來超大型油輪應該向右舷轉向，去準備呢船頭對船頭的碰撞，使用右滿舵加快迴轉，然後就是緊急倒車，來減少碰撞的動量（這是現階段的作法，情勢還在變，要看整體的趨勢）。在法庭上，油輪可能要費一番口舌，去解釋為什麼要轉向去碰撞。
⇒ 快速船超大型貨櫃船在一分鐘之內加俥，如果要減速的話，就非常不容易，因為它是尖船，加車容易停車難。
⇒ 超大型油輪應該尋找機會，從貨櫃船的船尾通過，因為碰撞的位置往船頭方向移動，這是我們對避碰的直覺。
⇒ 超大型貨櫃直接加車，但並沒有轉向，是明顯的錯誤，要不然他就是被其他的事情所分心。
⇒ 在雷達瞭望的時候，看不出碰撞位置改變，是因為沒有這一方面的知識，這種情況不會改善，如果沒有本書特別指出來，在交叉相遇也就是橫越的情況，永遠都是"提早通過碰撞點是最危險的事"，因為這會將本船船邊的軟肋，向目標船開放，本船被撞到或撞沈，都會是重大損失。

圖形 5-06 碰撞位置超大型貨櫃跟超大型油輪在 58 分 17/47 秒的情勢

5-13 An advantage of AIS lookout

In Figure 5-05 right picture, we see Stand on vessel "VLCS" course 132 degrees (changed from Port side 129^0) / speed 10.3 Kts (increased very fast from 9.5 kts within one minutes). collision position almost unchanged (because no vessel had altered course, both changed speed) shows as a big yellow circle. Crossing vessel VLCC course 247 degrees (from 249) / speed 14.3 Kts.(decreased slowly from 15.0)

⇒ If Both vessels maintained current course and speed, collision will happen about 3.5 minutes later.
⇒ Compass bearing of both vessels had not changed 280/100 degrees(T), Sure sigh of collision. But collision situation changed.

⇒ This is an advantage of radar lookout by using speed vector. But these speed input in speed vectors are from AIS data. So, this is also an advantage of AIS lookout.

⇒ Possible collision scenario is side to side, or VLCS Bow hit VLCC Midship section as VLCC arrives a little bit earlier. Actual collision scenario is hard to define as the coordinated setting of two vessel's center in AIS system may not be the same.

⇒ Collision position onboard VLCC had shifted from her stern to midship section, moving ahead because VLCS increased her speed. We knew reduce ownship speed can move collision point ahead (see 3-30 Safety Awareness of collision position change) and target vessel increase speed will move collision point ahead too.

⇒ VLCC should alter course to starboard side to prepare for bow to bow collision with "Hard Starboard Rudder" and "Crash stern on Main Engine" to reduce a side-to-side collision momentum, also reduce possible side area damage.

⇒ Fast speed vessel VLCS increase speed 2.9 knots in one minute very quickly and she will reduce it slowly as she is a sharp vessel.

⇒ Once she VLCS relative bearing is decreased (as a sign of passing ahead), ownship VLCC should seek the opportunity to pass her stern. Our collision avoidance instinct come from seeing target vessel relative bearing reduced.

⇒ VLCS had increased speed very quickly without alter course. This is an obvious mis-judgment. Or she is preoccupied by other things.

⇒ NO knowledge of what we can judge on collision position changed in Radar Lookout will bring No radar lookout skill to us.

Increase speed in crossing situation always means passing collision point earlier than before which will get more chance to open ownship's side to be hit by target vessel.

圖形 5-06 碰撞位置超大型貨櫃跟超大型油輪在 58 分 17/47 秒的情勢

Time 14:58:17 (1.5 minutes passed) VLCC hit VLCS port quarter scenario

5-14 如果本船無法在 3 分鐘的時間內完成回轉

在圖形 5-06，我們看到直航的超大型貨櫃船，航向是從左邊 129 度轉到 134 度，航速是從 10.3 節的速度，30 秒前開始加俥到 11.0 節。橫越船超大型油輪航向 248 度，航速從 14.3 節緩慢減下來到 13.8 節。可能的碰撞區域是以黃色的圓圈表示。

⇒ 兩條船的航向跟航速都在緩慢的改變，在這 30 秒的時間。

⇒ 碰撞會在 3 分鐘後發生，就像是預測的。

⇒ 可能的碰撞場景是船頭撞到船邊，油輪的船頭撞到大型貨櫃船的船中，從他們的速度向量線所顯示的，這是一個正確的觀察，從後續所發佈碰撞的照片來看，也是如此。

⇒ 在接下來的 3 分鐘時間內，大型貨櫃船正遭受一場惡夢，因為本船加大車想要脫離碰撞點，希望油輪可以從本船的船尾通過，這兩點都是很難達成，又看到油輪的相對方位不變，誰都知道碰撞即將發生。

⇒ 大型油輪應該向右舷轉向來避讓，或是準備船頭的碰撞，右滿舵與警急倒車的車鐘命令（在主機遙控器上）。

⇒ 現在這個時候，如果大型油輪沒有轉向，大型貨櫃船應該向右轉，讓路給橫越的船隻，如果船長有信心可以在 3 分鐘的時間內，完成向右的回轉。

就像圖形 5-07 所顯示的，如果貨櫃船沒有使用右滿舵，完成第三階段的回轉，或是用了右滿舵，但是慢了 1 分鐘，都會對本船造成極大的危險，會造成本船的船尾機艙，被他船也就是被大型油輪船頭，撞擊到本船的機艙部位。

⇒ 本船的船尾或是機艙，是最脆弱的部位，船殼破裂會造成大量進水，如果本船不能完成這 3 分鐘的回轉。

圖形 5-07 及時回轉，3 分鐘前避免碰撞的可能性

5-14 If ownship cannot finish the turn within 3 minutes time

In figure 5-06, we see stand on vessel "VLCS" course 134 degrees (changed 5 degrees from Port side 129) / speed 11.0 Kts (increased slowly from 10.3 knots, 30 seconds ago)

Transit vessel VLCC course 248 degrees (from 249) / speed 13.8 Kts.(decreased slowly from 14.3 kts)).

POC (Possible area of collision with two ship lengths in diameters) shows as a big yellow circle

⇒ Both vessels course and speed change slowly during this 30 second, collision will happen about three minutes later as predicted in this figure 5-06.

⇒ Possible collision scenario is Bow to shipside, or VLCC Bow hit VLCS Midship section as their speed vectors end suggested. This is a correct observation from the collision scene.

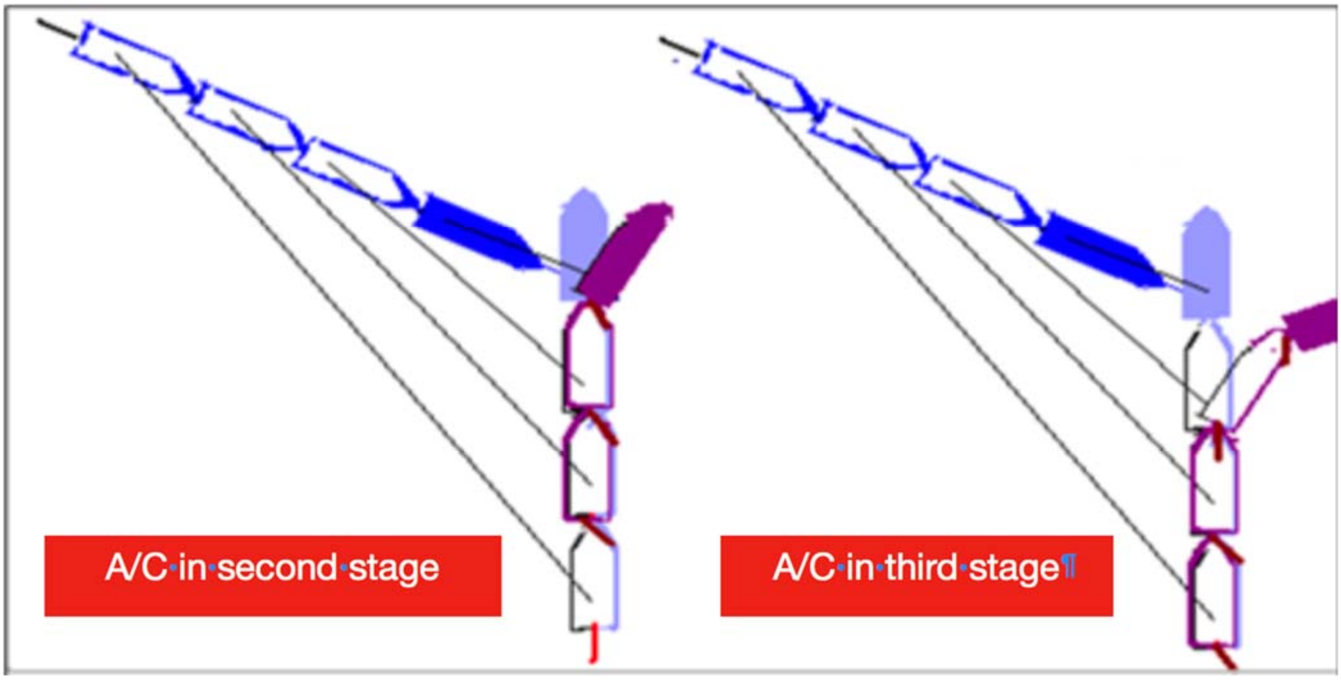
⇒ VLCS had got herself ***a nightmare to overcome in next three minutes because ownship increased speed try to get away or hoping VLCC can go around ownship*** are both very difficult to achieve in this close range. When VLCS saw VLCC's relative bearing had not changed (or increased) a lot, everybody know this is a sure sign of collision even he had not read this book before. This is the nightmare which may have the threat of our own life and whole ship's loss.

⇒ VLCC should alter course to starboard side to give way or prepare for collision on bow with "Hard Starboard Rudder" and "Crash Astern" telegraph on Main Engine.

⇒ If VLCC has not alter course, VLCS should alter course to starboard side to give way to crossing vessel if Master has the confidence to finish a 90 degrees turn in next three minutes.

⇒ As figure 5-07 below shown, If Very Large container ship (purple one) did not use the "Hard starboard" rudder to finish the turn in three stages or applied "Hard Starboard" rudder with one minute delay, it will be very dangerous to ownship which will cause collision on ownship stern or engine room.

⇒ Ownship's stern or engine room are most vulnerable parts once breached and flooded If ownship cannot finish the turn within 3 minutes time.



圖形 5-07 及時回轉，3 分鐘前避免碰撞的可能性

Time 14:58:47 (2 minutes before collision) Most critical moment = Last chance to avoid

回轉的時間如果是在 58 分 47 秒，也就是碰撞的前兩分鐘，這是最關鍵的時刻，也是避碰的最後機會。

5-15 先到碰撞點的船隻更脆弱

在這 30 秒的時間，兩條船的航向都沒有改變，或可能仍在回轉的第一階段，船速緩慢改變，碰撞將會在兩分半鐘後發生。時間已經過了 30 秒，可能的碰撞區域是以兩倍船隻的直徑來做估計，以紅色的圓圈顯示。

⇒ 直航船大型貨櫃船航向 134 度航速 11.4 節，緩慢增加從 11 節/10.3 節（在一分鐘之前的速度）。
⇒ 西南行的大型油輪航向 249 度，航速 13.3 節，緩慢地從 13.8 節慢下來。
⇒ 為什麼讓路船超大型油輪，並沒有改變航向，這不太合理，只要創造 0.2 海浬的正橫距離。就可以避免碰撞，是否是船長的操船技術不足。
⇒ 在油輪可能碰撞的部位在船頭，會撞到大型貨櫃船的船艉，是因為貨櫃船提早到達碰撞位置，早了 30 秒，這是過去半分鐘都沒有改變的情勢。
⇒ 大型貨櫃船將他的船艉部位開放，讓碰撞發生。
⇒ 油輪的船長應該使用目視瞭望，來確認大型貨櫃船的船尾，相對方位是否有減少？
⇒ 大型油輪的船長應該向右舷轉向，使用右滿舵，以通過大型貨櫃船的船尾，如果貨櫃船的船尾相對方位，已經有在減少。（實際上，一定有）
⇒ 大型貨櫃船的船長應該走到駕駛台的左舷，這樣才看得清楚與判斷左舷大型油輪的船頭，相對方位是否有增加？意思是說，觀測油輪的船頭的動向，作為最後操船的依據。

如果本船先到碰撞點，大型貨櫃船的船長應該打左滿舵，向左舷回轉，如果大型油輪的船頭，相對方位是在增加，或是已經通過了本船的迴旋支點，就像圖形 5-08 的左圖（碰撞的前兩分鐘，才開始回轉），這樣做的目的，是將本船的船尾撇開，希望能夠減少船尾被撞的可能性。
如果本船先到碰撞點，大型油輪在近距離向右轉向（碰撞的前兩分鐘，才開始回轉），大型貨櫃船的船長還是需要使用左滿舵，來向左轉向，來平行油輪的航向，就像圖形 5-08 的右圖所示。

圖形 5-08 顯示的是，如果大型貨櫃船紫色的船隻，沒有辦法確認本船是否有時間完成右滿舵 90 度的回轉？（需要三階段/3 分鐘）那就最好向左轉向，使用左滿舵，來避免本船的全損。也就是不能確定是否向右轉向來不來得及？這時候就應該向左轉，避免本船機艙部位受到撞擊。
在任何近接情況，早到碰撞點的船隻，都是比較脆弱。不論是對人的生命，或是本船的存續，都是如此。**慢速，在任何情況下，都是最安全的速度**。但是

減速或是停車，對一條超大型的油輪，或是超大型的貨櫃船都是一個緩慢的過程，從來都不是簡單的工作。首先我們需要很多的壓縮空氣，有足夠的的空氣壓力作用在主機上，才能停下。在停車的第一階段，只是單純的切斷油門，雖然船隻沒有燃油的供應，主機還是會以原來的速度跟動量，繼續向前滑行。
本船無論何時，都具有向左右兩舷轉向的選項，這需要船長的專業判斷，**如果本船先到碰撞點，我們應該向來船轉向來平行來船的航向，以減輕碰撞的力道。**
如果本船先到碰撞點，使用這樣子的方法，如同圖形 5-08 向目標船轉向，首先船長要先接受碰撞的命運，這是船長的心理障礙，因為向來船轉向，很可能的後果，就是碰撞無可避免，這樣做的目的，是保存船員船隻貨物，與船長他自己的小命一條。

圖形 5-08 如果本船先到碰撞點，減輕碰撞力道的回轉，碰撞前兩分鐘執行

5-15 Vessel arrive collision point earlier will be more vulnerable

In figure 5-06 right picture, Both vessels course had not changed, speed change slowly during this 30 seconds, collision will happen about 2.5 minutes later as 30 seconds had passed. POC (Possible area of collision with two ship lengths in diameters) shows as a red circle.

⇒ Stand on vessel "VLCS" course 134 degrees (No change) / speed 11.4 Kts (increased slowly from 11.0/10.3 in one minute).
⇒ Westbound vessel VLCC course 249 degrees (No Change) / speed 13.3 Kts.(decreased slowly from 13.8). Why give way vessel VLCC did not change course is not reasonable? To create 2 cables abeam distance should be enough for collision avoidance unless captain is not good at shiphandling.
⇒ Possible collision location on board: VLCC Bow hit VLCS Midship section because VLCS arrives collision location 30 seconds earlier (situation had not changed from last 30 seconds).
⇒ VLCS had got herself midship section open up to collision.
⇒ Master of VLCC should use visual lookout to ascertain VLCS stern relative bearing has decreased or not?
⇒ Master of VLCC should alter course to starboard side with “Hard Starboard Rudder “ to try to pass VLCS stern if VLCS stern relative bearing has decreased.
⇒ Master of VLCS should go to port side of her bridge to have a better view or judgement of port side VLCC’s bow relative bearing is increasing or not?
⇒ Master of VLCS should alter course with “Hard port Rudder “ to port side if VLCC bow relative bearing is increased to our stern (as we discussed before in 5-03) and passed ownship’s pivot point as figure 5-08 left drawing.
⇒ Even VLCC had altered course in this distance, Master of VLCS should alter course with “Hard port Rudder “ to port side to parallel with VLCC as figure 5-08 right drawing.
⇒ As figure 5-08 shown, If Very Large container ship (purple one) cannot make sure ownship has the time to finish the “Hard starboard” turn in three stages (need 3 minutes), it will be better to change course to port side with “Hard Port” rudder to avoid total loss of ownship.

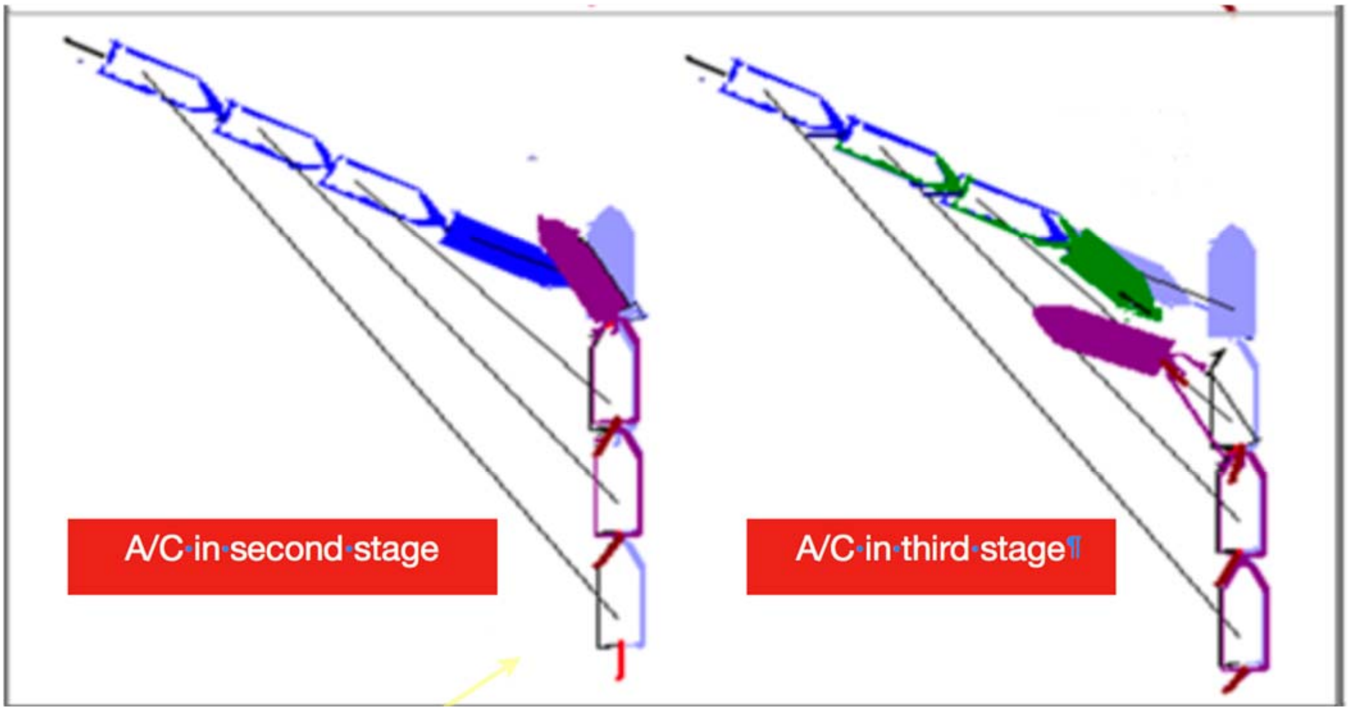
In any close quarter situation, ***vessel arrive collision point earlier will be more vulnerable*** whether it is regarding of crews’ life or ownship’s survival. Slow speed is always the safest speed in any case. But

⇒ Slow down or stop a VLCC/VLCS is a slow process and never an easy process at sea.
⇒ We need a lot of compressed air working on Main Engine to stop the RPM and in the first stage vessel will carry away by her original speed and momentum.

⇒ Ownship have the option to alter course each side depends on Captain's judgement.

⇒ If ownship arrived collision point earlier we have to alters course to parallel with target to mitigate the impact force.

⇒ In this way (figure5-08 right picture A/C to target side), Master had accepted his fate of collision and try to preserve ship's lives including himself.



圖形 5-08 如果本船先到碰撞點，減輕碰撞力道的回轉，碰撞前兩分鐘執行

5-16 改變航速比改變航向，需要更多的時間來避碰

⇒ 大型油輪跟大型貨櫃船是兩條不同典型的船型，大型的油輪是圓船，建造的目的主要是取得更多載重噸位 。大型貨櫃船是尖船，也希望能多裝一些貨櫃，但他更注重船隻的速度，希望能夠跑更多的航次，增加他的運費收入。

⇒ 大型油輪是回轉容易，啟動快，但是不容易停止，圓船的特性，轉向快停止轉向慢。它的船體形狀比較飽滿，船體阻力大，有助於第二階段的回轉。

⇒ 大型貨櫃船啟動第二階段回轉比較困難，但是要停止回轉，卻是比較快，是尖船。轉向慢穩舵快。因為他的船體比較流線型，所以在水中回轉的時候呢，已經沖出去比較遠的距離，才會啟動第二階段的回轉，那這個我們會在以後再做討論。

⇒ 從圖形看大型油輪航行的軌跡，尤其是在用舵之後是扭曲不直，從開始就是這樣，這表示這一條大型油輪呢，很難維持他的航向，貨櫃船的航跡，就是非常的平順，轉向啟動比較慢。

⇒ 大型油輪沒辦法及時停止左轉，即使他看到大型貨櫃船已經通過他船頭的區域，這就是圓船的特性，要停止已經啟動的回轉是困難的。

⇒ 大型油輪缺乏情境的認知，沒辦法由船隻的速度向量線，判斷出碰撞點，也沒有看出大型貨櫃船會先通過碰撞點，或是目視的時候，不知道貨櫃船的相對方位已經在減少之中，這些都是判斷大型貨櫃船，先通過碰撞點的依據。

⇒ 大型的貨櫃船增加船隻的速度，從 56 分 47 秒，碰撞前 4 分鐘前，由 9.5 節加到 11.9 節的速度，算來只有兩節半的速度增加，4 分鐘的平均速度增加是 0.6 節，平均速度增加了 4 分鐘等於 136 米，這是少於 1 倍的船長，少於大型貨櫃船 365.8 米的長度。

⇒ 在大型貨櫃船的船上碰撞的部位是在船尾，大型的貨櫃船沒有增加船速的話，碰撞位置可能會在 74 米之前，那樣的碰撞，沒有增加船速的話，可能是在大型貨櫃船的船艏。

⇒ 我們已經計算了油輪要避碰的正橫距離是 594 公尺，大型貨櫃船跑的距離 9.4 節一分鐘，加上本身的長度 366 米等於 594 米。

⇒ 594 減掉 136 米是 458 公尺，所以大型貨櫃船增加了兩節半的船速，還是不足以安全地通過 594 米的長度。

- 594 meters = 1852 x @ knots x 4 minutes.
- Average speed increase over 4 minutes @ = 4.81 kts.
- The final speed should be = 7.5 + 9.62 kts = 17.12 kts.

如果大型貨櫃船希望利用加車來避免碰撞，速度的增加，應該要能夠超越 594 米，依照我們計算的結果呢，就是船速平均要增加 4.8 節，所以最後的船速應該要達到 19.12 節，在 4 分鐘的時間，從 7.5 節的速度加到 17 節，來產生 594 米的避碰距離，這是一項不可能的任務，至少也需要 30 分鐘的加車，才能達到這樣的速度，而碰撞早已經發生了。

Time 14:58:47 (2 minutes before collision) Most critical moment = Last chance to avoid

5-16 Increase speed need more time to avoid collision than alter course

⇒ VLCC and VLCS are two typical ship type. **VLCC is round ship** which is aimed to carry more tons of weight. **VLCS is sharp vessel** which is designed to carry more boxes and quick turnaround for more money.

