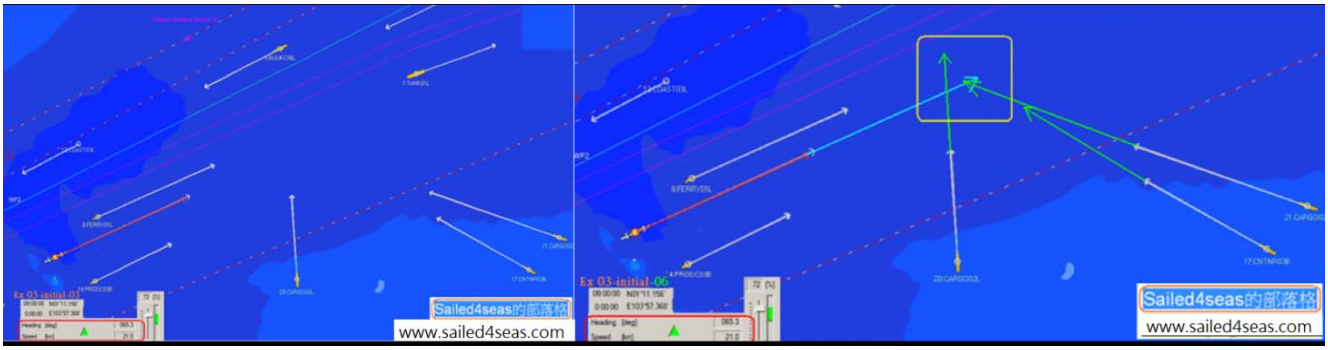
Chapter 9: Situational Awareness for Master

Figures:

9-01 避碰知覺操演-11 目視瞭望

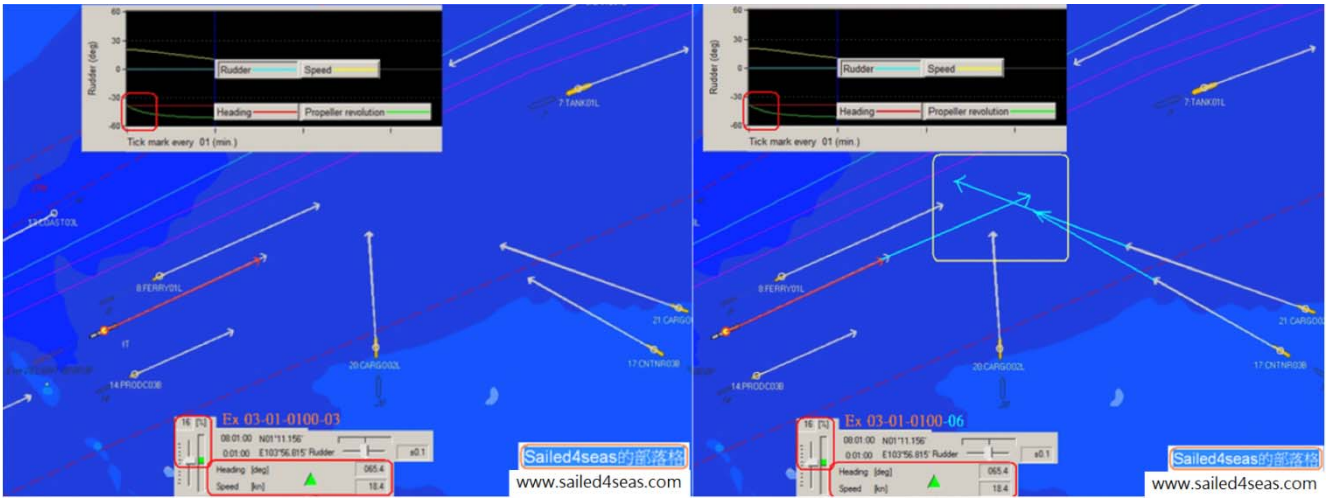
9-01 可以目視瞭望的時間由雷達瞭望決定



圖形 901 本船的速度向量是 3/6 分鐘，在開始操演的時候

情勢知覺如下：

⇒ 本船使用 3 分鐘的速度向量線，航向 065 度，速度 21 節。本船速度向量線長度大約 10.5 個 CABLE。
⇒ 本船有三條橫越船在右舷，距離未知。
⇒ 經過本船調整速度向量線到 6 分鐘的長度，我們看到有碰撞面的危機，有 3 條橫越船。



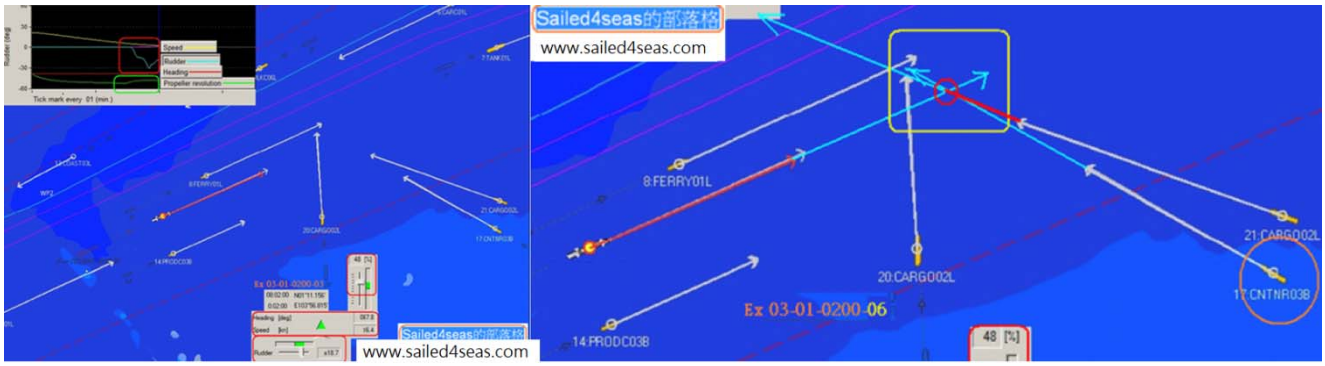
圖形 9-02，本船速度向量現在 3/6 分鐘長度，在第 1 分鐘的時間

經過 1 分鐘的操演時間過後，本船的速度是 18.4 節，這是從 21 節，將主機的出力減到 16%，雖然主機的設定是 16%，螺旋槳的轉速將下來，還是來非常緩慢。這是因為船隻先前以 21 節的高速前進，具有龐大的動量，繼續推動船隻向前，和螺旋槳的轉速。

本船的航向是穩定在 065 度，經過 1 分鐘之後，也就是這一段時間，並沒有轉向。

情勢知覺如下：

⇒ 第一條橫越船會通過本船的船頭，在 3 分鐘後。這是在 3 分鐘速度向量線的畫面上看到的。
⇒ 第二條橫越船在 3 分鐘的速度向量線上看不出來，何時橫越？我們改變速度向量線到 6 分鐘的長度，本船跟第二條右舷的橫越船在 6 分鐘左右，通過同一碰撞區域，這是用 6 分鐘速度向量線的觀測。
⇒ 顯然安全速度並沒有辦法解決任何問題，在這個情況之下，如果我們不能確定，本船的減速，是否能夠及時？
⇒ 安全的位置比安全的速度來得好一點，這個是在狹窄水道的重要規律。
⇒ 本船並沒有採取任何行動來避免碰撞面的危機，也就是多船碰撞的場面，我們看到在這 1 分鐘，並沒有轉向的動作。



圖形 9-03 本船的速度向量線在 3/6 分鐘長度，操演兩分鐘過後

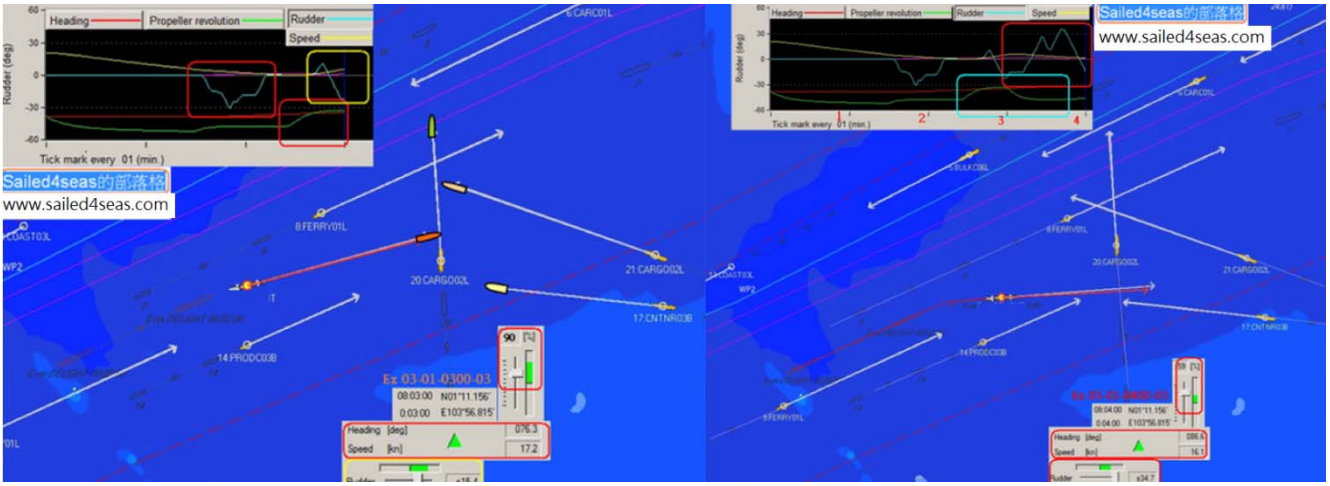
兩分鐘操演時間過後，本船的速度是 16.4 節，從 18.4 節下來，雖然主機的出力增加到 48%，在 1 分半鐘的時候。

本船的航向從 065 轉到 067 度，1 分半鐘時，使用右滿舵的舵令。情勢知覺如下

⇒ 第一條橫越船將在本船的船頭，在 3 分鐘之後，這是看到的。
⇒ 其他兩條橫越船在 3 分鐘的速度向量線上，無法判斷。在使用 6 分鐘的速度向量線後，情勢是這樣
⇒ 本船跟第二條橫越船有碰撞危機，在粉紅色圓圈內，在 5 分鐘後有碰撞危機，這是使用 6 分鐘速度向量線看到的。
⇒ 第三條橫越船會通過本船的船頭，在 4 分鐘之後，以我們現在的船首向。

估計碰撞時間技術如下：

利用確認碰撞點在速度向量線上的位置（紅色的圓圈位置），紅色線條長度就是第三條橫越船 3 分鐘速度向量線的 3 分之 1 長度，使用手指的跨距來量，是可以的。但是雷達旁邊放一個分規，才是我們推薦的做法。



圖形 9-04 本船的速度向量線 3 分鐘長度，在 3/4 分鐘的時間

在 3 分鐘的操演時間過後，本船的速度是 17.2 節，這是從 16.4 節開始增加的，主機的出力增加到 90%，在兩分半鐘時間。本船的航向改變是從 065 到 076.3 度，30 秒中不同的右舵操作，在兩分半鐘的時候，再次右舵 15 度。

第二條橫越船已經向左邊轉向，航向未知。但是與本船速度向量線已經沒有碰撞點。

9 – 01 Collision Awareness Exercise – 11 Visual Lookout

9-01 Time in visual lookout depends on your ARPA skill.

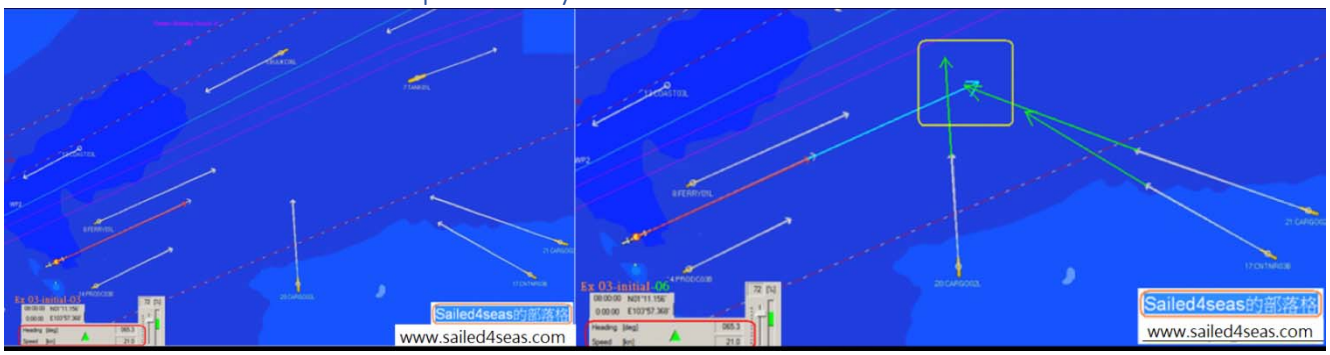


Figure 9-01 Ownship speed vector in 3 and 6 minutes at beginning

In figure 9-01, the situational awareness is:

1. With three minutes speed vector Course 065^0(T), speed 21 Knots, OS speed vector length is about 10.5 cables as above.
2. Ownship have three crossing vessels at starboard side, distance unknown.

After Ownship adjust speed vectors to 6 minutes length we found a collision area risk with three crossing vessels.

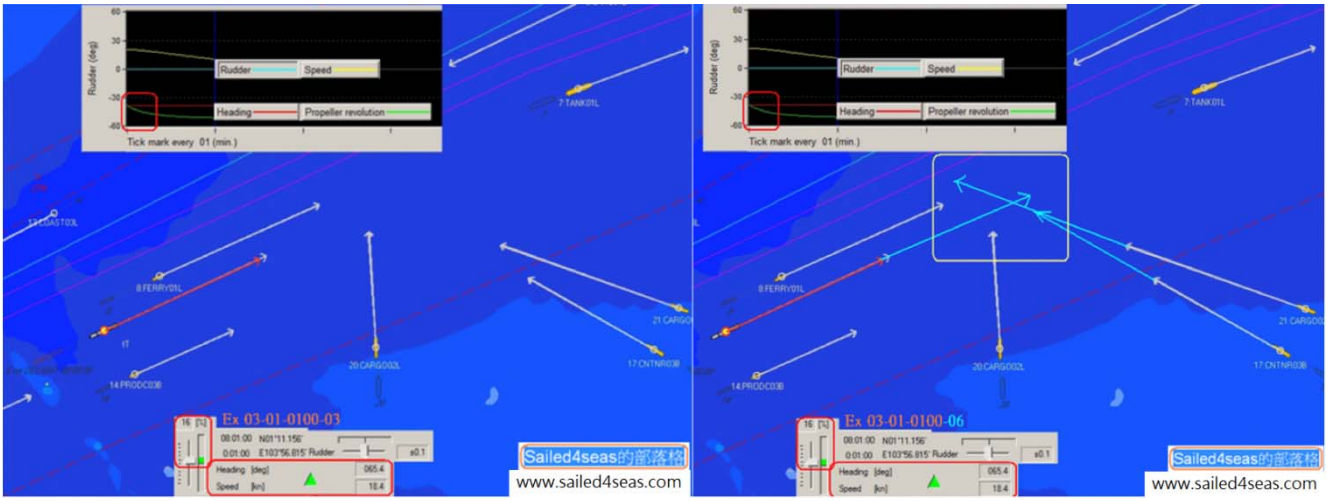


Figure 9-02 Ownship speed vector in 3 and 6 minutes at one minute time

After 01minutes exercise time lapsed, in figure 9-02:

1. Ownship speed is 18.4 knots which had reduced from 21 kts by reducing Engine Revolution to 16%. Although the engine telegraph setting is 16%, propeller revolution reduced very slowly. This is due to vessel proceeds with 21 knots before with great momentum which push vessel forward continuously.
2. Ownship course is steady on 065 degrees after one minute.

The situational awareness is

- First crossing vessel looks like to pass ownship bow after three minutes in 3 minutes speed vector picture. (sighted)
- Two other crossing vessels are unknown with three minutes speed vector. (sighted)
- We change speed vector to 6 minutes in figure 9-02 to the right one. Ownship have collision risk with two starboard side crossing vessels after 6 minutes more or less in same collision area. (sighted with 6 minutes speed vector)
- Obvious safe speed had not solved problem of this case as we cannot make sure ownship can further reduce speed in time.
- Safe position is better option than safe speed now. (rule in this dense traffic area)
- Ownship had not altered course to avoid collision area risk. (sighted no course alternation in this minute)

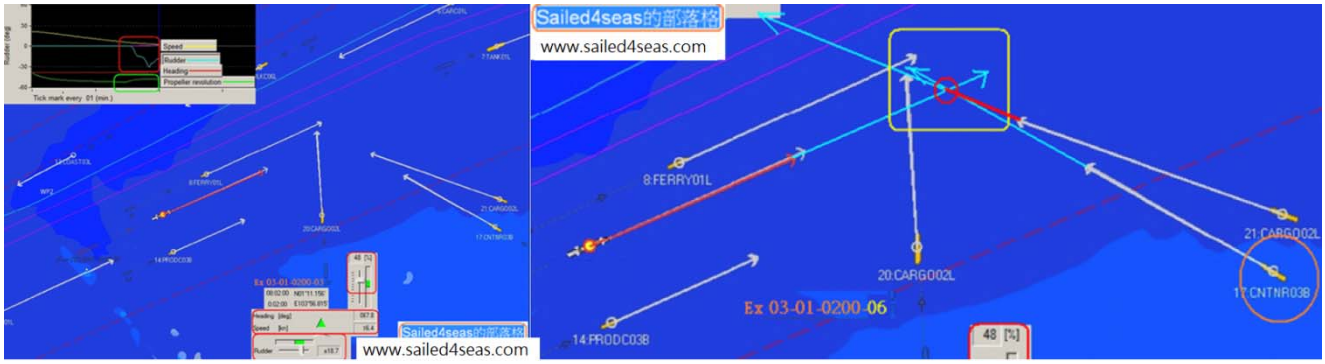


Figure 9-03 Ownship speed vector in 3 and 6 minutes at 2 minutes time

In figure 9-03, After 02minutes exercise time lapsed:

1. Ownship speed is 16.4 knots which had reduced from 18.4 kts even engine output increased to 48% at 01 minute 30 seconds.
2. Ownship course is changing 065 to 067.8 degrees after 1 minute 30 second ordered "Hard Starboard" rudder.

The situational awareness is

- first crossing vessel will pass ownship bow after 3 minutes. (sighted)
- Two other crossing vessels are unknown with 3 minutes speed vector. (sighted)

The situational awareness after speed vector change to 6 minutes is:

- Ownship have collision risk with one starboard side crossing vessel (in pink circle) after 5 minutes. (sighted with 6 minutes speed vector)
- Another crossing vessel will pass ownship bow after 4 minutes in our heading now. (skill as below)
- By verifying collision point (red circle on speed vector) position, red line length is about one third of her three minutes speed vector. (By using finger span to compare is Good, have a divider beside ARPA is recommended)

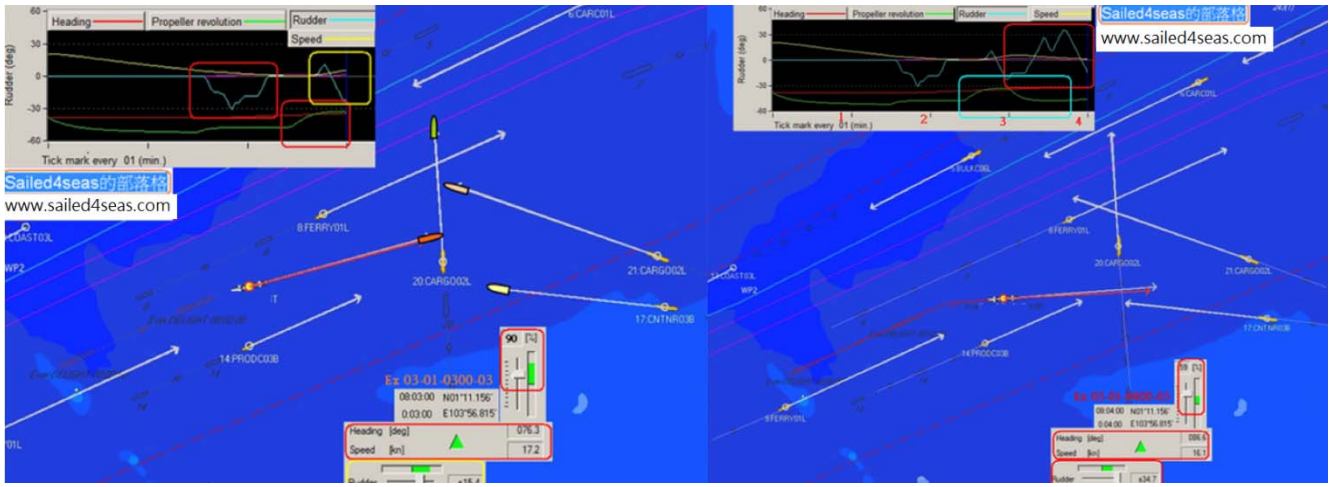


Figure 9-04 Ownship speed vector in 3 minutes at 3 and 4 minutes time

9-02 增進阿帕能力，會有更多時間目視瞭望

情勢知覺如下：

⇒ 這 3 條橫越船在這個船首向 076 度，應該是 OK 的，這是由速度向量線來判斷。如果我們使用 3 分鐘的速度向量線，碰撞的情勢不像 6 分鐘那麼明顯，第一條橫越船有碰撞點，但是他會在很短的時間之內通過本船。這是我們現在看到的

⇒ 第二條右舷的橫越船已經向左轉向，雖然他的最後航向還不確定，他的航向改變是很明顯的，這是比較圖形 9-03，操演的時間是在一分鐘之前。

⇒ 在真實的海上船長的注意力，也許被其他船隻動向分散，在 1 分鐘之前。借由使用 3 分鐘的速度向量線，船長可以判斷橫越船的碰撞危機，一眼就可以看出來。即使他不知道第二條橫越船在 1 分鐘之前的船首向是多少？

⇒ 本船跟第二條橫越船，現在是安全的，這是在這 3 分鐘的時間內，能夠確認。

第二條橫越船的位置是否在分道航行制之內？

- 在我們採取避碰行動之前要確認，這是很重要的。她也許並沒有要進入分道航行制，和使用分道航行制。確認目標的型態，補給船或是漁船，在我們讓路之前，也是很重要的，因為他可能只是在分道航行制之外面捕魚。
- 這兩點都沒有確認，造成今年轟動的雙擱淺事件，就在我們這些操演海域的南方，可見模擬機上，早就看出潛在的風險何在？
- 持續監控目標船的航向，使用目視也是很重要的，我們可以判斷它的船首向，利用他兩盞桅燈的排列，碰撞危機隨著她航向改變而變。
- 觀測目標船航向改變，最有效的方法是目視，不像使用雷達瞭望，使用速度向量線還有一些時間的落差（約一分鐘）。
- 我們有多少時間可以用來目視目標船的航向，是取決於你在雷達遼望的技術水準。

本船增加速度來增加舵效，或是讓路給橫越船隻，或是擔心從船艉來的追越船，這是我們的懷疑。但是從雷達上面看，本船在這個航向跟速度上，是安全的。但是船長並不能察覺這種情況。

- 4 分鐘的操演時間過後，在圖形 9-04 本船的速度是 16.1 節，這個是從 17.2，16.4，18.4 節而來，當主機的出力第三次由 90%降到 59%，在兩分半鐘時，這同樣的也使得舵效減低不少。
- 本船的航向改變到 086 度，從 076.3 度。使用“右舵”是比較有效，但是左舵的回應，來的就比較慢，這是我們看到紅色方塊內的舵角變化。
- 現在是用“左滿舵”來穩定船首向，

情勢知覺是這樣

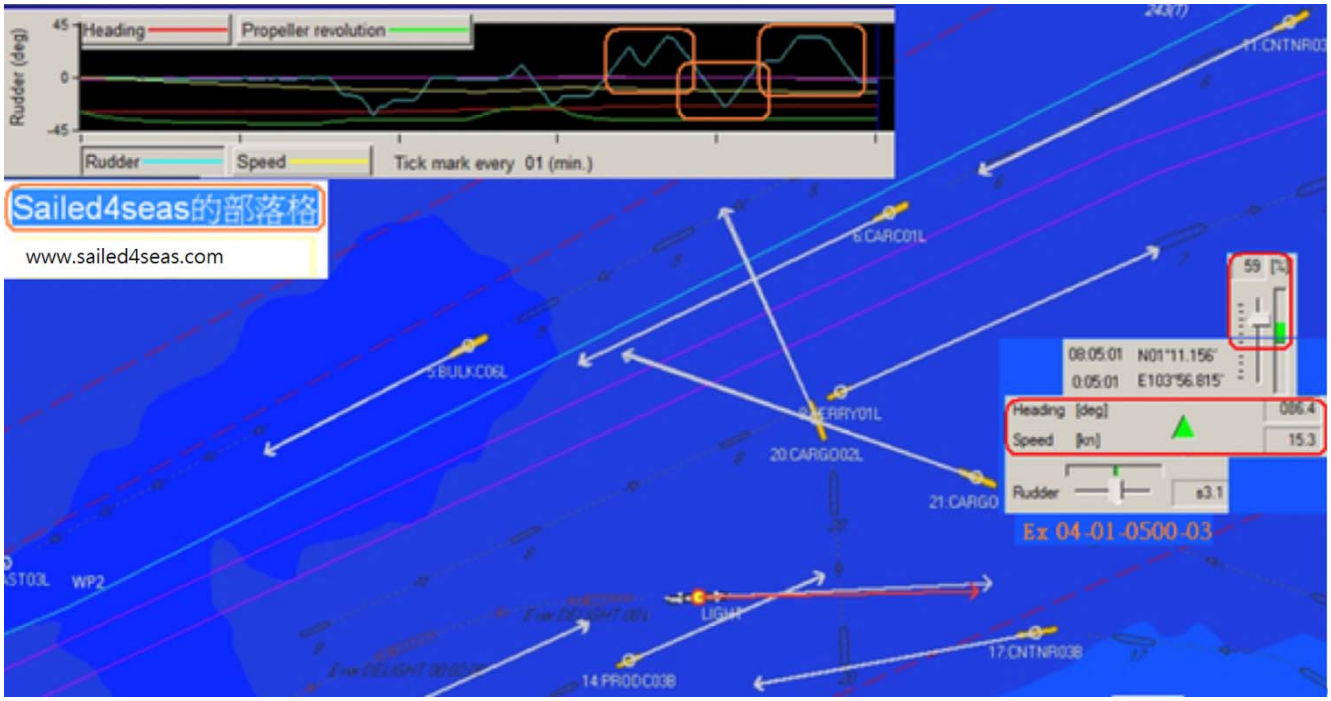
⇒ 第一條與第 3 條的橫越船會通過本船的船頭，這是看到的

⇒ 第二條橫越船是在右船頭，幾乎迎艏正遇。本船的轉向在海面上，造成迷惑。

⇒ 這個 2 號橫越船隻應該是 OK，如果我們保持在原來的航向 076 度，即使本船正在轉向，船長應該利用目視，看看窗戶外面，其他船隻的動態，這是熟練的航海家，如果他從雷達瞭望上畢業了。如果在雷達上，他看得出眉目，就不必浪費太多時間，繼續在雷達上面觀測。

⇒ 減速不明顯，但是航向的改變，用了很多的舵令，用舵次數的多少，就是船長對操船確定不確定的一個明確指標。就像有的領港的舵令，比其他領港整整多了 3 倍，還不一定能夠安全的靠泊。

⇒ 右舷正橫一條被追越船，速度向量線幾乎相交。中點對端點：一半安全，一分半鐘。



圖形 9-05 速度向量線在 3 分鐘長度，操演 5 分鐘後的情勢

9-02 Improve your ARPA skill will allow more time in visual lookout.