⇒ VLCC is easier to start, harder to stop her turn (round ship turning quickly stop slowly) because fuller underwater hull.

⇒ VLCS is harder to turn, easier to stop turn (sharp ship turning slowly stop quickly) because his slim streamline body underwater. This is next chapter story.

⇒ VLCC vessel's track is twisting from the beginning which shows this VLCC is hard to maintain her course. VLCS vessel's track is quite smoothie but hard to initial the turn.

⇒ **VLCC lack of situational awareness cannot read the collision point on speed vector to judge VLCS will pass earlier or visualize VLCS relative bearing decreased.**

⇒ VLCS increase ship's speed from 14:56:47 Hours (4 minutes before collision) from 9.5 kts to 11.9 kts.

⇒ This 4-minutes speed run is 1.2 knots (average speed increased) x 4 min = 136 meter which is less than her VLCS 365.8 meters ship's length to clear collision point.

⇒ Collision spot on board is stern of VLCS. If VLCS did not increase speed the collision spot on board will 136 meters ahead. The collision spot without increase speed may be at VLCS's bow.

⇒ We have calculated the beam distance VLCC have to avoid is 659 meters (clearing distance: one-minute distance run of VLCS 9.5 knots speed plus VLCS length over all = 293 meter + 366 meter = 659 meters).

⇒ 659 – 136 = 523 meters short. So, VLCS increase average speed 1.2 kts is not enough to clear 659 meters.

- If VLCS want to increase speed to avoid collision, the speed increased should cover this distance 659 meters.
- 659 meters = 1852 x @ knots x 4 /60 minutes.
- Average speed increase over 4 minutes @ = 5.34 kts is needed to cover 659 meters run.
- The final speed should reach to 9.5 + 10.68 kts = 20.18 kts to have @5.34 knots speed increased.
- VLCS need to increase from 9.5 to 20.18 kts within 4 minutes to clear 659 meters ahead. (9.5 + 20.18) /2 kts @ speed is 14.84 kts ; 14.84 Kts – 9.5 Kts = 5.34 Kts
- VLCS need to increase from 9.5 to 20.18 kts in 4 minutes is impossible.

5-17 倉促決策後遺症

人在做了決策之後，或是在做決策時，都會有一種放棄一切的決心，不再監控外在的環境，表示對於一切都由命運安排，好像只要做了決定，以後的事，就不是自己應該要負責的。大型貨櫃船的船長，應該要自問，“是否本船能夠在這樣的情況之下，順利的加車？”4 分鐘的時間來加速 10 節，當然這是我們計算以及估計的結果，以當時現場的情況，船長不可能瞭解到他需要加這麼多的車，才會完全沒問題。我想大多數的大型貨櫃船，都不可能這麼快速的加車，船長可能並不知道，在這麼短的時間內加車，是沒有用的。所以這個就是在避碰時的快速決策，或是倉促決策，主因卻是無知。

⇒ 同樣的當貨櫃船加車，到“全速前進/15 節”的俥令的時候，船長放棄了他的雷達與目視瞭望，或是放棄判斷碰撞危機，利用船尾相對方位的改變，對碰撞危機的監測。
⇒ 因為船長作加車的時候，這些監控技術與碰撞危機的評估，都不可靠，因為船速跟航向都在改變之中。
⇒ 增加船速避碰，沒有多大的用處，但是失去心裡的警覺性，對碰撞危機的持續監測，才是在避碰時最危險的事情。
⇒ 大型貨櫃船從 9.5 節加到 11.9 節，在 3 分鐘的時間，在這個案件中，並不足以避免碰撞。在海上要在 4 分鐘的時間內達成，從 9.5 節加車到 19 節，是困難或不可能，因為船隻巨大的重量，以及原始慣性需要克服。
⇒ 加減俥需要更多的時間，來避免碰撞，這是跟轉向來對比的。
⇒ 碰撞可以避免，如果大型油輪使用右滿舵，在 58 分 37 秒，如果大型油輪瞭解到，貨櫃船會早 1 分鐘通過碰撞點。
⇒ 在這麼近的距離，是很難講，尤其是雷達瞭望所需要的速度向量線，在雷達上，是否能夠觀測到速度向量線？就像桑吉輪的案件。
⇒ 不過，新加坡水道風浪不大，所以呢失去目標速度向量線的機會，也就小很多。
⇒ 同樣的，近距離貨櫃船的水準夾角快速的增加，也會造成呢目視瞭望的困難。
⇒ 大型油輪向左舷轉向，是追著大型貨櫃船船尾跑。圖形 5-09 一但大型油輪開始追逐，就沒有辦法停止油輪的回轉，這是因為圓船的特性。
⇒ 大型油輪向右舷回轉是一個比較好的選擇，可以避開大型貨櫃船船尾，在碰撞的前兩分鐘，如果大型油輪的船長，可以瞭解到本船能夠在兩分鐘時間之內，完成 36 度的回轉，或是在兩倍船長的距離之內，完成 36 度的回轉。
⇒ 這兩分鐘的時間，是否足夠 90 度的右轉？這個答案是不一定，對圓船也許是可以，也許對尖船就不行，所以啊你必須檢查你自己船上的性能曲線，在駕駛台上面的標示。
⇒ 建議使用循環舵，在 58 分 47 秒碰撞的前兩分鐘，用在大型油輪上，用來減速。

5-17 Lost mental vigilance on surveillance of collision risk due to jump out decision.

Captain of VLCS can ask yourself “Is your good vessel can increase speed in this manner?”. 10.68 knots in 4 minutes. I think most VLCS is not able to increase speed in this way. Captain may not aware that increase speed is not useful in this short time interval if he had not study before. This is a jump out decision in collision avoidance. Also, while ownship increase speed to “navigation full/sea speed” Captain will give up his Radar / Visual Lookout skill and his willingness to judge collision risk. Because Captain knows when ownship increasing speed, collision risk assessment is not reliable. Increase speed may not have much effect on collision avoidance. The consequence of Lost mental vigilance in surveilling of collision risk is most dangerous for further avoidance.

⇒ VLCS increase from 7.5 to 11.9 kts within 3 minutes in this case is not enough to avoid the collision.
⇒ At sea, increase speed from 7.5 kts to 17 kts is very hard or impossible to achieve within 4 minutes due to massive momentum of vessel have to overcome.

⇒Increase speed need more time to avoid collision than alter course.

⇒ Collision could be mitigated if VLCC applied "Hard Starboard" rudder at 14:58:37 Hours (two minutes before collision) when VLCC understand VLCS will pass collision point one minute earlier than her.

⇒ Once again, in this close rang it is hard to say speed vectors (radar Lookout skill) is available or not. (like Sanchi's case)

⇒ It is better for VLCC to have visual skill to verify VLCS relative bearing change.

⇒ VLCS's horizontal angle increased rapidly which may cause visual lookout more confused.

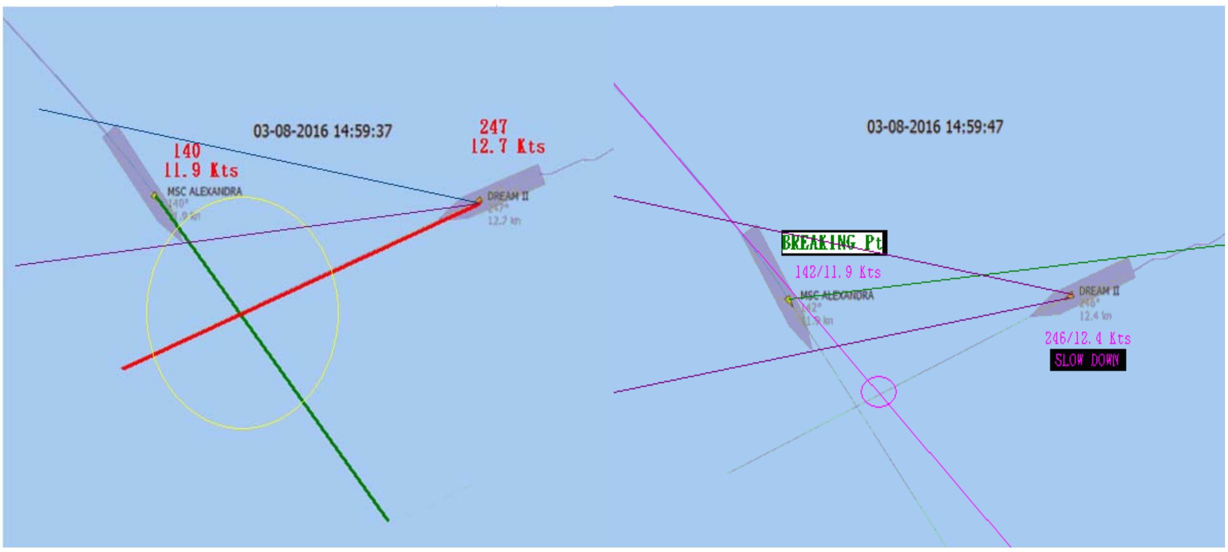
⇒ VLCC turning to port side is chasing VLCS (see figure 5-09). Once the chasing begins VLCC have the trouble to stop turning as her round ship property.

⇒ VLCC starboard side Turning is a better choice to avoiding VLCS two minutes before collision if VLCC Captain can utilize ownship turning characteristics is capable of 36 degrees turn within 2 ship's length advance distance.

⇒ Does Two minutes enough for a 90 degrees turning to starboard side? The answer is "depend". May be enough for round ship? May be not enough for sharp ship? Check your own ship maneuvering curves on bridge.

⇒ Rudder Cycling may be recommended to use at 14:58:47 (C-2) for VLCC to reduce speed.

Time 14:59:47 (one minute before collision)



圖形 5-09 大型貨櫃船跟大型油輪的碰撞位置，59 分 37 秒-47 秒

時間 14：59：47 碰撞前 1 分鐘

5-18 對目標船轉向，當本船在最後一分鐘時，已經到碰撞點

⇒ 直航船大型貨櫃船向右舷轉向到 142 度，由 134 度轉了 8 度，這是從 11.4 節緩慢增加到 11.9 節，這個大約是 HALF AHEAD 半速前進。

⇒ 橫越的大型油輪從 249 度轉到 247 度，速度是 12.7 節，可能他已經停車，但是速度是緩慢的從 13.3 節減到 12.7 節，原來呢它的通航速度是 15 節。

⇒ 這兩條船的航向跟航速改變，在這 50 秒鐘，貨櫃船已經進入了真正的碰撞區域，或是太空船的狀態。碰撞已經是無可避免，因為在這樣的時間距離之內，改變航向，或航速都已經來不及了。

⇒ 大型貨櫃船向右舷轉向，是在回轉的第一階段，這時本船的船尾被推向一邊，他向右轉就是將本船的船尾推向左邊，不幸的事，左邊是油輪來船的方向。
⇒ 大型油輪向左舷轉向，他也是在回轉的第一階段，只不過呢他的船尾呢是比較巨大，移動的比較緩慢。
⇒ 在舵角使用了 1 分鐘之後，貨櫃船呢是沒有太大的回轉，大型油輪的回轉，雖然啟動，卻是在錯誤的方向，也許呢他根本就沒有轉向，只是因為操舵上面，有兩度的誤差。
⇒ 大型貨櫃船的碰撞部位是她的左舷船尾，如果大型油輪向右舷轉向來避免碰撞，會有擱淺的風險，大型油輪有可能會通過大型貨櫃船的船尾。
⇒ 大型貨櫃船的船尾相對方位緩慢減少，他還是有機會可以通過大型油輪的船頭，只要有足夠的時間。
⇒ 大型油輪應該看的到大型貨櫃船的船頭，已經通過了本船船頭，大型油輪卻沒向右舷轉向，大型油輪沒有使用右滿舵。這就是大型油輪減速後，就交給命運。
⇒ 大型貨櫃船應該確認大型油輪相對方位的改變，在左船頭增加，有可能來船在減俥，本船是否沖不過去？沖的過去，會不會沖出航道擱淺？
⇒ 大型貨櫃船本來的航線去中國，就是要在西南向航道做 90 度的向左回轉，航道上有船，實在沒有理由亂沖，除非沒看到，不知道。
⇒ 使用主機全速前進來離開碰撞位置，只是呢我們主觀的想像，實際上呢沒辦法立刻就產生避碰的效果。
⇒ 大型貨櫃船應該使用左滿舵來將本輪的船尾推開，如果大型油輪的船頭通過本船的迴旋支點，就像圖形 5-08 所顯示的。
⇒ **向目標船轉向，當本船已經到達碰撞點，是最佳的避碰行動**，這是在避碰規則的第三階段，也就是近接避碰，如同圖形 5-08 的紫色船隻。

圖形 5－10 大型貨櫃船在 00 分 47 秒的碰撞部位

5-18 Alter course to target vessel when ownship arrive earlier in last minute

In figure 5-09 Stand on vessel "VLCS" alter course to starboard side 142 degrees (from Port side 134) / speed 11.9 Kts (may be this is a "Half Ahead" increased slowly from 11.4).
Crossing vessel VLCC alter course to port side 247 degrees (from 249) / Speed 12.7 Kts.(may be he had stop the engine but decreased slowly from 13.3)

⇒ Both vessels course and speed change slowly during this 50 seconds (58m47s to 59m37s), VLCS is already inside the PCP (Possible Collision Position) or space ship status collision is inevitable.
⇒ VLCS alter course to starboard side is in first stage of turn where ship's stern push sideway to target to her portside.
⇒ VLCC alter course to port side is also in first stage of turn only.
⇒ One minute after wheel over VLCS is helpless in turning and VLCC make the wrong direction turn. (or VLCC had not make any turn at all, her original course is 247^0 (T))?
⇒ Collision spot of VLCS is at her port quarter. If VLCC had alter course to starboard side to avoid the collision area, VLCC may have the chance to pass VLCS's stern.
⇒ Relative Bearing of VLCS stern decreasing slowly VLCS have the chance to clear VLCC's bow.
⇒ VLCC should verify VLCS BOW has passed ownship (she will not hit ownship) and ownship have no risk to alter course to starboard side with "Hard Starboard Rudder ".
⇒ VLCS should verify the Relative Bearing change of VLCC at Port bow had decreased.
⇒ Go "Full Ahead in M/E" to clear collision position is in imagination but hard to effective in time.
⇒ Prepare to use "Hard Port Rudder " to kick ownship stern off if VLCC's bow fall behind own ship Pivot Point. (as figure 5-08)

⇒ Alter course to target vessel when ownship arrive collision position earlier in last minute is best aid to avoid collision in third stage of COLREG as figure 5-08 purple ship .

圖形 5－10 大型貨櫃船在 00 分 47 秒的碰撞部位

Time 15:00:17 (30 seconds before collision)

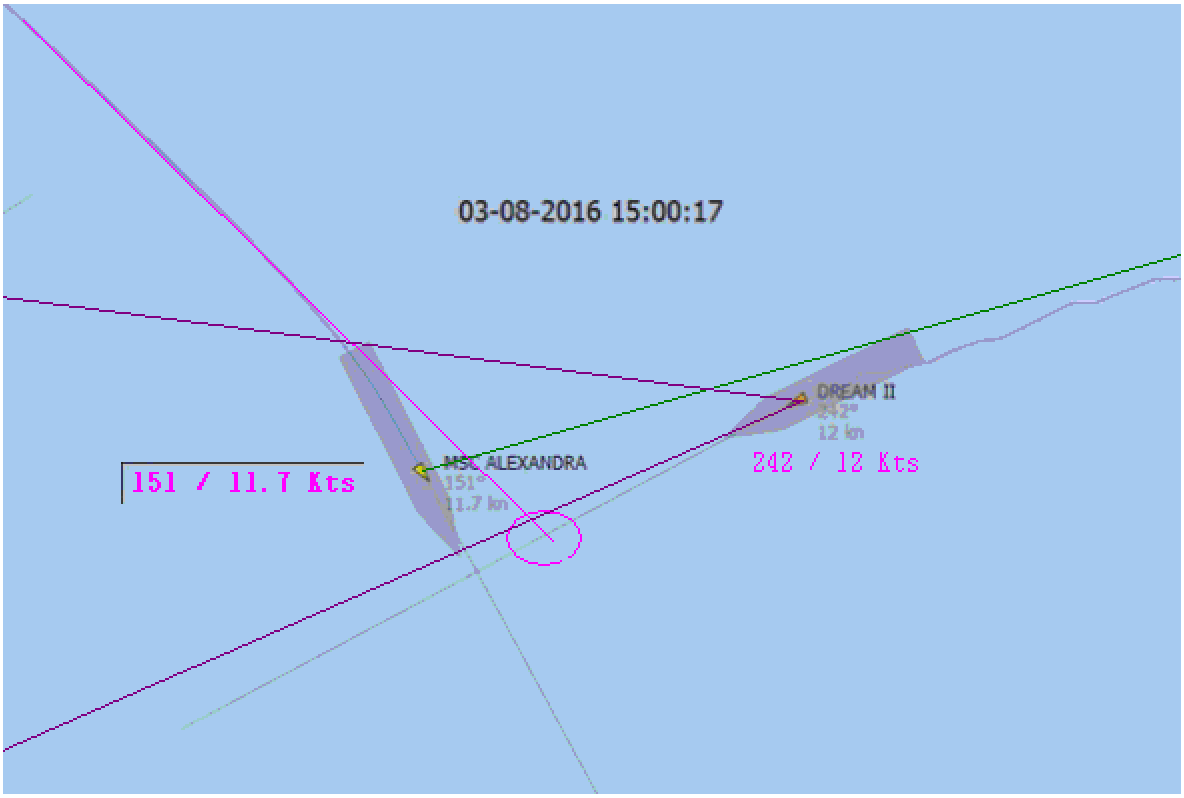
5-19 使用滿舵，將本船的船尾推開

圖形 5-11，15:00:17 碰撞前 30 秒，直航船超大型貨櫃船 151 度的航向，是由 134 度右轉 17 度來的（快速右轉），船速 11.7 節，這是從 11.4 節緩慢增加的。

橫越船超大型油輪航向右轉 7 度從 249 度到 242 度，速度是由 13.3 節減速而來。兩條船的航向航速的改變，都是他們最後的舵令以及減速而來。

⇒ 大型貨櫃船船頭已經通過碰撞點，但是船尾仍然是在大型油輪的航線上。
⇒ 油輪應該知道大型貨櫃船船頭，已經通過碰撞點，就是本船的船頭。
⇒ 但是貨櫃船的船尾相對方位並沒有太大的改變，只是從 37 度減少到現在的右舷 31 度，因為花開效應，這是不足以避碰。
⇒ 31 度是大型貨櫃船現在船尾的方位，如果大型油輪希望繞過大型貨櫃船的船尾，必須轉向 31 度以上。
⇒ 這個機會不多，因為實際上船正穩定在他的航向 247 度上，這是從開始就是如此，他的小角度航向改變，主要是用來減速，他的對地速度已經從 15 節減到 12 節。
⇒ 跟大型貨櫃船一樣，他的船速增加了以後，他就讓上帝去決定命運。在大型油輪是一旦船速已經減少，其他的就讓上帝去決定。
⇒ 這兩條船現在做的事情都一樣，都是聽天由命，事實上可以做的事情也不多，但是我們要堅持到底。
⇒ 油輪應該使用緊急到車的車鐘，雖然並不能確定碰撞是否會發生？
⇒ 在圖形 5-11，貨櫃船可以確認大型油輪的船頭相對方位，是否在本船的左舷持續增加。
⇒ 大型貨櫃船如果想要脫離大型油輪的船頭，可以準備向左轉向，使用左滿舵將本船的船尾推開，這是最後的機會。

⇒ 使用人員落水同樣的概念，也就是用滿舵向目標船回轉，將本船的船尾推開。



圖形 5-11，15:00:17 碰撞前 30 秒

5-19 Use Hard 0ver rudder to push ownship’s stern away

In figure 5-11, Stand on vessel "VLCS" course 151 degrees (changed from 134 degrees) is turning 17 degrees to Starboard Side / speed 11.7 Kts (increased slowly from 11.4).

Crossing vessel VLCC course 242 degrees had changed 7 degrees to Port side (from 249) / only Speed 12.0 Kts.(decreased slowly from 13.3). Both vessels course and speed had changed slowly carried from their last rudder order and speed reduction.

⇒ VLCS’s Bow already pass collision point and stern hull still in VLCC’s course line.
⇒ What VLCS needs now is to decide “How to get her stern clear of VLCC’s bow?”.
⇒ VLCC should know the bow of VLCS passed already.
⇒ Relative Bearing of VLCS stern (purple line from VLCC) had not so much change due to blossom effect (reduced from 37 degrees to 31 degrees now).
⇒ 31 degrees is VLCS’s horizontal angle now if VLCC want to go around VLCS’s stern.
⇒ The chance is rare because VLCC is actually steady on her course 247^0 degrees (T) from the beginning. Her small courses change are used to reduce her speed over ground from 15 knots to 12 knots as part of her rudder cycling skill (in next chapter).
⇒ This mindset is same as VLCS. ” Once speed is increased or decreased, others let God to decide”, in VLCC is “Once speed is reduced others let God to decide”.
⇒ VLCC should use Crash stern engine order on Main Engine as not sure the collision will happen or not?

⇒ In figure 5-11, VLCS can see the Relative Bearing of VLCC bow had increased from ownship Port bow to Port Beam which is a sign of danger?

⇒ VLCS have the chance to clear VLCC's bow and prepare to alter course to port with "Hard Port Rudder " to **push away ownship's stern by the knowledge of 1st stage of turning.**

⇒ Use same concept of man overboard: **Use Hard Over rudder to target vessel's side to push ownship's stern away."**

Time 15:01:17 (30 seconds after collision)

5-04 駕駛台資源管理或人為因素領導管理

5-20 使用人為因素理論的駕駛台資源管理

直航船大型貨櫃船的航向 249 度，（在左船尾的碰撞之後，向左轉了兩度）。船速 11.3 節維持不變。

橫越船大型油輪航向 225 度向左舷轉 24 度，（因為右船頭發生的碰撞，或是本船產生的舵效），速度只有 11.4 節，（就是很快的失去了 1.9 節的船速，從 13.3 節）

⇒ 圖形 5-12，紅圈是原始的碰撞點，當碰撞發生的時間，在這一原始的碰撞點，應該是大型貨櫃船的船頭，撞擊到大型郵輪的船尾。

⇒ 黃色的圓圈可能是後來的碰撞點，因為兩條船的航向航速改變而發生轉移，大型貨櫃船是加速，所以呢原來是船頭的碰撞，因為他的加車，碰撞點向船尾方向移動，到了他的船尾。

⇒ 而油輪的碰撞點，由他的船尾部位向前移動，因為他的選擇是減速，所以最後大型油輪是船頭裝發生碰撞，大型油輪向左舷轉向，追著大型貨櫃船的船尾跑，因為沒有去注意大型貨櫃船的相對方位在減少之中。

⇒ 沒有碰撞發生，沒有人會指責大型貨櫃船的加速，從 9.5 節加到 11.9 節，在分道航行制里加車，船長差一點就成功了，如果大型油輪沒有向左舷轉向，或是減速更有效率一點。

⇒ 大部分的海員，都不瞭解速度向量線的長度越長，也就是本船速度越快，碰撞危機就越多，加速代表增加碰撞危機。

⇒ 情境知覺在碰撞的時候，並不能用來指責兩位船長，他們並沒有接受過近接避碰的訓練，我完成的近接避碰中文版，是船長級的。如果只有知識背景的介紹，對有經驗的船長來講，是太過繁瑣，對於一個學生或是資淺船副，又無從體會。

⇒ 在我寫長慧輪的案件時，配合不同職級的需求，重寫了 4 次，因為不同海勤的年資。

⇒ 所以避碰的知識，技巧，適任性對不同的船副，在船上的訓練不同，要求都不一樣。

⇒ 在英文版我把它全部歸納起來，命名為"21 世紀駕駛台資源管理"，作為不同適任程度的管理級船員訓練之用，再加上適用的人為因素理論，使之綜和起來。

Time 15:01:17 (30 seconds after collision)

5 – 04 BHRM: Bridge Human Resource Management

5-20 Bridge Resource Management according to human elements theory

In figure 5-12 Stand on vessel "VLCS" course 149 degrees (after port quarter been collided slightly, 2 degrees to port side) / speed 11.3 Kts about the same

Crossing vessel VLCC course 225 degrees had changed 24 degrees to Port side (collided target vessel's starboard quarter or by ownship's rudder order) / only Speed 11.4 Kts.(lost 1.9 knots from 13.3 knots)

⇒ Red circle is Original Collision Point and should be the point VLCS's bow will hit VLCC stern at collision time by our estimation. (15:00:47 UT1).