In figure 9-04, after 3 minutes exercise time

1. Ownship speed is 17.2 knots which had increased from 16.4, with engine output increased again to 90% at 02 minute 30 seconds.
2. Ownship course is changing from 065 to 076.3 (T) using 30 seconds varied “Starboard” rudder. Rudder order “Starboard 15” once again after 2 minutes 30 seconds.
3. Second crossing vessel had altered course to port side, course unknow but speed vector had cleared collision point.

The situational awareness after 3 minutes is

- Three crossing vessels should be OK in this heading 076^0(T) judging by speed vectors. (sighted)
- If we use 6 minutes speed vector the collision situation will not so obvious as 3 minutes speed vectors (sighted).
- First crossing vessel has collision point but she will pass ownship’s bow in very short time. (sighted)
- Second starboard side crossing vessel had altered course to port side already, although her final course is unknow to ownship.
    - Her course change is obvious by comparing figure 9-03 when exercise time is 1 minutes ago.
    - In real sea, master’s attention may distract by another vessel’s movement at 1 minute ago.

    - With the use of 3 minutes speed vectors, master can judge the collision risk with No.2 crossing vessel immediately even he did not know No.2 crossing vessel heading had changed since last minute.
    - Ownship is safe with No.2 crossing vessel within this 3 minutes time.
- Verify No.2 crossing vessel's position (is it inside TSS?) before give way action is important. (she may not come inside or use TSS)
- Verify target's type (supply vessels or fishing vessels) before give way action is also important. (she may do the fishing outside TSS)
- Monitor target's course constantly by visual is important, we can judge her heading by her headlight alignment change. (collision risk changes if she alters course)
- Visual is the most effective way to monitor target's course change as no time lag like speed vector in 1st stage. (Radar lookout)
- How many times you can spend in monitoring target vessel course visually depends on your skill level in radar lookout. (sense)
- Ownship Increase speed now to increase rudder effect or give way to overtaken vessel or worry about fast overtaking vessel astern? (suspect)

Ownship is safe in this course and speed, only captain didn't aware this situation.

After 04 minutes exercise time lapsed in figure 9-04 right side:

1. Ownship speed is 16.1 knots which had changed from 17.2, 16.4, 18.4 kts with engine output decreased third time to 59% from 90% at 02 minute 30 seconds which reduced rudder effect.
2. Ownship course is changing to 086 (T) from 076.3 (T). "Starboard" turning rate is high due to rudder ordered twice and "Port" rudder checking is slow (red square in rudder angle).
3. Master use Rudder order "Hard Port" now in 4th minute to steady the vessel to the course 076 (T) one minute before, but in vain.

After 04 minutes exercise time, the situational awareness is

- No.1 and No.3 crossing vessels passed ownship bow. (sighted)
- No.2 crossing vessel is at starboard bow almost head-on. (collision in 2.5 minutes, TTC)
- This No.2 vessel should be OK if ownship keep original heading 076^0 (T) one minute before. (skill)
- Even ownship is altering course, captain should look outside the window to know other ship's movement by visual. (Prudent navigator: only if he had not absorbed in Radar picture.)
- Speed and course change with many engine/rudder orders. (More attempt is only an indication of uncertainty, in accessor's eye is incompetence in master's job.)

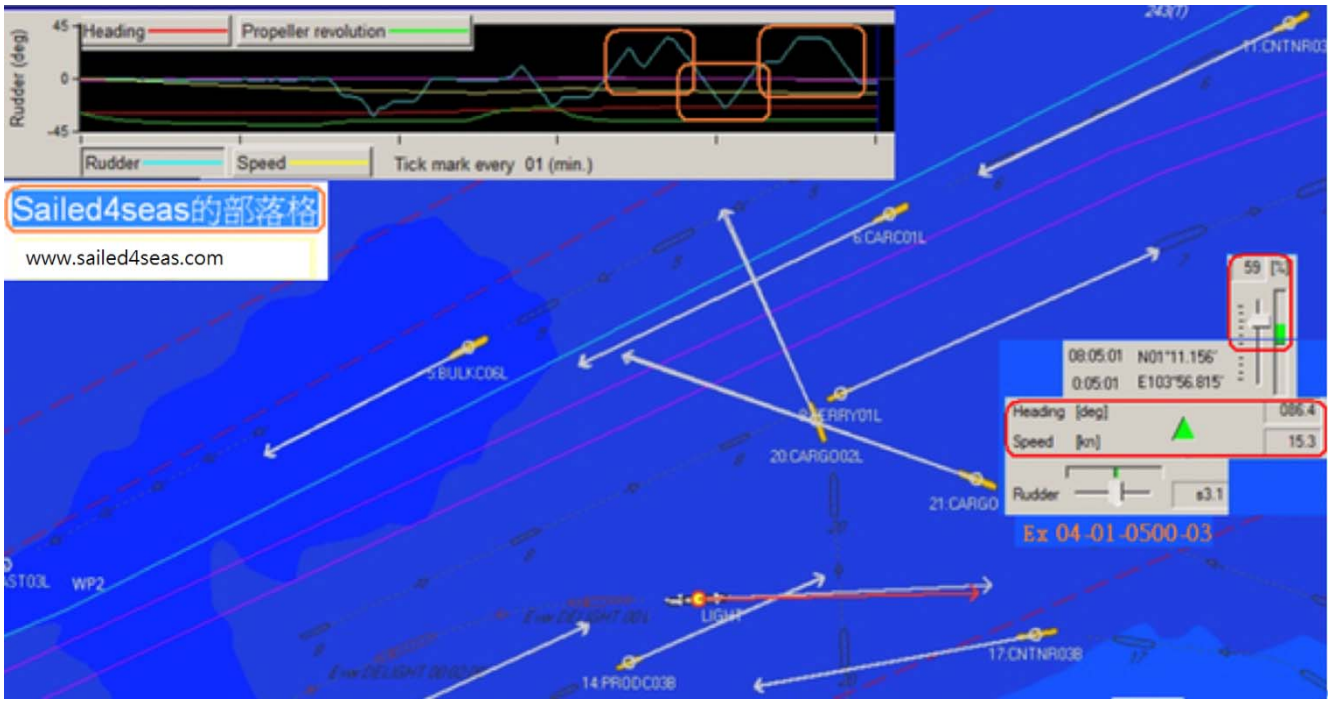


Figure 9-05 Ownship speed vector in 3 minutes at 5 minutes time

9-03 不可抗力：風向水流是上駕駛台檢查的第一件事

經過 5 分鐘的操演過後，

- 本船的速度是 15.3 節，這是從 16.1 ，17.2 ，16.4 ，18.4 節而來，從兩分半鐘開始，主機的出力是 59%。
- 本船的航向是穩定在 086 度從 065，076.3 度而來。

情勢知覺如下：

⇒ “右舵”是下方的方塊，是比“左舵”上方的方塊有效，這是不可抗力。風力跟水流的大小跟方向，是船長到駕駛台必須檢查的第一件事。
⇒ 這種對上風舷的警覺，應該是當直船副和船長剛到駕駛台報到的時候，就應該要建立。
⇒ 兩條橫越船，第一條跟第三條船已經經過本船的船頭。這是我們看到的
⇒ 第二條橫越船在右船頭，已經向左舷轉向。
⇒ 減速是緩慢的，本船並不擔心被追越的船隻，在我們的正橫位置。
⇒ 這也許對本船來說，這是一種錯誤。我們比他的速度快，但是兩條船的 CPA 會太接近，在 1 分鐘之後。
⇒ 我們與他在 3 分鐘的速度向量線上，有一個碰撞點。
⇒ 通常在 3 分鐘的速度向量線上，有碰撞點，就是認為有碰撞危機。
⇒ 本船已經通過追越船隻的船頭，這是我們的懷疑。
⇒ 確認目標的位置跟船型，即使是在近距離，我們採取避讓行動之前，這是一定要有的常識。

9-03 Force Majeures: Wind and current are first things to check on bridge.

After 05 minutes exercise time lapsed:

1. Ownship speed is 15.3 knots which had changed from 16.1, 17.2, 16.4, 18.4 kts with engine output 59% from 02 minute 30 seconds.
2. Ownship course is steady in 086 degrees from 065, 076.3 degrees.

The situational awareness is

- "Starboard" rudder (Lower Square) is more effective than "Port" rudder (Upper Square). (Force Majeures: Wind/current direction and force are first things should be checked by Master in bridge)
- Awareness of which side is windward should be established when OOW or Captain first come to bridge. (force majeure)
- Two crossing No.1 and No.3 vessels passed ownship bow. (sighted)
- One crossing No.2 vessel at starboard bow had altered course to port side. (sighted)
    - Speed reduced slowly. Ownship had not sensed overtaken vessel in port quarter.
    - This is incompetent for ownship is faster than her but the CPA is too close now. (incompetence due to lack of relevant skill, this is not a neglect)
    - We have a collision point with overtaken vessel's 3 minutes speed vector.
    - Collision point on 3 minutes speed vector usually regard as a collision line risk by OOW.
- Ownship had passed fast overtaking vessel's bow. (suspect)

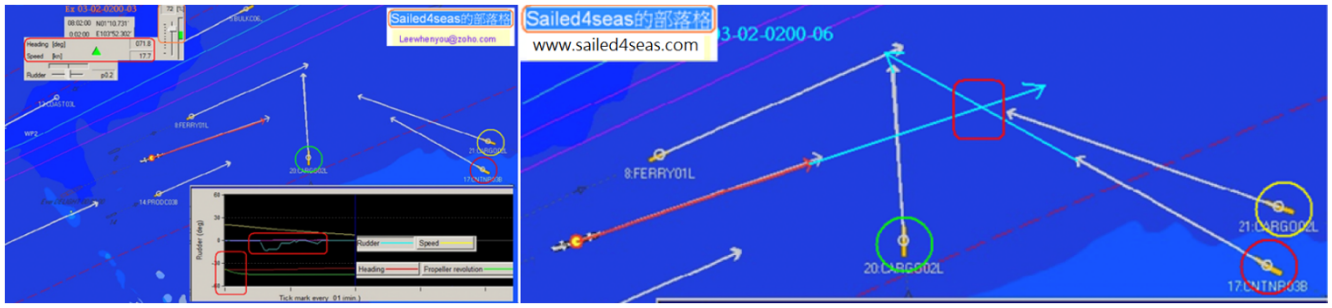
Verify target's position and type in close range before our give way action.

9-02 避碰知覺操演-12 觀測碰撞線危機

請參考圖形 9-01，起始的知覺如下：

本船 3 分鐘的速度向量線長度，航向 065 度，航速 21 節。船速度向量線的長度是 10.5 個 CABLE。

本船會有三條橫越船，碰撞距離位置未知，本船調整速度向量線到 6 分鐘的長度後，我們發現三條橫越船具有碰撞面的危機，也就是有一個碰撞區域。



圖形 9-06 速度向量線在 3/6 分鐘長度，兩分鐘過後的情勢

- 本船的速度是 17.7 節，這是從 21 節減下來的，主機的出力減到 72%，也就是操縱的全速。
- 在開始的時候，本船的航向從 065.8 度向右轉到 07 1.8 度，使用"右舵 15 度"的舵令，已經有 10 秒鐘的時間。

情勢知覺如下：

⇒ 一條綠色橫越船隻在 3 分鐘的速度向量線上，並沒有碰撞危機。因為與本船沒有交點。我們看到的

⇒ 另一條黃色圓圈的橫越船，將會通過本船的船頭，在 3 分鐘後。這也是我們看到的

⇒ 一條紅色圓圈的橫越船，使用 3 分鐘速度向量線，情勢不明

9 – 02 Collision Awareness Exercise – 12 Observing collision line risk

Initial situational is the same as figure 9-01:

1. Course 065^0(T), speed 21 Knots, OS speed vector length is about 10.5 cables as above.
2. Ownship have three crossing vessels at starboard side, distance unknown.

When ownship use three minutes speed vectors setting, situation unknown.

After Ownship adjust speed vectors to 6 minutes length we found a collision area risk with three crossing vessels.

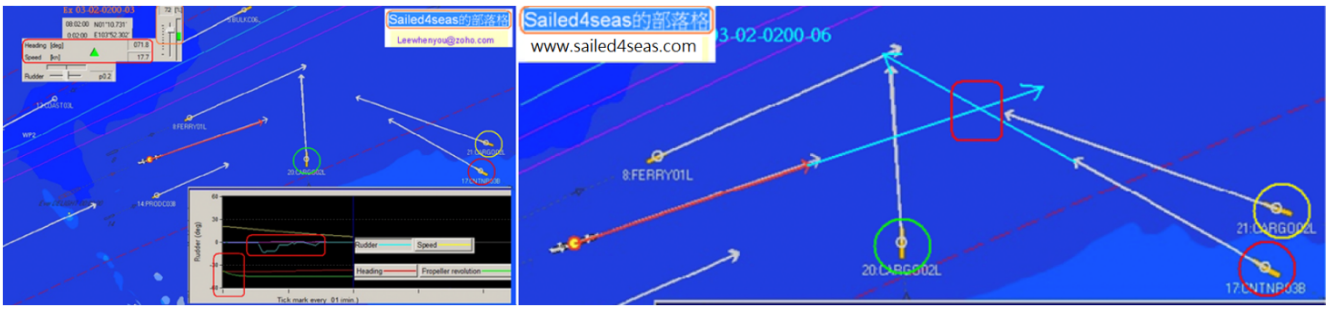


Figure 9-06 Ownship speed vector in 3/6 minutes at 2 minutes time

After 02minutes exercise time lapsed:

1. Ownship speed is 17.7 knots which had reduced from 21 kts with engine output decreased to 72% (maneuvering full) at beginning.
2. Ownship course is changing from 065.8 to starboard side 071.8 degrees with “Starboard 15” rudder for 10 seconds.

The situational awareness in left picture is

- One crossing vessel (green circle) has no collision risk for 3 minutes speed vector is not crossed. (sense)
- One crossing vessel (yellow circle) is about to pass ownship bow after 3 minutes. (sense)
- One crossing vessels (red circle) are unknown with 3 minutes speed vector. (sighted)

9-04 如何在速度向量線上標出 3 分鐘的長度

速度向量線的長度改為 6 分鐘後，情勢知覺如下：

⇒ 紅色圓圈的橫越船會通過碰撞點，在 4 分半鐘之後。這是觀測碰撞點的位置，在她第二段三分鐘速度向量線的中點，在真的雷達或是阿帕上，在速度向量線上，沒有 3 分鐘距離的標誌。

⇒ 我們可能需要使用我們的視覺殘留，或是可變距離圈來標出 3 分鐘速度向量線的長度，或是用分規，或是黃色的蠟筆來標注 3 分鐘的長度，在螢幕上。

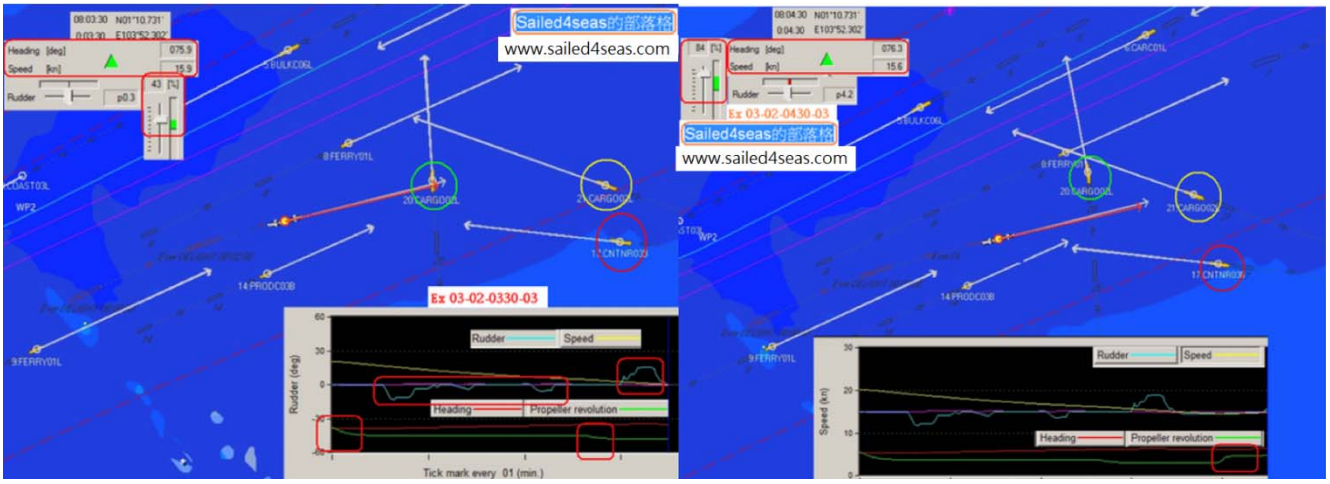
⇒ 這個就是看我們個人的喜好，標出 3 分鐘長度的位置在哪裡？方便我們估計與他船的碰撞時間跟碰撞距離。

⇒ 一般來講，在海上，如果是全速航行，最高速度一般都是固定不變。可以跑 20 節的，18 節的，15 節的，12 節的，所以知道 3 分鐘速度向量線的長度，是固定不變，就可以用來估計碰撞時間跟碰撞距離有多少？

⇒ 從這一個圖形，我們可以瞭解，有這個三分鐘長度的標記在手，可以方便評估本船的碰撞時間。這是熟練的船長

⇒ 我們會通過碰撞點，大概是在 5 分鐘後，這是碰撞點在本船速度向量線上長度的技術。

⇒ 橫越船會通過碰撞點比較早，對本船比較有利，因為呢在避碰的時候，我們可以具有更多的選擇，包括繼續減速，或是轉向，如果有必要的時候。



圖形 9-07 本船速度向量線 3 分鐘長度，在 3 分半鐘與 4 分半鐘操演過後

在 3 分半鐘的操演時間過後：

- 本船的速度是 15.9 節，從 21 節減下來，主機出力減少到 72%，港內的全速，然後再兩分 40 秒的時候，又減到 43%，大約是港區的半速前進。
- 本船的航向 06 5.8 度右轉到 075.9 度，右轉 10 度，使用右舵與正舵，一分多鐘的時間。本船現在穩定在 0 75.9 度。

情勢的知覺如下：

⇒ 第一個綠色的橫越船在本船的船頭，現在沒有碰撞危機，因為他的碰撞線，很快就會通過。端點對目標：安全，3 分鐘。

⇒ 紅色的橫越船已經轉向左舷，碰撞點已經移到本船的船尾，所以這也是 OK 的。這是我們的懷疑，因為如果他又轉回來，又會有碰撞點發生，所以呢雖然現在是 OK，還是觀察。

⇒ 第三條黃色的橫越船，將會在本船的船頭在 1 分半鐘之後，現在沒有碰撞點。3 分鐘之後，也沒有。換句話說，這船跟我們沒有碰撞線的危機，就是在 3 分鐘之內，都沒問題。這是我們觀測的技術

⇒ 在操演時間經過 4 分半鐘後，這三條橫越船，都已經安全了，如果以本船現在的航向航速航行。

9-05 How to mark 3 minutes run in speed vector?

In figure 9-06, the situational awareness after speed vector change to 6 minutes is,

- One crossing vessels (red circle) will pass collision point about 4.5 minutes later. (sighted)
- Skill is by observing the collision point position is in middle of her second three minutes speed vector. (sense)
- In real Radar or ARPA, there is no mark of three minutes run at speed vector. (sense of its deficiency)
- Ownship may have to use our vision residues of 3 minutes speed vector or divider or yellow crayon pen to mark 3 minutes length on speed vector. (try to find your own skill)
- From this diagram, we can understand it is important to have this mark/pen/divider at hand to facilitate the evaluation of collision time. (prudent seamanship)
- Ownship will pass collision point about 5.0 minutes later. (skill by compare the collision point with ownship speed vector)
- Crossing vessel will pass collision point earlier which is good for ownship (ownship have more option in collision avoidance including further reduce speed if necessary. Prudent seamanship)

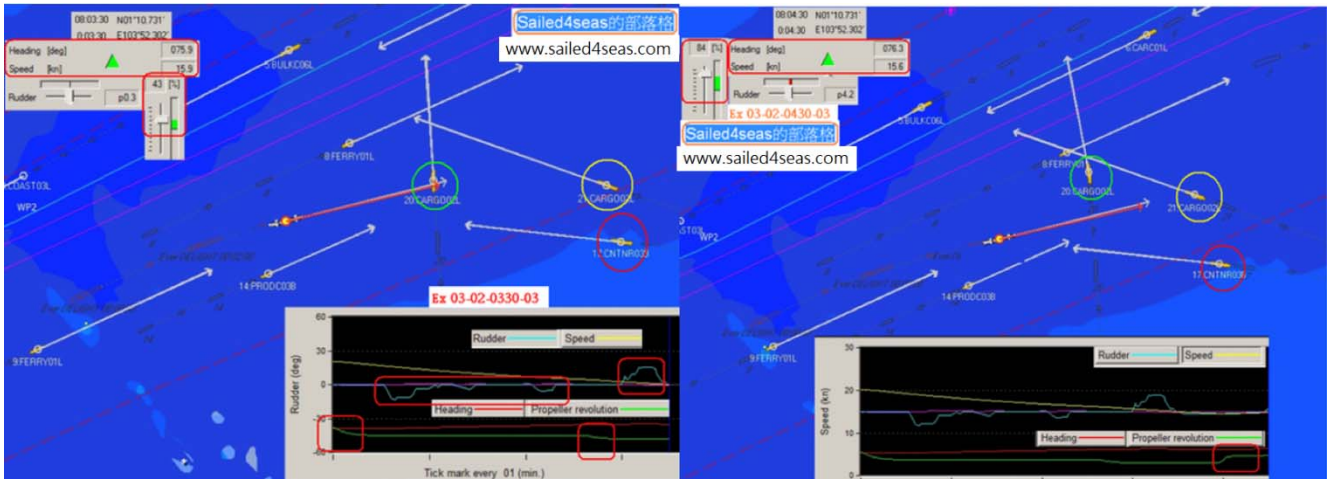


Figure 9-07 Ownship speed vector in 3 minutes at 3.5 and 4.5 minutes time

In figure 9-07, after 03minutes 30 seconds exercise time lapsed:

- Ownship speed is 15.9 knots which had reduced from 21 kts with engine output decreased to 72% (maneuvering full) at beginning and further decrease to 43% (maneuvering half ahead) at 2m 40s.
- Ownship course is changing from 065.8 (T) to starboard side 075.9 (T) with "Starboard" rudder and midship for 2 minutes.Ownship is steady on 075.9 (T) now

The situational awareness is

- First crossing vessel (green circle) at ownship bow now which has no collision risk. (sighted)
- Second crossing vessels (red circle) had changed course to port side seems OK for collision point is shifting to ownship's stern. (suspect)
- Third crossing vessel (yellow circle) will be about ownship bow after 1.5 minutes. (No collision point now and 3 minutes later. In another words, no collision line risk. sighted with skill)
- After 4m30s exercise time lapsed: **all three crossing vessels are safe at current course and speed.**

9-06 如何使用碰撞線來協助情勢知覺？

- 如果我們經常使用 3 分鐘的速度向量線，我們會有一些觀察，能夠幫助我們的情勢知覺。如果本船的 3 分鐘速度向量線，也就是碰撞線，沒有跟其他船隻的速度向量線交叉，我們就會有 3 分鐘的安全間隔。

- 這 3 分鐘的速度向量線，就是我們在繁忙水道裡面的自由度，跟最後的防線。

一旦碰撞點在速度向量線內產生，在交叉點發生的時候，我們的安全間隔仍然是 3 分鐘，這個情形，包括兩種可能：

- 本船的速度向量線碰到了其他船隻的速度向量線，像是綠色的橫越船隻，本船跟他在圖形 9-06 裡面，沒有碰撞點。一旦本船的速度向量線的端點，接觸到他的 3 分鐘速度向量線，在三分半鐘的時間，例如圖形 9-07 本船仍然有 3 分鐘的時間，才會到達碰撞點。如同圖形 9-07 的左圖
- 我們看到的第二個可能，就是其他船隻的速度向量線端點，碰觸本船的速度向量線，碰撞點也許位於本船的速度向量線 1 分半鐘的時間，那本船到達碰撞點的位置是 1 分半鐘，但是目標船要 3 分鐘後才會到達碰撞點，結果本船仍然是 3 分鐘以後，才會發生碰撞，因為目標船還沒有到達碰撞點。
- 至於第三條黃色橫越船也是同樣的情形，如果本船速度向量的線的端點，碰觸到她 3 分鐘的速度向量線，在 4 分半鐘的時間後，本船仍然有 3 分鐘的間隔，才會到達碰撞點。終點就像圖形 9-07 的右圖，這是我們看到的

9-06 How to use collision line to help our situation awareness?

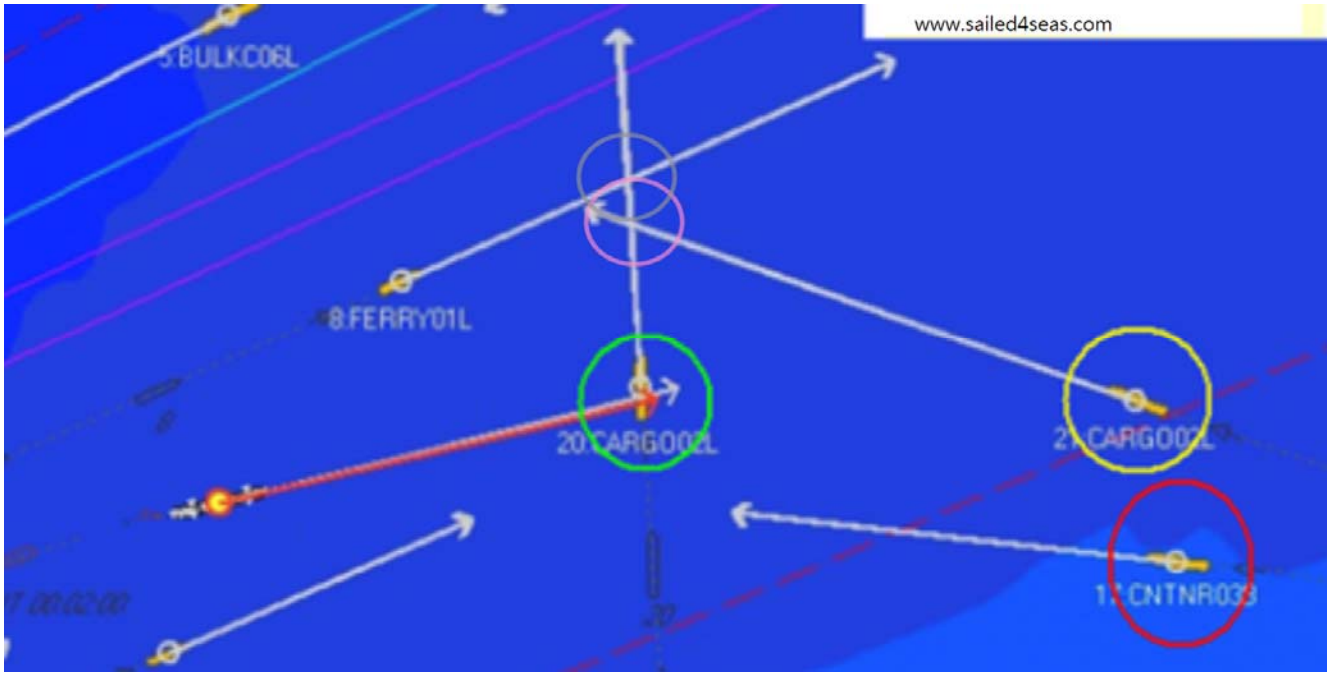
If we steer 3 minute speed vector carefully, we may have some observations to help our situation awareness later:

- If ownship's 3 minutes speed vector (collision line) had not crossed other vessel's speed vector, ownship have 3 minutes safe window. (sense)

This 3 minute speed vector (collision line) is our freedom (sea room to alter course) and minimum safety in dense traffic.

- Once collision point happened in our speed vector in the beginning our safety allowance is still 3 minutes. (sighted) This situation including two possibilities:
    - Ownship's speed vector end point touched another vessel's speed vector. For first crossing vessel (green circle) ownship has no collision point with her at 2 minutes time in figure 9-06. Once ownship's speed vector end point touched her three minutes speed vector at 3 minutes time in figure 9-07, ownship still have 3 minutes time to arrive collision position as figure 9-07 left picture. (sense)
    - Other vessel's speed vector end point touched ownship's speed vector. Collision point may locate on 1.5 minutes on ownship's speed vector. Ownship's TTC time to collision is 1.5 minutes but target vessel's is 3 minutes. Ownship still have at least 1.5 minutes safety allowance.
- For example, third crossing vessel (yellow circle) in figure9-07 left picture, her speed vector touched green circle crossing vessel speed vector in the middle. In the right picture after one minute, we can see green circle crossing vessel is about to pass yellow circle crossing vessel's bow. And, yellow circle crossing vessel will arrive their collision after 1.5 minutes in 4 minutes exercise time.
- If ownship's speed vector end point touched her after 0.5 minutes later, ownship still have 3 minutes time lapse in collision as figure 9-07 right picture. (sense)

9-07 設定通關密語協助碰撞情勢知覺



圖形 9-08 3 分鐘速度向量線上的交叉點

在圖形 9-08，我們要設定通關密語，協助得到一些碰撞線危機的知覺，使用 3 分鐘的速度向量線：

端點對目標：目標船在本船速度向量線的端點上，如同現在的綠色目標船。本船到達碰撞點會在 3 分鐘後，目標船現在正在通過碰撞點。碰撞時間的對比是本船 3 分鐘，而目標船到碰撞點的時間，就是現在。結論呢是安全的，這是端點到目標：有 3 分鐘的安全間隔。

端點對本船：目標船的速度向量線端點接觸到本船，本船會現在會通過碰撞點，目標船會在 3 分鐘後才到。碰撞時間的對比是，本船 0 分鐘，目標船 3 分鐘，安全。結論就是端點到本船是安全的，有 3 分鐘的安全間隔。

端點到中點：黃色目標船的端點接觸到綠色目標的中點，如果本船是黃色的船隻，這個安全的間隔是 1 分半鐘，碰撞時間的對比是本船 3 分鐘，綠色船是一分半鐘，只能說是一半安全。端點對中點：一半安全，一分半鐘的安全間隔。

中點對端點：綠色目標船的中點接觸到黃色目標船的端點，如果本船是綠色的目標船，這個安全的間隔是 1 分半鐘，碰撞時間的比例是本船 1 分半鐘，目標船的 3 分鐘。一半安全，一分半鐘的安全間隔。

中點對中點：如果綠色的目標船是本船，與左舷 8 號渡輪有碰撞點，兩條船都會在一分半鐘後到達碰撞點，碰撞時間的比例是本船 1 分半鐘對目標船 1 分半鐘，這個是極度危險。危險是因為是中對中，碰撞的時間是 1 分半鐘。

最後一種情形是，端點對端點：如果目標的兩條船之間有碰撞點，都在他們速度向量線的終點，碰撞時間就是 3 分鐘。碰撞時間的對比：是本船 3 分鐘對目標船 3 分鐘。在 3 分鐘後，端點對端點就是有碰撞發生。

總結的來說：

端點對目標：安全，3 分鐘

端點對本船：安全，3 分鐘

端點對中點：一半安全，一分半鐘

中點對端點：一半安全，一分半鐘

端點對端點：碰撞，3 分鐘後

中點對中點：碰撞，1 分半鐘後發生碰撞。

9-07 Set passwords to help our awareness of collision line risk?

In figure 9-08, Let's simulate the communication **of collision line risk in use of 3 minutes speed vectors.** How shall we report to our superior in the emergency when we saw new risk emerge?

- End to Target:
  Ownship speed vector end point crossed to green circle target now, ownship arrive collision point 3 minutes later than target. TTC in ownship is 3 minutes to target is 0 minutes, Safe.
  End to target (safe. 3 minutes)
- End to Me:
  Ownship speed vector end crossed to green circle crossing vessel now, ownship arrive collision point after 3 minutes and target vessel had arrived already. TTC in ownship is 3 minutes to target is 0 minutes, Safe.
  End to Me (safe. 3 minutes)
  These two safe situations are prudent seamanship as all risks are under control.
- End to Middle: Yellow circle target's end touched green circle target middle, if ownship is yellow circle vessel the safety margin is 1.5 minutes. TTC: ownship is 3 minutes, to target is 1.5 minutes, Safe Margin is 1.5 minutes only.
  End to middle (Caution. 1.5 minutes)
- Middle to End: Green circle target's middle touched by Yellow circle target end, if ownship is Green circle vessel the safety margin is 1.5 minutes. TTC: ownship is 1.5 minutes to target is 3 minutes, Half Safe.
  Middle to End (Caution. 1.5 minutes)
  These two caution situations usually happened when target vessel or ownship is altering the course without early acknowledgement (or wrong assumption on target's intention).
- End to End: If both vessels have collision point at their speed vector's end, TTC time to collision is at 3 minutes time to both vessel, Dangerous.
  End to end (Collision in 3 minutes)
- Middle to Middle:
  If Green Circle vessel is ownship and port side No.8 Ferry have collision point (color grey) with ownship, both vessels is in Middle to Middle situation, TTC is 1.5 minutes to both vessels. Very Dangerous.
  Middle to middle (collision. 1.5 minutes)
  This is the situation developing from End to End. We had missed the last chance to avoid when the situation is End to End, Collision is almost inevitable now.
- End to Target (safe. 3 minutes)
- End to Me (safe. 3 minutes)

=> End to target or End to Me, safe. 3 minutes

- End to Middle (Caution. 1.5 minutes)
- Middle to End (caution. 1.5 minutes)

=> End to middle or End to middle, Beware of the turning. Caution. 1.5 minutes

- End to end (collision in 3 minutes)
- Middle to middle (collision in 1.5 minutes)

=> Collision situation need immediate action to avoid.

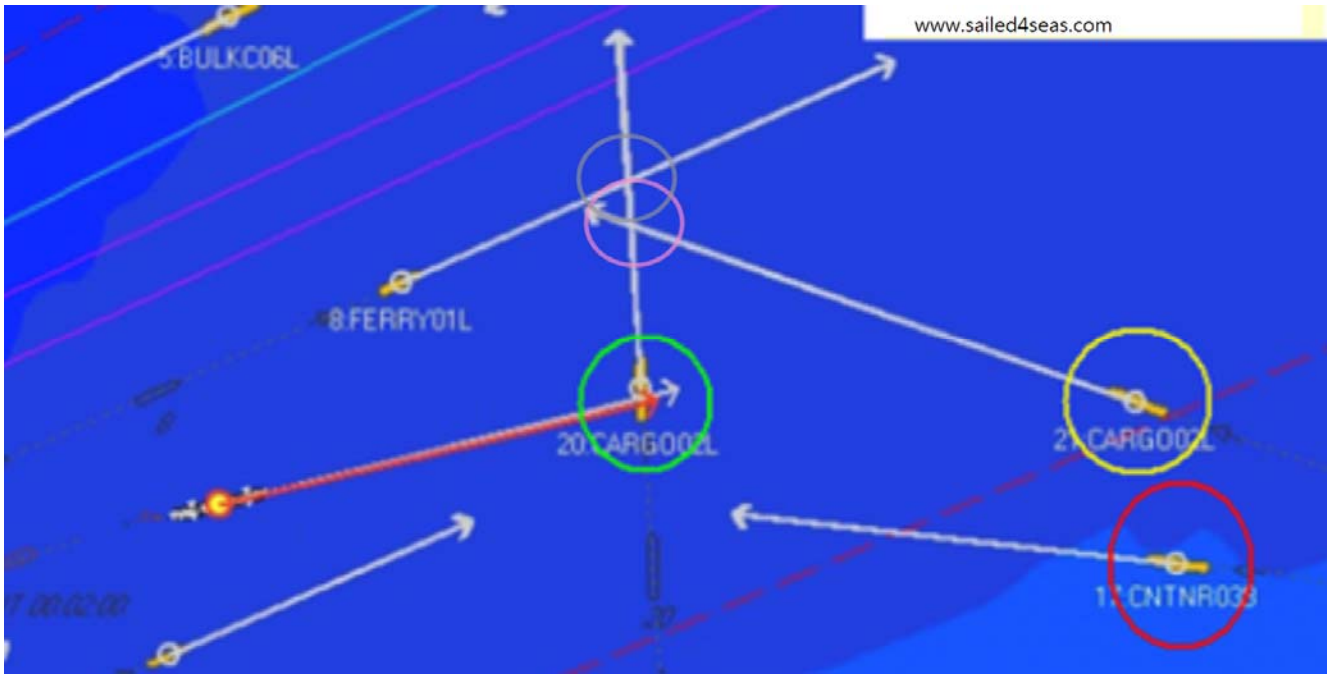
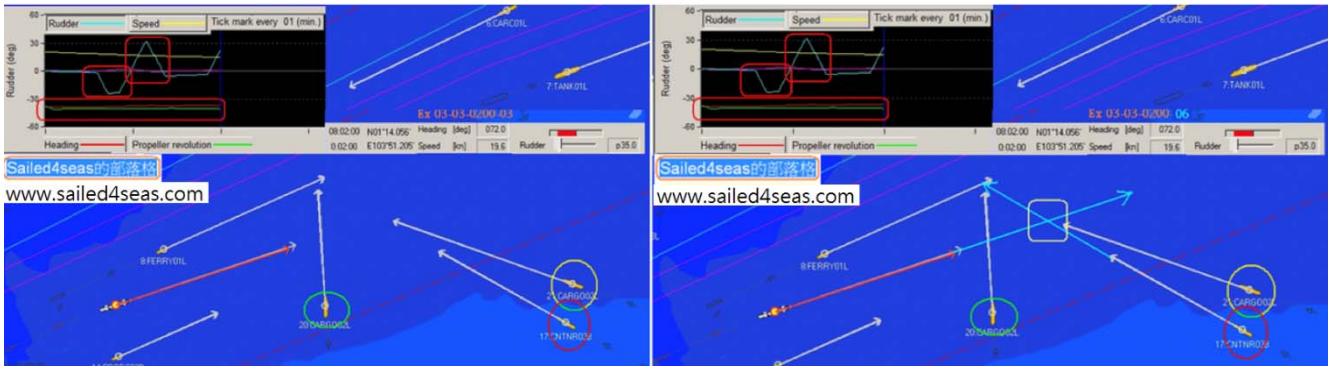


Figure 9-08 crossing points in 3 minutes speed vectors

9 – 03 避碰知覺操演 – 13 離開碰撞面

參考 圖形 9-01 ，開始的情勢如下：

- 使用 3 分鐘速度向量線，航向 065 度，航速 21 節，速度向量線的長度是 10.5 CABLE。
- 本船有三條橫越船在右舷，距離未知。使用 6 分鐘的速度向量線，在 6 分鐘後，我們發現一個碰撞面的危機。



圖形 9-09 本船的速度向量線在 3/6 分鐘 兩分鐘操演時間間隔之後

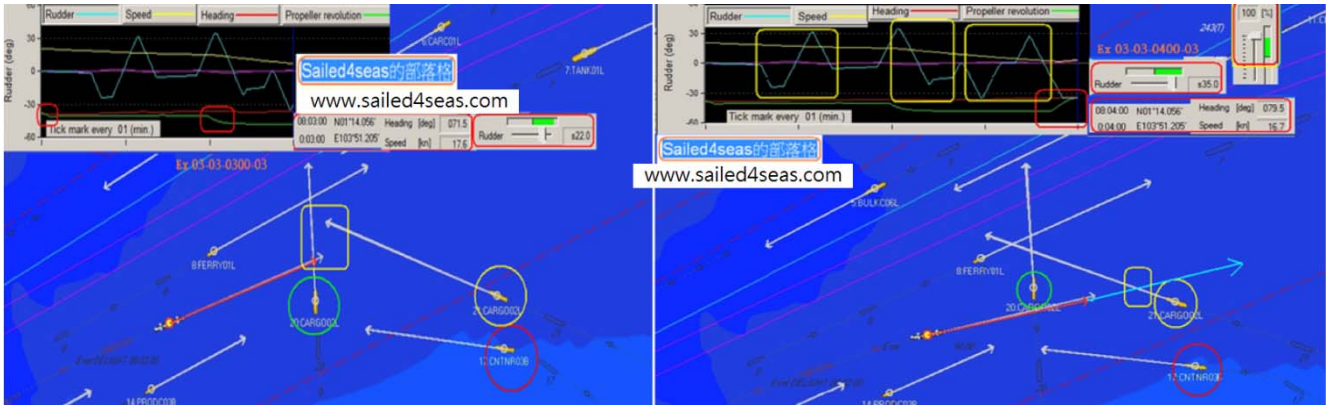
經過兩分鐘操演時間的間隔，

- 本船的速度是 19.6 節，這是從 21 節減下來的。出力減到 90%，在開始的時候。
- 本船的航向，是決定性的滿舵向右轉到 072 度，在操演開始後的 40 秒。
- 現在本船轉向到 072 度，就像上一個操演，但是以較高的速度 19.6 節，

情勢知覺如下：

⇒ 一條綠色的橫越船會通過本船的船頭，在一分半鐘，這是端點對中點，1 分半鐘。
⇒ 一條黃色橫越船將會在本船的船頭，在 3 分鐘後。這是我們看到的
⇒ 一條紅色的橫越船，使用 3 分鐘的速度向量線，位置未知。

使用 6 分鐘的速度向量線之後，本船發現與紅色橫越船具有碰撞危機，在 4 分半鐘的時間。這是終點對終點，碰撞的時間是 4 分半鐘。



圖形 9-10 本船速度向量 3 分鐘，在 3/4 分鐘操演之後

9 – 03 Collision Awareness Exercise – 13 Leave collision area

Refer to figure 9-01, the initial situational is:

1. Course 065^0(T), Speed 21 Knots, With three minutes speed vector, vector length is about 10.5 cables.
2. Ownship have three crossing vessels at starboard side, distance unknown.

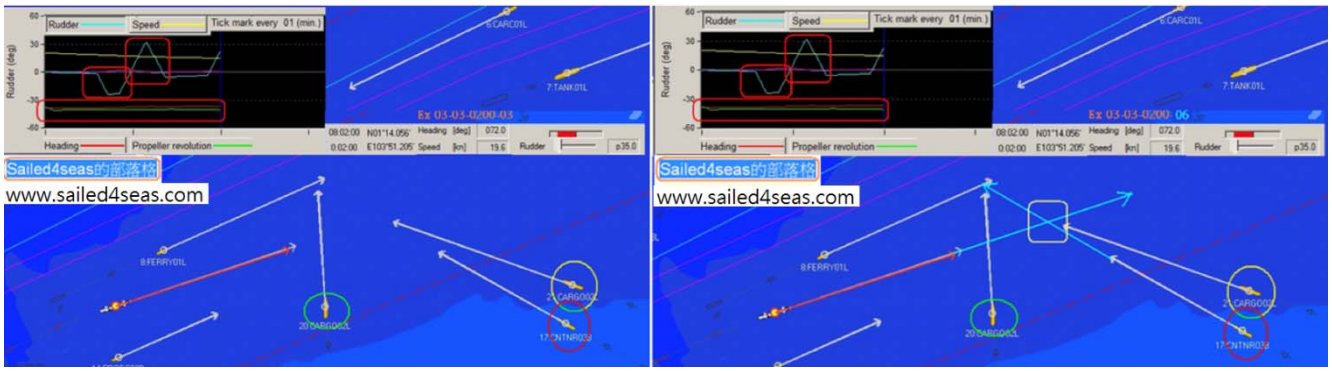


Figure 9-09 Ownship speed vector in 3/6 minutes at 2 minutes time

In figure 9-09, after 02 -minutes exercise time lapsed:

1. Ownship speed is 19.6 knots which had reduced from 21.0 kts with engine output reduced to 90% at beginning.
2. Ownship course is altered with decisive “Hard over” rudder to starboard side to 072 degrees from 065 degrees at 40 second from beginning.
3. Now ownship had altered course to 072 degrees as last exercise but with higher speed 19.6 knots.

The situational awareness is

- One crossing vessel (green circle) will pass ownship bow after 1.5 minutes. (**end to middle: 1.5 minutes**)
- One crossing vessel (yellow circle) will be at ownship bow after 3 minutes. (sighted)
- One crossing vessels (red circle) is unknown with three minutes speed vector. (sighted)

The situational awareness after 6 minutes is: Ownship have collision risk with starboard side crossing vessel (red circle) after 4.5 minutes. (**middle to middle: collision in 4.5 minutes**)

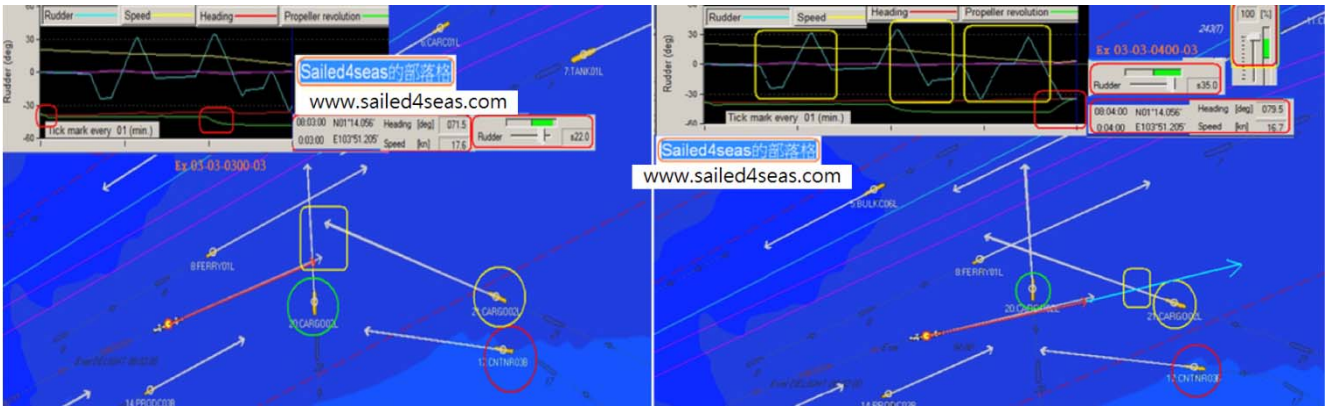


Figure 9-10 Ownship speed vector in 3 minutes at 3 and 4 minutes time

9-08 學學哪裡上風，並在轉向時注意

經過 3 分鐘操演時間的間隔，

- 本船的速度是 17.6 節，這是從 19.6 節，21 節減下來的。主機的出力，開始時只減到 90%，在 2 分鐘的操演時間，減到 60%。
- 本船的航向 072 度，在上 1 分鐘的時間，並沒有改變，但是在兩分半鐘時，使用了右舵的舵角。在上次航向改變的時候，右舷是上風，船隻向右轉是比較快速，船長使用正舵，即使船首向還沒有改變，因為在右邊有很多的船隻。

情勢知覺如下

⇒ 一條綠色橫越橫越船會通過本船船頭，在 1 分鐘之後，端點對中點，兩分鐘的安全間隔。

⇒ 一條黃色的橫越船會通過本船的船頭，在 3 分鐘後，速度向量線並沒有相交，這是安全的，在這 3 分鐘時間間隔內。

⇒ 一條紅色橫越船向左轉向，看起來是 OK，沒有任何的交叉點，就是沒有碰撞的顧慮。

經過 4 分鐘的操演之後，本船速度是 16.7 節，這是從 17.6 節減下來的，主機的出力在兩分鐘的時候，減到 60%，現在再 3 分 40 秒又開始加車。

航向轉到右舷的 079.5 度，從 072 度，所以船長的加車，可能是對右舷橫越船的顧慮，要增加舵效。

9-08 Learned which side is upwind and apply it in course change.

In figure 9-10, after 03 minutes exercise time lapsed:

1. Ownship speed is 17.6 knots which had reduced from 19.6, 21.0 kts with engine output reduced to 90% at beginning and 60% at 02 minutes.
2. Ownship course 072 degrees had not changed since last 1 minute time but rudder had used to starboard side at 2.5 minutes. Master had learned from last course change that starboard side is upwind side where course change is more quickly. He midship the rudder even heading had not changed yet due to many vessels in starboard side.

The situational awareness is

- One crossing vessel (green circle) will pass ownship bow after one minute. (end to middle: 2 minutes)
- One crossing vessel (yellow circle) will pass ownship's bow after three minutes. Collision line have no touch. (safe for 3 minutes)
- One crossing vessels (red circle) had altered course to port side seems OK. (no cross point any more)

In figure 9-10 right picture, after 04 minutes exercise time lapsed:

1. Ownship speed is 16.7 knots which had reduced from 17.6, 19.6, 21.0 kts with engine output reduced to 90% at beginning and 60% at 02 minutes and increased again at 03 minutes 40 seconds.
2. Ownship course is altered to starboard side 079.5 (T) from 072, 065 (T).