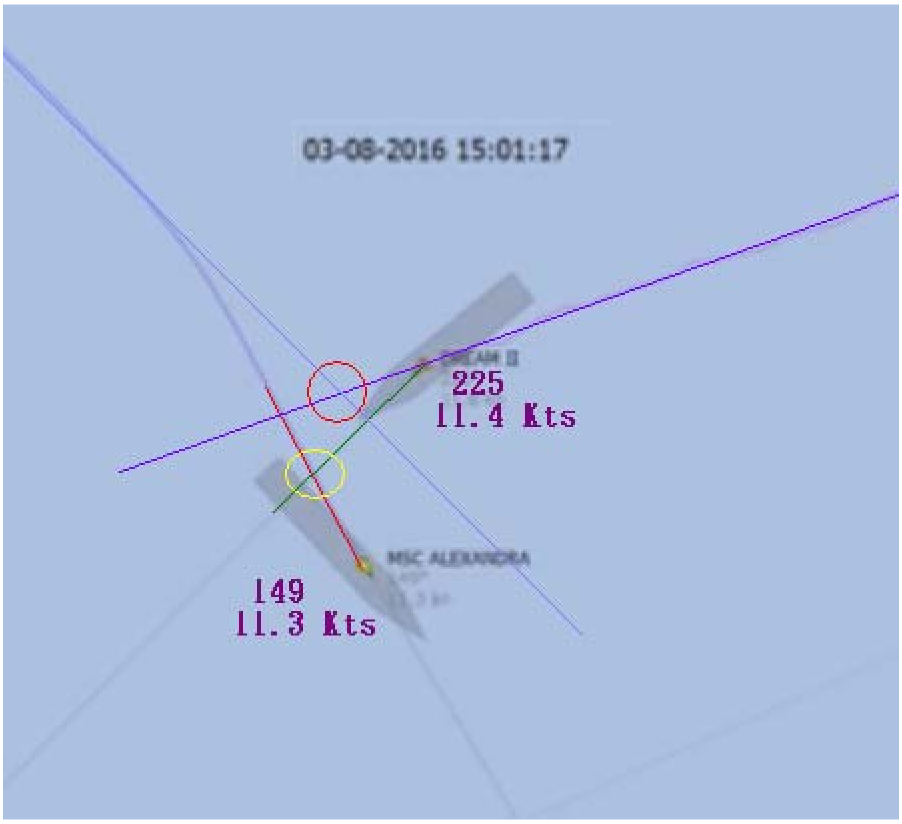
⇒ Yellow circle is possible collision point which had shifted ahead by VLCS increase speed and turn to starboard side by VLCS deviated from her original course line.

⇒ Collision point moving ahead of VLCC's speed vector due to VLCS alter course to starboard.

⇒ VLCC alter course to port side is chasing the stern of VLCS due to not aware of VLCS relative bearing decreased.

⇒ If no collision happened, no one will blame VLCS for increased speed from 7.4 Kts to 11.9 Kts into a Traffic Separation Scheme. Captain almost did it if VLCC had not alter course to port side or reduce speed more effectively.

⇒ Most mariner did not realize that longer speed vector (fast speed) means more collision risk. Increase speed means increase collision risk.



圖形 5-12，紅圈是原始的碰撞點 15:00:47

⇒ No situational awareness in collision situation should not be used to blame both Captains for no one had trained them with close quarter situation like this.

⇒ Close quarter collision avoidance for Master level in knowledge base is next chapter.

⇒ Only in knowledge base is too tedious to an experienced Master and too complicated to a student or Junior Officer.

⇒ It is obvious collision avoidance knowledge/skill/instinct are never in same level for different Officer on board. These collision avoidance knowledge/skill/instinct are valuable human resource if they had proper trained.

⇒ I summarized it all and name it "21 century Bridge Human Resource Management" BHRM for different competent levels according to human elements theory I knew.

5-21 最佳的 3A 知覺：最佳知覺的避碰行動在第三階段

為什麼大型油輪不希望向右舷轉向，從一開始就是這個趨勢，看起來是要避免擱淺，其實有很多的心理轉折。

⇒ 在 56 分 47 秒的時候，碰撞危機是大型的貨櫃船緩慢的前行，而且也很可能減速停車。在現場看，大型油輪似乎能夠在大型貨櫃船之前通過，不需要轉向。
⇒ 碰撞危機只有在 1 分鐘後，57 分 47 秒以後，才會明顯：當大型貨櫃船加速到 10.3 節，大型油輪並沒有注意到直航船，應該保持航向航速的船，大型貨櫃船速度正從 9.5 節加到 10.3 節。
⇒ 在 58 分 17 秒，碰撞危機，木板釘釘，一板一眼，已經跑不掉了，這時候已經能夠確定，碰撞會在兩分半鐘後發生。

兩條船應該採取避碰的措施來保護本船的生命財產安全，在避碰的第三階段，3A 知覺，Best aware aid to avoid 最佳協助避碰行動，應該要知道些什麼東西？或是注意什麼東西，那是船長一定要會的。

- 目標船船頭或是船尾的相對方位變化，是在增加或是減少？這需要目視的技巧，可能很多人沒有。
- 如果目標的船頭相對方位落後，也就是變大，船長應該考慮向目標轉向，以保護本船的船舯，或是船尾的部位，除非目標船正在向我們的船頭方向轉向。
- 相對方位變大的目標，有通過本船船尾的趨勢，不論他的動作如何？
- 如果目標的船頭通過了本船的船頭，船長應該看看目標船的船尾相對方位，是否也是同樣的在減少，這是因為目標船可能正在快速的花開效應，看起來船頭是過了，如果船尾的相對方位不變，那表示呢碰撞根本就是馬上就要發生，船長呢最好是全速倒車，雖然速度不一定會減下來，但是在法庭上，本船才會站的住腳。
- 如果目標的船頭通過本船的船頭，而且目標船的船尾相對方位也是在減少，應該考慮向目標船的船尾轉向，以加速通過他的船中跟船尾的部位。
- 當然他船如果先到碰撞點，本船緊急倒車，可能有點幫助，應該是一邊全速倒車，一邊呢全速轉向，以加速脫離碰撞點。
- 如果目標船的船頭，通過本船的船頭，但是目標船的船尾相對方位正在增加，或是不變，應該考慮停車，使用循環舵的技術來加速本船停車減速的效果。碰撞已經無可避免，因為目標船正在本船的船頭，展開全力的開花效應，船長應該鳴放霧號，開啟通用警報器，以通知本船與對方船上的所有人員，準備應變，這是保護無辜的人命安全的考量。
- 再看看雷達上的速度向量線，跟相對方位線的指向，如果雷達的速度向量線端點的連線（也就是由本船速度向量線的端點。連接到目標傳速度向量線的端點），方向是向前，這個相對方位線是指向前，指向本船的船頭，船長應該要考慮停車，倒車，循環舵減速，因為這就是目標船會先通過碰撞點。
- 如果雷達的速度向量線端點的連線，指向船尾，本船的船尾方向，船長要考慮要向目標船回轉，將本船的船舯跟船尾部位推開碰撞點，以避免直接的撞擊，全損。
- 檢查這兩條船速度向量線的交點，船長應該能夠決定距離碰撞還有多少距離？碰撞會發生的時間是多久？
- 要考慮本船的回轉性能，與船的前進距離，跟迴旋所需要的時間，才能完成大角度的回轉。

5-21 Best 3A Awareness: Best Awareness to Aid Avoidance Action in third stage,

Why VLCC don’t want to alter course to Starboard from the beginning when

- It seems no collision risk at 14:56:47 while VLCS proceed slowly or might stop engine afterward. VLCC seems can pass before VLCS and No need to change course by that time.
- Collision risk is obvious at 14:57:47 after one minute when VLCS increase speed to 10.3 knots.
- VLCC did not notice stand one vessel VLCS increase speed from 9.4 kts to 10.3 Kts.
- At 14:58:17, collision risk is rigid, collision will happen after 2.5 minute.
- Both vessels should find best heading to steer to protect ownship's life and property.

Best 3A Awareness: Best Awareness to Aid Avoidance Action in last minute, Captain should

- observe the Relative Bearing change of target vessel's BOW and STERN is increasing or decreasing by visual.
- If target's bow had fall behind ownship, Captain should consider to alter course to parallel Target vessel to clear ownship's midship or stern area.
- If target's bow had passed ownship's bow, Captain should wait and see target vessel's stern relative bearing is decreasing or not?
- If target's bow had passed ownship's heading and target vessel's stern relative bearing is decreasing, Captain should consider to alter course to Target vessel's stern to clear her midship or stern area.
- If target's bow had passed ownship's heading and target vessel's stern relative bearing is increasing or unchanged, Captain should consider to stop engine with rudder cycling to target's bow. Collision is inevitable. Sound general alarm and whistle on board.
- Get the feeling on radar speed vectors' end. if its relative bearing line pointing ahead (target vessel pass collision point first), Captain should consider to stop the engine.
- Or if radar speed vectors' end relative bearing line pointing astern Captain should consider to alter course to parallel target vessel to clear our midship or stern area.
- Check cross point on two vessel's speed vectors Captain should be able to decide the distance to collision DTC and time to collision TTC.
- Consider ownship's turning time and distance needed for complete large degrees turn.

5-05 長江口：新興海事衝突區

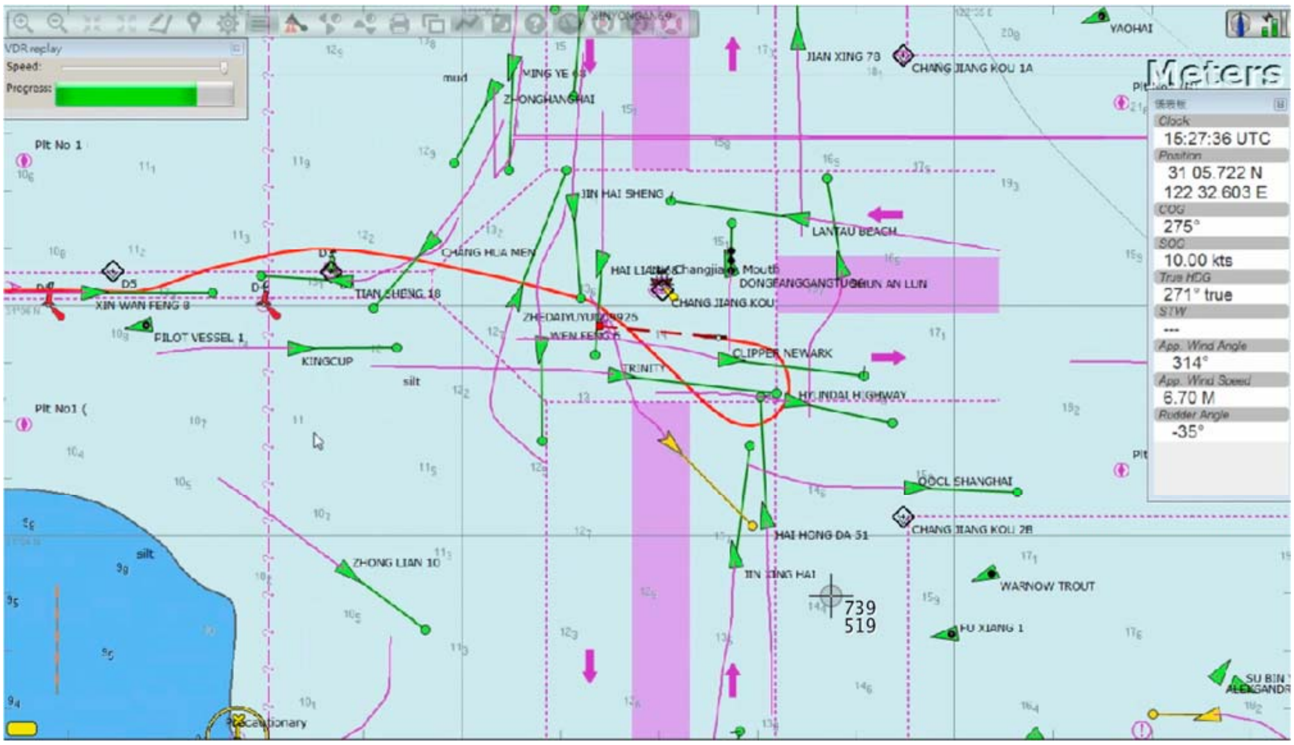
貨櫃船與漁船碰撞的省思 2014

一條英國籍的貨櫃船總噸位 99946 噸，載重噸位 104300 噸，船隻總長 334 點 8 米，船寬 45 米，在他的處女航離開上海港之後，與一條漁船發生碰撞。碰撞之前沒有 VHF 的通訊，也沒有做目標的確認，全靠船長的心裡有數，船長年紀小於 50 歲，是 STCW 的新世代，24 年的海勤，其中有 7 年完美船長資歷，是公司倚重接新船的船長。在圖型 5-13 紅色航跡是全部出港的航跡，引擎無故障，這航路有什麼問題？

At 1450 hours UTC figure 5-14

5-22 出航的第一階段，如何下領港，在強烈的潮流下？

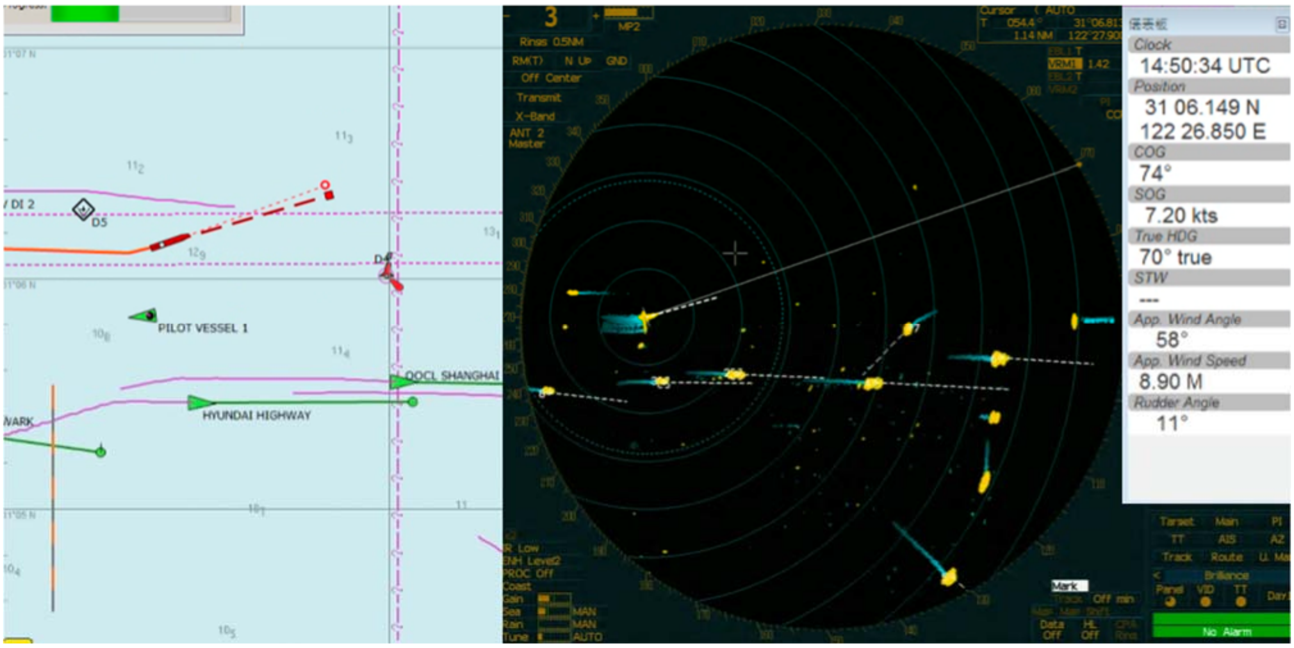
在 1450 時 UTC，圖形 5-14 領港船一號在航道的右邊等待，預期會有強大的流水，從北方而下，流速可以達到三，四節，依照過去的經驗，需要做一個下風或是採取一些流水修正，讓領港離船時，本船不致危險。長江口的燈船，在本船正東邊 4.5 海浬，在這個時候向左轉向，將 90 度的航向轉到 74 度，橫越來船的航道，本船的速度是 7.2 節，準備下領港。



圖形 5-13 貨櫃船的全部紅色航跡

其他的出港船隻 OOCL 上海，與現代高速，都不在出港的浮標航道裡面航行，那是為什麼？領港已經離船了

還是他們已經選擇航道南邊，航道的外側，避免本船下領港的時候，太靠近領港船。



圖形 5-14 紅色現場的軌跡 1450 hours

⇒ 在圖形 5-14 右圖，我們看到 4 條船出港，在一直線上航行，他們的航線跟燈船後東航的航行巷道方向一樣，請看圖形 5-13。

⇒ 他們的出港航線，都在出港的航道南邊 0.8 海裡的正橫距離。

- o 他們要保持在航道的南邊航行，是要避免本船橫越航行巷道，與他船產生交叉相遇的情形。
- o 當需要做下風的時候，船隻往上流的地方航行，讓領港離船。
- o 東航的出港船要保留更多的時間，以便觀測左邊南下的船隻，在他們到達碰撞點的之前。
- o 或是保持本船在正確的巷道，避免與西航的船隻迎艏正遇。

- o 遵守避碰規則第九條狹窄水道，船舶循狹窄水道或適航水道行駛，于安全且實際可行時，應儘量靠近本船右舷水道或適航水道之外側行駛。

本船做下風時，是在航道內，是在 1450 UTC 時間，圖形 5-14 潮流之下開出航道，下領港的時候，本船剛通過領港船，這時候留下一個危險的狀況，讓在船上的船長，自己去處理，也許這是一個沒有經驗的領港，這個我們就不清楚了。

⇒ 碰撞點隨著本船的船首向而移動，這是我們在第三章第五節所學到的。
⇒ 現在本船的船首向指向左舷 074 度，我們就會跟左邊的來船，發生碰撞危機。
⇒ 左邊也許有西航的迎艏正遇船隻，他們的航向也就是 270 度，本船向左轉向，製造了新的碰撞點，與這些西航的船隻。
⇒ 當本船必須回到東航的巷道，我們將會再次橫越西航船只的船首向，或是更糟橫越東航被追越船的航線。
⇒ 本船應該盡可能靠航行巷道的外側航行，（其他船隻保持在大約 0.8 海浬正橫距離，在出港航道的南邊）這樣本船就能保留，向左舷轉向下領港的空間。

5 – 05 Chang Jiang Mouth new merging maritime conflict zone

Aftermyth of Container ship collided with fishing boat 2014

A UK Flag container ship with Gross Tonnage 99,946 Deadweight 104,300 t Length Overall x Breadth Extreme 334.8m × 45m at her maiden voyage departure Shanghai port had a collision with a fishing boat. There’s no VHF communication, no Target identification, all situation are in captain’s mind. Captain age is under 50, new STCW generation, 24 years sea time with excellent 7 years Master records. The red track in figure 5-13 is her maiden voyage outbound Shanghai. No engine breaks down. What’s wrong in this track?

Figure 5-13: whole red track of outbound container ship

5-22 Departure Phase 1: How to disembark pilot in strong current?

At 1450 hours UTC in figure 5-14

Pilot vessel No.1 is waiting in starboard side of channel now. Expected strong current coming from north which could reach to 3 or 4 knots by experience. Ownship is about to make a lee for pilot disembarkation. Own Ship OS alter course to port side 074^0 (T) from 090^0 (T) and sail across the channel. OS speed is 7.2 knots at this time. Chang Jiang mouth light vessel is 4.5 nm to the east.

Figure 5-14: Vessel Track of container ship in red at scene 1450 hours

Other outbound vessels in our portside (OOCL Shanghai & HYUNDAI Highway) are not inside buoyed channel, why?

⇒ Their pilots may had left already.
⇒ They had chosen south route outside of channel to avoid their vessel disembark pilot while crossing the channel.
⇒ In the figure 5-14 radar picture we saw four vessels eastbound sailed in line. Their course lines are in line with eastbound traffic lane before Chang Jiang mouth light vessel. See figure 5-13.
⇒ Their out bound routes are all well outside the channel to the south about 8 cables abeam distance.
⇒ The reason to keep sailing along south of channel is to avoid ownship cross the traffic while some inbound vessels may need to pass.
⇒ Or allow for more time to check portside southbound vessel coming from North.
⇒ Keep ownship in correct position can avoid the collision with west inbound vessels (avoid head-on situation).
⇒ Observed COLREG rule 9: *Narrow Channels (a) A vessel proceeding along the course of a narrow channel or fairway shall keep as near to the outer limit of the channel or fairway which lies on her starboard side as is safe and practicable.*
⇒ Ownship make lee inside the channel at 1450 hours UTC figure 5-14, sailed out the channel in strong tide, disembark after passing pilot boat, leave a dangerous situation for Master on board, maybe this is a pilot with less experience, who knows?

⇒ Collision points moves with ownship's heading as we learnt in 3-05 Collision position changed by ownship's action.

⇒ Now Ownship's heading pointed to port side 074^{0} (T) we will have collision risk with port side vessels.

⇒ Port side may have head-on inbound vessel's course line. OS ownship alter course to port side create collision point with head-on vessels.