9-09 只有減少主機的出力，本船不會離開碰撞面

情勢知覺如下：

⇒ 一條綠色橫越船通過本船船頭，這是我們看到的。
⇒ 一條黃色橫越船會通過本船的船頭，再 1 分鐘之後。我們知道碰撞點的位置的技術
⇒ 一條紅色橫越船，已經轉向左舷，看起來是 OK 的。我們看到的

- 本船直到操演開始 3 分鐘過後，都沒有轉向，這是我們看到的。只有減少主機的出力，是不夠的。本船需要轉向來避免這些碰撞面，否則本船隻會延長碰撞的時間，這是我們的觀察。
- 安全的位置比安全的速度重要，尤其是在繁忙水域。這也是能見度受限制時候的一般通則。減少主機的出力，並不等於是減少本船的速度，尤其是減俥沒有立即的功效，這個是我們多次看到的。
- 減速是一個緩慢的過程，至少需要 3 分鐘才會有效，本船直到 3 分鐘之後，才開始向右轉 15 度。
- 只有這個右轉 15 度，在避碰的時候是有效的。
- 本船使用左滿舵，大膽的用舵，沒有失去對船首向的控制，因為回轉速率並沒有持續很久，還不夠大。這是我們的觀測
- 控制本船的回轉速率，本船就能夠緩慢安全的改變本船的航向，這是我們的操船技術。
- 也許航向的改變，在船隻的航跡裡面，並不明顯。即使我們的船首向已經改變了，本船仍然是在原來的軌跡上。這個也是告訴我們，只要改變船首向，碰撞危機看起來就會非常不一樣，即使本船還是待在原來的船位上打轉。
- 這是我們一直在講，碰撞是船長的選擇，因為船長選擇了碰撞的航向，就會發生碰撞。
- 調整本船的航向，就可以改變碰撞危機的發生機率。

9-09 Our radar lookout skill is enough to cover restricted visibility

In figure 9-10 right picture, The situational awareness is

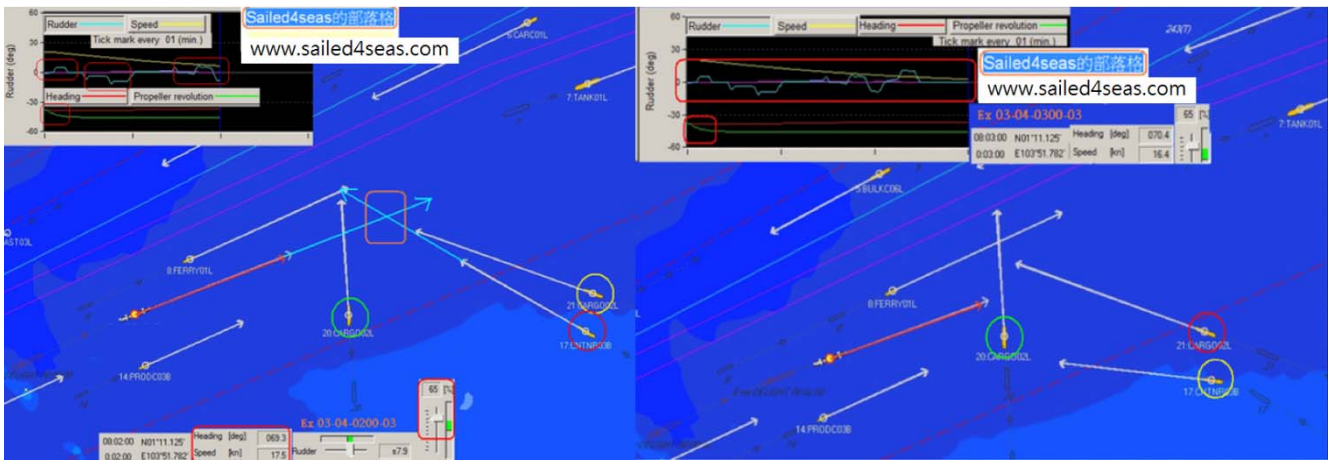
- One crossing vessel (green circle) had passed ownship bow. (sighted)
- One crossing vessel (yellow circle) will passed ownship bow after one minute. (skill)
- One crossing vessels (red circle) had altered course to port side seems OK. (sighted)
- Ownship had not altered course in first 3 minutes exercise time. (Sighted)
- Only reduce main engine output is not enough. Ownship need to alter course to avoid the collision area otherwise ownship only postpone collision time. (Sighted)
- Safe position is more important than safe speed in dense traffic. (General Rule)
- This is also a general rule in restrict visibility. (suspect, however our radar lookout skill is enough to cover restricted visibility)
- Reducing main engine output is not equal to reduce ownship speed immediately. (sense)
- Speed reduction is a slow process which needs at least 3 minutes time to be effective. (sense)
- Ownship had not altered course to starboard side 15 degrees in first 03 minutes exercise time. (Sighted)
- Only by course alternation 15 degrees to starboard side is more effective in collision avoidance. (sighted)
- Ownship use hard-over rudder angle boldly without lost control of ownship heading. (good shiphandling)
- Controlling ownship turning rate, ownship could change heading in slow and safe manner. (even with Hard starboard rudder)
- Ownship course alternation may be not obvious in ship track. Ownship is still in original collision track only now course had changed. (our collision risk is decided by our heading)

9-04 碰撞知覺操演-14 把挑戰簡化

9-10 再複雜的多船避碰，就只有一個碰撞面

參考圖形 9-01，起始時的情勢知覺如下：

- 本船使用 3 分鐘的速度向量線，航向 165 度航速 21 節，速度向量線的長度是 10.5 個 CABLE。
- 本船有三條橫越船在右舷，距離未知，使用 6 分鐘的速度向量線後，發現了一個碰撞面的危機，在 6 分鐘之後。



圖形 9-11 本船的速度向量線在 3 分鐘的長度，操演時間是在 2/3 分鐘過後

- 本船的速率是 17.5 節，這是從 21 節減下來，主機的出力從開始時，就降到 65%。
- 航向右轉 4 度到 069.3 度，從 65 度轉來，使用了小角度的舵角。

情勢知覺如下

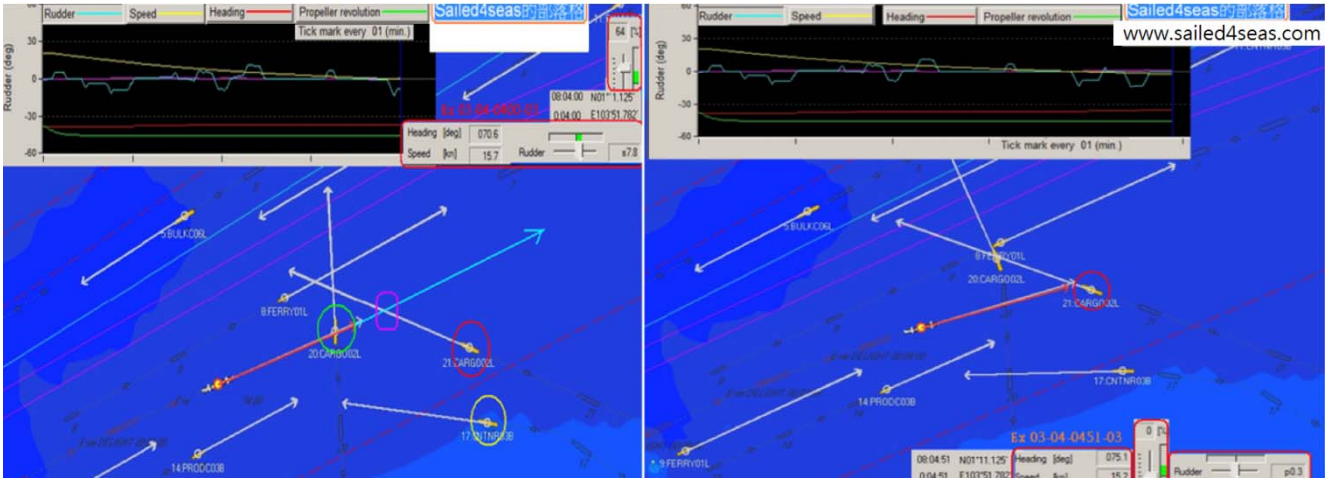
⇒ 一條藍色的橫越船會通過本船船頭，在兩分鐘之後，就是端點對中點：一半的安全。
⇒ 一條黃色的橫越船會在本船船頭，在 4 分鐘之後，本船在 5 分鐘之後通過，端點對端點：危險。
⇒ 紅色的橫越船在 5 分鐘之後，有碰撞危機，這是端點對端點，也就是有碰撞會發生。

經過 3 分鐘的操演時間過後，

- 本船的速度是 16.4 節，這是從 17.5 節減下來的，主機的出力仍然是從開始時的 65%。
- 本船的航向向右轉 5 度，到 070.4 度，是從 065 度，使用小舵角度的回轉。

情勢知覺如下

⇒ 綠色的橫越船會通過本船的船頭，在 1 分鐘後，這是端點到目標。
⇒ 紅色的橫越船將會在本船船頭，在 3 分鐘之後沒有交叉點，安全的船隻。
⇒ 黃色的橫越船向左舷轉向，也沒有交叉點，安全的船隻。



圖形 9-12 速度向量線是 3 分鐘，在 4/5 分鐘的操演時間過後

在經過 4 分鐘的操演時間後，本船的速度是 15.7 節，這是從 16.4 節繼續減下來的，主機出力在 65%不變。本船的航向向右轉 5 度，到 070 度，用小角度的舵角。

情勢知覺如下

⇒ 一條綠色的橫越船已經在本船船頭，這是安全的。
⇒ 一條紅色的橫越船將會在本船船頭，再過一分半鐘之後，這是端點對中點，只有一半的安全性。
⇒ 一條黃色的橫越船向左轉向，應該是 OK，沒有問題。

在操演 4 分 51 秒時間過後，本船的速度是 15.2 節，穩定下降，使用了 65%的出力。本船的航向穩定在 07 0.6 度，從上 1 分鐘。

9-11 劇烈轉向或是大膽用車，並不是一個常態

在這個操演，我們看到船長的操作，是非常輕鬆，而且沒有太大的航向航速的改變，這表示船長的情勢的判斷是非常好，那我們可以，從中得到一些觀察如下：

⇒ 我們之所以，並不會經常遇到這些碰撞面的危險，是因為這些船隻不是集中在某一個區域出現的話，跟本船的航行，根本就是不相關的。即使周邊的船隻發生很多驚險的情況，只要本船不在其中，就是等於天下無事。
⇒ 所以船隻很多時候，牽涉的其實只有一個碰撞面的危機，也就是只有一個碰撞區域。我們如果能夠瞭解這一點，就可以把從這些多重碰撞的危機之中，輕鬆地脫身。
⇒ 減速是要爭取更多的時間，而轉向就是要改變我們碰撞的命運。這是定律
⇒ 在船隻繁忙區域的避碰行動，是從碰撞面輕鬆愉快的脫離，劇烈的航向改變，或是大膽用車，都不是操船的常態。
⇒ 一般對避碰的迷思，就是要避開目標船，我們在下一個操演上，會看得更清楚。
⇒ 轉向只是要避開碰撞的區域，或是碰撞點，這個才是規律。
⇒ 如果目標船在分道航行制之外，避碰必須確認碰撞的區域，是不是在分道航行制之內？
⇒ 有些船長轉向避免位於分道航行制之外的目標，沒有檢查碰撞的區域是在哪裡？例如馬士基 MAERSK KENDAL 的案件，在加坡港外面擱淺。
⇒ 使用多餘的舵角跟主機的調整，就不是一個熟練航海家的徵兆。
⇒ 操船隻要將清晰的指令，船長需要的船首向要求，交給舵工就可以了，船長不需要自己操船。

9 – 04 Collision Awareness Exercise – 14 Simplify the Challenge

9-10 Such a multiple collision situation is actually involved with one Collision Area only.

The initial situational in figure 9-01 is:

1. Course 065^0(T), speed 21 Knots, three minutes vector length is about 10.5 cables.
2. Ownship have three crossing vessels at starboard side, distance unknown.

We found a collision area risk after 6 minutes with 6 minutes speed vector.

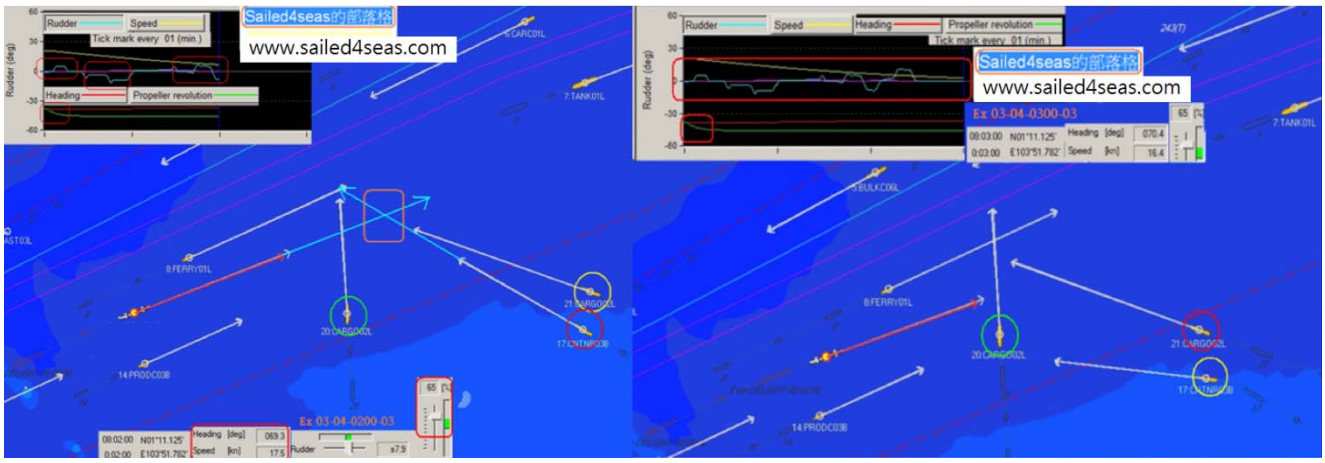


Figure 9-11 Ownship speed vector in 3 minutes length after 2 and 3 minutes time

In figure 9-11, after 02 minutes exercise time lapsed:

1. Ownship speed is 17.5 knots which had reduced from 21.0 kts with engine output reduced to 65% at beginning.
2. Ownship course is altered to starboard side 4 degrees to 069.3 from 065 degrees with small rudder angle used.

After 2 minutes time in left picture, the situational awareness is

- One crossing vessel (green circle) will pass ownship bow after 2 minutes. (Safe after 2 minutes)
- One crossing vessel (yellow circle) will be at ownship bow after 4 minutes. (may cross after 1 minutes)
- One crossing vessels (red circle) has collision risk after 5 minutes. (Middle to Middle: Collision)

After 03 minutes exercise time lapsed: in right picture

1. Ownship speed is 16.4 knots which had reduced from 17.5, 21.0 kts with engine output reduced to 65% at beginning.
2. Ownship course is altered to starboard side 5 degrees to 070.4 from 065 degrees with small rudder angle used.

The situational awareness is

- One crossing vessel (green circle) will pass ownship bow after 1 minute. (End to Target: Safe)
- One crossing vessel (red circle) will be at ownship port bow after three minutes. (End to Middle: Half safe)
- One crossing vessels (yellow circle) has altered course to port side. (no crossed point: Safe)

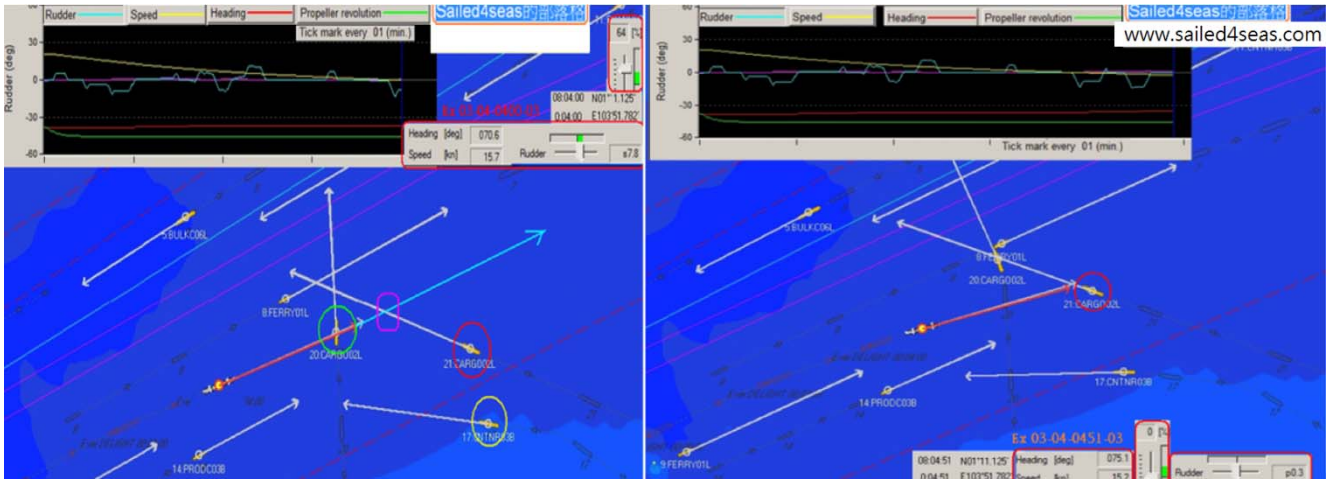


Figure 9-12 Ownship speed vector in 3 minutes at 4 and 5 minutes time

In figure 9-12, After 04 minutes exercise time lapsed:

1. Ownship speed is 15.7 knots which had reduced steadily from 16.4, 17.5, 21.0 kts with engine output reduced to 65% (maneuvering full) at beginning.
2. Ownship course is altered to starboard side 5 degrees to 070.6 from 065 degrees with small rudder angle used.

The situational awareness after 4 minutes is

- One crossing vessel (green circle) is at ownship bow now. (End to Target: Safe)
- One crossing vessel (red circle) will be at ownship bow after 1.5 minute. (End to Middle: Half Safe)
- One crossing vessels (yellow circle) has altered course to port side seems OK. (no crossing point)

After 04minutes 51 seconds exercise time lapsed:

1. Ownship speed is 15.2 knots which had reduced steadily from 15.7, 16.4, 17.5, 21.0 kts with engine output reduced to 65% (maneuvering full) at beginning.
2. Ownship course is steady at 070.6(T) since last minute.

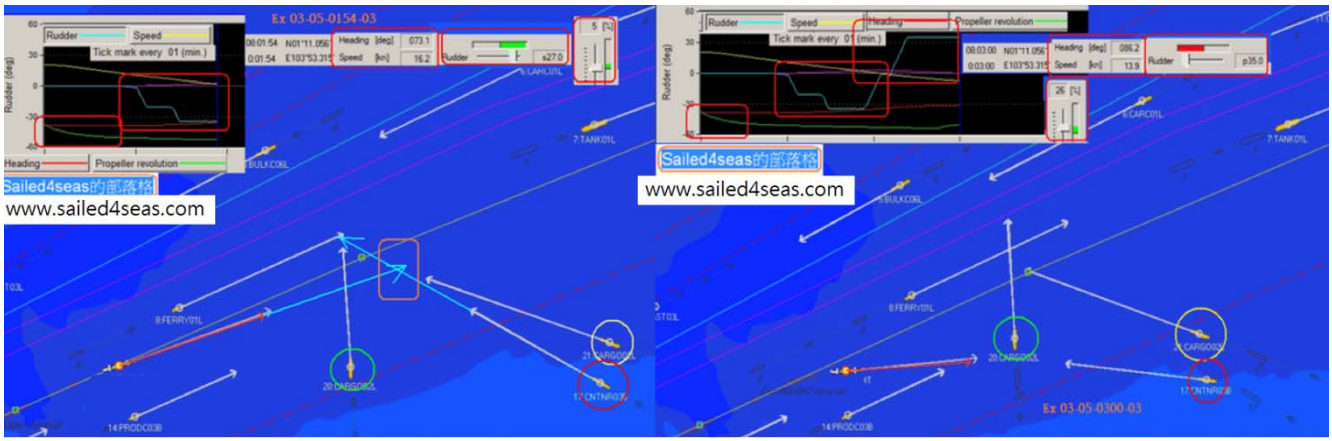
The moral of this maneuvering are:

- Such a multiple collision situation is actually involved with one Collision Area only. **(simplify the challenge)**
- Reducing speed is to get more time and altering course is to change collision position. (skill)
- In dense traffic area, avoidance action is to go away from the collision area nice and easy, **sharp course change or bold engine action is not a norm. (skill)**
- **General myth in collision avoidance is to avoid target vessel. (This will be demonstrated in next exercise)**
- **The truth of collision avoidance is to avoid the Collision Area (or collision ground). (final instinct or simple truth)**
- If target vessel is outside the traffic scheme, ownship have to verify collision area is inside the TSS or not. **(this point is well known after double ground case)**
- **Some Master had altered course to avoid target vessel outside TSS without checking where is collision area as Maersk Kendal case.**
- No excessive rudder and engine adjustment are a sure sign of prudent navigator.
- Captain don't need to steer the vessel to avoid this one and that one, one course change will be enough. (he just need to give clear heading required to helmsman to steer).

9-05 避碰知覺操演－15 失去船首向控制

9-11 船長應該控制船首向，而不是舵角

請參考圖形 9-01 起始情勢知覺如下：本船是 3 分鐘的速度向量線，航向 065 度航速 21 節，速度向量線長度大約是 10.5 個 CABLE。本船有三條橫越船在右舷，我們使用 6 分鐘的速度向量線後，發現一個碰撞區域。



圖形 9-13 速度向量線 3 分鐘長度，在操演 2/3 分鐘時間

經過一分 54 秒的操演時間過後，本船的速度是 16.4 節，這是從 21 節，將主機出力減到 5%，這是一個大膽的減車。本船的航向向右轉 8 度到 073 度，從零 65 度，這是在第 1 分鐘的時間。

情勢知覺如下

⇒ 雖然主機的出力設定是 5%。螺旋槳的轉速仍然是緩慢的減少，這是我們看到的。這是因為船隻以 21 節的速度在前進，這個水流經過船體還是很快，巨大的動量，使得螺旋槳仍然以高速旋轉，就算船體的機具本身，也是具有一定的慣性。
⇒ 綠色橫越船隻會通過本船的船頭，在兩分鐘之後。端點對目標，是安全的。
⇒ 黃色橫越船隻在本船船頭，再 3 分鐘之後，端點對目標是安全的。
⇒ 紅色的橫越船會通過本船的船頭，在 4 分半鐘之後。本船在 6 分鐘之後，才會到達這個碰撞點，所以這是端點對中線，這只有一半的安全性。

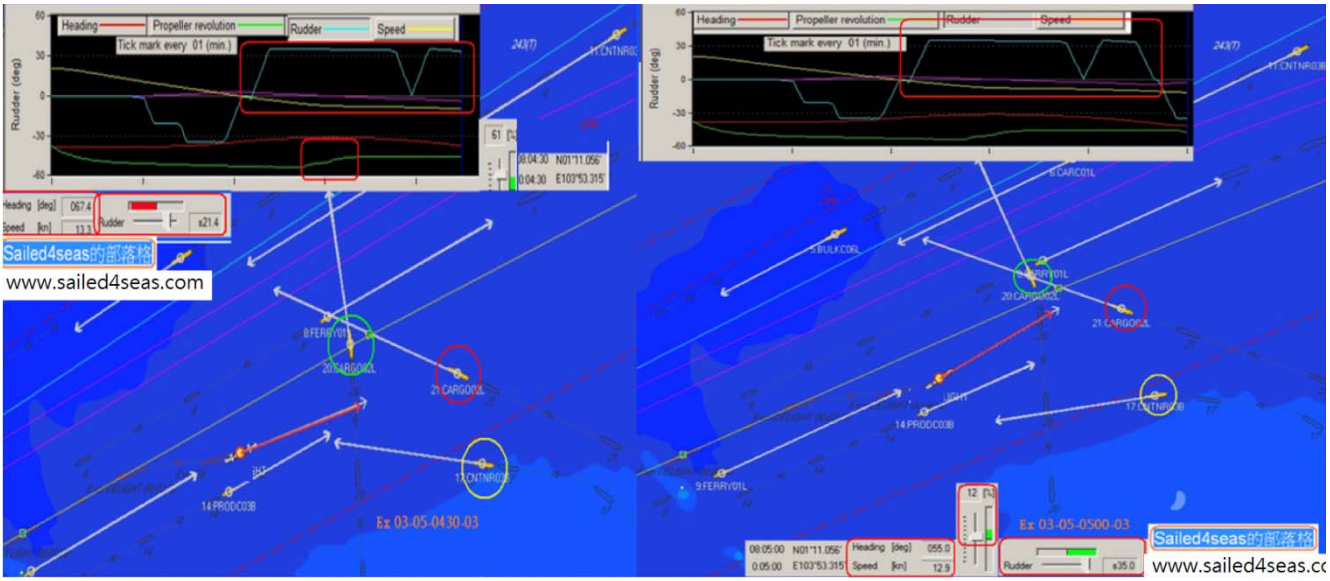
這三條船看起來都還 OK，在 3 分鐘操演時間過後，本船的速度是 13.9 節，這是從 16.4 節，21 節，把主機的出力降到 5%。本船的航向向右轉 20 度，來到 086 度，從 065 度轉過來。

情勢知覺如下

⇒ 快速的減車，然後大膽的轉向，但是在圖形 9-13 的右圖，情勢非常危險，本船是進入了另外一個碰撞區域。
⇒ 本船已經使用左滿舵 1 分鐘了，因為要穩定在 086，或是回到左舷的航向，這是我們的懷疑。
⇒ 這是船長在做迴圈舵的操作嗎？本船有這種失去控制的危機感，因為使用了太長右滿舵的舵令嗎？這是我們的懷疑。
⇒ 如果我們檢查船隻的回轉曲線，第二分鐘的位置，船長就開始正舵，當時本船隻有向右轉了 8 度，還沒有很多的回轉速率，但是本船已經失去了舵效，繼續右轉。

船隻繼續右轉，並不是回轉的速率太多，而是因為主機的排出流不見了，主機的出力已經降為 0，所以主機的螺旋槳後，沒有強力的水流繼續衝擊舵板。（這類比機的動態方程式可能是有問題。）在實際的海上，舵效不會這麼差，不論如何，我們應該要呢來克服這個困難，使用我們的技術，或是利用我們的警覺。因為船上的操縱性能，也是隨著船隻裝載的狀況，會產生很大的差異。

⇒ 綠色的橫越船在本船的船頭，這是端點對目標，應該有 3 分鐘的安全間隔。
⇒ 黃色的橫越船是在本船的船頭，所以呢現在是沒有交叉點，沒有危險。
⇒ 紅色的橫越船已經向左舷轉向，這個是端點對端點，這個會在 3 分鐘後，跟本船發生碰撞。
⇒ 右舷的被追越船隻也根本船太接近了，所以在 3 分鐘後，也是會發生碰撞。



圖形 9-14 本船的速度向量線是 3 分鐘，在 4 分半鐘跟 5 分鐘的操演時間

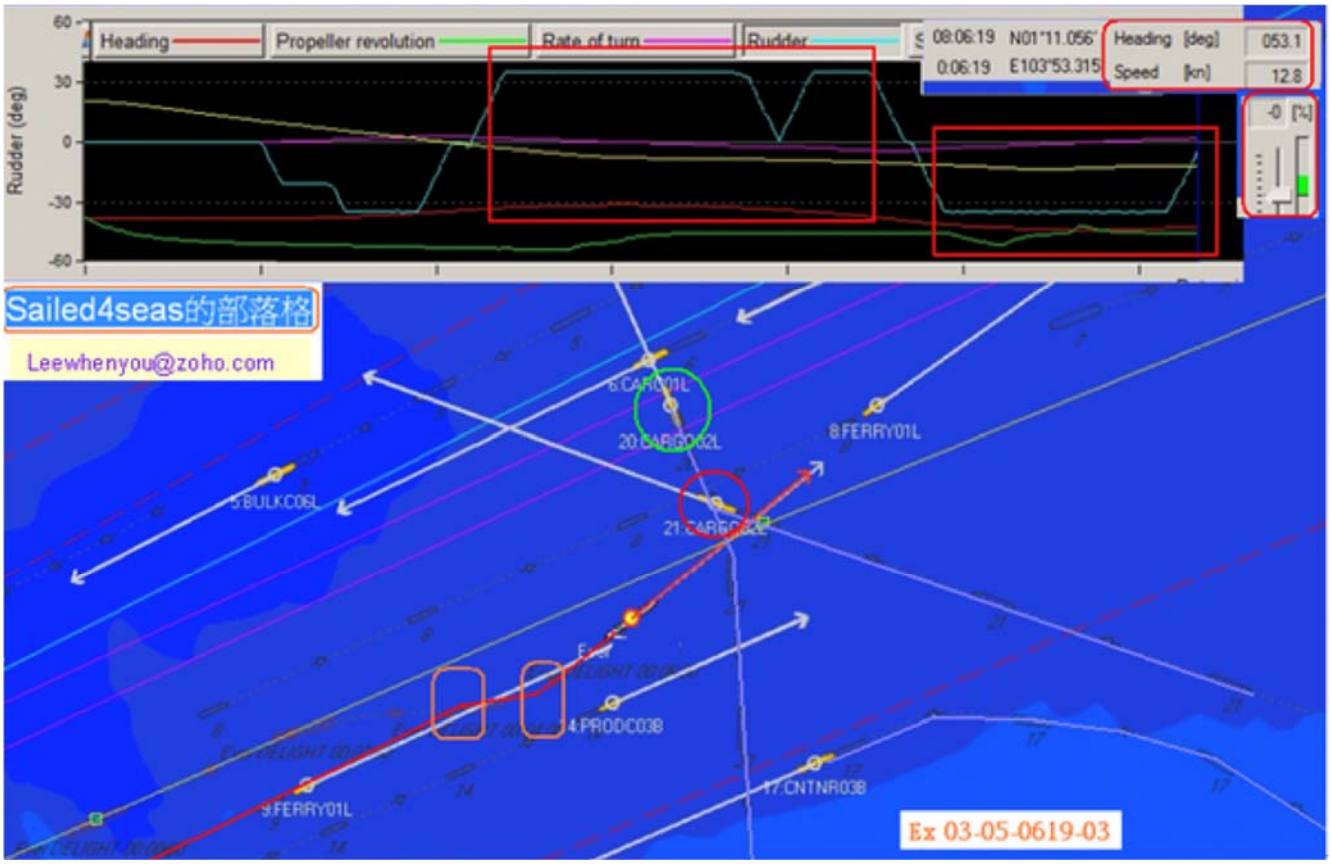
在 4 分半鐘的操演時間過後，現在看起來全部都 OK 啦。

本船的速度是 13.3 節，這個呢是從 16.4 節降下來，主機的出力增加到 61%，在 3 分鐘的時間來增加舵效。本船的航向改變到左舷 067.4 度，經過 086 度跟 065 度，在兩分鐘的時間。

在 5 分鐘操演時間過後，圖形 9-14 的右圖

本船的速度是 12.9 節，這個是從 13.3 節等等減下來的，主機的出力增加到 61%，在 3 分鐘的時間，然後在五分鐘的時間，又減到 12%。本船的航向向左轉到 055 度，從 067.4 度，在 30 秒前。3 分鐘之前是 08 6 度

9-12 船長應該分派操舵的任務給舵工



圖形 9-15 本船的速度向量線是 3 分鐘，在 6 分半鐘的操演時間

在圖形 9-15，操演的 6 分半鐘之後，情勢知覺如下：

⇒ 是否船長在做迴圈舵的操作，本船現在的回轉速率每分鐘 20 度，這次我們看到的。
⇒ 長時間的左滿舵，超過 3 分鐘的時間，使本船失去控制，這是我們的觀察。
⇒ 每分鐘 20 度的回轉速率，在惡劣天氣下，就可能引起船隻的失控，如果有強風或強勁的流水影響。
⇒ 本船是在追逐越左舷紅色橫越船，這是我們看到的。
⇒ 船長應該指派操舵的任務給舵工，這是我們的感覺。
⇒ 船長應該使用他的時間，來找出正確的船首向，去脫離險境，而不是呢控制舵角的大小跟回轉速率。

9 – 05 Collision Awareness Exercise – 15 Lost Heading Control

9-11 Captain should control heading rather than rudder.