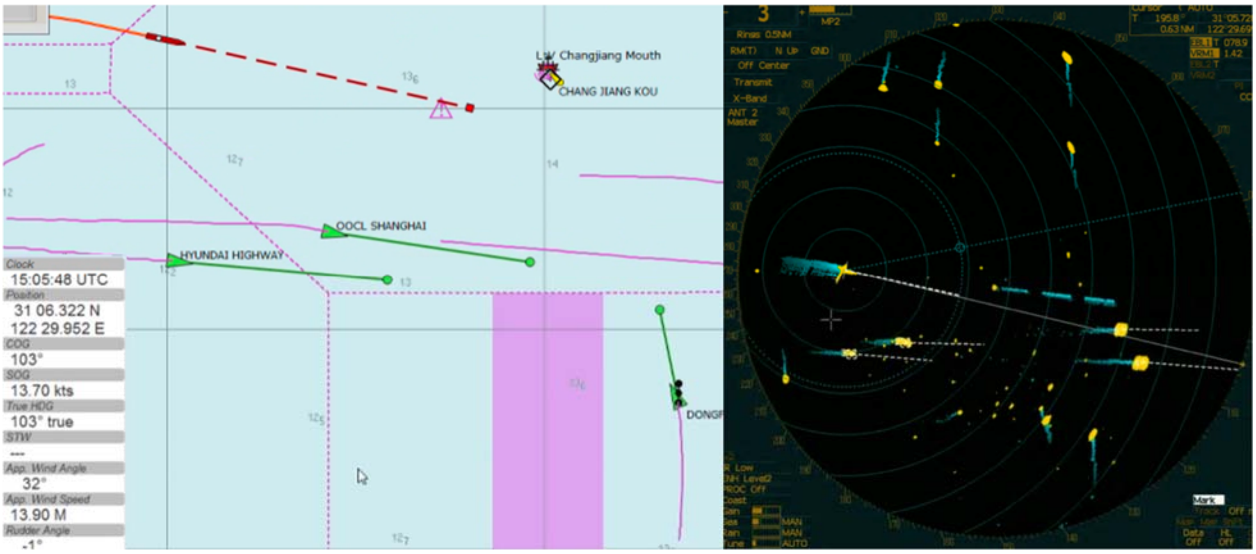
⇒ When ownship has to go back to east outbound traffic lane we will cross the West inbound vessel's course line two times or even worse cross the Eastbound overtaken vessel's track.

⇒ Ownship *shall keep as near to the outer limit of the channel or fairway*. Follow the route of other outbound vessel: about 8 cables abeam distance south of outbound channel. Ownship can have more room in port side for pilot disembark.

At 1505 hours UTC, 15 minutes later

5-23 出港航行第二階段，怎樣回到原航行巷道

1505 時 UTC， 15 分鐘之後，領港已經離船，本船在航道的外側，已經有 15 分鐘之久，本船從 090 轉向到 103 度，橫越西航的航道，現在速度從 7.2 節增加到 13.7 節，在這時候長江口的燈船在東邊 1.8 海浬，請看圖形 5-15。



圖形 5-15 小船的回跡與海浪雜斑混合在 1505 時

本船的船長對他的技術非常有信心，他快速的加車到 13.7 節，這比所有出港船隻的速度都要快。**這是本船麻煩的開始**。

⇒ 越快越長的速度向量線，就會產生越多越快的碰撞危機。

⇒ 怎麼知道本船速度是最快的？我們可以比較本船 13.7 節的速度向量線，這是 6 分鐘的時間長度，跟其他出港船隻的速度向量線比較長短。

⇒ 我們說過，在多目標的情況，最好的解決方法，就是與其他船隻保持同樣的速度，因為速度最高，就會追越我們船頭所有的船隻。

所有東航的船隻，現在距離長江口的燈船，大概都有一海浬的正橫距離，燈船位置就是在十字路口的中心點，出港船隻的速度，大約都是 10 節左右，本船在燈船的北邊 0.1 海浬。

⇒ 所以本船要跟出港船隻一同航行的話，就有 1.1 海浬的正橫距離需要穿越，本船要穿越了西航巷道，再一次穿越，也就是可能再一次新的碰撞危機，請看圖形 5-15。

⇒ 一群小型船隻在北向航道北上航行，在本船的右舷，海浪回跡在這區域的設定，是在 15 分鐘之前，海浪雜斑已經對小型船隻的回跡，時不時的產生一些遮蓋，因為船隻已經到了長江口之外，因為沒有陸地的遮蔽，海上的風浪加大。

⇒ 所有雷達的增益，海浪回跡都需要隨時加以調整，才能夠消除海浪雜斑對小型船隻回跡的影響，這個就是雷達觀測的訓練，要從不良的雷達回跡中，分辨出小型的船隻，這個在以前雷達瞭望的時代，是很大的一個困擾，也需要有相當的經驗，才能夠在雷達回跡

的判讀上成功，所以最好的方法，就是分別設定雷達，來分辨不同的回跡，就像我們前面討論過的，10 公分雷達比較能夠區分海浪跟小型船隻的差異，3 公分的雷達主要是搜尋大型船隻，回跡強的目標，作為阿帕自動測繪的目標。

⇒ 本船的速度向量現在是 6 分鐘的長度，沒有阿帕的資料擷取，只有北上小型目標船的回跡，但不知道自己跟北上船隻是否有碰撞危機，因為呢沒有速度向量線，可以作為碰撞點的參考。

⇒ 我們知道本船與出港船隻在這 6 分鐘之內，是沒有碰撞危機。現在與他們的速度向量線，沒有交點，在 9 分鐘內，本船跟出港船隻是否有碰撞危機呢，就不得而知。

⇒ 目標的大小以雷達上的回跡大小來比較，區分並不明顯，距離遠的時候，目標的大小在回跡上，還分得出來，近距離的時候，就會有困難，尤其是在 3 公分的雷達。

⇒ 本船追越 2 條在右邊正橫方向出港的船隻，現在看起來是安全的，但是事情請變得非常快，如果本船必須右轉讓路給橫越船。

⇒ 碰撞危機在高速的時候，會在兩個不同方向同時出現，與出港的東航被追越船，與北上橫越的小型船隻，都會產生碰撞危機，所以這兩個方向的船隻，都有問題，如果本船的出港速度太高。

5-23 Departure Phase 2: Pilot disembarked, how can ownship re-enter general traffic flow?

Pilot disembarked. Ownship OS stayed outside the channel already 15 minutes' long. OS alter course from 090^0 (T) to 103^0 (T) and across westbound channel now. OS speed is increased from 7.2 knots to 13.7 Knots at this time. Chang Jiang mouth light vessel is 1.8 nm to the east. In figure 5-15

Figure 5-15: small ship's echo mixed with sea clutter after pilot disembarked at 1505 hours

⇒ OS Master is very confident of his skill. He had increased speed to 13.7 knots which is fast than all outbound vessels. This is the trouble begins: Longer speed vector create more collision risk.

⇒ How can we Knows he is fastest? Compare his 13.7 knots speed vector length (in 6 minutes setting) with other outbound vessels' speed vector.

⇒ We said before **in multi ship situation the best solution to avoid collision is to keep same speed with another vessel.** Ownship is overtaking all vessels ahead by fastest speed.

⇒ All eastbound vessels have about 1.0 nm beam distance to Chang Jiang Mouth L/V (the center of cross fairway) and speed 10.0 knots. OS is -0.1 nm beam distance to (is in north of) Chang Jiang Mouth L/V.

⇒ OS has 1.1 nm beam distance to sail between outbound vessels and Chang Jiang Mouth L/V.

⇒ OS crossed westbound (inbound) vessel's traffic lane once again (may create new collision risk), see figure 5-15.

⇒ A pack of small vessels unknown north bound at OS starboard side. The sea clutter set in this sea area is more than 15 minutes before when seas are calmer inside the harbor and obscured small target now from time to time. The radar Gain, Sea Clutter have to adjust periodically when vessel is outbound to distinguish small targets and sea clutter. This called **Radar observation skill** to find small target from poor radar echoes. Or two radar set should prepare to distinguish targets as recommended by "10 cm radar for small vessel" and "3 cm radar for big vessel)

⇒ OS speed vector is 6 minutes now. No ARPA data acquired for small target at this moment. **Ownship don't know our collision risk with these crossing vessels** as no speed vectors for our reference.

⇒ We know ownship has no collision risk with outbound big vessels in 6 minutes because no cross points on their speed vectors. What about 9 minutes later ownship's collision risk with outbound vessels?

⇒ Target size difference is not obvious on radar.

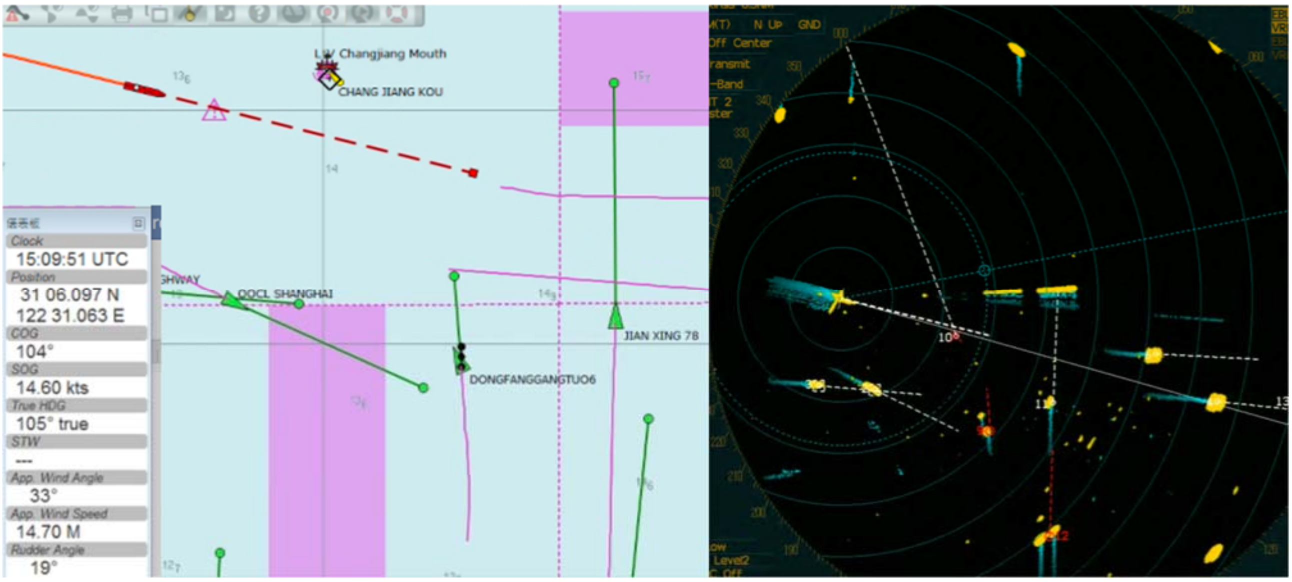
⇒ Ownship overtake two outbound vessels beam distance seems safe. But things change very quickly when ownship alter course to give way to crossing vessels.

⇒ Collision risk in high speed become higher with outbound and small crossing vessels around.

At 1510 hours UTC, 5 minutes later, **Figure** 5-16, 5-17

5-24 出港第三階段：什麼使得船長現在開始惶恐？

在 1510 時 UTC，5 分鐘後圖形 5-16， 5-17，本船維持航向 103 度 5 分鐘後，船速仍然在持續增加，由 13.7 增加到 14.6 節，長江口燈船已經在東邊 0.8 海浬的位置，本船是在海面上最帥的船隻，讓人愉快的 14.6 節。



圖形 5-16 在 1510 時，所有船隻的速度向量線顯示

⇒ 在 AIS 的瞭望，左邊的螢幕，所有船隻 5 分鐘的速度向量線，都是清爽的，沒有碰撞危機。

⇒ 但是情況有些混淆，在雷達的瞭望上，右邊的螢幕上小型的目標船 10 號，具有離譜的速度向量線長度，顯示 10 號目標的雷達回跡已經失去了，因為海浪雜斑的影響。

⇒ 10 號目標的擷取是在 1508 時做的，這是一條拖船拉著駁船，在 AIS 的資料顯示上，這是很清楚的顯示（左邊螢幕有三盞黑球），現在左邊這個螢幕 OPEN CPN，在船上也許呢並不具備，因為有些船公司已經自行配備這種顯示器（OPEN CHART PLOTTER NAVIGATOR， OPEN CPN in Personal Pilot Aid， PPA），有的船公司呢還沒有強制要求配備

⇒ 拖船跟他的駁船在雷達上面的回跡追蹤後，已經跟海浪回跡互相交換，也就是目標追蹤，已經追蹤到錯誤的海浪回跡上了。

⇒ 再一次呢，這個雷達的設定，沒有調整好，沒有適應已經增加的海浪雜斑干擾，在這過去 5 分鐘的時間，當本船從北方接近長江口的燈船。

⇒ 這是雷達瞭望的失敗，在實際的海上，雷達瞭望的失敗，就是船長的失敗。船長平常沒有要求，或是沒有盡心教導。5 分鐘之前，船長不知道這一條拖船跟他後面拉的駁船的動態，五分鐘之後，船長仍然不知道這一條拖駁的動態，因為雷達的回跡，已經失去了。

⇒ 各位，我必須說，船長應該要具備目測能力，能夠分辨出這兩個橫越船的碰撞危機，（本船已經維持航向 103 度，5 分鐘之久）看的出他們相對方位的變化，才不會對雷達回跡的失去，而感到惶恐不安。

⇒ 如果船長已經知道，或評估過目標相對方位的變化，對這一條拖船，他就會發現這一條拖船的相對方位，是正在增加之中，尤其是他已經左轉，準備讓路。

如果船長已經知道，本船的速度是 13.75 節，他就能夠使用安全的相對方位，SRB 的技術，去瞭解碰撞危機。

⇒ 這一條拖駁的速度，大約是本船的 4 分之 1，（利用目標尾跡的長度）與 SRB 的規則，我們知道這條船的安全相對方位是 15 度，（ 60 度的 4 分之 1），他的相對方位，現在是 28 度，從我們的船頭往右邊量到拖船跟他的駁子，本船是可以從他船頭安全通過。請參考第四章 43 節，更多視覺安全的知覺，相對方位運用在橫越船

⇒ 要搞清楚這些混亂雷達回跡的目標，10 號目標是在本船船頭的一海浬，圖形 5-16，船長應該能夠眼睛來確認是否是正確的回跡？

⇒ 如果 10 號目標不在我們船頭，就像雷達螢幕顯示的，本船應該繼續現在的航向，來通過拖船跟他駁子的前方。（4-49 高速船使用的安全航向）

⇒ 10 號目標的尾跡顯示，比速度向量線的顯示更穩定，尤其是在惡烈天氣下，要是尾跡設定時間跟速度向量線設定的，是一樣長，也就是尾跡的設定，也是 6 分鐘的時間。船長就可以使用尾跡的長度來估計目標的速度向量線，當目標的雷達回跡消失在海浪雜斑裡面。

⇒ 本船應該觀測這條拖駁的相對方位變化，在 1508 時，兩分鐘之前，擷取到這條目標，得到他的雷達回跡的同時，你同時也要做目視的相對方位變化的觀測。

⇒ 10 號目標的羅經方位，是 128 度，在 1508 時，然後兩分鐘之後，在 1510 時，增加到 130 度，所以羅經的方位變化，只有兩度，在 1.75 海浬的距離之外，1.75 x 1852 x sin (20) = 113 meter 等於 113 米。

⇒ 這麼小的方位變化兩度，在這麼近的距離 1.75 海浬，就能夠有 113 公尺的距離差別，這個是本船寬度的 2.5 倍，如果本船呢希望橫越拖駁的船頭。

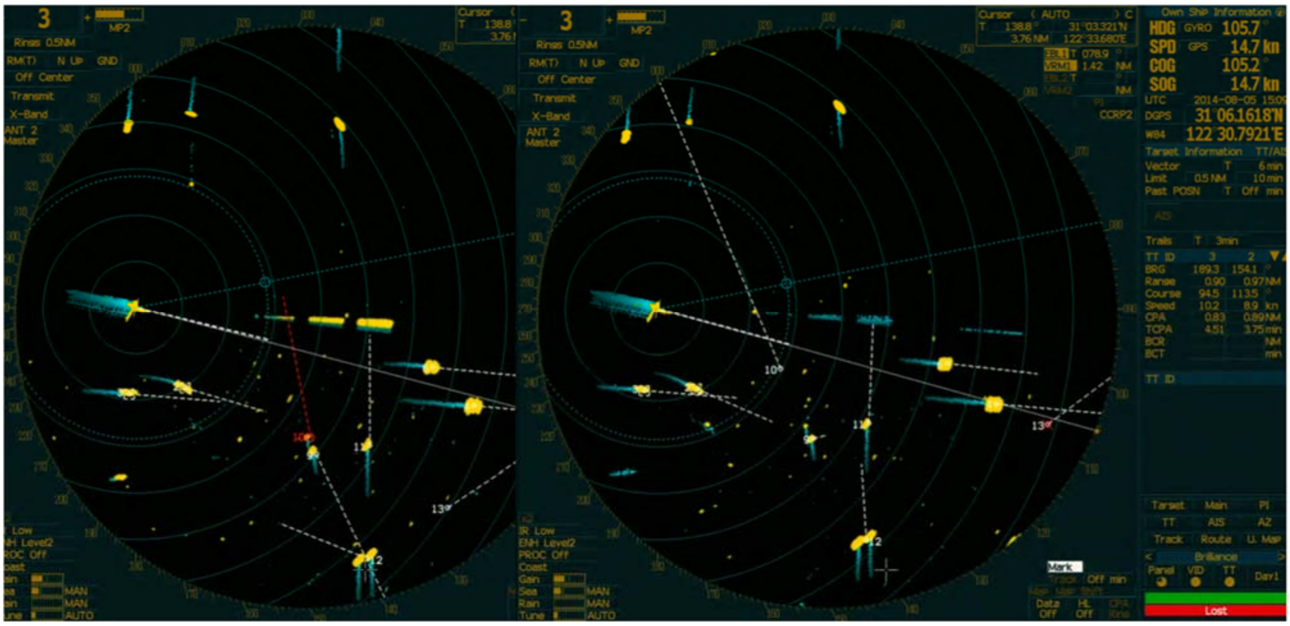
⇒ 拖駁是橫越船，所以本船需要一些足夠的海域，方便以本船的寬度來脫離拖駁。

是的，這些的距離計算，在實際目視時，不可能有太多代表性，但是我們不必知道的非常清楚，到底有多少度的方位，相對方位已經改變多少，或是目標的距離多少等等，只要我們呢保持目視瞭望的實務，已經有相當的時間，你就會有正確的碰撞危機的感應，尤其是對這些小型目標。不願意練習的人，永遠也不會有正確的直覺。

⇒ 安全的相對方位就是由實際目視瞭望的實務所推導而來的，沒有實際的經驗，再多的理論，都是廢話。

⇒ 如果本船在 1508 時，沒有做方位的觀測，本船仍然能夠多花一兩分鐘的時間，去觀測這一條拖船跟駁子的相對方位變化，來知道碰撞點的動向。

要完成一次航向的改變，需要 3 分鐘，在這個時刻，本船的速度向量線仍然是 6 分鐘的設定，應該設到 3 分鐘的時間，這樣才能夠瞭解，附近水域是否有本船運轉所需要的前進距離，可以滿足本船在這些近距離的目標之間，能否自由的運轉，還是要顧慮到轉向之中，可能發生的碰撞？



圖形 5-17 10 號的目標船在 1508 時與 1509 時

⇒ 在圖形 5-17 的左圖，是 1508 時，這個 10 號的目標船，顏色已經變成紅色，表示雷達失去了目標的回跡。

⇒ 在圖形 5 之 17 的右圖，是 1509 時的畫面， 10 號目標回跡已經快速的向前移動，追逐海浪雜斑去了，速度向量線顯示的是 30 節的速度，這根本就是無稽，或是沒有用的顯示，雖然如此，他也已經讓船長注意到，並且對他的真實速度感到非常的迷惑，這就是為什麼我們在前面要求目標回跡的長度，要跟速度向量線一樣，在緊急的時候，船長才不會迷惑。

⇒ 目標船的速度估計，可以與本船的速度向量線的長度來互相比較，使用分規或手指頭的跨距，來取出本船的速度向量線的長度，放在目標船的速度向量線上，做一個比較，就知道他現在顯示的速度是多少？是否合理。

⇒ 這是目標識別的一個重要線索，不可能的速度，除了使用增益大小跟海浪雜斑抑制的設定，來做目標的識別。

⇒ 再次的，如果當值船副抑制了阿帕的海浪雜斑的顯示，不要讓船長對 10 號目標的識別，產生疑惑，也就是拖船顯示的回跡，要比海浪雜斑的回跡強度要強，也比較穩定的出現在螢幕上。

⇒ 良好的當值船副，讓緊張的船長省下很多麻煩，這個就是駕駛台資源管理，如果資淺船副能夠適度的調整，雷達的增益跟海浪雜斑的抑制，來清楚的顯示目標船隻的回跡，與海浪雜斑的不同。

At 1510 hours UTC, 5 minutes later, **Figure** 5-16, 5-17

5-24 Departure Phase 3: What make Master panic now?

OS maintained course 103^0 (T) for 5 minutes, speed still increase slowly from 13.7 to 14.6 knots. Chang Jiang mouth light vessel is 0.8 nm to our due east. Ownship is the smartest ship at sea with comfortable 14.6 knot.

Figure 5-16: ALL ship with ARPA speed vector at 1510 hours

⇒ In AIS lookout (left screen) all vessels are clear within 6 minutes speed vector (no cross point).

⇒ However, some confused situation happened in radar lookout (right screen). One small target No.10 is dead ahead with impossible speed vector length. This false speed vector is tug boat's radar echo which is carried away by sea clutter (echo swapped).

⇒ No. 10 target acquired at 1508 hours is a tug boat with a tow which is clearly indicated in AIS data display (left screen OpenCPN chart (Open Chart Plotter Navigator): this screen may not available on board).

⇒ The tug boat and his tow had acquired in ARPA separately or tugboat's echo is carried away by sea clutter.

⇒ Tug boat and his tow radar echo had swap each other and further swap with sea clutter.

⇒ Once again, this radar setting has not adjusted (decreased the GAIN setting) to cope with increased sea clutter in past 5 minutes (1505 hours) when ownship approached to open sea from Chang Jiang mouth light vessel.

⇒ This is the failure of radar lookout. 5 minutes before Captain don't know this tug and tow movement. After 5 minutes Captain still cannot know this tug and tow's movement due to radar echoed failure.

⇒ I have to say **if Captain can distinguish these two north bound crossing vessels' collision risk by relative bearing change,** he will not panic with radar's failure.

⇒ If Master had **evaluated relative bearing change of this tug boat he will notice it is increasing.**

⇒ If Master had known tugboat speed is about 3.75 knots, he will be able to **use SRB skill to know collision risk immediately.** This tug boat speed is ¼ of ownship. By SRB rule, we know 15 degrees (1/4 of 60 degrees) relative bearing is her SRB safe relative bearing. Her relative bearing is 28 degrees from ownship starboard side now. This tug and tow are safe to pass ahead. Please refer to 4-43 More awareness from visual: Safe Relative Bearing SRB in crossing vessels.

⇒ To clear the smoke, No. 10 target's radar echo (false echo) is one nm ahead of OS bow (In figure 5-16). Captain should be able to identify its existence by eye.

⇒ If No.10 target is not there as radar screen shown Ownship should stay on this course to pass Tug boat and its tow.

No. 10 target's trail display is more stable than her speed vector in heavy sea in figure 5-16. If target trail setting time is same as speed vectors (all set to 6 minutes long) Master can use same time interval trail length to estimate target's speed vector when target's echoes lost in the seas.

⇒ **Ownship should observe relative bearing of this tug and tow when we acquire it from 1508 hours, 2 minutes before for better understand the collision situation if any.**

⇒ The compass bearing of No.10 is 128 degrees(T) at 1508 hours, and compass bearing increase to 130 degrees(T) after 2 minutes.

⇒ 2 degrees in 2 minutes at distance 1.75 nm away at 1510 hours. $1.75 \times 1852 \times \sin(2^0) = 113$ meter.

⇒ This small bearing change 2 degrees in this close range 1.75 nm has created 113 meters distance which are 2.5 times of ownship's width (45 meters width) if OS want to pass ahead of tug and tow.

⇒ This tug boat is crossing vessel. So ownship need some sea room in ownship's width to clear target.

Yes, these calculations mean nothing in real visual lookout. We don't need to know exactly how many degrees relative bearing had changed or distance to targets…etc., when you keep visual lookout practice long enough you will have the correct sense of collision risk with these small targets. Remember SRB which is derived from actual lookout practice.

⇒ If OS miss the bearing observation at 1508 hours (2 minutes before) OS can still spare one or two minutes to observe relative bearing change of this tug and tow.

⇒ To finish a course change (alter course) needs three minutes.

⇒ At this moment OS speed vector is still in 6 minutes setting. It should set to 3 minutes setting to clear the smoke of "Does our maneuvering requirement (limitations) can be met (overcome) with these close range targets?".

⇒ in figure 5-17 left is 1508 hours where No.10 target had change color to red means Target Lost.

⇒ in figure 5-17 right is 1509 hours where No.10 target had moved fast ahead to chase big sea clutter. The speed vector shows 30 knots more is nonsense and useless for t tug boat. But it had caught Captain's attention and confused him from there.

⇒ **The estimated speed can be read by comparing ownship's speed vector length to no. 10 target's speed vector by your finger span or divider if you had one divider stand by ARPA panel (recommend practice).**

⇒ This is one way to identify target (decide impossible speed by ownship's speed vector).

⇒ Once again, if OOW had reduce the Gain of ARPA sea clutter may not confuse Master in No. 10 target's identification.

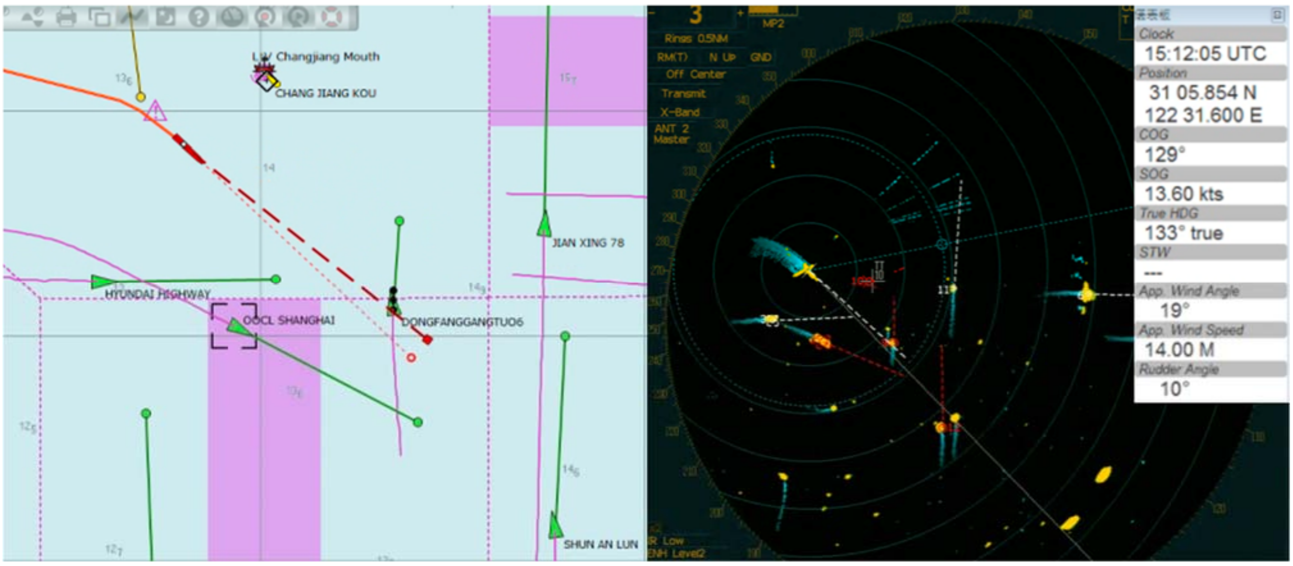
⇒ A good OOW save the trouble of nervous Master. This is BHRM if Junior OOW is capable to adjust radar's gain and sea clutter to clearly distinguish Radar's echoes from sea clutters.

Figure 5-17: No.10 target echo swapped at 1508 and 1509 hours

Phase 4: At 1512 hours UTC, 3 minutes later figure 5-18

5-25 出港第四階段，不要讓自己成為傻瓜

第四階段在 1512 時 UTC，圖形 5-18 三分鐘後，本船從 103 度向右轉向到 133 度，此時長江口的燈船在東北方，雷達速度向量設定是 6 分鐘，這種情勢下，雷達速度向量設定 6 分鐘的畫面，已經太複雜了。



圖形 5-18，本船在 15 點 12 分，第一次對 10 號目標轉向。

⇒ 從 103 度右轉向 30 度到 133 度，這是資淺船副的技術，在能見度受限制時用的。繞過拖船的尾部，這個技術對資淺船副必須的。

⇒ **正確的評估碰撞危機，永遠都是確認碰撞點為第一優先**，以前的想法是不知道目標船的動向，不可以採取避碰行動，那經常呢目標船的動向很明確，但是避碰行動，卻產生不可預期的後果。所以現在應該修正為，如果你不能確認碰撞點的位置在哪裡？不要貿然採取行動，否則會越來越亂，越避越碰。

⇒ 在當值船副的階段，永遠要先確認目標動向，這個格言，對船長已經改變，永遠要先確認哪裡才是碰撞位置？才能保留充分水域與運轉位置。

⇒ 好像我們在雙重擱淺案例裡看到，碰撞位置，如果是在淺水區域，我們就會因為避讓，造成擱淺的後果。

⇒ 如果船長不能確認，或在雷達上，找不出碰撞位置，他就會像現在一樣，有很大的麻煩，造成倉促的決策。

⇒ 這個決策在 1510 時就已經錯誤了，當本船的航向還是 103 度的時候，也就是在轉向之前，就已經錯了，轉向到 133 度，只是多浪費了兩分鐘的避碰時間。

⇒ 如果原始的碰撞位置，已經確定，就會發現在航向 103 度，並沒有碰撞危機，如同圖形 5-16 的左圖（AIS 資料），或是像我們前面所討論的。

1. 相對方位的變化：觀測這一條拖駁，發現他的相對方位是在增加，可以左轉 10 度來避免他的碰撞位置，也就是說找出正確的碰位置，再轉向加以避免。
2. 使用相對方位規則，對船速只有本船四分之一的拖駁，15 度的相對方位是 60 度的 4 分之 1，15 度就是他的安全相對方位，他現在的相對方位是 28 度。
3. 在圖形 5-19，我們看到所有的速度向量線端點上，都有船隻的標誌，這些船隻的標誌，是這些船隻在 6 分鐘後所在的位置，我們看得出來 6 分鐘後，沒有速度向量線的交點，也就是沒有碰撞點的發生。
4. 本船可以從拖駁船頭 1.5 海浬的距離，安全通過。
5. 本船可以在這兩條近洋船隻間，安全的通行，他們有 1.5 海浬的距離分開。

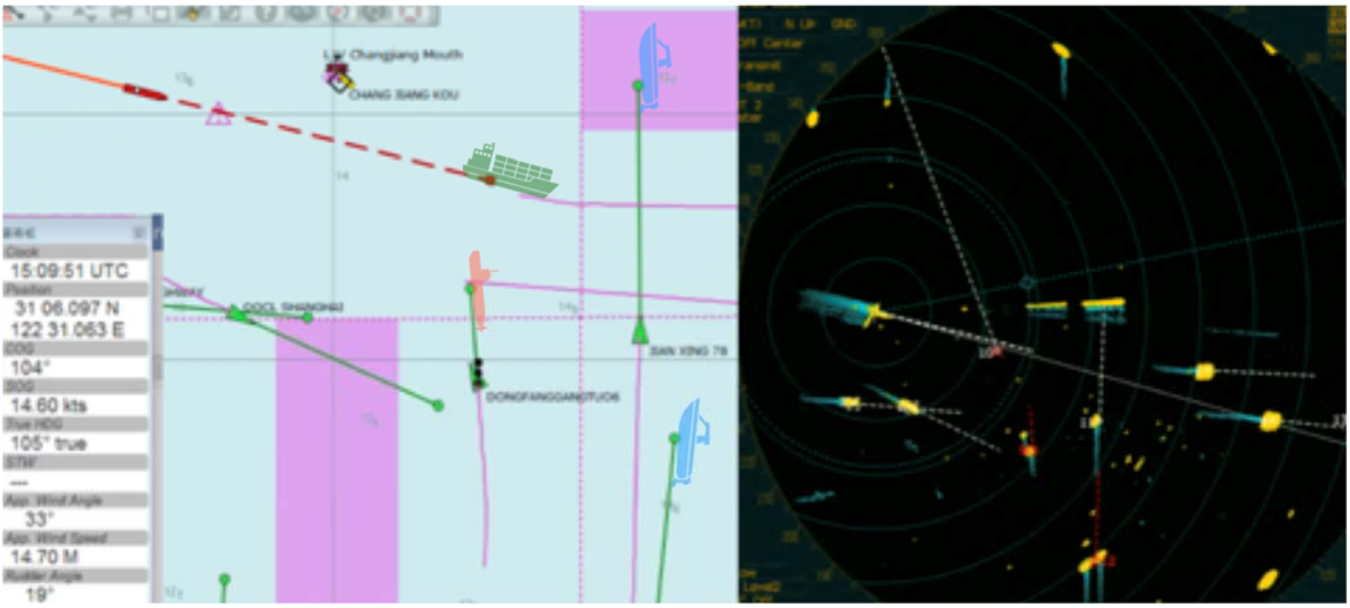
⇒ 第四圖像化的避碰知覺，對船長是雷達瞭望的基本訓練。

⇒ 向右舷轉向 10 度，或是向左舷轉向 10 度，1.48 x 1852 x sin (100) = 476 meter = 2.57 cable，等於 476 米，就是 0.257 海浬，想像這一條拖船跟他的駁船是 300 米的長度，10 度的轉向，可以提供 300 米的 1.58 倍的正橫距離。如果船長會使用電子游標線 EBL 來類比新的 093 度，或者 113 度的航向，以他雷達瞭望的知識，去確認轉向的可行性與技術。

⇒ 使用安全的相對方位規則，如果這一條拖船是本船的速度的三分之一，他的安全相對方位是 20 度，現在他們的相對方位是右舷的 30 度，這個應該是可以通過他的船頭，沒有問題。

⇒ 現在你的估計跟我的是不一樣，我們可以檢查相對方位的變化，在下面的兩分鐘，也就是 1510 到 1512 時的時間，來考慮避碰行動的有效性？或是拖駁的碰撞危機是否確實？適當速度向量時間的設定來，探測碰撞危機？或確認碰撞位置是非常重要的。

⇒ 無論如何，現在要讓速度向量現重新出現，都已經太慢了，但是拖船的速度，可以在 AIS 或者是阿帕的資料區看得到（4.8 節），船長呢可以用這些數位化的資料，來確認相對方位(30 度)是否足夠？ 也就是給我們小船 5 節的速度，對於本船 14 節的速度，他的現在相對方位是 30 度，我們不必看圖，是否就能夠判斷出，能否安全通過？



圖形 5-19 圖解碰撞的迷思，在 1510 時

⇒ 仔細觀察在圖形 5-18 的螢幕，如果本船向右舷轉向 30 度，我們就會深入眾多船隻形成的口袋，在那裡面，碰撞危機就是四面埋伏。

⇒ 在多船隻相遇的情況，本船轉向讓路給一條慢速船，會等待更長的時間，才能繞過這條小船的船尾，

⇒ 即使目標船的速度未知？我們也能夠用本船的速度向量，來做一些預測，本船速度為 13.6 節，AIS 速度向量線是本船的三分之一，這代表的 4.5 節的船速，但是船速多少並不重要，跟本船速度的比例才重要，雷達的速度向量顯示是本船的一半，也就是 6.8 節的速度，透過目標 AIS 發送的實際速度，是 4.8 節的速度，這是由他船上的 AIS 所發送出來的資料。

⇒ 目標發送的 AIS 的速度是比較准的，即使我們是用本船的速度向量，去跟他的 AIS 速度向量線做比較，比雷達上面，目標回跡測繪的速度向量線，更要准一點。

⇒ 記得安全的相對方位：本船速度的 3 分之 1，60 度的三分之一等於 20 度。

⇒ 這條船拖駁是在本船右舷的 30 度，我們如果不轉向，也能夠安全地通過目標船的船頭，這就是在 15 10 時，我們得到的線索。

⇒ 如果我們對這一個目標的碰撞危機，有所懷疑的時候，本船直接向右轉向 30 度（倉促決策），我們將會遇到另外一個困難。

5-25 Departure Phase 4: Into the chaos, don't make a fool to yourself? In Figure 5-18,

OS altered course from 103 degrees(T) to 133 degrees(T) in 2 minutes. Chang Jiang mouth light vessel is in NE direction. Radar speed vector setting in 6 minutes is too complicate to handle in close range.

Figure 5-18: First coursed change for target 10 at 1512 hours

Altered course 30 degrees from 103 degrees(T) to 133 degrees(T) is Junior OOW skill in restricted visibility area. Go around stern of tug boat is the skill necessary in Junior OOW. Captain's skill level is Always identify collision position first.

⇒ In OOW times, always make sure target's movement first is the motto. Now, the motto had changed for Master. Find out where is collision position and give wide berth to it.

⇒ We see in double grounding case; the collision position is at shallow water.

⇒ If Master cannot identify collision position in Radar he will be in trouble: jump out decision.

⇒ The decision is wrong at 1510 hours, 2 minutes before while course is 103^0 (T).

⇒ If original collision position is positive identified "no collision risk at course 103^0 (T)" from figure 5-16 left picture. Or as we had discussed

1. "Evaluated relative bearing change of this tug boat Captain will notice it is increasing" OS no need to take any action to avoid collision position.
2. By SRB rule, we know 15 degrees (1/4 of 60 degrees) relative bearing is her SRB safe relative bearing. Her relative bearing is 28 degrees.
3. In figure 5-19, we see all speed vectors have vessel's mark on her end. These vessel marks are where these vessels will be after 6 minutes. It will be safe after 6 minutes because 6 minutes speed vectors have no cross point with any vessel. Ownship will pass tug boat bow at safe 0.5 nm abeam distance.
4. Ownship will sail between two northbound coastal vessels with 1.5 nm distance apart.
5. These graphical observations are Master's basic training in radar lookout.

⇒ How about Alter course 10 degrees to starboard side or to port side? 1.48 x 1852 x sin (10^0) = 476 meter = 2.57 cable. Imaging the tug and tow is 300 meters long. A/C 10 degrees is 1.58 times of 300 meters. The answer is OK if master can use EBL to simulate new course needed is 093^0 (T) or 113^0 (T) with his radar lookout knowledge and skill to verify.

⇒ By SRB safe relative bearing rules, this tug boats is about 1/3 speed of ownship her SRB is 20 degrees. Now their relative bearing is 30 degrees to Starboard side which should be OK to pass ahead of this tug.

⇒ Now your estimation is different from mine. We can check the relative bearing change in next 2 minutes (1510 to 1512 hours) to verify the avoidance effect or collision risk with this tug.

⇒ Have properly set speed vector to detect collision position is very important. However, it is too late now to make tug boat speed vector to re-appear.

⇒ But tug boats speed is readily available in AIS data or ARPA Master can use it to verify RSB is enough or not? This collision awareness is readily available by SRB skill if you have.

Figure 5-19: Graphical solution to solve collision mystery at 1510 hours

⇒ Take a close look of the screen in figure 5-18, if ownship alter course 30 degrees to starboard side (from 103 to 133 degrees), we will be deep into the pocket of ships where collision risk is all around ownship.

⇒ In multi- target situation, OS alter course to give way to a slow vessel have to wait a very long time to go around.

Even Target speed is unknow we can estimate by ownship speed vector. Ownship speed is 13.6 kts. In her AIS speed vector is one third 1/3 length of ownship is about 4.5 knots. In radar speed vector is one half of ownship is about 6.8 kts.

⇒ Tug boat actual speed is 4.8 knots by AIS data.

⇒ Remember SRB relative safety bearing: one third OS speed is one third of 60 degrees = 20 degrees.

⇒ This tug boat is at 30 degrees to ownship's starboard bow. OS can safely pass target's bow without problem.

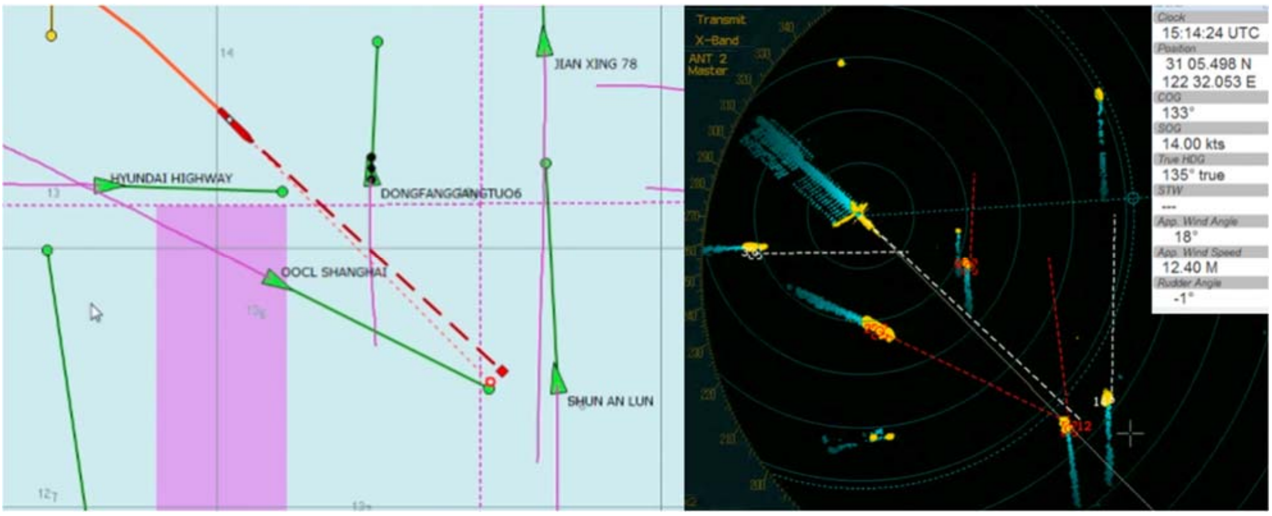
⇒ This is the clue at 1510 when we have doubt about this target's collision risk.

⇒ Right now, ownship have alter course 30 degrees to starboard side. We are facing another difficulty.

At 1514 hours UTC, Figure 5-20

5-26 出港第五階段，尋找出路並且默默祈禱

在 1514 時 UTC，圖形 5-20，本船維持航向 133 度，已經有兩分鐘，航速 14.0 節，長江口燈船在正北方，本船即將進入北上航道遭遇北上來船，雷達的距離設定由 3 海浬改到 1.5 海浬，這是在當時比較合適的設定，因為來往船隻太多了。



圖形 5-20 因為目標 12 號目標，維持航向 133 度 在 1514 時

⇒ 本船位于長江口燈船南方 0.7 海浬。這個 0.7 海浬是正横距離，或是平行游標線的垂直距離，對於本船來說，只要能夠維持燈船在本船左舷正横 0.7 海浬（航向必須為正確的 090 度），就可以知道本船是在東航的航道上，航道寬度是一海浬。

⇒ 平行游標線的用法，在本書並未討論過，這是電子海圖定位系統沒有問世前，最有效的無定位導航法，也是號稱“看一眼，就知道船位如何？”，可以幫助航行或避碰的決策之用。現在就看看電子海圖，就可以了。

⇒ 本船的航向 133 度，等於穿過東航的航道，以 43 度的交角穿越，因為對拖船避讓，產生的結果，如果本船不能及時轉向，再 6 分鐘之後，本船的船位，就會開出航行巷道。

⇒ 這也是本船的航向，沒有遵照到一般流通方向所產生的後遺症，雖然這是為了緊急的避難，也增加了本船擱淺的風險。

⇒ 在這些航行巷道的邊緣，因為船長選擇的 133 度的航向，本船遭遇到兩個方向的來船。

⇒ 船長採取明確的動作，對 12 號目標讓路，卻沒有注意到本船的位置，已經陷入非常危險，而無法順利脫身的口袋陷阱。

在這個現在的位置，我們可以預測本船 6 分鐘之後的位置，請參考圖形 5-20.

⇒ 被追越船在我們的右邊正横，航向 090 度，將會落在本船之後，距離一海浬。

⇒ 兩條横越船在船頭，航向正北，正在通過本船現在 133 度航線的前方。

⇒ 在本船右船頭的被追越船，航向 115 度，將會在 6 分鐘後，與本船發生碰撞。

⇒ 本船無法大角度向左舷轉向，拖駁在我們的左船頭。

⇒ 本船可以減速或是停車，這樣就不會追越右前方船隻，現在還有一條在本船船尾 0.5 海浬的船隻，對本船後面 0.5 海浬的船隻直接停車，需要一點勇氣，如果船長不知道本船停車的特性，瞭解不足的話。

⇒ 本船也沒辦法繞過 OOCL 上海的船尾，因為跟他只有 0.5 海浬的距離，他又在我們的右船頭，這樣的距離，是不足以完成航向的改變，使用右滿舵需要比減速停車，更大的勇氣。

⇒ 如果你只是一名當值船副，你可以等待並觀察，船長要如何操作，他總是能夠做到，就像變把戲一樣的完美。對船長來說，本船正以 14 節的高速，帶著 334 點 8 米長，45 米寬，50 米高的尺寸前進，我無法只是看著他去發生碰撞。

⇒ 本船與 OOCL 上海的碰撞危機，發生在當兩條船都決定要繞過 12 號目標的船尾，要繞過目標的船尾，對單一目標的情況是安全的。在多船隻的情況，就不一定了，**多目標的情況，我們必須繞過最後一條船的船尾**，現在的情勢是，最後一條船就是 OOCL 上海，並沒有很多的海域，可以運轉本船。

好了，讓我們打破這些當值船副的迷思，距離碰撞的時間估計是 6 分鐘，本船在現場已經超速。

⇒ 第一件事是本船無法減速，就像我們所需要的，在圖形 5-20，想像本船的速度向量線，只有現在的一半，碰撞危機會是怎麼樣？如果本船的速度只有 14 節的一半，7 節的船速，根本就不會有任何的碰撞危機，減速就是最好的脫身之計，請參考第三章 06 節的討論，警急倒車的情境知覺。

⇒ 本船無法減速，正在追越現代高速輪是對的，但是本船也無法立刻停車，本船仍然會有比較高的餘速通過他的船頭，現階段的減俥，只有切斷燃油的供應，沒有實際制動的效果。

⇒ 向左舷轉向，向左舷轉向到 OO CL 上海的航向 115 度，現在 1514 時轉向會撞到拖駁，碰撞危機是在 6 分鐘後，本船呢只能先轉到 123 度，這是前 3 分鐘，3 分鐘後（1517 時）再轉向到 115 度，此時右前方的拖船，開的比較遠一點。參考第 2 章 24 節，改變本船速度向量線的方向來避免碰撞危機。

⇒ 本船無法繞過 OOCL 上海輪，兩船隻有 0.5 海浬的距離，他在我們的右船頭 0.5 海浬，這只有 926 米，這只有本船的船長的 2.5 倍的長度，只能達到回轉的第二階段，所以沒有辦法及時回轉避碰，如果 OOCL 上海速度航向不變，他是以 10 節的速度在航行，與本船的速度差距，只有 4 節，兩條船距離 0.5 海浬，兩條船速度的差距 4 節，追越的話，需要 7 分半鐘才能夠追上他，本船就能夠利用這 7 分半鐘的時間，來完成我們轉向的需求，來繞過 OOCL 上海的船尾。

⇒ 所以再一次，**先確認碰撞地點，在做避碰的決策之前，要冷靜**。碰撞地點是在 7 分半鐘之後，本船的轉向只需要 3 分鐘的時間，表面上看起來 0.5 海浬是不足以轉向避碰，因為進距不夠，但是因為目標船的動態，本船其實是可以繞過 OOCL 上海的船尾，具有足夠的時間及距離，只要 OOCL 上海的航向航速不變，這個就是一個很大的迷思，船長如果能夠看破這個迷思的話，他就會輕鬆很多。

5-26 Departure Phase 5: Find the way out and cross fingers?