Refer to figure 9-01, the initial situational is:

1. Course 065^0(T), Speed 21 Knots, three minutes speed vector length is about 10.5 cables.
2. Ownship have three crossing vessels at starboard side, distance unknown.

We found a collision area risk after 6 minutes with 6 minutes speed vector.

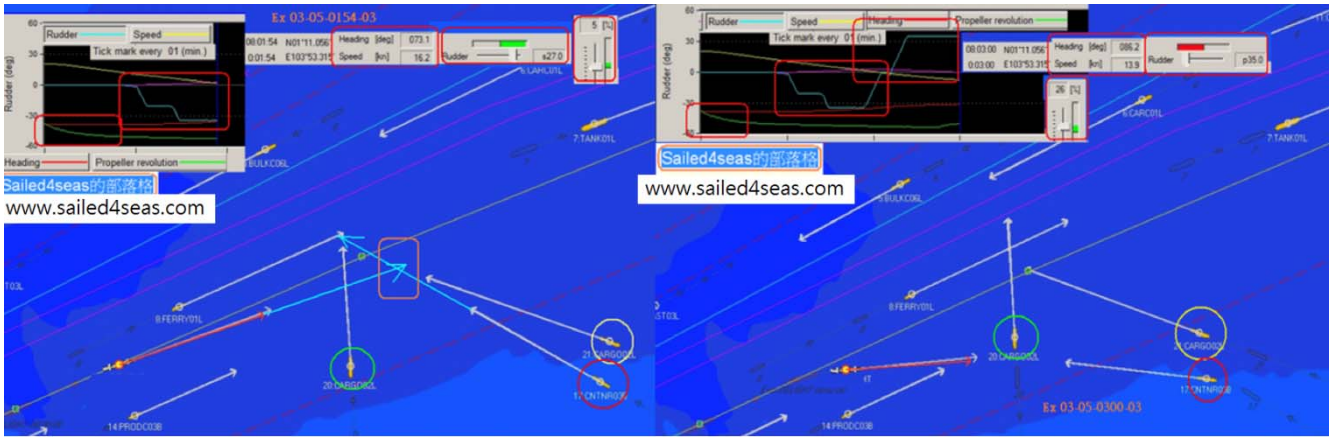


Figure 9-13 Ownship speed vector in 3 minutes at 2 and 3 minutes time

In figure 9-13, after 01minutes 54 seconds exercise time lapsed:

1. Ownship speed is 16.4 knots which had reduced from 21 kts by reduce Engine Revolution to 5%. (bold)
2. Ownship course is altered to starboard side 8 degrees to 073 degrees from 065 degrees after one minute.

The situational awareness is

- Although the engine telegraph setting is 5%, propeller revolution is reduced very slowly. (sense)
- This is due to Vessel proceeds with 21 knots before. Ship's body has great momentum which keep propeller rotating in high speed. (rule)
- Green crossing vessel will pass ownship bow after two minutes. (End to Target: Safe)
- Yellow crossing vessel will be at ownship bow after three minutes. (End to Target, too: Safe)
- Red crossing vessels will pass ownship bow after 4.5 minutes. ownship arrive at 6 minutes. (end to middle in last 3 minutes, Caution)

When all three vessels seem OK, after 03minutes exercise time lapsed in right picture:

1. Ownship speed is 13.9 knots which had reduced from 16.4, 21 kts by reduce Engine Revolution to 5%.
2. Ownship course is altered to starboard side 20 degrees to 086 (T) from 065 (T) after 1st minute.

The situational awareness is

- Ownship had reduced speed sharply and altered course boldly. But, the situation at figure 9-13 right picture is very dangerous. It seems ownship had stepped into another collision area.
- Now ownship is using "Hard Port" rudder for one minute try to steady on 086 (T) or go back to port side. (no propeller expel current : Titanic effect)
- If this is a rudder cycling maneuvering, ownship has the dangerous feeling of lost control due to prolong "Hard-Starboard" rudder used. (suspect)
- If we check the maneuvering curve master had midship from 2 minutes position where OS course had only changed 8 degrees. The is not excess rate of turning but vessel already lost rudder effect without main engine expel current been used. (**in simulator, vessel movement is not correct. In real sea, rudder effect won't be so bad in this way.**) Maybe we can assume strong current is experienced.
- Green crossing vessel is at ownship bow now. (end to target, more than 3 minutes)
- Yellow crossing vessel is at ownship bow now. (no crossing, no danger)

- Red crossing vessels had altered course to port side. (**end to end, have collision after 3 minutes**)
- Starboard side overtaken vessel is too close to OS. (**end to end, have collision after 3 minutes or early**)

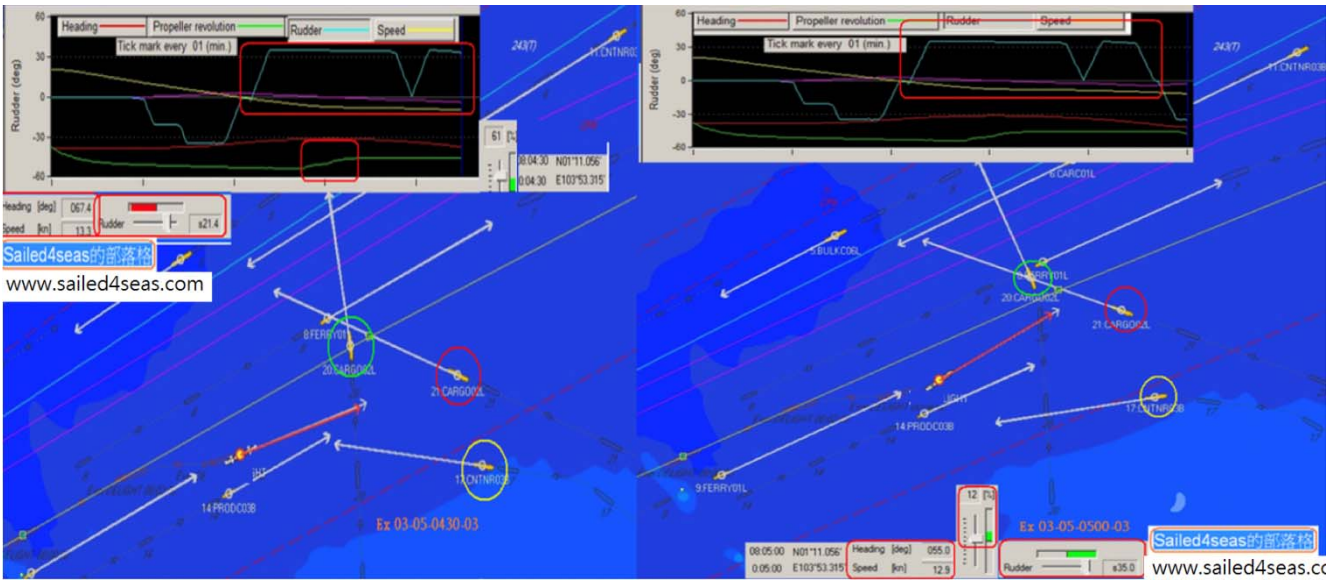


Figure 9-14 Ownship speed vector in 3 minutes at 4.5 and 5.0 minutes time

In figure 9-14, after 04 minutes 30 seconds exercise time lapsed: It seems all OK with very little margin in ownship heading.

1. Ownship speed is 13.3 knots which had reduced from 16.4, 21 kts. Engine Output increased to 61% at three minutes to increase rudder effect.
2. Ownship course is altered to port side to 067.4 degree after 086 degrees and 065 degrees in 2 minutes time.

After 05 minutes 00 seconds exercise time lapsed: Figure 9-14 right picture

1. Ownship speed is 12.9 knots which had reduced from 13.3, 16.4, …21 kts. Engine Output increased to 61% at three minutes and reduced to 12% at 5 minutes now.
2. Ownship course is altered to port side to 055 degree after 067.4 at 30 second ago and 086 degrees 3 minutes ago.

9-12 Captain should assign the steering duty to quarter master.

The situational awareness in figure 9-15 in 6.3 minutes exercise time are:

- Is this a rudder cycling maneuvering; only hard port and hard starboard rudder been used and ownship had turning rate of 20 degrees per minutes now. (sighted)
- Prolong “Hard-Port” rudder for three minutes had caused ownship lost control. (statement)
- Turning rate of 20 degrees per minutes is in danger of lost control in adverse weather. (strong wind or current)
- Ownship is chasing red crossing vessel into portside. (sighted)
- **Captain should assign the steering duty to quarter master.** (sense)

- Captain should **use his time in finding correct heading to steer** rather than control the rudder effect and turning rate. (sense)

9-13 正確的船首向：很可能就是航道的一般流通方向

⇒ 在這個案例，正確的船首向來操舵是 065 度，就像一般的通例，採用同樣的航向，或是同樣航速的船隻，可以減低碰撞危機。

⇒ 船長沒有時間去處理本船的舵效跟船速，在同時又要去評估繁忙水域的碰撞危機。這是我們的感覺

⇒ 如果船長老是感到自己的瞭望時間並不充分，手忙腳亂，你就應該檢討自己的技術，不管是在瞭望，或是 BRM 的應用方面，本書可以提供良好的參考。

⇒ 本船轉向左舷，是在追逐左舷的碰撞面危機。將會又一次進入同樣的危機。這是我們的感覺

9-13 Correct heading to steer: very likely is general direction of traffic lane.

- **Correct heading to steer is 065^0 (T) in this case or as always: Same course vessel will reduce collision risk. (rule)**
- Captain has no time to handle ownship's rudder and speed at same time in a rush while evaluating collision risk in dense traffic take most of his efforts. (sense)
- If Captain always feel nerves in bridge, it is lack of lookout time. You should review your skill either in lookout or BRM by this book's context carefully. (sense)
- Ownship alter course to port side is chasing port side collision area risk again. (sense of ownship close to separation line again)

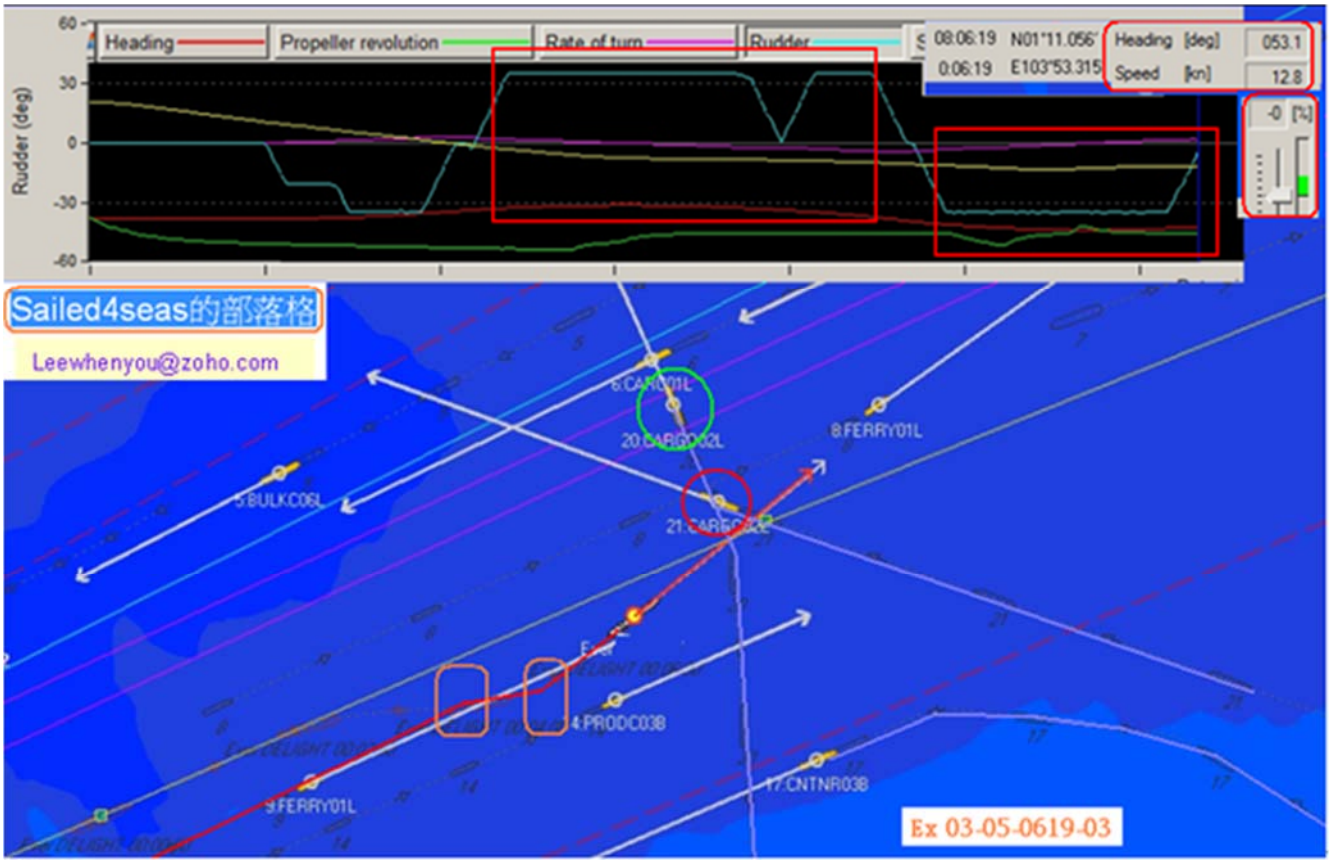
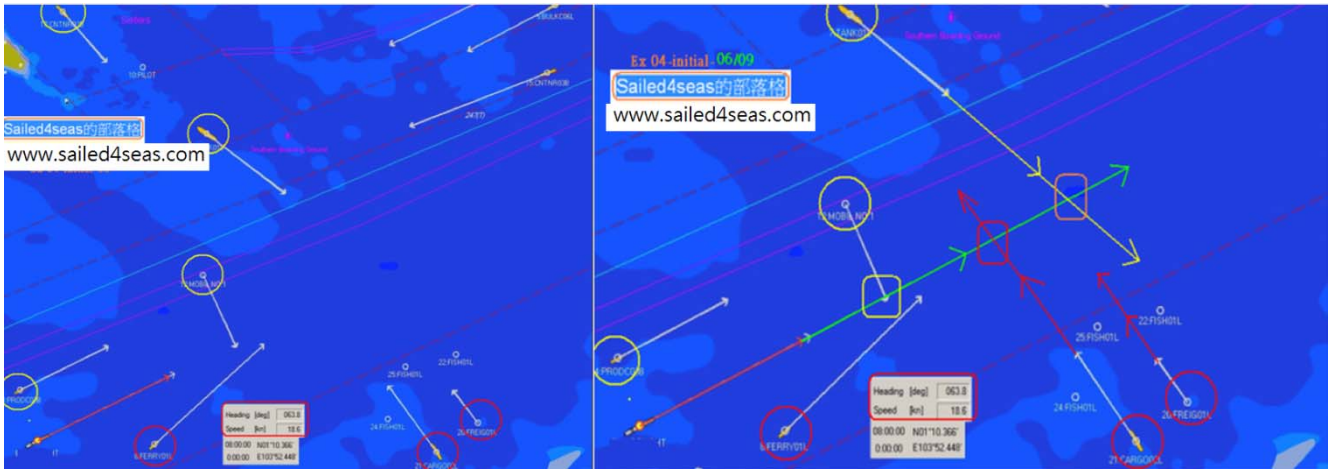


Figure 9-15 Ownship speed vector in 3 minutes at 6.3 minutes time

9-06 避碰知覺操演 – 16 整體情勢評估

9-14 綜合所有碰撞危機成一碰撞面去處理



圖形 9-16 本船速度向量線 3/6 分鐘長度，在操演開始時

就像圖形 9-16 這個場景，就是雙擱淺案件發生的地點。本船的速度是 18.6 節，航向是 063.8 度，在開始的時候是用 3 分鐘的速度向量，船速 18.6 節，現在向量線的距離長度是 9.3 CABLE。

情勢知覺如下：

- 本船有兩條橫越船在右舷（紅色的圓圈），距離未知。
- 一條被追越的船隻在右舷，跟本船同速，這是比較速度向量線得知
- 還有 3 條左舷來的橫越船（在黃色的圓圈內），距離未知。
- 一條被追越船在左正橫，比本船慢，這是比較速度向量線長度的技術。

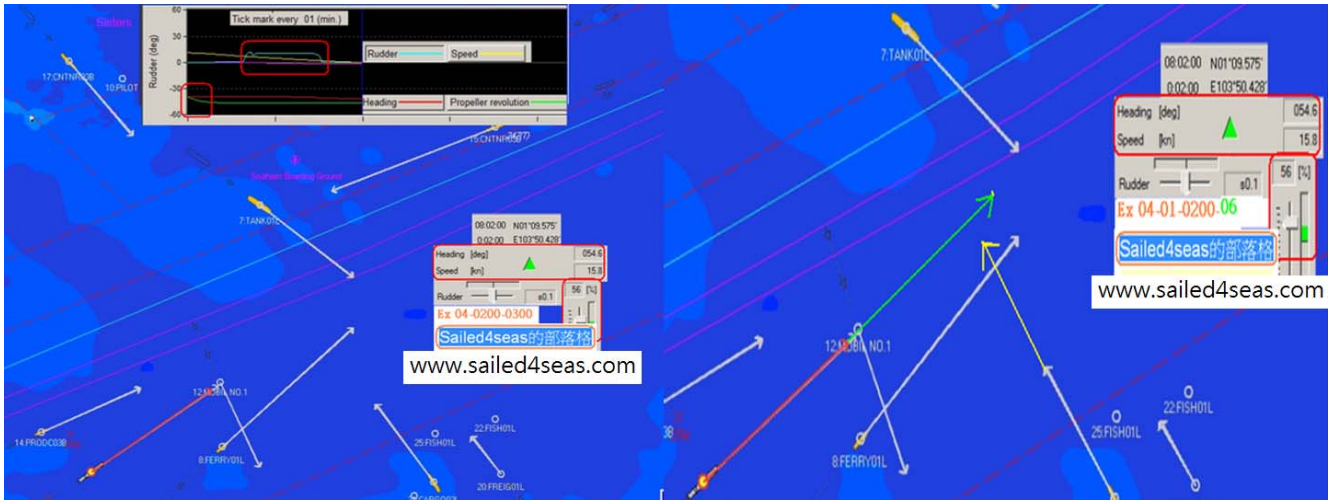
在 6 分鐘速度向量線的情勢知覺如下：

⇒ 1 條左舷的橫越船，將會在本船船頭經過，3 分鐘之後。本船端點對她中點：一半安全，一分半鐘的安全間隔。
⇒ 一條右舷的橫越船將會在本船的船頭，再 7 分鐘之後，這個是端點對端點，所以在 7 分鐘後，會有碰撞發生。（在紅色的方塊內）
⇒ 另外一條右舷的橫越船隻，沒有碰撞危機，因為 9 分鐘的速度向量線都沒有碰撞點。我們觀察她的船速比較慢，她在本船的安全相對方位範圍之外。
⇒ 一條橫越船在左舷，將會在本船船頭再 7 分鐘，這是粉紅色的方塊，這是端點對端點，這個碰撞危機是在 8 分鐘後。

整體的情勢知覺如下：綜和所有的碰撞危機，成一個我們可以處理的碰撞面危機來避免。

⇒ 第一個左舷的橫越船，將在本船船頭，再 3 分之後。
⇒ 3 分鐘之後，同速的被追越船在我們的右船頭沒問題，只要本船開始減速。這是我們的感覺
⇒ 本船仍然必須讓路給右舷的橫越船，借由向右舷轉向 5 度，改變一點航向就可以了，這是我們需要的行動。

⇒ 這個航向的改變，會延遲左舷橫越船通過本船船頭的時間，最好是同時減速，避免跟左舷橫越船發生問題。
⇒ 右舷的被追越船的航向很奇怪，跟航道的一般流通方向不一樣，也許她要去領港站，要準備進港。
⇒ 是否左舷的第二條橫越船，也會加入東航的航行巷道，向左舷轉向，本船就沒問題，這個是我們懷疑的地方。
⇒ 其他比較慢的橫越船，就不去管他了，對本船並沒有安全的顧慮，這是我們的想法。
⇒ 是否慢一點的橫越船的航向是穩定的，那他們現在又是在什麼位置？這個還需要觀察確認一下。



圖形 9-17 本船的速度向量線 3/6 分鐘長度，兩分鐘的操演之後

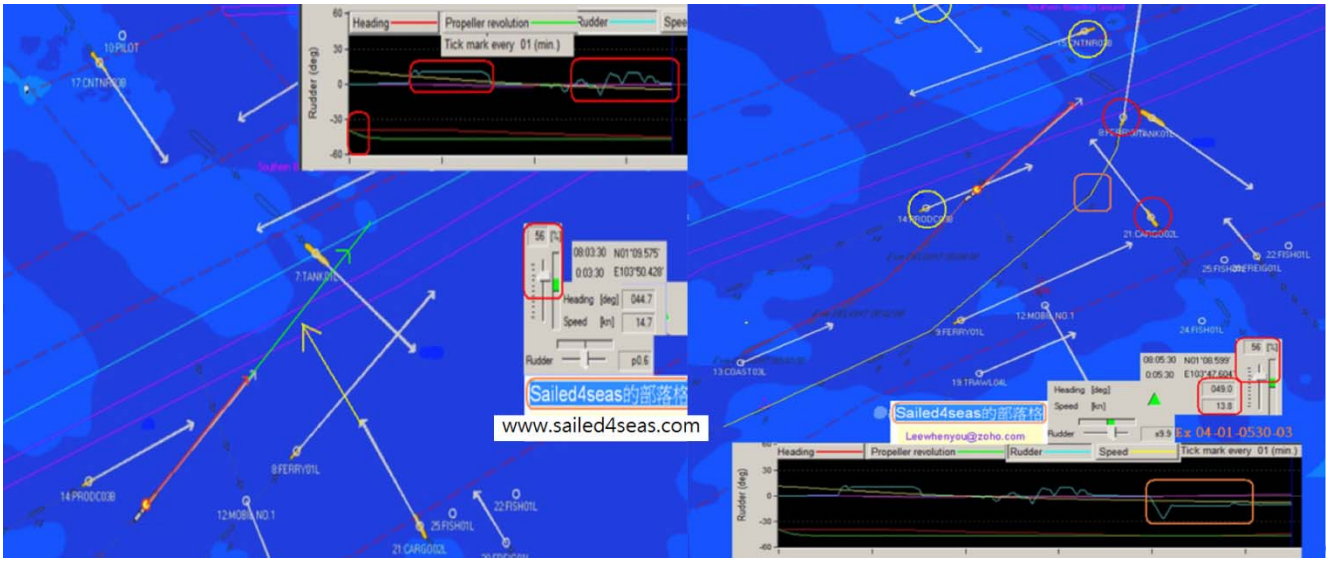
在兩分鐘操演之後，本船的速度是 15.8 節，這個是已經從 18.6 節減下來了，主機的出力減少到 56%，相當於港內的半速前進。本輪的航向向左轉的 9 度，是 054.6 度從 063.8 度，使用小的“左舵 10 度”

情勢知覺如下

- 本船讓路給左舷的橫越船，在經過 1 分鐘的操演後，向左轉 9 度，改變了兩條船會遇的情況，從端點對中點，到端點對目標，端點對目標代表的就是安全。
- 被追越船隻在右舷跟本船同速，現在已經離開了。因為我們減速下來，他的速度變快。
- 本船有 3 條左舷的橫越船在黃色的圓圈，距離未知。這是我們看到的
- 被追越船在左舷，仍然是比本船的速度慢，這是我們比較速度向量線的長度得知。

使用 6 分鐘的速度向量線，情勢知覺如下

⇒ 左舷的橫越船在隔離區，將會在本船的船頭 3 分鐘之後，這是端點對目標，安全。
⇒ 右舷的橫越船是一個麻煩，在 5 分鐘之後，他的碰撞點已經轉移到左邊，當本船向左轉向，這個事端點對端點，5 分鐘後會發生碰撞。



圖形 9-18 本船的速度向量線在 3/6 分鐘，操演 3 分半鐘跟 5 分半鐘之後

經過 3 分半鐘操演時間後。本船的速度是 14.7 節，這是從 15 點 8，18.6 節而來，主機出力降到 56%，從一開始的時候。本船的航向又向左轉 10 度，從 054.6 度轉到 044.7 度，使用左舵 10 度的小舵角。情勢知覺如下：

⇒ 本船進一步向左舷的橫越船讓路，在兩分半鐘的時候，當她還在其他的航行巷道。由碰撞點判斷，這條船應該是不相關的，只要本船維持原來的航向 054.6 度就可以了。
⇒ 一條追越船在右舷是 OK 的，他的速度比較快，又跟本船同向。
⇒ 利用 6 分鐘的速度向量線來檢查，本船會通過右舷橫越船的船頭在 4 分半鐘的時間。這個是中點對端點，一半的安全，碰撞時間的安全間隔是一分半鐘。
⇒ 被追越船在左舷是中點對端點，這也是一半安全。
⇒ 雖然本船的航向是與一般的流動方向成 20 度的差異，情勢看起來還好，如果本船能夠保持現在的速度，在 4 分半鐘之後，能夠避免右舷的橫越船，再向右轉回原始的航線。

經過 5 分半鐘的操演時間過後，本船的速度是 13.8 節，這個是從 14.7 15.8 18.6 節而來，主機的出力呢維持在 56%。本船的航向是回到右舷 049 度，是從 044.7 度，使用小的右舵舵角“右舵 10 度”，直到現在。

9 – 06 Collision Awareness Exercise – 16 Overall Situation Awareness

9-14 Summarize all collision risks into one accessible collision area risk to avoid.

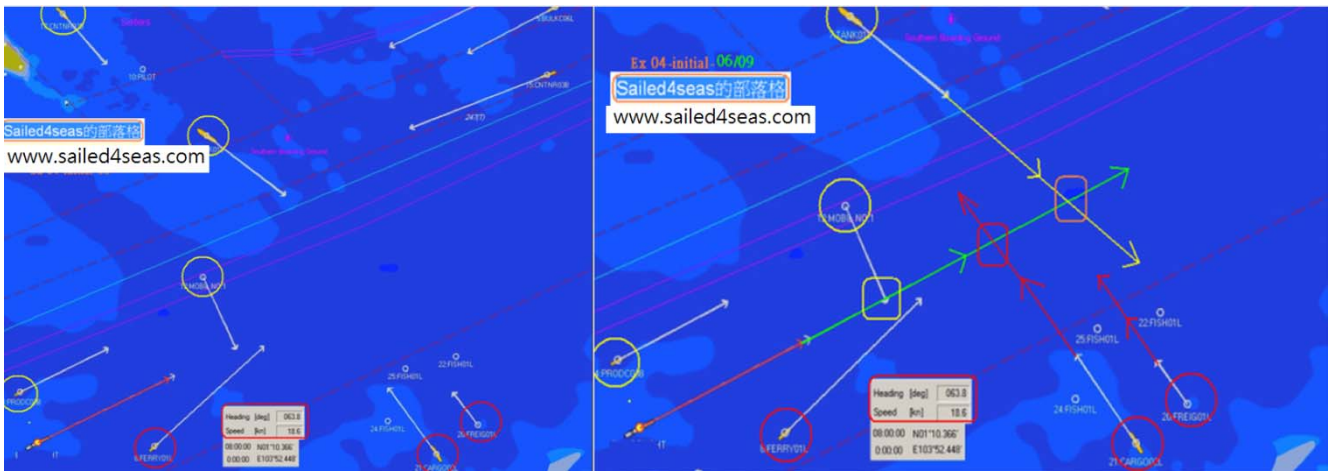


Figure 9-16 Ownship speed vector in 3/6 minutes at beginning

As figure 9-16 (this is the scene where double grounding case happened) Ownship speed is 18.6 knots and course is 063.8 degrees at beginning. With 3 minutes speed vector in 18.6 knots, this vector length is about 9.3 cables long. The situational awareness is:

1. Ownship have two crossing vessels at starboard side (red circle), distance unknown. (sighted)
2. One overtaken vessel at starboard side has same speed as ownship. (skill by comparing vector length)
3. Ownship have three crossing vessels at port side (yellow circle), distance unknown. (sighted)
4. One overtaken vessel at port side slower than ownship. (skill by comparing vector length)

The situational awareness with 6 minutes speed vector is:

- One port side crossing vessel will be at ownship bow after 3 minutes. (End to Target, 3 minutes safety allowance)
- One starboard side crossing vessel will be at ownship bow after 7 minutes. (end to end, have collision risk after 7 minutes, in red square)
- Another crossing starboard side vessel has no collision risk as 9 minutes speed vector has no collision point. (sighted. slower vessel. Out of Safety Relative Bearing SRB range maybe)
- One crossing vessel at port side will be at ownship bow after 7.0 minutes or so (Pink Square). (end to end: have collision risk after 8 minutes)

Overall situation awareness is: (summarize all collision risk into one accessible collision area risk to avoid)

- First port side crossing vessel at ownship bow after 3 minutes and same speed overtaken vessel at our starboard side are OK as long if ownship reduce speed now. (sense)
- Ownship still has to give way to starboard crossing vessel by alter course 5 degrees to starboard side. (Just a little course change will do)
- This course change will delay port side crossing vessel pass ownship's bow. It is better to reduce speed at the same time.
- This overtaken vessel at starboard side is in a strange course not follow general traffic flow direction. (She may go to pilot station then inbound the harbour)
- Does Port side second crossing vessel will join east bound lane and alter course to port side? (suspect)
- Forget other slower crossing vessels, it is no harm can be done now. (suspect)
- Are slower crossing vessels course steady and where are their position now? (outside the TTS, sighted)

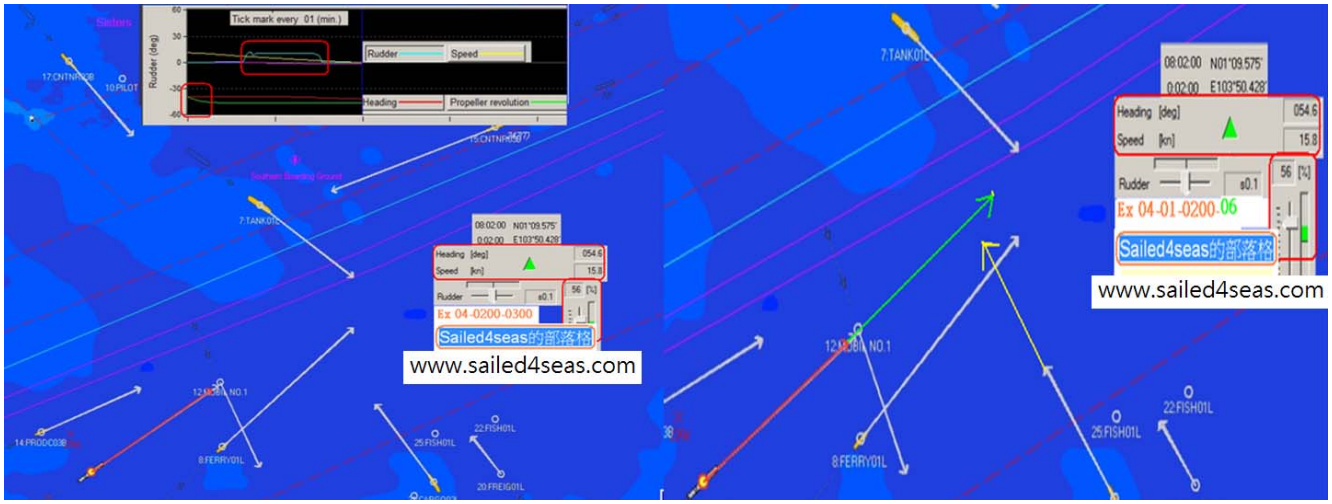


Figure 9-17 Ownship speed vector in 3/6 minutes at 2 minutes time

After 02minutes exercise time lapsed:

1. Ownship speed is 15.8 knots which had reduced from 18.6 kts with engine output reduced to 56% at beginning.
2. Ownship course is altered to port side 9 degrees to 054.6 (T) from 063.8 (T) with small rudder angle "port ten" used.

The situational awareness is:

- Ownship have given way to port side crossing vessel after one minute with course change 9 degrees to port side. Change the meeting situation from End to Middle to End to Target. (End to Target: Safe)
- One overtaken vessel at starboard side has same speed as ownship is now leaving. (she is faster after we reduce speed)
- Ownship have three crossing vessels at port side (yellow circle), distance unknown. (sighted)
- One overtaken vessel at port side is still slower than ownship. (skill by comparing vector length)

The situational awareness with 6 minutes speed vector is:

- Port side crossing vessel at separation zone will be at ownship bow after three minutes. (end to target: safe)
- Starboard side crossing vessel still is a trouble after 6 minutes the collision point had shifted to port side as ownship alter course to port side. (End to End after 6 minutes)

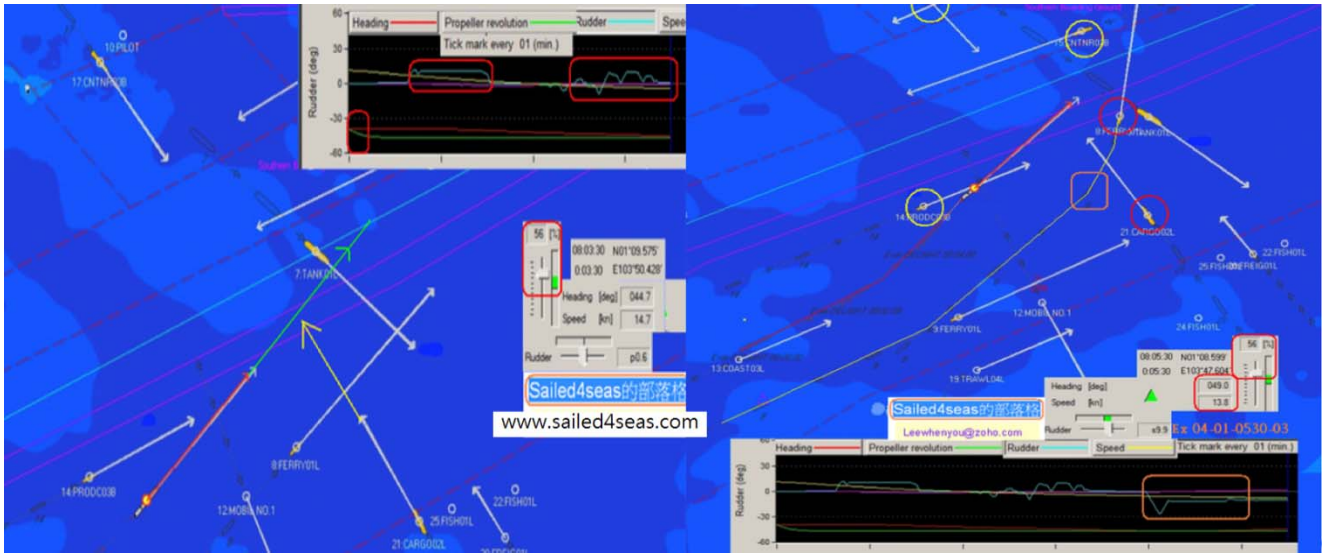


Figure 9-18 Ownship speed vector in 3/6 minutes at 3.5 and 5.5 minutes time

In figure 9-18, after 03 minutes 30 seconds exercise time lapsed:

1. Ownship speed is 14.7 knots which had reduced from 15.8, 18.6 kts with engine output reduced to 56% at beginning.
2. Ownship course is altered to port side 10 degrees more from 054.6 to 044.7 (T) with small rudder angle "port ten" used.

The situational awareness after 03 minutes 30 seconds is:

- Ownship gave way to port side crossing vessel in other traffic lane at 02 minute 30. (judging by collision point, this vessel is irrelevant. Original course 054.6 (T) will be OK.)
- One overtaking vessel at starboard side is OK. (has faster speed and same course as ownship)
- By using 6 minutes vector to check, Ownship will pass starboard side crossing vessel's bow after 4.5 minutes. (middle to end, caution. margin in TTC is 1.5 minutes)
- One overtaken vessel at port side is middle to end. (caution in our turning)
- Although ownship is 20 degrees difference to general traffic direction, things look like very easy if ownship can keep current speed after 4.5 minute to avoid starboard side vessel. (caution: middle to end)
- After ownship passed starboardside crossing vessel, ownship can alter course to starboard side and back to original course line. (awareness)

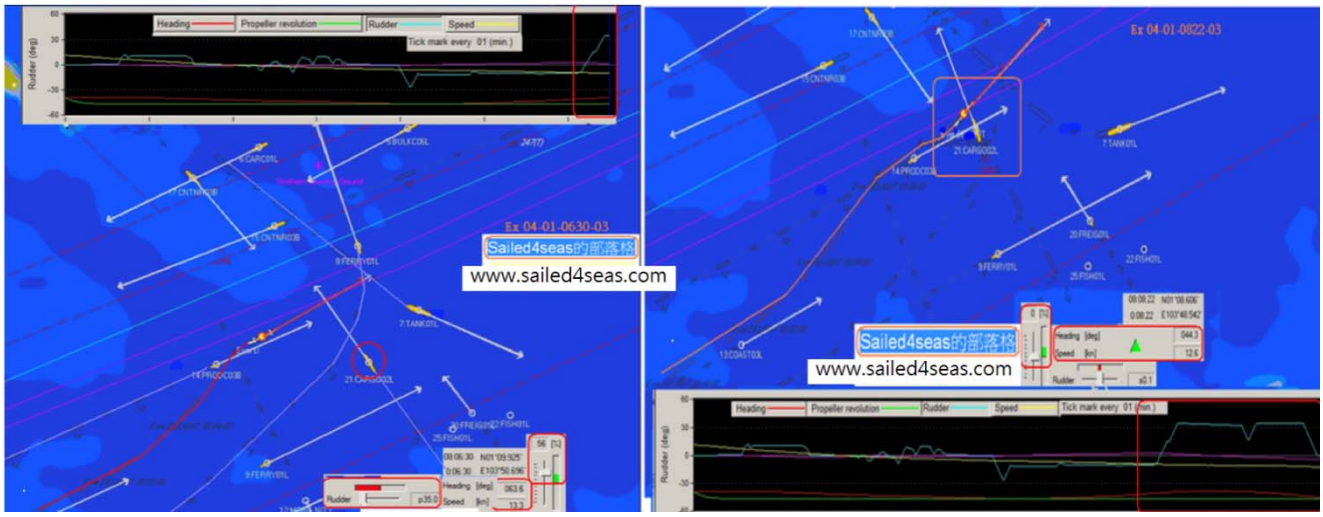
In figure 9-18, after 05 minutes 30 seconds exercise time lapsed:

1. Ownship speed is 13.8 knots which had reduced from 14.7, 15.8, 18.6 kts with engine output reduced to 56% at beginning.
2. Ownship course is back to starboard 049 (T) from 044.7, 054.6, 063.8 (T) with some small starboard rudder angle used and "starboard ten" till now.

9-15 如果本船不能穩定在一航向上，碰撞危機將不會結束

情勢的知覺是本船幾乎進入隔離區，等一下有些官員可能來到船上，帶來某些錄影帶資料，要求船長去簽罰單。

⇒ 本船是在左舷被追越船隻的正前方，這是我們看到黃色圓圈的船隻。
⇒ 本船試圖回到右邊，但是使用小的舵角，“右舵 10 度”。
⇒ 緩慢的回轉，在這些情況之下，就是在找麻煩。如果本船不能穩定在一個航向上，我們的碰撞危機，永遠都不會過去。因為在回轉之中，沒有一件事情能夠確定的，即使是對本船的回轉都不能確定。
⇒ 右舷的追越船已經再一次在近距離轉向左舷，這是在粉紅色的方塊內，這是端點對目標是安全的。
⇒ 這一條船意圖橫過隔離區，向領港站前進，這是經驗，這就是為什麼？他的航向跟航道一般流通方向如此不同。
⇒ 本船不必採取任何行動，去避免這條橫越的渡輪。從一開始就是這樣，因為他的速度快，這是我們比較速度向量線的來的資料，所以不管我們在後面怎麼開，都不會去追撞他。
⇒ 本船向右舷轉回去，緩慢的，這會跟右舷的橫越船發生危險，在 3 分鐘之後，這個可能發展成，端點對端點，或是中點對中點的情況。
⇒ 事情看起來非常複雜，因為所有本船的操船，導致本船又回到原來碰撞面的危機的。
⇒ 安全的位置是由安全的船首向所決定的



圖形 9-19 速度向量是 3/6 分鐘，在 6 分半鐘跟 8 分半鐘的時間過後

6 分半鐘的時間過後，本船的速度是 13.3 節，這是從 13.8，14.7 節等等，主機的出力減少到 56%，這從一開始就沒改變過，情勢如下：

本船的航向是 063.6 度，從 049.0，044.7 度回轉過來的，使用長久的右舵，本船正嘗試穩定在新航向，現在使用左滿舵的舵角。

9-15 If ownship cannot steady on one course our collision risk will never be over.

In figure 9-18, the situational awareness is ownship almost enter separation zone, later some officer may come on board with some video picture and ask Captain to sign the penalty bills.

- Ownship is dead ahead of port side overtaken vessel. (sighted very close astern)
- Ownship had tried to go back to starboard side but small rudder angle “starboard ten” is not effective. (sighted)
- Turning slowly in these situations is looking for trouble.

If OS cannot steady on one course our collision risk will never be over because nothing can be sure when ownship is turning(sense)

- Starboard side overtaking vessel is at port bow had alter course to portside again (Pink Square). (this is an end to target situation)
- This vessel intended to cross traffic lanes into pilot station. (Experience, this is why she had different course with general traffic in east bound lane.)
- Ownship only need reduce speed or pass her astern to avoid from the very beginning. (skill)
- Ownship changed our position into portside near separation line where outbound vessel will present there. (create another collision area risk)
- Safe position is more important and should be achieved by clear awareness of our intention and prediction ability of another vessel. (instinct of not to close separation line)

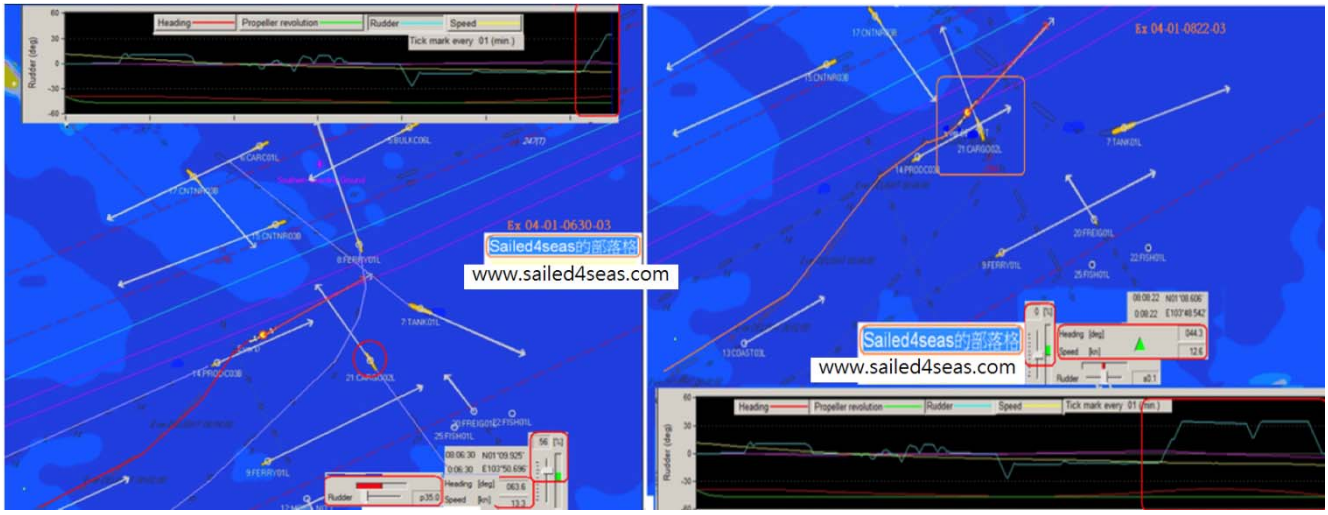


Figure 9-19 Ownship speed vector in 3/6 minutes at 6.5 and 8.4 minutes time

In figure 9-19, after 06minutes 30 seconds exercise time lapsed:

1. Ownship speed is 13.3 knots which had reduced from 13.8, 14.7, 15.8, 18.6 kts with engine output reduced to 56% at beginning.
2. Ownship course is 063.6 degrees changed from 049.0, 044.7, 054.6, 063.8 degrees with prolonged Starboard rudder angle used, she is tried to steady with “Hard Port” rudder now.

9-16 在這些情況，緩慢的回轉是找麻煩

情勢的知覺如下：

⇒ 本船向右舷轉向，要回到航道的一般流通方向，但是使用小的舵角，也許船長希望右舷的船隻會自動的通過本船的船尾，在這些情況之下，緩慢地回轉，就是找麻煩。
⇒ 這不但會使其他的船隻感到困惑。同時也使本船自己不能明瞭，我們會往哪裡去？
⇒ 本船改變船首向向右舷，就是增加右邊的碰撞危機。
⇒ 本船使用左滿舵來穩住船首向，但是不曉得本船會停在那裡？這是有懷疑的地方
⇒ 如果本船不能夠現在穩住，會變成與右邊的橫越船發生碰撞。情勢已經由端點對端點，改變成中點對中點的情況。

⇒ 本船橫越左舷追越船的船頭，現在又在試圖橫越一次，這是完全沒看到後面有追越船，碰撞時間是 1 分半鐘，這就是本船最後的機會，能否避開追越的船隻？但是又應該如何避開呢

⇒ 轉向左舷比較好，因為 1 分鐘前是這樣，但是現在已經太晚了，從用舵到產生回轉，也需要 1 分鐘的時間，才會有有效。

經過 8 分半鐘的操演時間後，仍然發生了碰撞。

⇒ 本船的速度是 12.6 節，這是從 13.3，14.7 節一路減下來，主機的出力仍然是 56%，最後的關鍵時刻，減到 0%，但是這只是心理安慰，沒有用的。

⇒ 本船的航向是 044.3 度從 063 度轉過來，這是兩分鐘前，使用了兩分鐘的左滿舵，所以產生急遽的左轉。

9-16 Turning slowly in these situations is looking for trouble.

The situational awareness is:

- Ownship turned back to starboard side general direction of traffic flow with small rudder angle been used. (maybe in hope that starboard side crossing vessel will pass ownship's stern automatically)
- **Turning slowly in these situations is looking for trouble**.
  - It's not only confused another vessel around.
  - It is also confused ownship for not aware which heading ownship can be steady.
  - Ownship change heading to starboard side increase collision risk in starboard side.
- Ownship had used "Hard Port" to steady but not knowing what heading ownship will stop? (suspect)
- If ownship cannot steady now, ownship will have collision with starboard side crossing vessel. (meeting situation change from end to end situation to middle to middle situation now).
- Ownship had crossed port side overtaken vessel's bow and tried to cross again. (suspect)
- Time to Collision TTC is 1.5 minutes. Is now the last chance ownship can avoid crossing vessel? But how?

Alter course to port side is better as one minute ago. But now is too late for wheel over need one minute to be effective.

After 08minutes 22 seconds exercise time lapsed, collision happened:

- Ownship speed is 12.6 knots which had reduced from 13.3, 13.8, 14.7, 15.8, 18.6 kts with engine output reduced to 56% at beginning, reduce to 0% at last moment. No use.
- Ownship course is 044.3 degrees changed from 063.6 (T) two minutes ago with "Hard Port" rudder been used over two minutes. No use.

9-17 為什麼不避開這條船，在開始的時候

情勢的知覺如下，

⇒ 本船又一次回到左邊，使用左滿舵的舵角，本船沒有採取堅決的行動，來離開麻煩的水域。

⇒ 每次本船向左轉向，就是在隔離區裡面找麻煩。

⇒ 本船速度慢下來，但是仍然向原來的碰撞區域前進。

⇒ 當 3 分鐘的速度向量線有交叉的時候，任何避碰的行動可能都沒有用，尤其是中點對中點的碰撞，因為可以反應的時間太短，回轉的半徑也不足。
⇒ 如果我們檢查碰撞危機，從一開始的時候，會碰撞的船隻就是跟操演開始時候，那條船隻是一模一樣。左舷的橫越船隻跟本船再 7 分半鐘，8 分半鐘的時間內會發生碰撞。只是延長了 1 分鐘的碰撞時間，因為本船轉向左邊，同時將碰撞位置移到本船的左舷。請看圖形 9-16 的紅色方塊船隻，這是多麼讓人失望，發現這 8 分半鐘的操船，船長在這邊做的，只是將本船帶到最後碰撞的發生。為什麼不能在一開始，就避開這條船呢？
⇒ 本船可以從一開始，就使用右滿舵來離開碰撞區域，向航道的外側前進，

要記得隔離區永遠代表的，都是一個危險的區域。

9-17 Remember the separation zone is always a danger zone.

The situational awareness is:

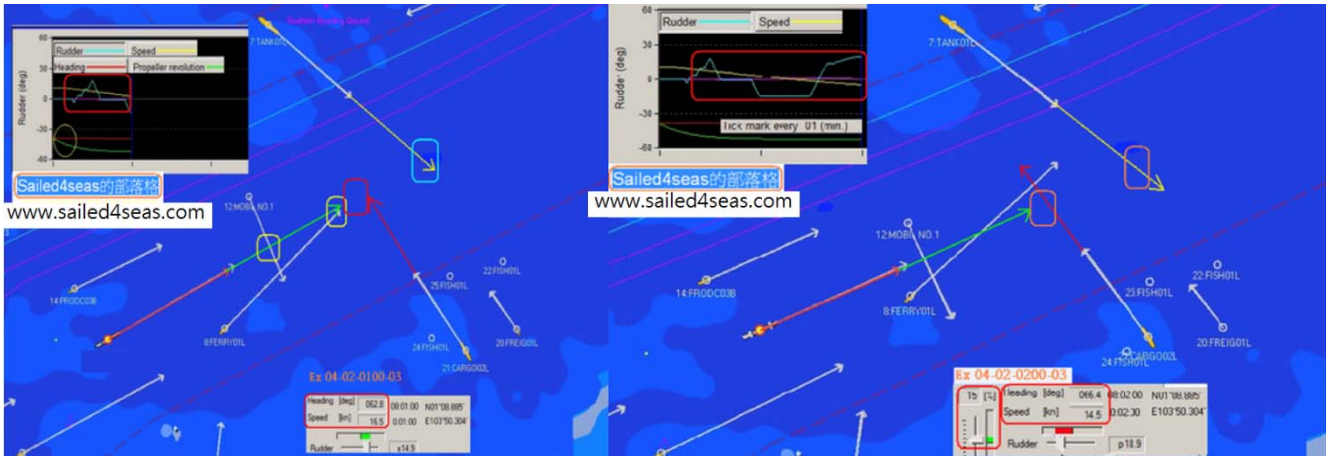
- Ownship once again go back to port side with “Hard Port” rudder angle been used. (sighted)
- **Ownship have no decisive action to clear trouble area**. (collision risk area)
- Every time ownship alter course to port side is looking for trouble inside the separation zone. (sense)
- Ownship speed slow down but still proceed to original collision area. (sighted)
- When 3 minutes speed vector crossed, any avoidance maneuvering may be useless. (Middle to Middle: Collision).
- If we examine the collision risk in the beginning, collision vessel is exactly the same as exercise began. The starboard side crossing vessel has collision risk with ownship at 7.5 minutes in the beginning and finally collided at 8.5 minutes, one minute later than we expected in the beginning.
- Because ownship alter course to port side which move collision position to ownship’s port side too. (red square vessel in figure 9-16)
- What a disappointed discovery! All 8.5 minutes maneuvering Master had done here is only leading into final collision. (Why not avoid this vessel in the beginning?)
- Ownship should use “Hard Starboard” rudder to clear the collision area in the beginning. (instinct)
- Remember the separation zone is always a danger zone.