Ownship maintained course 133 degrees(T) for 2 minutes/speed 14.0 knots. Chang Jiang mouth light vessel is in due North direction. Radar range setting had changed from 3 nm to 1.5 nm which is more suitable for now.

Figure 5-20: maintain coursed for target no.12 at 1514 hours

⇒ Ownship position is 0.7 nm due south of Chang Jiang mouth light vessel. This 0.7 nm is the cross track distance or parallel index distance to light vessel. Eastbound channel is 1 nm in width.

⇒ Ownship heading 133^0 (T) had crossed Eastbound traffic lane 0.7 nm south and is about to go out of traffic lane within next 3 minutes.

⇒ Still ownship take positive move to give way to Target No. 12 without notice ownship's position is very dangerous into the pocket trap or have no way to go out.

In this position now, we should predict vessels' position after 6 minutes. refer to figure 5-20

⇒ Overtaken vessel Hyundai Highway on our port beam course 090^0 (T) will behind OS astern about 1 nm distance.

⇒ Two north bound Crossing vessels course 000^0 (T) ahead will be passed by OS current course 133^0 (T) without problem.

⇒ Overtaken vessel OOCL Shanghai on our port bow course 115^0 (T) will have collision with OS about 6 minutes time.

Ownship's option now:

⇒ ownship cannot alter course to port side: tug boat is at port bow.

⇒ ownship can reduce speed or stop engine with very little risk to overtaking vessel HYUNDAI highway. For a vessel 0.5 nm distance behind OS, reduce speed or stop engine need some courage if Captain did not know her vessel's stopping characteristics very well.

⇒ ownship cannot go around OOCL Shanghai: only have 0.5 nm distance away at starboard bow. This distance is not enough to complete the course change unless Captain is to use hard over rudder which need more courage than stop engine.

Well, you are right because you are an OOW. You can wait and see Master to maneuver. He can always do the magic trick. For Master, ownship is steaming at 14 knots full ahead with 334.8m × 45m x 50m dimensions, I cannot just watch her to collide.

⇒ Ownship have collision risk with OOCL Shanghai when both vessels choose to go around same Target No. 12.

Go around to target's stern is always safe for one Target situation but not in multiple vessels situation.
In multi target situation, we need to go around the last ship's stern. In current situation, the last vessel is OOCL Shanghai. That saying is for open sea OOW level when ownship has lots of sea room to maneuver.

OK. Let's crack down the myth of OOW: the time to collision TTC is 6 minutes. Ownship is over-speed at scene.

- First thing is OS cannot reduce speed as fast as possible. In figure 5-20, imagine half-length on OS speed vector what collision risk will be? NO collision risk at all.
- Ownship cannot alter course to port side once for all: alter course to port side to parallel with 115^0 (T) course of OOCL Shanghai. OS can alter course to 123^0 (T) in the beginning then alter course to 115^0 (T) after tug boat is clear.
- Ownship cannot reduce speed: we are overtaking HYUNDAI highway now even ownship will not stop immediately. Ownship still have higher residue speed to pass her bow. HYUNDAI highway will arrive current collision point after 6 minutes. Ownship can pass collision point with her by 1/5 of original speed about 2.8 kts.
- Ownship cannot go around OOCL Shanghai: she only have 0.5 nm distance away at starboard bow. 0.5 nm is 926 meters is about 2.5 times of ownship length which is at most "in second stage of turn". It may have trouble to finish the turn in time if OOCL Shanghai have no speed over ground. She is sailed in 10 knots speed. By 4 knots speed difference, 0.5 nm need 7.5 minute to reach her. OS could have 7.5 minutes to finish our course change to go around OOCL Shanghai if ownship determined to do so.

5-27 在編隊航行時，避碰的金科玉律

即使在這麼混亂的情況下，我們應該記得兩條金科玉律，來避免碰撞：

第一是與其他所有的船隻，保持同樣的速度，成為在一個編隊航行的態勢之下。
第二保持與其他船隻同樣的航向。

⇒ 本船現在已經超速，應該試著減速，這是優良船藝的一部分，高速船在海面上，是其他所有船隻很嚴重的威脅，就好像現在本船要採取避碰措施，讓路給北上的船隻，但是前面的慢速船，也要避讓同一船隻，本船的高速，就產生了新的衝突。

⇒ 也就是新的碰撞可能，因為本船在追越前船的同時，也追上了前面船與他船的碰撞點，這一聽就知道愚不可及，事實上就是如此，讀過避碰規則的船副，都知道追越是最困難的操作，在本船加車的同時，在這繁忙水域裡，也同樣宣告了本船追越的義務？

⇒ 保持同樣的速度，是跟哪一條船同速呢？跟本船船頭最接近的那條船，只要呢他的速度不是慢的離譜，我們最好跟大多數船隻的速度是一樣的，就可以避免很多的碰撞危機。

⇒ 如果本船的速度，跟別的船隻都一樣的話，碰撞危機就少了很多，那如果不得已的話，本船必須加車或者減速，那我們應該要怎樣航行，才能夠避免碰撞的發生？

⇒ 也就是跟其他船隻採取同樣的航向，我們在前面應該討論過，同樣航向的船隻在海面上航行，就好像兩條平行線，永遠都不會相交，這尤其是近距離避碰的時候，很重要的一

個技巧。避免了碰撞造成的損害到最低，所以本船現在呢最好是跟 OOCL 上海輪，保持同樣的航向是 115 度，雖然我們沒辦法減速到跟 OOCL 上海一樣，十節的速度。

使用中心點出發的電子游標線，用來跟 OOCL 上海的速度向量線平行，然後從羅經盤的刻度上，讀出他的航向，OOCL 上海現在的航向就是 115 度，前面幾分鐘，他的航向，可能改變過，這個技巧主要是節省，在雷達上操作阿帕目標回跡的時間，直接呢可以判斷需要的航向。順便呢利用電子游標線的轉動，我們可以觀察 115 度方向，有哪些碰撞的可能？包括呢剛剛才通過船頭的拖駁，現在的方位是多少？一兼二顧，照顧到各個層面避碰需求的瞭望技巧。

⇒ 實際上 OOCL 上海真實的航向是多少？並不重要，我們只需要儘量保持跟他平行，來避免速度向量線產生交點，也就是避免碰撞點的產生，因為他船的速度方向，也是隨時在變，阿帕上面的資料不能一致，所以保持持續的觀察，就可以避免後續其他的變化。

⇒ 跟目標船航向平行的目的，可以不要一次達成，也就是緩慢的轉到我們希望的航向，如果時間不允許一次快速的轉向，希望一次航向的改變，就能夠解決所有的麻煩，這是一種幼稚的想法。

⇒ 第一次的航向改變，也許只能從 135 度轉到 126 度。這個方位是剛剛通過本船船頭，拖駁船尾現在的方位。

⇒ 在此同時，本船的霧號應該鳴放五短聲，或使用 VHF 頻道 16 來警告 OOCL 上海輪碰撞的危險，如果我們在駕駛臺上，可以找得到人，去操作 VHF 的通訊，否則就是由船長自己鳴放霧號，因為在這麼近的距離之內，船隻都有著很大的危險，船上的人員也應該要得到一些提早的警報，不論是本船或是他船。

⇒ 讓舵工將船穩定在 126 度，船長應該再度檢查拖駁方位，如果沒有碰撞的疑慮，然後再次轉向到 115 度。當然轉向的同時，船長應該減低本船的船速，以爭取更多的避碰時間。

⇒ OOCL 上海的船名，本船應該在追越之前，就應該知道，也就是在連續的操作之中，應該事先知道他船的船名，在本船開始加車，超越其他所有船隻的時候。

⇒ 距離碰撞時間是 6 分鐘，船長仍然有時間可以停俥，來避免進入這個口袋之中，船隻的停車特性，應該是和第三章警急到車一樣。

⇒ 長時間的使用舵角，在回轉時對減速有一點幫助，但是最好的減速方法，如果我們知道如何使用，是循環舵的技巧。

好的，我們知道現在情況很危險，需要學習循環舵的快速減速，這是比緊急倒車有效的方法。總結，船首向決定了本船會發生碰撞的地點，每一度的差異，在我們的船首向都是非常寶貴的。保持操船時良好的習慣，給舵工我們需要的舵令，然後監測本船回轉的速率，是否是船長所需要的，最後給我們需要的航向，讓舵工去穩住。因為穩定船體的回轉，需要舵工的評估與經驗，船長可以先給個大概的航向，再檢查目標船的方位變化，以及本船的回轉性能是否良好，回轉的效率是否良好？

5-27 Two golden rules to avoid the collision in dense traffic

Even in this mess we should remember two golden rules to avoid the collision:

1. Keep same speed as other vessels in this area.
2. Keep same course as other vessels in same lane.

⇒ OS is over speed now. Try to reduce speed as soon as possible as good seamanship.

⇒ Keep same speed to which vessel? The one in closest ahead.

⇒ Keep same course to which vessel? The one with closest collision risk: OOCL Shanghai is the top priority now.

⇒ What is the course of OOCL Shanghai? How could we know?

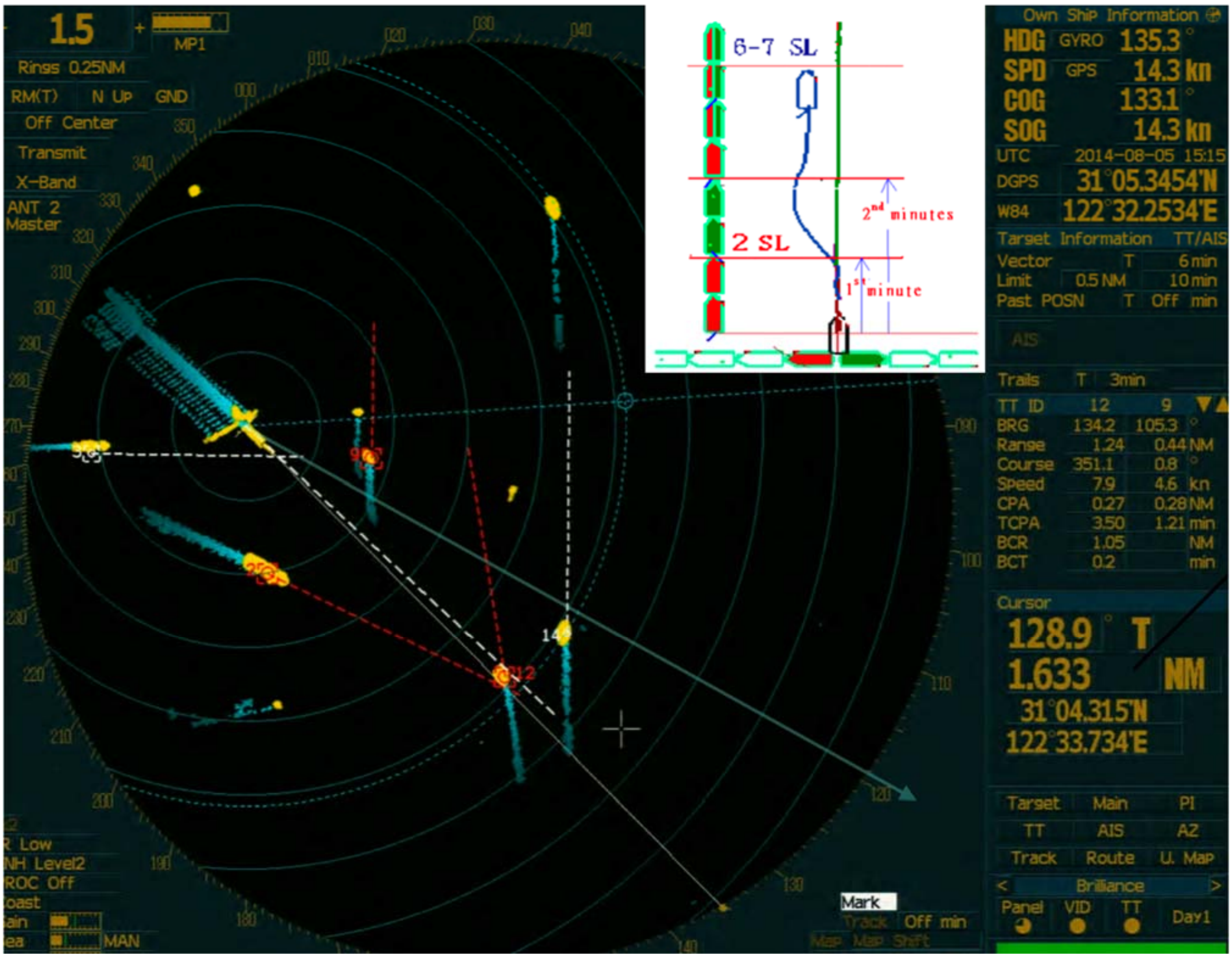
⇒ Use centered EBL to parallel her speed vector and read it from compass bearing. Because in this way, we don’t need to identify which target no. of OOCL vessel in ARPA and find the correct data window of it. The TTC is precious in a critical situation. OOCL Shanghai heading is 115 degrees(T).

⇒ Actually, what heading she has now is not important. <u>We need to resolve the collision point by paralleling ownship’s course line to her speed vector by our visual estimation on ARPA screen</u>.

- ⇒ The goal to parallel with target's heading can be achieved step by step.
- One course change to solve all problems is not feasible for all situation.
- First course change may be 126^0 (T) which is compass bearing of the stern of tug boats and his tow.
- At the same time sound ownship's whistle 5 short blasts or calling at our VHF channel 16 to give OOCL shanghai collision warning if you can find someone to help in bridge.
- Once helmsman steady on 126^0 (T) captain should check the bearing of Tug boat and his tow. Alter course to port side once again to 115^0 (T) if tug and tow had passed and relative bearing increased.
- The ship's name OOCL Shanghai should be known ever since ownship begin the overtaking or increase ownship speed over other vessels around.
- TTC is 6 minutes, captain still have time to stop the engine to avoid going inside the trap. Ownship can mauver same as: 3-06 Situational awareness of Crash Astern.
- Prolong rudder usage time in turning has a little effect on speed reduction. But, best speed reduction is "rudder cycling" skill if we know how to use it.
- Well. You know it is dangerous.

  You should learn how to reduce ownship's speed more quickly than "Crash Astern".
- ⇒ Ownship Heading will decide where the collision will happen. Every degree difference in heading here and now is very important.
- Keep good maneuvering habit:
  - Give the "rudder order" to helmsman first (turning rate should be decided by master) and
  - monitor rate of turn Captain need in turning. (turning rate may not enough or cannot create by rudder angle been used by bad weather condition)
  - Give the course degrees to steer or to steady as needed to helmsman (inform the helmsman what is the course required now) and
  - evaluate new situation after heading change by Captain. (to monitor the relative bearing change of target vessel)

5-28 如何做到在口袋裡搖擺



圖形 5-21 1515 時，本船在口袋裡搖擺，循環舵

在 1515 時 UTC 圖形 5-21 本船穩定航向在 135 度，長江口燈船在西北方，雷達的距離圈設定從三海浬改到 1.5 海浬，這是比較合適的設定，速度向量線時間是 6 分鐘的長度，這是決定碰撞時間的重要工具。

⇒ 一旦我們確認了速度向量線的時間設定，就立刻知道距離碰撞的時間是 5 分鐘。
⇒ 如果你不知道為什麼？就想一想吧！
⇒ 應該打開主機遙控器上面的緊急倒車旋蓋，立刻按下緊急倒車的按鈕。
⇒ 在這個時刻，警急到車已經按下去了，我們應該將速度向量線的長度改成 3 分鐘，來讓避碰的情勢更為清晰，因為我們並沒有太空船的狀態，可以參考。使用碰撞線 3 分鐘的速度向量線，來代替我們探路的工作，這個可以參考圖形 2-14。
⇒ 本船的左舷 0.3 海浬被拖駁檔住，第二糟的是右舷 0.45 海浬，有目標船同時擋住了本船的右舷，第三糟糕的是 1.2 海浬距離的慢速船，正在通過船頭，距離碰撞的時間是 5 分鐘。
⇒ 本船可以借著避免與船頭 12 號北上目標，在最後 3 分鐘的速度向量線相交，來避免碰撞。我們可以在 135 度的航向，等個一兩分鐘，然後轉向到 119 度。藍色的游標線在羅經方位 119 度，就是對船長的推薦航向。

119 度跟 OO CL 上海的航向 115 度有 4 度的差距，為什麼不用 115 度航向就好，這個航向 119 度是在拖船的速度向量線中間，也就是代表這條拖船前進 3 分鐘的距離，保持這 3 分鐘距離的差距，就是我們的安全範圍。

⇒ 如果太快速的轉向到 119 度，我們可以看到 12 號目標，仍然在本船的右船頭。
⇒ 再發出左滿舵，跟 119 度航向的指令給舵工以後，我們應該繼續鳴放霧號，跟 VHF 的呼叫，並且希望能夠產生功效。
⇒ 現在最不利的情況，是 OOCL 上海開始轉向，回到 090 度的航向，前面說的鳴放霧號，VHF 呼叫的努力，都是希望他不要左轉，因為本船在他的左後方。

⇒ 現在是我們應該要瞭解到，什麼是循環舵的技巧？來有效地降低本船前進的速度，緩解碰撞的危機。

5-28 Departure Phase 6: Rocking ship in the pocket? But how?

At 1515 hours UTC, in Figure 5-21

Ownship steady course on 135 degrees(T). Chang Jiang mouth light vessel is in NW direction. Radar range setting had changed from 3 nm to 1.5 nm which is more suitable for now.

⇒ The speed vector is in 6 minutes length. This is important tool to decide Time To Collision TTC.
⇒ Once we make sure of speed vector time setting, we know immediately TTC is 5 minutes.
⇒ If you don't know why think about it?
⇒ Ownship should open the safety cover on Main Engine telegraph panel and push down "Crash Astern" button immediately.
⇒ In this moment (after crash astern pushed) ownship should change the speed vector length to 3 minutes to make the situation clearer to us (to make the maneuvering space estimation). Well, we did not see the space ship here please refer to figure 2-14.
⇒ OS portside is blocked by tug boat and tow. OS starboardside is the collision risk (TTC 5 minutes.) with target at 0.45 nm distance away, also blocked by small rudder angle turning which need at six times of ownship's length (333 x 6 = 1998 meters = 1.08 nm). OS ahead is third worse with 1.2 nm distance slow targets crossing now,
⇒ OS can avoid Target No. 12 by using three minutes speed vector if we wait 1 or 2 or 3 minutes in 135^0 (T) then alter course to 119^0 (T) (the EBL light blue line on compass bearing 119^0 (T) is recommended course to Captain).
⇒ 119 degrees(T) has 4 degrees difference with OOCL Shanghai course 115 degrees (T). Why not using 115^0 (T)? Because this course 119^0 (T) is already on middle position of No.12 target vessel speed vector which means its 3 minutes run (we want to keep 3 minutes distance run as our safety margin because of blossom effect this 3 minutes run may be not enough to clear No.12 vessel).
⇒ Alter course too quickly to 119^0 (T) we may see target No. 12 may still locate on ownship's bow.
⇒ After give the "hard port" and "119 degrees" to helmsman, we should continue sound the whistle and VHF and hope "Crash Astern" will work. The most unfavorable situation now is OOCL Shanghai alter course to go back 090^0 (T).
⇒ It is the time we should know somethings about "Rudder Cycling" skill as last option to reduce speed.

Figure 5-21: Rocking ship in the pocket at 1515 hours, Rudder Cycling

5-29 循環舵：在避免擱淺，超速，避碰時的緊急操作

循環舵是使用 3 到 4 次的相反方向的滿舵，以減低本船的速度，重點是保持對本船船首向的控制。

先將舵角放到左滿舵或右滿舵，來啟動本船的回轉，請參考圖形 5-21 的小圖，循環舵的開始階段，本船先使用左滿舵，在回轉第一階段，或是回轉第 1 分鐘是以兩隻紅色小船代表需要的進距與左滿舵。

等到本船完成了第一階段的回轉，說明如下：

⇒ 本船的船尾已經被推到右舷，
⇒ 船首向向左舷轉向大約 10 度，
⇒ 回轉的速率在第二階段會開始增加，因為船首向的改變，船頭的水流阻力增加，作用在我們的迴旋支點之前。
⇒ 本船主要是使用水流對船體的阻力來減速，情況良好時，或是有足夠水域時，可以嘗試使用更大的航向差距（大於 10 度），來創造更大的水流阻力。
⇒ 現在我們的船頭即將離開我們的原始航線，也就是前進兩倍船長的進距後，這是在回轉的第一階段，當本船的船首向改變了有 10 度以上，就將舵角放到另外一舷的滿舵，也就

是前面說的第一個舵角是左滿舵，第二個就使用相反方向的右滿舵，請參考圖形 5-21 的小圖，本船第二個就使用使用右滿舵，是以兩隻綠色小船代表需要的進距與右滿舵。

- ⇒ 本船將需要一些時間，才能夠停止原先向左的回轉，然後開始向右轉向，我們的原始船首向，請參考圖形 5-21，本船使用左滿舵，在本船回到原來的船首向之時，也就是在 3-4 船長的進距之後，
  1. 再度使用反向的滿舵，再一次滿舵的目的，是要回到原來的航向，保持原來的航向，可以降低與同一航行巷道船隻碰撞的損害與可能性。
  2. 再度使用反向的滿舵，是要回到船長要求的航向，保持與來船的航向相同，可以降低碰撞的損害與可能性。
  3. 穩定本船的船首向，依照船長的要求，以抵抗風力跟水流對本船船首向，所可能產生的影響，也就是漂流角的影響。如果本船的速度已經降的非常低了。
- ⇒ 因為本船的船速降低，受到流水的影響就會變大，可能需要增加流水修正在我們的船首向上，才能夠穩定在我們所需要的航向上。（此時需要 5 到 6 倍船長的進距，也就是以此取代我們滿舵回轉的第三階段）。

我們普通用一次性的滿舵，做大角度回轉的時候，在回轉第三階段，都是將近失控的邊緣，不過在循環舵的時候，船首向是隨時在船長的控制之下，在使用循環舵的時候，最有效減速的階段是第二階段，進距是 2-4 倍船長的距離，來自船頭的水流阻力，在這個情況如果本船的長度是 335 米，<u>4 倍的船長就是 1340 公尺，有效的減速階段是 0.36 到 0.72 海浬的進距，代表的是循環舵最少需要 0.7 海浬的距離</u>。