9-07 碰撞知覺操演－17 操縱速度向量線

9-18 避開其他船隻的速度向量線

就像圖形 9-16，雙擱淺案件發生的地方，本船的速度是 18.6 節，航向 063.8 度，現在速度向量線的長度是 9.3 CABLE 的距離。情勢知覺如下：

⇒ 有兩條橫越船在本船的右舷，紅色的圓圈，距離未知。
⇒ 被追越船在右舷，跟本船同速，這是比較速度向量線長度。
⇒ 有三條橫越船在左舷，黃色的圓圈，距離未知。
⇒ 一條追越船在左正橫，比本船的速度慢。這是比較速度向量線長度得知。



圖形 9-20 本船的速度向量 3/6 分鐘， ½分鐘操演時間過後

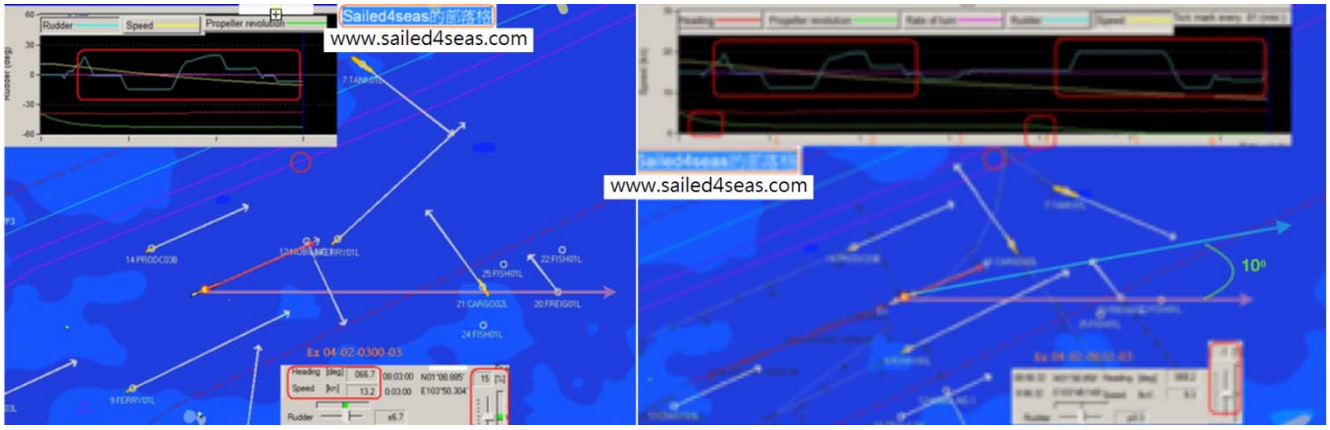
在 1 分鐘操演的時間過後，本船的速度是 16.5 節，這是從 18.6 節減下來的，主機的出力，同時也下降到 15%。本船的航向向左轉 1 度到 062.8 度，從 063.8 度，使用左舵 10 度。情勢知覺看起來沒有太大的改變：

⇒ 左舷的橫越船隻會通過本船的船頭，在一分半鐘後。這是端點對目標，安全。
⇒ 一條追越船在右舷是 OK 的，因為他比本船的速度要快，這是端點對目標。
⇒ 本船在右舷有一條橫越船，具有碰撞危機，紅色方塊，在 6 分鐘之後，端點對端點的碰撞。
⇒ 紅色方塊是端點對端點的情勢，碰撞危機是確定的，在 6 分鐘之後。
⇒ 一條被追越船在左舷正橫是 OK 的，比本船速度慢。
⇒ 1 條左舷的橫越船距離太遠，藍色方塊，在 6 分鐘內沒有碰撞危機。因為速度向量線沒有相交

經過兩分鐘的操演過後，航速是 14.5 節，16.5， 18.6 節，主機的出力減到 15%，從一開始。航向右轉 4 度到 066.4 度，從 062.8 度，使用右舵 15 度的舵角。

情勢知覺是：

⇒ 本船的速度減少兩節，在最後一分鐘，但是本船的船首向控制非常好。
⇒ 本船大膽減俥，而且使用小舵角，非常適當的控制船首向，這是我們看到的。
⇒ 左舷的橫越船會通過本船船頭，在 1 分鐘後，這是端點對目標，這是安全的。
⇒ 一條追越船在右舷，比本船快，會通過本船船頭，在一分半鐘後，這是安全的。
⇒ 本船在右舷有一條橫越船，5 分鐘之後會在本船船頭，粉紅色方塊，是端點對中點，有一分半鐘的安全間隔。
⇒ 一條左舷的橫越船會通過本船船頭，在 5 分鐘後，（粉紅色的方塊），在這 6 分鐘的速度向量線沒有交點，沒有碰撞危機。
⇒ 一條被追越船在左舷正橫是安全的，比本船的速度慢。



圖形 9-21 本船 3 分鐘速度向量線，3.5/6 分半鐘的操演時間

在 3 分鐘的操演時間過後：本船的速度是 13.2 節，這是從 14.5，16.5，18.6 節，將主機的出力一開始就將到 15%。本船航向是穩定在 066.4 度，從 06 2.8 度使用右舵 15 度，右舵 10 度，右舵 5 度。情勢知覺如下：

⇒ 選擇使用舵角來適當的控制船首向，與看到的大膽減車。
⇒ 左舷的橫越船跟右舷的追越船 ，現在都在本船的船頭，是安全的。
⇒ 本船在右舷有一條橫越船，將在 3 分鐘後到達本船的船頭，這也是端點對目標的情況，這是我們現在的估計。
⇒ 另外的橫越船在右舷同樣的方位，會通過本船的船頭，我們使用的 6 分鐘速度向量線檢查碰撞點。

船長有兩個選擇，可以檢查這一條比較遠的船隻的動向：

⇒ 目視觀察他的相對方位變化，或是使用安全的相對方位概念，就像圖形 9-21 來標出目標船的方位。這是我們的技術。
⇒ 一條被追越船隻在左舷，看起來是 OK，跟本船的速度幾乎相同。
⇒ 經過有效的減速，可以節省很多的麻煩。
⇒ 減速跟減車是不一樣的，因為在減車下，本船還有前進的動量需要克服，速度才會減下來。
⇒ 要減速不能只靠把主機的出力減下來，有時候速度可能減得非常慢，所以要適當的利用迴圈舵的技術。
⇒ 在操演 6 分半鐘的時間過後，本船的速度是 9.3 節，這是從 13.2，14.5， 16.5，18.6 節，主機的出力減到 15%，從一開始。在第 4 分鐘的時間，又進一步減到了 0%。

本船的航向是穩定在 068 度，從 066.4 度，062.8 度，使用了迴圈舵兩次，這個情勢的知覺是如下：

⇒ 本船大膽減速，並使用小角度的迴圈舵的技術兩次，這是我們看到的。所有附近的船隻現在都 OK 了，這是使用 3 分鐘速度向量線檢查，沒有任何的麻煩。
⇒ 第二條橫越船在右舷，跟本船有碰撞危機，在本船經過這麼多操作之後，還有端點對端點的碰撞，在 6 分鐘之後，這個碰撞危機借由使用電子游標線 EBL 也得到了確認，電子游標線是設在 090 度，如果船長對他自己的目視觀測不太確定，也就是呢目標的方位確是在 090 上面，不變。
⇒ 本船也許需要向右轉向來讓路給這一條船，這是我們的感覺。

⇒ 本船的航向改變向右舷，跟在右舷的追越船會發生危險，這也是我們的感覺。
⇒ 本船現在能做的事，是繼續使用迴圈舵，從“右滿舵”來獲得更多的安全距離，或是
⇒ 本船可以再向右轉，轉向 10 度來建立一些新的正橫距離，跟這條橫越船，那可能得到的是 299 公尺，(9.3 x 1852 x sin (10) / 6 min. = 299.0 meters)。
⇒ 碰撞的時間也許是 6 分鐘，正橫的距離，用 10 度的航向改變，可以創造 299 公尺，對小型船隻，應該是足夠。這是我們的感覺
⇒ 本船向右改變航向 10 度，是向右邊的追越船 3 分鐘速度向量線的端點接近。
⇒ 速度向量線的相對方位差是 10 度，從他的端點到目標。
⇒ 避免碰撞點來避免碰撞，而不是避免碰撞的船隻。
⇒ 本船有 6 分鐘的時間到達碰撞點，我們可以考慮來增加本船的速度來通過他的船頭，因為附近沒有其他的船隻。或是
⇒ 本船可以轉向左舷，使用安全的相對方位概念來離開這一個目標，然後再增加船速脫離。

9 – 07 Collision Awareness Exercise – 17 Maneuver Speed Vector

9-18 Avoid other vessel's speed vectors to avoid collision.

As figure 9-16 (this is the scene where double grounding case happened) Ownship speed is 18.6 knots and course is 063.8 degrees at beginning. With 3 minutes speed vector in 18.6 knots, this vector length is about 9.3 cables long. The situational awareness is:

1. Ownship have two crossing vessels at starboard side (red circle), distance unknown. (sighted)
2. One overtaken vessel at starboard side has same speed as ownship. (skill by comparing vector length)
3. Ownship have three crossing vessels at port side (yellow circle), distance unknown. (sighted)
4. One overtaken vessel at port side slower than ownship. (skill by comparing vector length)

The situational awareness with 6 minutes speed vector is:

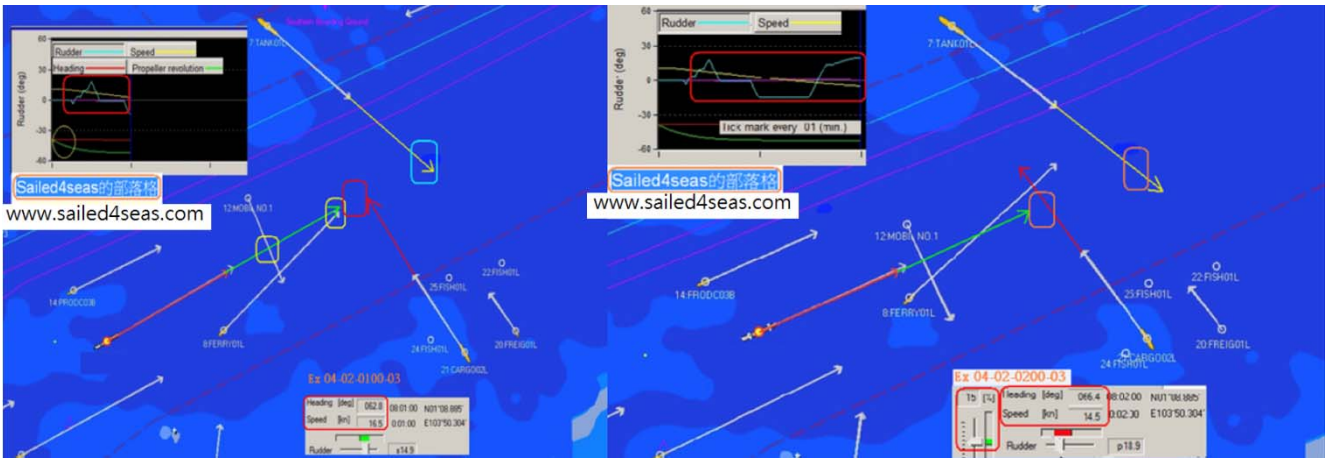


Figure 9-20 Ownship speed vector in 3/6 minutes at 1 and 2 minutes time

After 01minutes exercise time lapsed:

1. Ownship speed is 16.5 knots which had reduced from 18.6 kts with engine output reduced at beginning.
2. Ownship course is altered to port side 1 degrees to 062.8 from 063.8 (T) with “**port ten**” used.

The overall situational awareness seems not so much changed:

- Port side crossing vessel will pass ownship bow after 1.5 minutes. (end to middle (or target), Caution)
- One overtaking vessel at starboard side is OK. (faster than ownship, End to Target)
- Ownship have one crossing vessel at starboard side has collision risk (red square) after 6 minutes. (end to end, collision risk in 6 minutes)
- Red square is end to end situation, Collision Risk is for sure.(after 6 minutes)
- One overtaken vessel at port side is OK. (skill, slower than ownship)
- One crossing vessel at port side (blue square) will pass ownship's bow at 6 minutes. (no collision risk in 6 minutes for speed vectors are not crossed.)

After 02minutes exercise time lapsed:

- Ownship speed is 14.5 knots which had reduced from 16.5, 18.6 kts with engine output reduced to 15 % at beginning.
- Ownship course is altered to starboard side 4 degrees to 066.4 degrees from 062.8, 063.8 degrees with rudder angle "starboard 15" used.

The situational awareness is Ownship had reduce speed 2 knots in last minute but ownship's heading control is very well:

- Ownship reduced engine output decisively and used rudder with proper control of heading. (sighted)
- Port side crossing vessel will pass ownship bow after 1.0 minutes. (end to middle, Safe)
- One overtaking vessel at starboard side is faster than ownship will pass ownship bow after 1.5 minutes. (end to middle, Safe)
- Ownship have one crossing vessel at starboard side will be at ownship bow after 5 minutes (pink square). (end to middle, 1.5 minutes safety)
- One crossing vessel at port side has no collision point in 6 minutes speed vector (pink square: will pass ownship bow after 5 minutes).
- One overtaken vessel at port side is safe. (slower than ownship, sense)

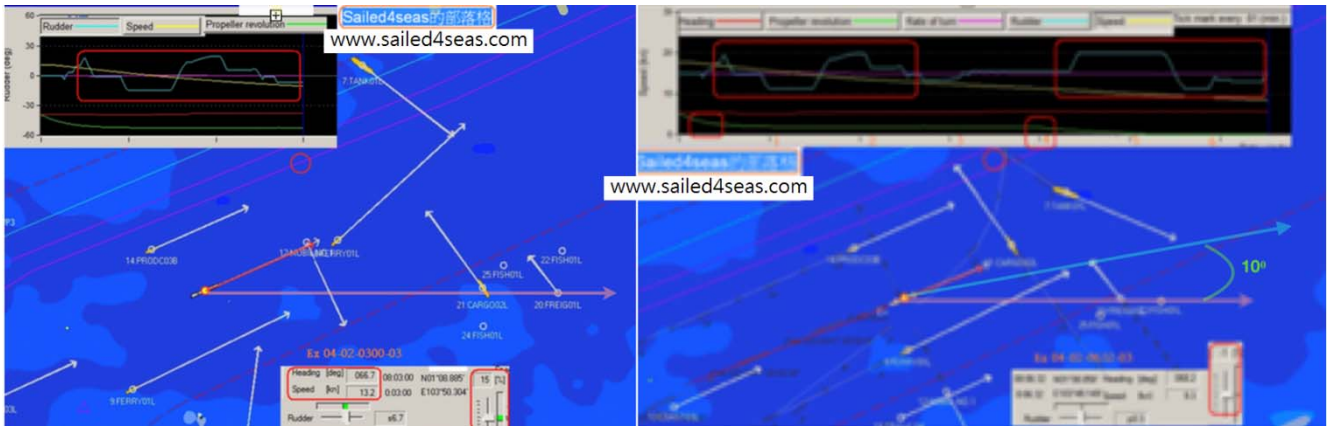


Figure 9-21 Ownship 3 minutes speed vector at 3 and 6.5 minutes time

After 03 minutes exercise time lapsed:

1. Ownship speed is 13.2 knots which had reduced from 14.5, 16.5, 18.6 kts with engine output reduced to 15 % at beginning.
2. Ownship course is steady in 066.4 degrees from 062.8, 063.8 degrees with rudder angle "starboard 15" "Starboard 10" "starboard 5" used.

The situational awareness is:

- Ownship reduced engine output decisively and used rudder angle needed for proper control of heading. (sighted)
- Port side crossing vessel and overtaking vessel at starboard side is at ownship bow now. (End to Target, safe)
- Ownship have one crossing vessel at starboard side will be at ownship bow after 3 minutes (this vessel also has end to target situation by estimate).
- Another crossing vessel at starboard side in same bearing further will pass ownship bow sometime later which will check later. (sense)
- Captain has two options to check this far away vessel in question:
    - Visual lookout of her relative bearing change, or
    - Use EBL as on figure 9-21 to mark target vessel's bearing. (skill)
- One overtaken vessel at port side seems OK. (almost same speed and course)
- By reducing speed effectively can save almost all problems in this case. (suspect)
- Reduce speed is not the same as reduce engine output. (ownship has forward momentum to overcome in speed reduction)
- Reduce speed cannot rely on reducing engine output only. (sometimes, speed reduced very slowly)

After 06minutes 32 seconds exercise time lapsed:

- Ownship speed is 9.3 knots which had reduced from 13.2, 14.5, 16.5, 18.6 kts with engine output reduced to 15 % at beginning and further reduce to 0% at 04 minutes time.
- Ownship course is steady in 068 degrees from 066.4, 062.8, 063.8 degrees with rudder cycling twice.

The situational awareness is:

- Ownship reduced engine output decisively and used small angle rudder cycling twice. (sighted)
- All vessels nearby are OK Now. (3 minutes speed vectors are clear, sighted)
- Second crossing vessel at starboard side have collision risk with ownship. (end to end collision after 6 minutes)
- The collision risk is confirmed by Electric Bearing Line EBL which had set to 090^0 (T) 3 minutes ago if captain was not sure about his visual relative bearing observation. (Target bearing unchanged at 090^0 (T))
- Ownship may have to alter course to starboard side again to give way to this vessel. (sense)
- Ownship course alternation to starboard side may have danger with overtaking vessel at starboard side. (sense)
- What ownship can do now is rudder cycling again from "Hard Starboard" rudder? (to gain some distance from new collision point)
- Ownship alter course a little (10 degrees) to port side is OK. (have no collision point in 056^0 (T) direction and by SRB concept with slower vessel)

- The collision time maybe 6 minutes, the beam distance created by 10 degrees heading changed will 299 meters which should be enough for small vessel. (9.3 x 1852 x sin (10) / 6 min. = 299.0 meters)
- Ownship 10 degrees heading change to starboard side is heading into starboard side overtaking vessel 3 minutes speed vector's end. End to Middle due to our course change)
- Avoid collision point to avoid collision, not collision vessel.
- Ownship have 6 minutes time to collision point.
    - We can consider to increase ownship speed and monitor her relative bearing change at the same time to pass her bow as no other vessel around.
    - OS can alter course to port side use SRB concept to keep away this target then course again.

9-19 應該轉向多少度，來避免碰撞線危機

從碰撞線的危機（3 分鐘的速度向量線）的研究上，我們知道碰撞危機開始於端點對端點的情勢，然後是中點對中點，最後就是目標與本船的碰撞。要避免碰撞，我們應該改變端點對端點的情勢，成為端點對中點的情勢，最後再改成端點對目標船，而保持 3 分鐘的安全間隔，安全的情況。

- 主要的操作就是，將本船的速度線向量線端點，從目標船的端點移動到目標船的方位（想像在碰撞前 3 分鐘，將本船船首向轉向目標船尾）。將端點對端點改變成端點對目標的狀況。
- 這就是說本船的航向改變，從指向目標船的速度線向量線的端點，轉而指向目標的相對方位。換句話說，如果本船希望跟目標船保持 3 分鐘的安全間隔，我們必須將我們的船首向，轉向目標船 3 分鐘速度向量線兩端方位的差異。請參考圖形 9-21 右圖，目標 3 分鐘速度向量線頭尾的相對方位差異是 10 度，如果本船跟著目標船具有端點對端點的情勢，本船可以轉向 10 度到右舷，來保持 3 分鐘的安全間隔。
- 如果我們在看看這些圖形，就很清楚，借由操作本船 3 分鐘速度向量線，小心的不要碰到目標船的速度向量線，我們就可以安全的航行，不會發生碰撞。
- 長期使用 3 分鐘速度向量線的問題是，本船會失去遠距離的碰撞警覺，本船必須使用長短不同分鐘的速度向量線，交互的觀測，就像近程跟遠端的瞭望，需要改變雷達的距離圈設定。
- 小型的橫越船可以有向左，向右轉向的自由度。或是增加船速，只要船長能夠瞭解碰撞線的危機，又或者是有我們講的安全相對方位的概念。

9-19 How many degrees course change to keep minimum 3 minutes safety margin?

From collision line (3 minutes speed vector) study we know the collision risk begin from End to End situation then Middle to Middle situation, finally target to Me collision. To avoid the collision, we should change End to End situation to End to Middle situation, finally End to Target's safe situation. The key point of maneuvering is to move ownship's speed vector (alter course) from End to End to End to Target situation.

Change ownship 3 minutes speed vector from pointing target's speed vector's End to pointing Target's stern.

In this way, ownship can keep three minutes safety margin with target vessel we need. Please refer to figure 9-21 right picture. 10 degrees is the angle between target's end to her stern in her 3 minutes speed vector. In relative bearing, this 10 degrees is the relative bearing difference from her 3 minutes speed vector end to target. If ownship has an End to End situation with her, ownship can alter course 10 degrees to starboard side

to keep 3 minutes safety passing time with her. However, we should remember the blossom effect when target's distance changed. 10 degrees is not fixed as this angle will change with distance (blossom effect) and her course/speed varied.

Actually, if we look at these figures again it would be clear that by maneuvering 3 minutes speed vector carefully without touching another vessels', ownship can safely navigate without collision. The problem with use of 3 minutes speed vector is ownship may lose long range collision awareness. So, ownship has to set short and long minutes speed vector alternately for young OOW.

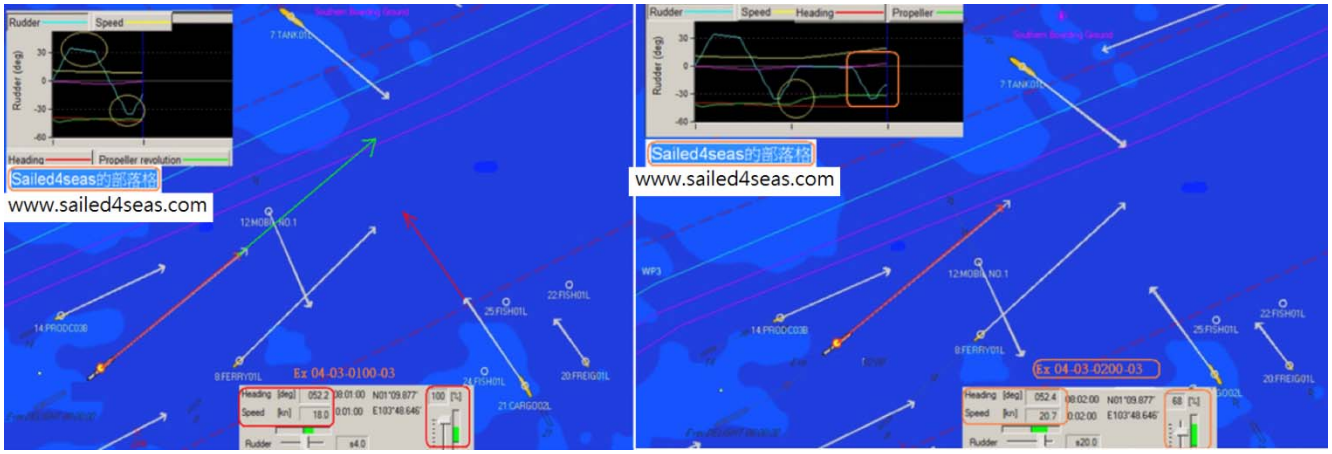
For a small crossing vessel, we have all the freedom to alter course to starboard side or port side or increase speed as long as Master understands what kind of collision risk is.