- ⇒ 12 號目標現在的距離是 1.2 海浬，是本船長度的 6.6 倍遠，本船總長是 335 公尺。
- ⇒ 依照這些資料，在這個情況之下，本輪要用循環舵來減速還來得及，要使用哪一舷的滿舵，這個就需要多的考量，先從右舷開始使用右滿舵，然後再以左滿舵，來制止向右舷的轉向。
- ⇒ 本船左舷的橫越船是最危險的目標，最危險的目標是因為他的距離最近。
- ⇒ 如果本船先使用左滿舵，然後右滿舵，如果沒有辦法很好的控制回轉，因為流水或是風力海浪的狀態，造成過度回轉，本船都會有很大的麻煩。所以保險起見，第一個滿舵先向右轉。
- ⇒ 循環舵跟會我們原始的航線，產生 1 倍船長的正橫距離，所以本船雖然控制了船首向，我們的船位，已經不在原來的航線上，這個就是我們在使用循還舵的時候，第一個需要考量的東西。本船的左舷，還是右舷比較危險？
- ⇒ 請參考圖形 5-21 小圖，因為第一個左滿舵使用後，所產生的本船航跡轉移到左舷，（在水準軸上紅色船隻的長度，代表本船的正橫位移），本船所需要的正橫距離。

我們不希望在左邊，發生麻煩。本船首向改變到左舷，碰撞危機就會移到左舷，在左舷造成新的碰撞危機。

- ⇒ 在右舷仍然有一些空間，因為 OOCL 上海跟本船還有 4 個 CABLE 的正橫距離。
- ⇒ 先使用右滿舵的舵令，當我們需要避讓左邊的船隻的時候。
- ⇒ 船隻的尾部會向左舷緩慢移動，在循還舵第一階段的回轉。
- ⇒ 如果循還舵第一階段回轉是兩倍船長 670 米，在現行的 14.3 節的速度，這個距離通過的時間，會是 1.5 分鐘，也就是距離碰撞時間有 6 分鐘，其中循環舵的第一階段，需要用到 1.5 分鐘的時間
- ⇒ 我們看到圖形上，這個時間給出的是大約 1 分鐘，這個是對小型船隻或是快速船隻而言。

船隻的船頭開始離開原始的航線，到達 145 度，也就是原航向右邊的 10 度之後，使用左滿舵的舵令，讓舵工去停止本船向右舷的回轉，利用船首向與原來航向的不同（船頭的水流阻力），來制動本船的速度，

- ⇒ 雖然在 145 度航向，使用了左滿舵來制動向右舷的回轉，船頭呢還是會繼續向右舷轉動。
- ⇒ 在舵角 10 度的 zip zag（Z 形）試驗，就是鋸齒形操作的特性，船隻的船首向，也許會繼續回轉到 155 度，或是 160 度的船首向(雖然我們在 145 度使用了左滿舵制動)，船長需要

心臟更強點，更冷靜，要不然呢船長可以去檢查船隻的回轉速率，或是舵角指示器是否使用了正確的舵角？

⇒ 反舵之後，回轉速率是否正在緩慢的減少。

⇒ 只要我們用了左滿舵 30 秒之久，這個回轉的速率。就會被左滿舵所減慢下來，這需要在回轉率的指示器上面，或借由本船的傾側角度來感覺。

再一次所有我們的恐懼，都是來自於對生命中發生事件的不確定性，如果船長沒有練習過循環舵的技巧，他就不會有任何的概念，本船會 overshooting 多少？也就是不知道會超越我們預定的航向多少？不知道船隻呢會多轉幾度，才會回頭？

⇒ 現在船長感到不確定性，或恐懼是正常的，因為船長面對的就是不可抗力，流水或是風力對轉向的影響，在不同的地點跟現場天氣狀況，都不一樣，現在是向南流的流水，是我們一開始就知道的。

⇒ 因為流水，本船向右轉向困難，因為是向下風轉向，就是慢速，這個其實是在出港的第一階段，船長就應該心裡有數，當本船下領港的時候，必須向北開。

⇒ 所以我們如果能夠及時的自動向右的回轉，是我們的幸運，因為流水是從左舷來的，會自動的讓本船左轉快速，反之，要讓本船順利的右轉，就會有相當的困難。

⇒ 循環舵的回轉產生的正橫距離可能是 1 倍船長，大約 300 米，這就是 0.18 海浬，比起 OOCL 上海現在還有 0.4 海浬的距離，還算是安全的，雖然他已經非常接近了，但是我們已經沒有選擇，也無法先向左舷旋轉。

⇒ 在循環舵的第三個階段，也就是 4 到 6 倍船長的進距，需要使用的舵角多少，要看現場的情況，是否需要避開右舷的大船，或是離左舷的小船太近，這要臨機應變，重點是循環舵是前面兩個滿舵，一個向左滿舵，另一個就是右滿舵，或是一個向右，另一個向左滿舵。

流水是從北邊來的，我們的右滿舵要及早下達，避免循環舵的第三個階段，船隻向左舷回轉不太容易制動，現在用的是滿舵的操船學，船隻的動態估計，一定要非常精確，準確估計到應該要有的流水容許值，而不是下了舵令之後，聽天由命，這是絕對不允許的。尤其是在船長級的操船，對我們的每一個動作（舵令或加減車），都要預先知道他的後果，以及事前防範的動作，這就是我們培養的很多年的知識技術所要用到的地方，長久就會變成我們的直覺。

⇒ 我們選擇第一個右滿舵，讓船隻的船位向右舷橫移，主要是因為左舷的小船，實在數量太多，船位太近，雖然主要的碰撞目標是在右舷，但是我們還是有一些海域，很可以做些循環舵的操作。因為他們的碰撞時間還在 6 分鐘之後，這是對 OOCL 上海而言。要撞到左邊的小船呢只需要前進 3 分鐘，就會發生碰撞，所以我們是兩害取其輕，先向右離開這些小船。

循環舵是緊急操船的三大技巧，除了緊急停車，滿舵回轉的第三個就是循環舵的使用，我們需要使用循環舵，即使是在非常狹窄，限制的水域，港區，領港站，防波堤，或是在開闊水域，有淺水區域，或是避碰等等。以後我們會有更詳細的討論，因為這是船長級的技術，船長的知識，技術我們都還沒有開始研究。

5-29 Rudder Cycling: emergency maneuvering in all emergency: collision, grounding or speeding

Rudder Cycling is to use 3 or 4 times hard over rudder to each side in turn to reduce ship’s speed and retain control of ownship’s heading.

1. Put rudder order “Hard Starboard” or “Hard Port” first to initial the turn to helmsman. Refer to inside white drawing of figure 5-21,
   I. ownship heading north use Hard Port rudder first in 1st minute or 1st stage (beginning of Rudder Cycling).
   II. When ownship had finished 1st stage of turn:
      1. ownship’s stern had push to starboard side already,
      2. heading changed about 10 degrees to port,
      3. OS about to feel the resistance of water ahead of our pivot point, the rate of turning will increase after this point because water resistance increased due to heading change.

4. OS is using water resistance to reduce speed. If situation is OK use more heading deviation to create more water resistance.

2. Change the rudder order to counter side fully. That is "Hard Starboard" after "Hard Port" or "Hard port" after first rudder order "Hard Starboard". Refer to figure 5-21, ownship use Hard starboard rudder after ownship's bow about to leave our original heading. (this stage is about two ship's length advance distance)

   I. Ownship will need some time to stop the original turn to port side and going back to our original heading.

3. Cycling ownship rudder to "Hard Port" again when OS is about to back to original heading (this stage is about 3-4 ship's length advance distance). One of rudder cycling purpose is maintaining original heading.

4. Steady ownship at original heading or Heading required by Master according to new situation or his judgement of the situation. Refer to figure 5-21, ownship use rudder order necessary to steady on heading required. (this stage is about 5-6 ship's length advance distance)

The most effective speed reduction stage is at second stage of rudder cycling which is the water resistance stopped ownship's ahead speed. This happened in 2 to 4 ship length advance distance about the same as one "hard over rudder" turning we discussed before. So. It is worth to wait a little longer while ownship start to turn our heading in the first hard over rudder. However, when to apply counter rudder to stop the original turn in second stage depends on ownship's turning property. For a sharp vessel not easy to turn the counter rudder may wait longer or shorter. It is prudent to decide the best practice for ownship in this rudder cycling process by captain experience to get a balance between reduce speed more effective and avoid losing control of ownship's heading.

In this case, ownship is 335 m in length. 335 x 4 = 1340 m. The most effective speed reduction stage is at 3.6 cable to 7.2 cable advance distance (1.5 to 3.0 minutes in her original 15 kts speed).

- ⇒ No. 12 Target is at 1.2 nm distance away which is 6.6 times of ownship's length 335 meters away.
- ⇒ It seems helpful in this situation but which side Hard Over rudder angle should we use first? Started to starboard side and counter starboard turn with "Hard Port" rudder.
- ⇒ Although ownship stop engine due to starboard side overtaken vessel most danger target is still at port side for his distance is closest.
- ⇒ If ownship use "Hard Port" first then "Hard Starboard" rudder cannot stop the turn very well due to other influences like current or sea state…et. No matter what is the reason, OS will be in big trouble.
- ⇒ Rudder cycling will need one ship's length abeam distance to original track.
- ⇒ This needs to take into consideration when we choose first Hard Over Rudder to use.
- ⇒ Please refer to figure 5-21 ownship's track shifted to port side (red ship length on horizontal axis below) due to first "Hard Port" rudder.
- ⇒ First hard-over rudder will decide which side ownship's track will deviate to.
- ⇒ We don't want to chase the trouble in port side as collision risk shift to port side with ownship's heading changed to port side.
- ⇒ We still have some space in starboard side as OOCL Shanghai is 4 cables abeam distance to ownship.
- ⇒ First give "hard starboard" rudder order to helmsman when port vessels need to avoid first.
  - o Vessel stern will move slowly to port side at first stage of turn.
  - o If first stage is about two ship's length 670 meter by current speed 14.3 knots the time to travel is 1.5 minutes.
  - o We see in the drawing the time is given as one minute (that is for smaller or faster ship).
- ⇒ When vessel bow begins to break from original course line at heading about 145^0 (T), (10 degrees more to starboard side)
  - o Apply "Hard Port" rudder order to helmsman to stop the turn and brake ship's speed by water resistance ahead.

- By 10 degrees Zig Zag maneuvering characteristics,
    - vessel heading may overshoot to 155 or 160 degrees(T). (this is the stage Master need strong heart to remain calm, instead of that Captain should check on rudder indicator "Does correct rudder angle been applied by helmsman?")
    - It is fine as long as we had applied "Hard Port" rudder 30 seconds ago (when heading is 145^0 (T)) and
    - The turning rate is slow down by "hard port rudder". (read from rate of turn indicator or feel it in ownship's list angle)

Once again, all our fear is coming from uncertainties of our life. If Master had not practice "Rudder Cycling" before he will not have any idea of "how much overshooting she will be now?". Now, Master feel the uncertainty (fear) is normal unless he had been taught before.

Anyway, we have other job to do. Let's take a look of force majeure "where the current is setting now?" Setting to south if you still remember what Master had done in phase 1 to disembark the pilot (he going to North of traffic lane). So, we are lucky to stop starboard side turn more quickly when current coming from port side.

    - The turning is quickly checked by upstream current.
- The beam distance gained by hard starboard turning may need one ship's length about 335 meter (1.8 cable) which is safe compared with 4 cables beam distance with OOCL Shanghai although it is very close and dangerous but OS has no choice to go port side first in this situation.

⇒ In third stage of rudder cycling (4-6 times ship's length advance), the rudder applied depends on situation at scene whether OS need to avoid starboard side big vessel or to avoid port side small vessels.

⇒ Turn to Port side will be very quickly as upstream turn is more effective.

⇒ We should apply "hard starboard" rudder earlier to stop the turn to port side.

⇒ If master do not know how many degrees per minute's turning rate OS will lose control, we should be careful in using rudder cycling in this emergency.

⇒ The reason to choose starboard side for first hard over rudder is too many targets at port side.

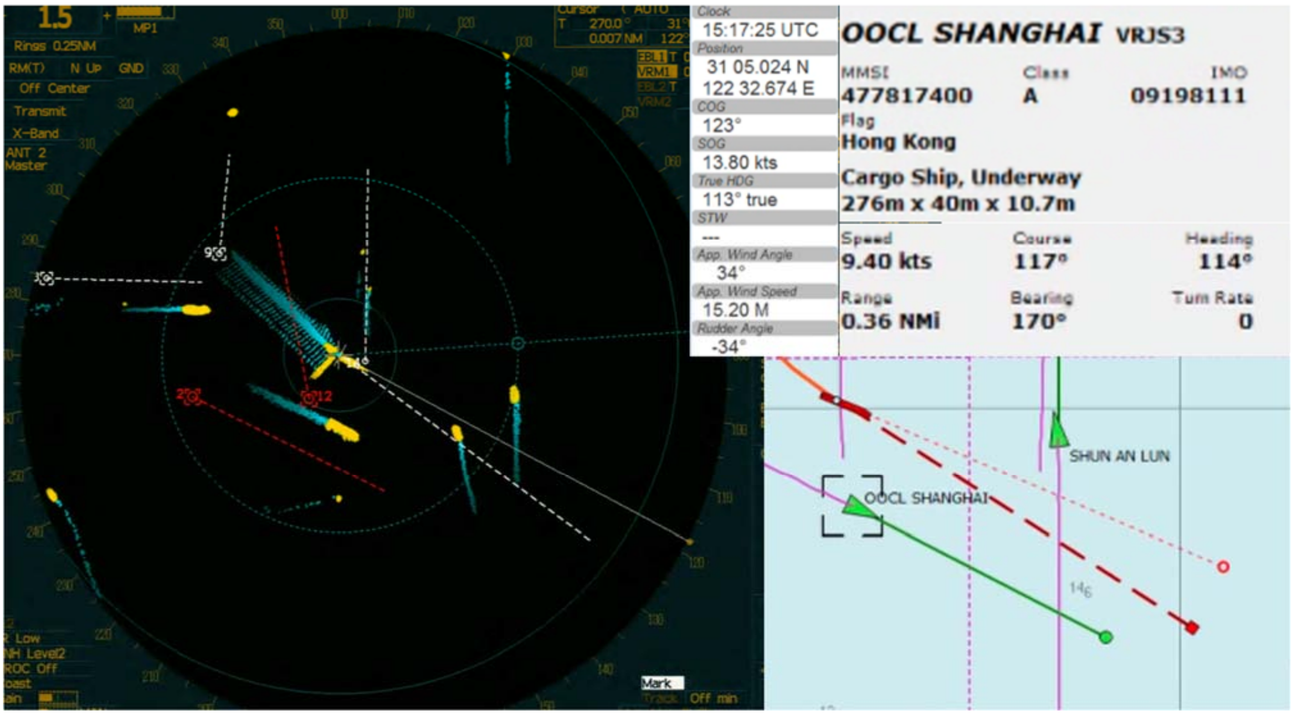
Rudder cycling use "hard over" rudders in turn to reduce speed but may lost control of turning at the same time.

- Rudder cycling is one of three major emergency maneuvering beside crash astern engine and hard over rudder turn.
- We may use it even inside very restrict area like harbor area, pilot station, break water entrance, etc…... or in open sea with shallow water or collision avoidance, etc.….

5-30 出港第七階段：避碰最後機會，將航向穩定在 117 度

1517 時 UTC 左滿舵後兩分鐘，圖形 5-22 本船使用左滿舵，圖形上顯示-34 度的舵角，本船對地航向是 123 度，船艏向 113 度，雷達距離圈是 1.5 海浬，船長已經將雷達上本船的位置移到雷達的中心點，方便讀取目標方位與需要操舵的航向，阿帕的顯示又開始變得狂亂，在船長最需要的時候。12 號目標並沒有操作的 AIS 信號顯示，而他的雷達速度向量線已經失去，OOCL 上海的速度向量線，也已經遺失。

所有的這一切說明，只有目視瞭望是最可靠的方法，尤其是在緊急的時候，現在還有最後的一個機會，如果本船的航向能夠穩定在 117 度。



圖形 5-22 滿舵回轉的第一階段 1 在 1517 時

⇒ 時間又從 1515 時，過了兩分鐘，為什麼 OOCL 上海沒有注意到本船，已經發展成近接碰撞的情況，需要共同避碰？

⇒ 本船的速度並沒有使用任何方法來降低，而且 OOCL 上海也沒有被通知到，或是警覺到本船的動態。

⇒ 現在才去通知 OOCL 上海，已經太晚，如果我們只是鳴放霧號，現在還比較有效，可以讓他驚覺到，本船已經在這麼近的距離。

⇒ 舵角是左滿舵，使用了兩分鐘，本船船首向在這兩分鐘，從 135 度轉到 113 度。

⇒ 本船已經通過第一階段的回轉，船首向改變了 22 度，現在本船是在第二階段的回轉，船首向從兩分鐘前改變了 22 度。

⇒ 如果能夠使用右滿舵來穩定航向在 110 度，回轉速率還是在可以控制的階段，緩慢的每分鐘 11 度。

⇒ 船長必須控制回轉的速率，在第二階段回轉速率會很快速的增加，尤其是向上流轉向，也就是向本船的左舷轉向，強勁的流水從左邊來的，都作用在本船的船體上面，產生強大的偏向作用，尤其是在回轉的第二階段，遭遇到船頭的水流阻力。

⇒ 117 度是 OOCL 上海的航向，也就是被追越船的航向。

⇒ OOCL 上海的 CPA 是 0.36 海浬 620 公尺，這是本船寬度的 15 倍，比一般狹窄水道需要的船隻寬度 8 倍還要多，這可以避免 OOCL 上海與本船之間的交互作用，也就是船體之間的相互吸引力，或是排斥力。

⇒ 如果船長還是擔心交互作用，會造成碰撞，降低船速，或是穩定在 117 度。

5-30 Phase 7: One last chance to avoid collision by steady ownship's course at 117^0 (T)

At 1517 hours UTC in figure 5-22, 2 minutes after Hard Port rudder

Ownship use "Hard Port" rudder for 2 minutes already, course over ground 123 degrees(T), heading is 10 degrees less 113 degrees(T). Radar range setting is 1.5 nm and Master had change OS position to center of the screen which is easy to read bearing and course to steer. ARPA display went crazy again when Master needs them critically. Target No. 12 did not have AIS signal operated and her Radar echo and speed vector are lost, too. OOCL Shanghai also lost speed vector in Radar (no way to know his heading changed or not by one look). Once again, Visual Lookout are only reliable means in emergency?

In this mess there is one last chance to avoid collision by steady ownship's course at 117^0 (T).

Figure 5-22: First stage of full rudder turn at 1517 hours

⇒ Two minutes had passed from 1515 hours why OOCL had not aware ownship had developed an close quarter situation with her?

⇒ Ownship's speed had not reduced by any means and OOCL Shanghai had not been informed or alarmed of ownship's movement. Ask somebody on bridge to inform OOCL Shanghai by VHF is too late.

⇒ Just sound the whistle now is more effective to alert the vessel close by.

⇒ Ownship used rudder "Hard Port" for 2 minutes time. Heading change 22 degrees in 2 minutes from 135^0 to 113^0 (T) degrees.

⇒ Ownship had passed first stage of turn (within 12 degrees turn). Now OS is in process of second stage of turn (heading changed 22 degrees from two minutes ago).

⇒ Rate of turn is still controllable (rate of turn is slow, 11 degrees per minute) by "Hard Starboard" rudder to steady the course at 119^0 (T). (as we discussed before, this is the heading shown on radar picture in figure -22)

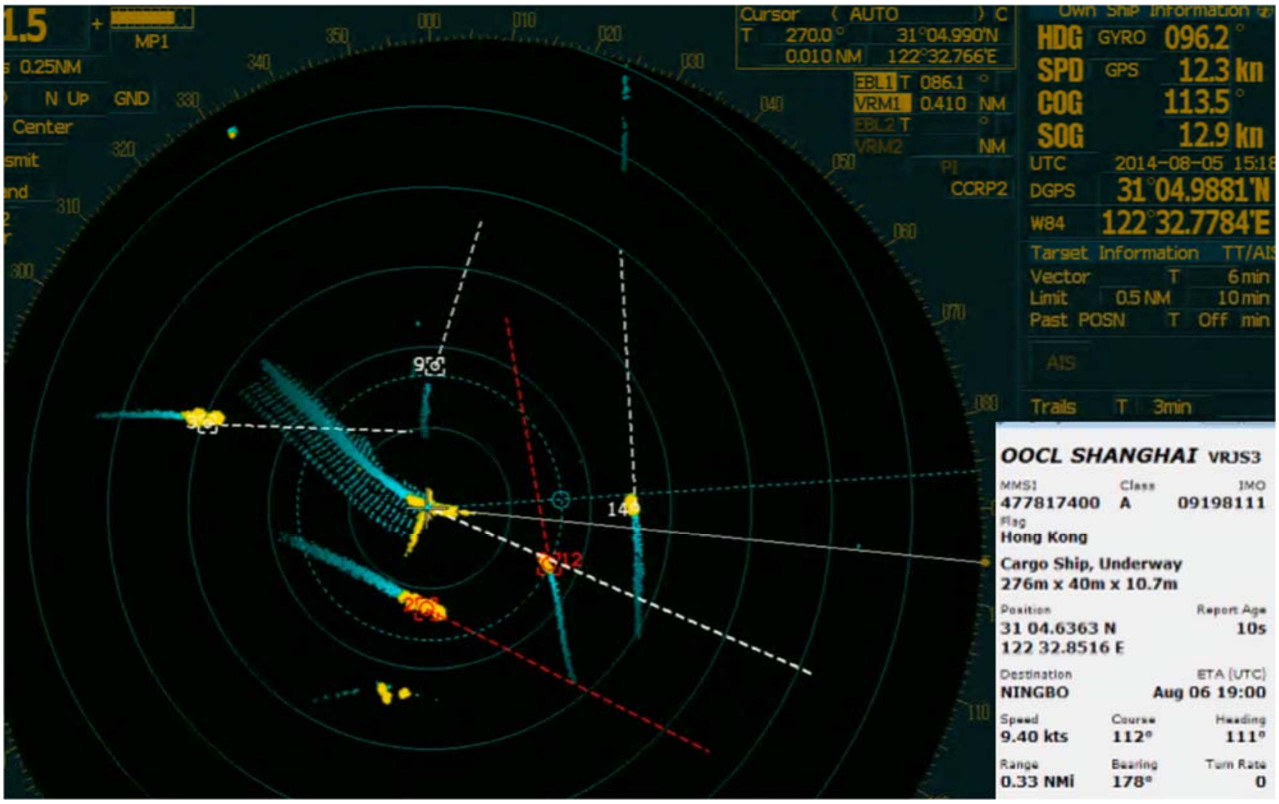
⇒ Master has to control rate of turn in first stage otherwise turning rate will increase very quickly while upstream turn is in port side and all current pressure working on ship's hull in second stage of turn will increase the momentum of turning.

⇒ 117 degrees (T) is the course of OOCL Shanghai (overtaken vessel).

⇒ CPA of OOCL Shanghai 0.33 nm = 620 meter is 15 times of ownship's width which are more than 8 times of ownship's width to have interaction effect with OOCL vessel.

⇒ If Master worried about interaction effect, reduce the engine immediately and steady on 117 degrees (T) will be good.

5-31 出港的第八階段，在繁忙的水域內使用滿舵操船



圖形 5-23 滿舵回轉的第二階段在 1518 時

在 1518 時 UTC，使用左滿舵 3 分鐘之後，圖形 5-23 本船使用左滿舵已經 3 分鐘了，已經來到回轉的第三階段，對地航向 113 度，船首向 096 度，漂流角是 113-96=17 度，雷達的距離設定是 1.5 海浬，每分鐘 17 度的回轉速率。

舵角還沒有改到右滿舵，船隻已經從 135 度轉到 096 度，左舷轉向了 39 度，用仍然是左滿舵的舵角。

船長心裡的盤算，不知道是什麼？可能想要直接左轉通過拖駁的船頭之後，再想辦法回到東航的航向 090 度，0.35 海浬的距離是不夠做一次回轉的，即使本船正在進行的是滿舵的回轉，又有流水的幫助，在現在距離不足的情況，我懷疑船長是否考慮過回轉的進距，需要多少。
本船的船首向，現在是 096 度，然而我們最需要的是 115 度的船首向，這樣可以跟 OOCL 上海的航向平行。

⇒ 現在的回轉速率，已經增加到每分鐘 17 度。
⇒ 碰撞的情勢與 1915 時，3 分鐘之前，似乎是一樣的，請參考圖形 5-21，船頭有船，左右有船。
⇒ 追越的 OOCL 上海只有 0.25 的正橫距離，463 米，接近但是本船還是有機會，平行他 115 度的航向。
⇒ 12 號目標是在本船右船頭，距離是 0.4 海浬，等於 740 米，2.2 倍本船長度之前。
⇒ 2.2 倍船隻的長度，是我們稱為操船的死亡區域，本船沒有辦法使用回轉，從這個區域脫身，尤其是對貨櫃船而言，船頭的盲區，就是我們的死角，沒辦法輕易的擺脫碰撞。
⇒ 本船從 135 度開始轉向，在 1515 時 3 分鐘前轉向，在航向 135 度時，目標船 12 號是一個清爽的目標，如果我們可以在 135 度的航向上，穩定航行 3 分鐘。

但是這個航向 135 度，跟 OOCL 上海會在五分鐘後，發生碰撞，也就是 1518+5=1523 時。
在 1515 時圖形 5-21 觀測到的碰撞時間是 1521 時，現在圖形 5-23 觀測到的碰撞時間改到 1523 時，因為本船向左舷轉向，同時呢也將本船的碰撞點，移到 OOCL 上海的速度向量線之前兩分鐘的距離，（為本船多爭取了兩分鐘的時間）如果我們能夠穩定在這一個航向 117 度，現在本船就有機會能夠脫身，避免碰撞。

⇒ 船長下令右滿舵給舵工，也需要 20 秒的時間，舵板才能夠從左滿舵移到右滿舵的位置，
⇒ 然後我們還需要兩分鐘，才可以將本船的船首向，從 096 轉到 117 度來避免碰撞。
⇒ 速度向量線仍然是 6 分鐘的長度，距離碰撞的時間，對目標 12 號來講只有 1.5 分鐘，下令右滿舵給舵工，也已經來不及。
⇒ 本船的船首向 096 度，已經小於 12 號目標的羅經方位 112 度，碰撞點已經從 12 號目標的船尾，移動到他的船頭，請參考第三章第五節本船的行動對碰撞點的轉移
⇒ 如果船長知道，多目標相遇的第二條金科玉律，是保持與所有船隻同樣的航向，在多目標的情況下，他就知道應該要穩舵在 OOCL 上海的航向 117 度上。
⇒ OOCL 上海的 CPA 0.25 海浬，等於 463 公尺，是本船寬度的 10 倍，就像圖形 5-23。
⇒ OOCL 上海已經慢慢地回到原始航向上，所以他並不知道本船正在追越，本船船長也沒有時間去警告他。
⇒ 112 度是 OOCL 上海現在操舵的航向，從圖形 5-23 我們可以看到 12 號目標的尾跡顯示，她的航向是 350 度，從 OOCL 上海的速度向量線 3 分鐘的位置，到本船 1.5 分鐘的位置，如果我們維持在 115 度的航向。

5-31 Phase 8: Conducting Hard over rudder turn inside dense traffic

At 1518 hours UTC, 3 minutes after Hard Port figure 5-23

Ownship use “Hard Port” rudder for 3 minutes. Turning is in third stage course over ground COG is 113 degrees(T), heading 096 degrees(T). Drifting angle is 113-096= 17 degrees. Radar range setting is 1.5 nm. Rate of turn is about 17 degrees per minute in this stage. Rudder angle had not changed to “Hard Starboard”. Vessel altered heading from 135^0 (T) to 096^0 (T), 39 degree to port side with Hard Port rudder.
Ownship is conducting a “Hard Port” turning with current coming from port side. OS heading is 096 (T) now when we need most is 112 degrees (T) (parallel with OOCL Shanghai course now).

⇒ Rate of turn had increased to 17 degrees per minutes.
⇒ Port side overtaking vessel OOCL Shanghai is 0.25 nm abeam, 463 meters, close but have chance to parallel her course 117 degrees (T).
⇒ No. 12 target is on OS starboard bow distance is 0.4 nm= 740 meters ahead (2.2 ship’s length ahead).
⇒ 2.2 ship’s length is what we call death zone of shiphandling.

⇒ Ownship has no way to clear No.12 target vessel by turning to starboard side especially for container vessel.

⇒ OS alter course from 135^0 (T) at 1515 hours 3 minutes before. 135^0 (T) is a clear course with No.12 target if OS steady on it from 3 minutes ago. But this course is in collision with OOCL Shanghai after 5 minutes at 1520 hours.

⇒ We have to give way to OOCL Shanghai. If we can steady on this course 117 (T) now OS have the chance to get away.

⇒ Even Master order "Hard Starboard" to helmsman now it will need 20 seconds to rotate rudder plate to "Hard Starboard" position.

⇒ And another two minutes to push her body back to 117^0 (T) heading from 096^0 (T) now.

⇒ Speed vector is still in 6 minutes time. We know TTC is about 1.5 minutes from now for target No. 12.

⇒ Ownship's heading already less than No. 12 's compass bearing 112 degrees (T). Collision point shift from No.12 target's astern to her bow. Please refer to 3-05 Collision position changed by ownship's action.

⇒ If Master knows second golden rule in dense traffic area is Keep same course as other vessels at scene.

⇒ What he has to do is to steady on OOCL Shanghai course 112 degrees (T) now.

⇒ CPA of OOCL Shanghai is 0.25 nm = 463 meter is 10 times of ownship's width as figure 5-23.

⇒ OOCL Shanghai had course again slowly who has no idea of ownship is overtaking dangerously and have collision risk with her. Ownship Master did not have time to warn her by whistle or VHF.

⇒ 112 (T) is the course OOCL Shanghai steer now.

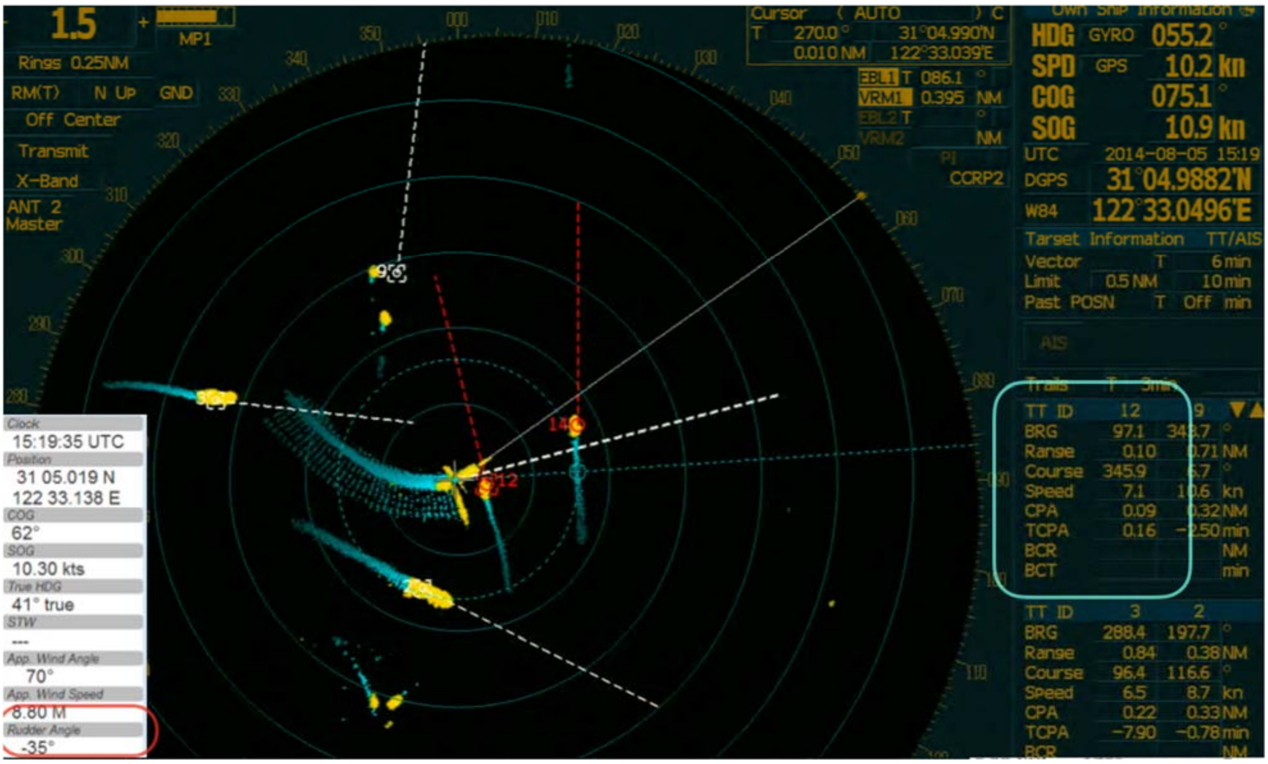
⇒ From figure 5-23 we can see No. 12 target's 3 minutes trail sailed 350 (T) (from OOCL Shanghai speed vector center to ownship's 1.5 minutes speed vector length).

⇒ If we maintain course 115 (T) No.12 target can be passed with 1.5 minutes different passing time and Bow crossing distance 0.4 NM.

Figure 5-23: Second stage of full rudder turn at 1518 hours

5-32 第九階段：在滿舵回轉的第三階段，停不了的回轉速率

在 1519 時 UTC，圖形 5-24 本船使用左滿舵已經 4 分鐘了，船隻已經回轉到第三階段，回轉速率是每分鐘 40 度，對地航向是 075 度，1 分鐘之前是 113 度，船首向從 1 分鐘之前的 096 度轉到 055 度，漂流角是 20 度，（075 減 055 等於 20 度），雷達的距離設定是 1.5 海浬，回轉速率每分鐘將近 40 度，在第三階段舵角仍然是左滿舵，本船正在瘋狂的轉向，船上的每個人，應該都會被這一陣子的回轉所搖醒。



圖形 5-24 滿舵回轉第三階段，1519 時發生的碰撞

⇒ 本船在左滿舵的回轉中，發生了碰撞，本船要避開的是右舷 OOCL 上海輪。

⇒ 這不是跟 OOCL 上海的直接碰撞，而是與未預料到的 12 號目標，在現場發生的碰撞。

⇒ 顯然我們設定碰撞優先目標的順序錯誤，**12 號的目標是第一優先的危險，因為他跟本船的距離最近**。

⇒ 船長只有 1 分鐘的時間，可以決定什麼是對的？例如在 1517 時使用右滿舵來穩定船首向在 115 度。或是錯誤的決策，在 1517 時，使用左滿舵來繼續他的回轉，在這 1 分鐘的決策，決定了本船碰撞的命運。

⇒ 如果船長不知道第二條金科玉律，他就不會有心理準備，本船應該要穩定在 OOCL 上海的航向上。

⇒ 在 1518 時才要使用右滿舵，就會太慢了，因為本船船首向已經越過目標 12 號的船頭。

⇒ 也就是以正確的右滿舵制動本船的回轉。這個事件的轉捩點應該在 1517 時，碰撞前兩分鐘，因為 12 號目標是一條小船，如果目標是一條大船，碰撞前 3 分鐘，就是命運的轉捩點。

⇒ 我們一直在強調使用 3 分鐘速度向量線作為避碰線，碰撞危機的金箍棒，主要原因就是配合船隻的回轉性能。

這是在航運界的人為因素，船長只有 1 分鐘的時間去決定他的命運，什麼是對的，什麼是錯的。

⇒ 最後讓我們再一次使用圖形 5-24，來檢討安全的相對方位理論，結果 12 號目標是 7.1 節的速度，這在阿帕的資料區域裡面可以看到，安全的相對方位以現在的船速 14.5 節，安全相對方位應該是 30 度，60 度的一半，本船的半速。

⇒ 如果我們能夠將 12 號目標，保持在船頭的 30 度之外，本船就能夠通過 12 號目標的船頭。

⇒ 在圖形 5-21 12 號目標的方位是 135 度，如果本船能夠保持船首向少於 105 度，135 度減 30 度等於 105，可以通過 12 號目標的船頭。

⇒ 不幸的是在 12 號目標的後面，有另外一條船，所以我們要從 12 號目標的船頭通過，也許會跟他後面那條船，發生碰撞，經過 12 號目標的船頭避碰，不是一個很好的選擇。

5-32 Phase 9: Unstoppable rate of turn in third stage of "Hard Over" turning

At 1519 hours UTC, in figure 5-24

Ownship use “Hard Port” rudder (-34) for 4 minutes. Turning is in third stage. Rate of turn is 40 degrees per minutes. Course over ground 075 degrees from 113 degrees (T) one minute before, heading 055 degrees from 096 degrees(T) one minute before. Drifting angle is 20 degrees (75-55=20). Radar range setting is 1.5 nm. Rate of turn is about 40 degrees per minute in third stage. Rudder angle is “Hard Port”. Vessel is turning crazily. Everybody on board would wake up now by this swing.

Figure 5-24: collision happened at third stage of full rudder turn 1519 hours

⇒ Collision happened during hard port turn to avoid starboard side vessel OOCL Shanghai.
⇒ This is not direct collision with OOCL Shanghai but indirect collision with unexpected target NO.12 at scene.
⇒ The collision target Priority is wrong. No. 12 port side target is No.1 dangerous because her distance is closest to ownship.
⇒ There only one-minute time Master can decide what is right (hard starboard at 1517 hours to steady on 115 (T)) or wrong (hard port at 1517 hours to start the turn).
⇒ If Captain don’t know second golden rule he will not prepare ownship to parallel and steady on OOCL Shanghai’s course.
⇒ “Hard Starboard” rudder in 1518 hours in figure 5-23 (hard port rudder over three minutes) is too late as ownship heading already crossed target no.12’s bow.
⇒ The twist point of this incident is in 1517 hours in figure 5-22. Two minutes before collision while rudder cycling is still available then.
⇒ For big vessel, 3 minutes before collision is last twist point of fate.
⇒ This is human element in shipping industrial.

Master has only one-minute time to decide his fate (right or wrong?).

Finally, let’s use figure 5-24 to review Safe relative bearing SRB theory once again. No. 12 target’s speed is revealed as 7.1 knots inside ARPA data area. SRB by our estimation of half speed vessel is 30 degrees. If ownship can keep No.12 target outside OS’s heading 30 degrees range we can pass ahead of No.12 target’s bow. In figure 5-21, No. 12 target’s bearing is 135 (T). If ownship can keep heading less than 105 (T) (135-30=105) we may pass ahead of Target No.12. Unfortunately, there is another vessel ahead No.12 target. Ownship cannot alter course earlier. Pass ahead of No.12 target is not available to ownship.

5-06 船長只有一分鐘可以決定他的命運

情境感識或是自滿，在十字路口上

超速是第一個錯誤

⇒ 當本船速度最高的時候，海面上所有在我們之前的船隻，跟本船都有碰撞危機。
⇒ 研究顯示在晨間飛翔小鳥的群聚裡，或是眾多在高速公路上面的車流裡，之所以不會發生碰撞，是因為所有個別的小鳥，或是車輛的速度差距，都保持在±7%之內。
⇒ 在最繁忙的東京灣浦賀水道裡面，速度限制被嚴格的遵守。任何船隻都不能超過 12 節的航速，在浦賀的所有航行巷道之內。
⇒ 最安全的方法就是跟所有出港船，使用同樣的速度航行。

沒有跟同航道船隻的航向一致是 2 個錯誤

⇒ 沒有保留下領港所需要的海域
⇒ 本船應該儘量沿著航行巷道的外側航行，儘量靠右航行，只要是安全並實際可行的。
⇒ 在長江口的分道航行制裡面，第一次橫越西向航道，是開到錯誤的一邊下領港，橫越西向的巷道第二次，是本船必須回到東航巷道的時候。

在船隻包圍的態勢之下，沒有減速，是第三個錯誤

⇒ 減速就是減少碰撞危機。
⇒ 一條靜止不動的船隻，幾乎是沒有碰撞危機，除非其他船隻來撞他。
⇒ 減速可以給本船更多的時間，來評估情勢與做決策。

⇒ 減速對一條快速船隻，特別有用，**因為減速前後的速度差距，才是創造避碰距離的重要因素，尤其是避免橫越跟追越的碰撞**。

⇒ 當本船停車，碰撞位置就會從本船後面的位置，往前面移動到本船的船頭，順便也解除了本船重大傷害的可能。

沒有檢查目標的關鍵資料，是第四個錯誤

⇒ 10 號目標船回跡消失在海浪雜斑裡面，引起了船長惶恐。

⇒ 不知道 10 號目標是條拖船拉著駁船，速度是 4.8 節，安全相對方位是 20 度。

⇒ 船長並沒有注意到十號目標是一群無測繪小船的第一條。

⇒ 10 號目標相對方位的改變，由目視或雷達瞭望上面，都沒有做檢查核對。

⇒ 沒有這種瞭望的技術，是因為缺乏相對方位改變的概念，沒有知識。

⇒ 他就沒有核對羅經方位改變的度數是多少？沒有技術。

⇒ 不知如何使用相對方位的變化，來做避碰的判斷，沒有直覺。

⇒ 這會是船長適任性的課程。

⇒ 船長如果知道如何評估 10 號目標的碰撞位置，或是與本船的碰撞危機，本船就不會進入口袋，而這些船隻全都是未知，沒有擷取過的目標，盲人騎瞎馬。

⇒ 本船不知道 OOCL 上海的航向，警急的時候，沒有辦法採取與其平行的航向。

太過自信或是自滿，在很多方面或是充滿了無知，這就是一個人為因素的案件，因為我們的知識，技術與直覺的不足。

很多變數可以改變事情的結果，但這是一個無法忘懷的經驗，在近接避碰的情況，沒有足夠的訓練，甚至連標籤口號都沒有，情境察覺的能力不夠，或是駕駛台團隊人員的不足，這些就是一般我們所使用的標籤，在掩飾我們真正的無知，駕駛台資源管理就是最大的狗皮膏藥，提的出口號的人，卻提不出方案。

當雷達應用在航海的時候，駕駛臺上沒有人批評過，它在目標識別上的困難，或是失去目標回跡的缺失，在霧中，在早期我們沒有選擇，回跡的品質很差，雷達很容易損害，尤其是以前磁控管的時代，磁控管會老化，導波管經常漏水，電羅經經常倒掉，對他船航向航速不知，主管機關使用了一個月的雷達訓練課程，訓練我們的當值船副，在雷達觀測模擬測繪運用上的知識，技術與直覺。但是雷達的資料仍然不可靠，尤其是在近距離，我們最需要這些資料的時候。我們成為了第一代的雷達航海家，雖然雷達不可靠，卻是寶貝，不到萬不得已，絕不輕易開啟，對於雷達觀測模擬，我們擁有良好的訓練，結果卻失去了我們目視瞭望的能力，沒辦法確認什麼是對的？什麼是錯的？

幸運的是一些目視瞭望的技巧，被老的乙級船員所保留傳承下來，有執照的當值船副，依賴學校教育，卻沒有接收到這一方面的傳承與訓練，在這裡我們討論了很多需要用來避免碰撞的目測技術，在今天的 AIS 世代，AIS 在駕駛台仍然是一個單獨的配備，雖然他在提供資料方面，有著非常優越的用途，現在的船位經由 GPS 的測定，也非常的準確，筆者很希望安全相對方位與碰撞點的理論，在目視與雷達瞭望裡，可以向新一代的 AIS 船副推廣使用，不至於有所懷疑，以節省因為碰撞引起的生命，財產，環境的危害。

第五章完。

5 – 06 Master has only one-minute time to decide his fate

Situational Awareness or complacency at fairway junction.

- Speeding is first mistake.
  - When ownship has fastest speed at sea we have to give way to all vessel ahead.
  - The study shows within a folk of thousand birds or in highway traffic, the secret of no collision is because all individual's speed difference is within 7 %.
  - In most heavy traffic Tokyo Bay Uraga Suido the speed limit is strictly obeyed. (No vessel shall navigate at a speed exceeding 12 knots in all areas of Uraga Suido Traffic Route).
  - The safest way is to keep same speed with other vessels in same direction.
- No paralleling with traffic direction is second mistake.
  - Leaves necessary sea room to make lee for pilot boat disembark.

- Ownship *shall keep as near to the outer limit of the channel or fairway which lies on her starboard side as is safe and practicable*.
- Crossed west bound vessels lane once is foolish. Sailed in wrong side of traffic lane is another mistake. Crossed west bound vessels lane twice when ownship have to follow Chang Jiang mouth TSS order to go back to eastbound lane.
- Entry course choose is randomly (course chose in 1510 hours, 105 degrees is OK) without correct knowledge and skill in radar speed vector usage.

- Did not reduce speed before pocket of vessels is third mistake.
  - Reducing speed is reducing collision risk.
  - A stationary vessel almost has no collision risk unless somebody hit her.
  - Reducing speed always give ownship more time to evaluate the situation.
  - Reduce speed is especially useful for a speedy vessel to avoid collision in crossing and overtaking.
  - When ownship stop engine collision position will moving from ownship position to forward of ownship bow
- Did not check for target critical data is fourth mistake.
  - No. 10 target echo lost into sea clutter cause the panic.
  - No. 10 target is a tug with tow which is in 6.8 knots speed. RSB is 20 degrees. Her Relative Bearing is 30 degrees which means no need to avoid it.
  - Course chose in 1510 hours; 105 degrees is OK. This is most critical time in decision to give way.
  - Master knew No. 10 target is only the first one of many other targets. He have to take chance in this situation but he has strong confidence of his experience.
  - NO. 10 target's relative bearing change with visual or Radar had not checked. this should be done before avoidance action been taken. Lacking these skills is the reason of mistake.
  - How to use relative bearing shall be the course for Master's proficiency.
  - If master knows how to evaluate No. 10 target collision position or collision risk ownship won't get into the pocket of vessels unknown/un-acquired by ARPA.
  - Ownship did not know the course of OOCL Shanghai to parallel in emergency.
- It is over confidence or complacency in many ways. It is a human element's case regarding our knowledge, skills and instinct. Many things can change the outcome. However, all together it is an unforgettable experience.
- Not enough training in close quarter situation, lack of situational awareness or BHRM,…. These are normal labels we used to cover up our true deficiencies in these knowledge, skill and instinct.

When radar come to navigation bridge no one critics its deficiency in target identification and lost target from time to time. We have no choice in fog. The echo quality is poor and equipment is easily damaged by severe weather (giving that weather forecast is no good then). Instead, our industrial initiated an one-month training program to our OOW to cultivate the instinct in radar application. Nevertheless, the radar data is not reliable from time to time when we need it most especially in close range. We had become the first generation who's good at radar observation and identification but lost our visual ability to decide what is OK or not? Luckily, some visual lookout skills had passed on through rating but not licensed OOW who is new to the sea. No mentorship had passed from last visual lookout generation because no theory of visual lookout been established.

In here we had many discussions of what skill is wanted and needed to avoid collision. Today AIS is a stand-alone equipment on the bridge. It is superior in data providing through modern GPS than ARPA can detect.

We hope the concept of SRB in visual lookout and Collison point in Radar lookout can be teached to new generations of AIS OOW to use without hesitation to save the trouble and lives and environment.