9-08 避碰知覺操演 -18 加速回轉

9-20 這些加車與轉向都浪費了

就像圖形 9-16 本船的速度 18.6 節，航向 063.8 度，在開始的時候，3 分鐘的速度向量線是 9.3CABLE 的距離長度。情勢知覺如下：

⇒ 右舷有兩條橫越船，距離未知。
⇒ 在右舷的被追越船跟本船同速。
⇒ 本船有 3 條左舷的橫越船，距離未知，
⇒ 左舷正橫的被追越船比本船慢。



圖形 9-22 本船的速度向量在 3/6 分鐘，在 1/2 分鐘操演過後

在 1 分鐘的操演過後，本船的速度是 18 節，這是從 18.6 節減速而來的。

- 主機的出力，在開始的時候，只有減了一點。本船的航向向左轉 11 度到 052.2 度，從 063.8 度，使用左滿舵已經 20 秒。
- 本船第一眼看到左舷的橫越船，就開始快速轉向，這就是沒有雷達瞭望的技術，而且也沒有花時間在目視的方位觀測。

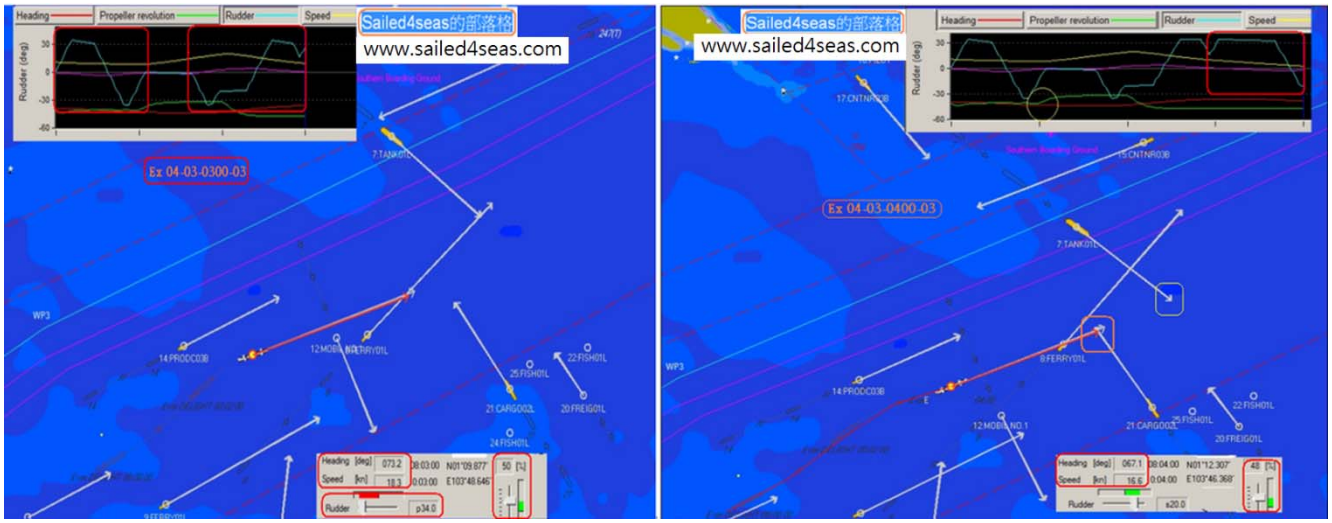
這個情勢知覺如下：

⇒ 本船再一次進入危險區域，因為左邊就是隔離區分道線，而且沒有減速，這個就是奇怪的地方。
⇒ 橫越船現在是在本船的船頭，因為我們已經左轉了 11 度。

⇒ 追越船在右舷，跟本船現在差不多是同樣的航向。
⇒ 本船可以通過右舷的第一條橫越船頭，在 6 分鐘之後，這是使用 6 分鐘速度向量線所看到的
⇒ 一條被追越船在左邊正橫是沒問題的，他比本船慢。
⇒ 第二條左舷的橫越船會通過本船的船頭，在 3 分鐘之後，這是 6 分鐘速度向量線得到的情報。

經過兩分鐘操演的時間之後，本船的速度是 20.7 節，這個呢是從 18 節開始增加的，現在主機的出力放在 100%。在一分鐘過後，本船增加主機的出力來增加舵效，右滿舵的舵效。本船的航向是穩定在 052.2 度，將近 1 分鐘，這是從 063.8 度，舵角是右滿舵，現在船長的意圖並不清楚，情勢的知覺如下：

⇒ 左舷一條橫越船已經通過本船船頭。一條右舷的追越船沒問題，因為兩條船現在幾乎是同向。
⇒ 本船能夠通過右舷第一條的橫越船船頭，在 4 分鐘之後，這代表了目標船會通過本船的船艉。
⇒ 左邊正橫的被追越船，仍然比本船慢，還是 OK 的。感覺起來 OK
⇒ 左舷的第二條橫越船，在另外一個航行巷道，會通過本船的船頭，在兩分鐘之後。這是我們估計速度向量線上碰撞點位置的技術。



圖形 9 之 23 速度向量線 3 分鐘，在 3/4 分鐘操演過後

在 3 分鐘操演時間過後，

⇒ 本船的速度是 18.3 節，再一次從 20.7 節減下來，主機的出力是 50%是在第 2 分鐘的時間設定的。主機的出力降低，在本船的船首向開始向右轉之後。
⇒ 本船的航向向右轉了 21 度，到 073.2 度，1 分鐘前是 052.2 度，跟 3 分鐘前的船首向是 63.8 度，使用右滿舵 30 秒，跟著左滿舵一分半鐘，這是在紅色方塊裡面。
⇒ 右舷的舵角是比較難操作，花的時間，整整比左舵快了 1 分鐘。
⇒ 本船已經有加速回轉，當主機的出力增加了 30 秒，向右轉的時候。
⇒ 然後船長使用左滿舵來壓著，並且降低主機出力 1 分半鐘，因為有一條船從右舷橫越過來。這是我們看到的

情勢的知覺如下

⇒ 本船航向突然改變到 073.2 度，從一分鐘前的 052.2 度，我們看到的
⇒ 左舷的橫越船現在在右船頭，中點對目標，只有一半的安全。
⇒ 一條追越船在船頭，正向隔離區前進，端點對終點，我們有兩分鐘的安全間隔。
⇒ 本船跟在右舷的橫越船，三分半鐘之後，有碰撞危機。這是端點對端點：3 分半鐘的碰撞時間。
⇒ 這個碰撞危機，我們應該要怎麼做？這個是我們要思考的
⇒ 一條被追越船在左舷，仍然慢於本船，沒問題。這是比較速度向量線的長度。

經過 4 分鐘操演的時間過後，

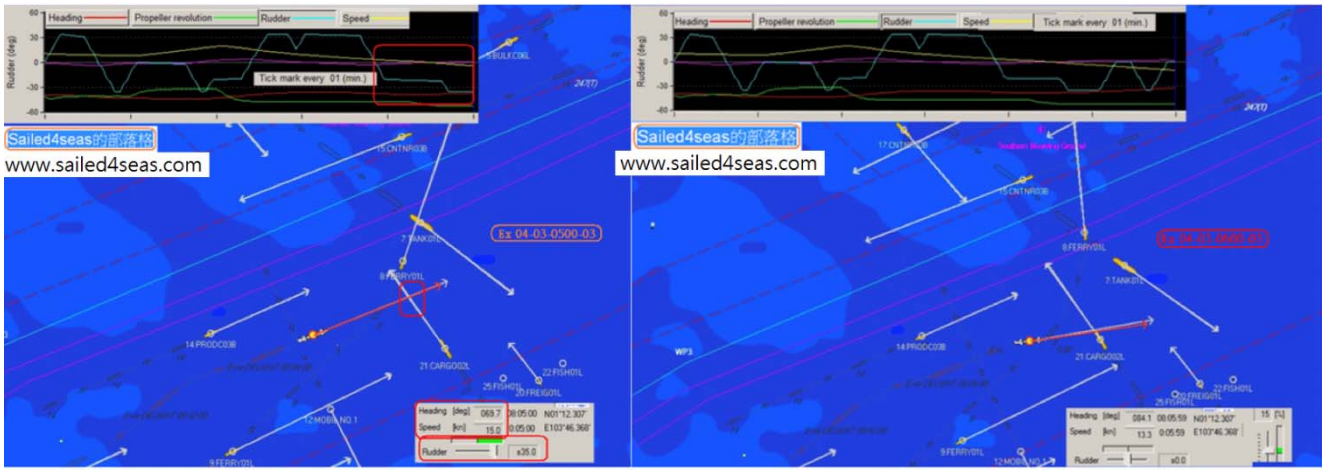
- 本船的速度是 16.6 節，再一次從 18.3 節，20.7 節減下來。
- 本船的航向向左轉了 6 度，從 073.2 度到 067.1 度 ，在 1 分鐘之前，現在已經停止使用左滿舵，因為本船已經向左轉，

情勢知覺如下

⇒ 航向向左轉 6 度，對解決右舷橫越船的碰撞危機，並沒有用。端點對端點：碰撞危機在 3 分鐘後
⇒ 回轉速率每分鐘 21 度，會增加失去控制的危險，在 3 分鐘的時間，這是我們的懷疑。
⇒ 一次加速的向右回轉，必須使用左滿舵，減車一分半鐘，使他穩定住。這是我們看到的
⇒ 現在船長沒有使用主機的出力，來穩定船隻的船首向，這是良好的選擇。
⇒ 在右舷的追越船，現在在本船的船頭，這是中點對目標，我們有兩分鐘的安全間隔。
⇒ 本船跟右舷的橫越船，在 3 分鐘後有碰撞危機。
⇒ 最後一分鐘本船減速，減了兩節的船速，但是對避碰沒有任何的效果。

對這個碰撞危機，我們應該怎麼辦？

⇒ 被追越船在左舷是 OK，比本船慢。
⇒ 在 4 分鐘的操演之後，本船又回到原來的碰撞區域，沒有一件事情有改變，4 分鐘的操船跟加減車都浪費了，請參考圖形 9-16 船長應該怎麼做，才能改進這種狀況？



圖形 9-24 本船的速度向量 3 分鐘在 5/6 分鐘的操演時間之後

在 5 分鐘的操演時間過後，

- 本船的速度是 15 節，從 16.6 18.3 節降下來，主機的出力是 50%，在第 2 分鐘，然後再 4 分半鐘的時候，進一步降低。但是這個時候減速，已經太晚了。
- 本船的航向又改變了兩度到 069 度，這是從 0 67.1 度來的，使用的舵角是“右舵 15 度”，然後是“右滿舵”，超過一分鐘的時間，現在船長對舵效更有耐心了一點，這個也是好的，這是我們的觀測。

情勢知覺如下：

⇒ 航向的改變緩慢，從 1 分鐘前的 067.1 轉到 069.7 度，所以本船是在第一階段的回轉。
⇒ 碰撞情勢沒有太大的改變，終點對中點：碰撞時間在兩分半鐘之後
⇒ 船長是幸運的，本船仍然有 3 分鐘的碰撞時間，碰撞危機非常明顯，從上一分鐘的操演時間，就已經察覺了。請參考圖形 9-23，所以船長仍然有時間去等待，產生舵效來回轉本船，這就是技術。
⇒ 一條追越的船隻通過本船的船頭，向左舷而去，這是上一分鐘的事情，這也是我們看到的。
⇒ 本船呢跟右舷的橫越船有碰撞危機，在 2 分鐘之後，而本船的船首向已經開始向右轉，這是我們看到的。
⇒ 減速 3.3 節，在這兩分鐘的時間，但是對避碰沒有任何實際的效果。這是我們看到的。
⇒ 本船使用右舵 15 度，40 秒時間，然後右滿舵 20 秒。
⇒ 航向的改變從 067.1 度到 069 度，對實際的避碰，也沒有什麼效果，這 1 分鐘的時間，對船長一定是非常痛苦的等待。

經過 6 分鐘的操演之後，

- 本船的航向向右改變了 15 度，轉到 084.1 度，從 1 分鐘的 069.7 度，使用了右滿舵 20 秒，然後正舵。
- 本船的速度是 13.3 節，再度從 15 節減下來，主機的出力，在第 2 分鐘減到 50%，在 4 分半鐘的時候，減到 15 %，到現在已經有一分半鐘的時間。

情勢知覺如下

⇒ 快速的向右改變航向，從上一分鐘的 069.7 度到現在 084.1 度，來改變碰撞危機。
⇒ 用航向的改變來避碰是 OK 的，是對第一條右舷的橫越船來講，如果本船不能停止回轉，在三分鐘後，將會跟另外一條小船發生碰撞。這是我們的觀測
⇒ 每分鐘向右轉 14 度的回轉速率是船長的技術嗎？技術就是知道本船的回轉特性。
⟹ 現在我們的工作，就是要趕快停止本船的迴轉，以免跟第二條橫越的小船，發生碰撞。

9 – 08 Collision Awareness Exercise – 18 Accelerated turning

9-20 What a waste in all these steering and engine output!

As figure 9-16 (this is the scene where double grounding case happened) Ownship speed is 18.6 knots and course is 063.8 degrees at beginning. With 3 minutes speed vector in 18.6 knots, this vector length is about 9.3 cables long. The situational awareness is:

1. Ownship have two crossing vessels at starboard side (red circle), distance unknown. (sighted)
2. One overtaken vessel at starboard side has same speed as ownship. (skill by comparing vector length)
3. Ownship have three crossing vessels at port side (yellow circle), distance unknown. (sighted)

4. One overtaken vessel at port side slower than ownship. (skill by comparing vector length)

The situational awareness with 6 minutes speed vector is:

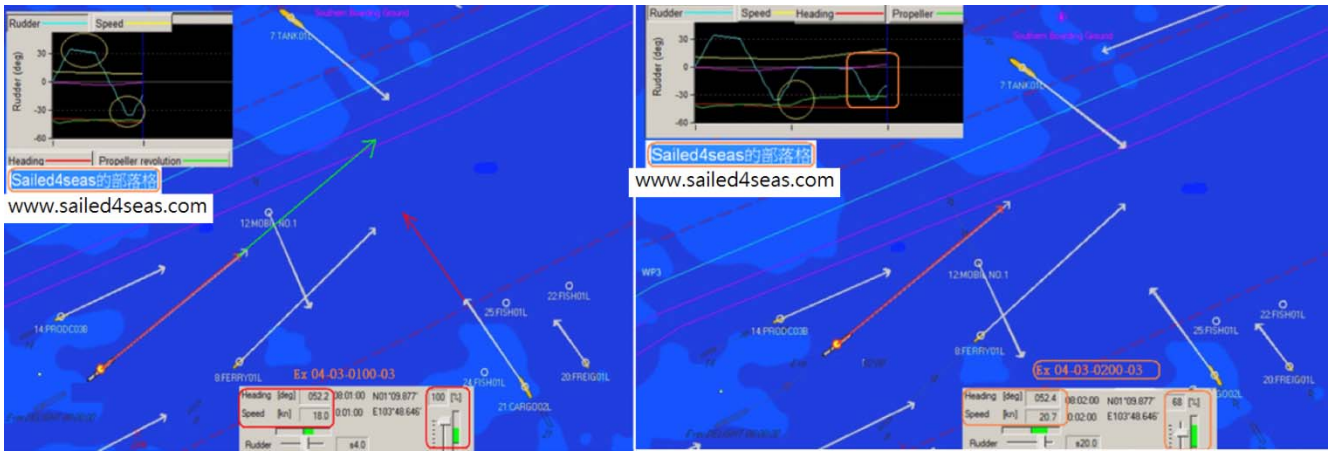


Figure 9-22 Ownship speed vector in 3/6 minutes at 1 and 2 minutes time

In figure 9-22 left picture, after 01minutes exercise time lapsed:

1. Ownship speed is 18.0 knots which had reduced from 18.6 kts with engine output reduced a little at beginning.
2. Ownship course is altered to port side 11 degrees to 052.2 (T) from 063.8 (T) with rudder angle "Hard Port" used 20 seconds. Ownship alter course at first sight of port side crossing vessel. This is an indication of no radar lookout skill and use no time for visual bearing check.

The situational awareness is:

- Once again, ownship headed into danger (separation zone) with no speed reduction. (suspect)
- Port side crossing vessel is at ownship bow now. (sighted)
- One overtaken vessel at starboard side is about same course with ownship. (sighted)
- Ownship has no problem with starboard side first crossing vessel. (skill by using 6 minutes vector)
- One overtaken vessel at port beam is OK. (slower than ownship))
- 2nd port side crossing vessel will pass ownship bow after 3 minutes. (skill by 6 minutes speed vector direction)

In figure 9-22 right picture, After 02 minutes exercise time lapsed:

- Ownship speed is 20.7 knots which had increased from 18.0 kts with engine output 100% after one minute. Increase engine output to increase rudder effect of hard starboard.
- Ownship course is steady in 052.2 for one minute from 063.8 degrees with rudder angle "Hard starboard" now (rudder effect is not good). Master's intention is not clear.

The situational awareness is:

- Port side 1st crossing vessel has passed. (sighted)
- One overtaking vessel at starboard side is far away now. (almost in same heading)

- Ownship can pass starboard side crossing vessel's bow after 4 minutes. (this means target vessel will pass ownship's stern)
- Port beam overtaken vessel is still slower than ownship. (sense as OK)
- Port side 2nd crossing vessel in westbound traffic lane will pass ownship bow after 2 minutes. (skill by estimating collision point on speed vector)

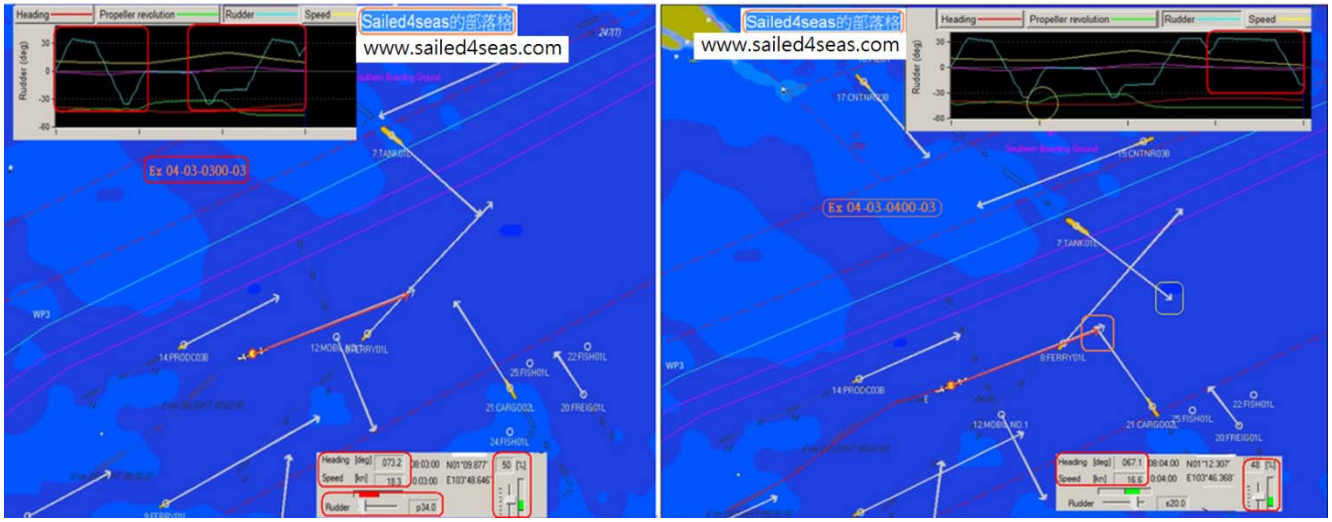


Figure 9-23 Ownship speed vector in 3 minutes at 3 and 4 minutes time

In figure 9-23 left picture, after 03 minutes exercise time lapsed:

1. Ownship speed is 18.3 knots again reduced from 20.7, 18.0 kts with engine output 50% after two minutes.
2. Engine output reduced after ownship heading change to starboard side.
3. Ownship course is altered 21 degrees to starboard side to 073.2 (T) from one minute before 052.2 (T), and three minutes before Heading is 063.8 (T) with rudder angle "Hard starboard" 30 seconds and "Hard Port" 1.5 minutes in red square. Turn to starboard side is hard (lee side).
4. Ownship had increased engine output 30 seconds to turn back to starboard side.
5. Then Master counter with Hard Port rudder with decreased engine 1.5 minutes for one vessel is crossing from starboard side right now. (sight)

The situational awareness is:

- Course change suddenly to 073.2 degrees from 052.2 degrees, one minute before.(sighted)
- First port side crossing vessel is at starboard bow now. (almost Middle to Target: Caution in turning)
- One overtaking vessel at starboard side is heading to separation zone. (end to middle, 2 minutes safety allowance)
- Ownship has collision risk with crossing vessel at starboard side after 3.5 minutes.(end to end in 3.5 minutes collision risk)
- What to do with this collision risk? (suspect: turn to portside or starboardside has different risk?)
- One overtaken vessel at port side is still slower than ownship. (skill by comparing vector length)

In figure 9-23 right picture, after 04 minutes exercise time lapsed:

- Ownship speed is 16.6 knots again reduced from 18.3, 20.7, 18.0 kts with engine output 50% after two minutes.
- Ownship course is altered 6 degrees to port side from 073.2 (T) to 067.1 (T) from one minute before. Stop using rudder angle "Hard Port" for ownship begin turning to port side now.

The situational awareness is:

- Course change to port side 6 degrees have no use in solving collision risk with starboard side crossing vessel. (End to End: collision risk in 3 minutes)
- Turning Rate 21 degrees per minutes increase the danger of lost control in last minute. (Suspect)
- Accelerated turn to starboard side had stopped by "hard Port" with reduced engine over 1.5 minutes (red square). (sighted)
- Now captain did not use engine output to steady the vessel. (good choice)
- One starboard side overtaken vessel sailed to separation line is at bow now. (middle to target, 2 minutes safety allowance)
- Ownship has collision risk with starboard side crossing vessel after 3.0 minutes. (end to end in 3 minutes)
- Last minute ownship had reduced speed about 2 knots with no actual effect on collision avoidance. (sighted)
- What to do with this collision risk? (suspect)
- One overtaken vessel at port side is OK. (slower than ownship)

After 4 minutes exercise time, ownship had coming back to original collision area with nothing had changed. What a waste in all these steering and engine output. Please refer to figure 9-16, what captain could do to improve this situation?

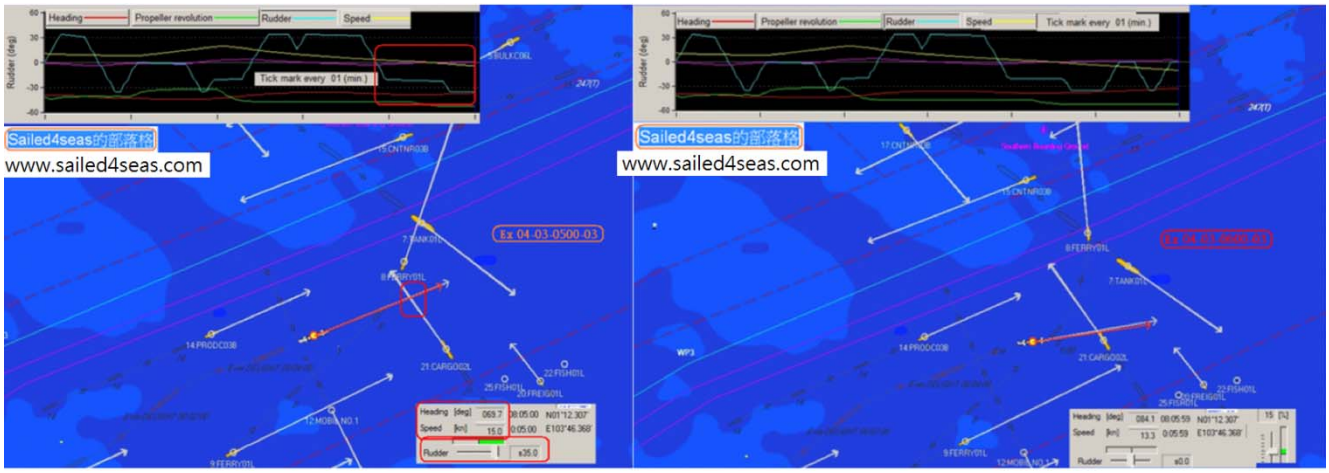


Figure 9-24 Ownship speed vector in 3 minutes at 5 and 6 minutes time

In figure 9-24 left picture, after 05 minutes exercise time lapsed:

1. Ownship speed is 15.0 knots again reduced from 16.6, 18.3, 20.7, 18.0 kts with engine output 50% after two minute and further reduce at 04 minute 20 seconds. (too late to reduce speed)
2. Ownship course altered 2 degrees to starboard side 069.7 (T) from 067.1(T). Using rudder angle "Starboard 15" then "Hard starboard "over one minute time. Now captain had more patience in rudder effect which is good. (sighted)

The situational awareness is:

- Course change slowly to 069.7 (T) from one minute before 067.1 (T).(sighted: Ownship is at 1st stage of turning)
- Collision situation had not so much changed (red square). (middle to middle, collision 2.5 minutes time))
- Captain is lucky that ownship still have three minutes time when collision risk is obvious in last minute exercise time. (refer to figure 9-23)
- So, captain still have time to wait for rudder to take its effect in turning. (skill)
- One overtaking vessel had passed ownship bow to port side since last minute. (sighted)
- Ownship has collision risk with starboard side crossing vessel after 2.0 minutes and ownship's heading already have starboard side turning rate now. (sighted)
- Ownship had reduced speed 3.3 knots over two minutes time with no actual effect on collision avoidance. (sighted)
- Ownship had used "starboard 15" 40 seconds and "hard starboard" 20 seconds rudder now. (sighted)
- Course changed from 067.1 (T) to 069. (T) with no actual effect on collision avoidance. (sighted)
- This minute must be very painful for captain. (suspect)

In figure 9-24 right picture, after 06 minutes exercise time lapsed:

- Ownship speed is 13.3 knots again reduced from 15.0, 16.6, 18.3, 20.7, 18.0 kts with engine output 50% after two minute and further reduce at 04 minute 20 seconds to 15%. (15% for 1.5 minutes)
- Ownship course altered 15 degrees to starboard side 084.1 (T) from 069.7, 067.1, 073.2 052 (T). Using rudder angle "Hard starboard " 20 seconds and midship.

The situational awareness is:

- Course change sharply to 084.1 (T) from last minute 069.7 (T) to avoid the collision.(15 degrees)
- Course change is OK to avoid the collision with 1st starboard side crossing vessel. But, if ownship cannot stop the turn it will have another collision risk after 3 minutes with a very slow vessel. (sighted)
- Is it OK for turning rate of 14 degrees per minutes to starboard side? (skill by knowing ownship maneuvering characteristics)
- The job now is to stop the turn immediately. (instinct)

9-21 三分鐘操船的提醒：先穩住，再減俥，一次機會

從這一個操演，我們必須提醒船長一些注意事項。

- 船長必須保持本船的船首向盡可能穩定。
- 船隻正在回轉時，本船就是增加回轉這一舷的碰撞危機
- 如果要減車，一定要先把船首向穩定下來再減車，否則容易失去控制。
- 主機開始減俥，或是停車時，船隻的舵效就變得非常不可靠。
- 準備 1 分鐘的時間，來等船隻對舵效有所反應。
- 一旦本船回轉進入第二階段，就有相當的回轉速率，船隻就很難立刻停下來。
- 當回轉開始的時候，必須等待 2 分鐘，才能讓反舵產生功效，也就是兩分鐘的時間，船首向才會開始反轉。

- 我們需要 1 分鐘時間啟動回轉，然後另外一分鐘讓他穩定在新的航向上，在 3 分鐘的速度向量線觀測，3 分鐘的操船時間內，我們只有一次機會，去選擇正確的船首向來避免碰撞。
- 每一次操船，必須要有事前計畫，在我們進入一個碰撞面危機的時候，在 3 分鐘的操船裡，只有一個船首向，可以正確的避免碰撞。如果沒有辦法決策，就是最好趁早離開碰撞面。

9-21 Reminders in last chance of 3 minutes maneuvering. Steady, reduce engine, only one shot.

From this exercise, we have to remind captain some safety concepts here.

- ♥ Captain should maintain ownship's heading as steady as possible to evaluate collision risk. (to counter the weather effect and excess rate of turn)
- ♥ When ownship is turning, ownship will increase collision risk in the side we are turning.
- ♥ Steady ownship heading before reducing speed otherwise ownship may lose control.
- ♥ Once engine reduced or stopped, ownship's rudder effect become very unreliable.
- ♥ Allow one minute time to have ownship response to the rudder in bad weather.
- ♥ Once vessel turning accelerated in second stage, it may very hard to steady it within next minute.
- ♥ When the turning started, at least another minute have to wait (or 2 minutes) for counter rudder to take effect.
- ♥ By using one minute to initial the turn and another one minute to steady, collision risk read in three minutes speed vector, we only have one chance to choose correct heading to avoid collision.
- ♥ So, every maneuvering should be planned well before entering a collision area.

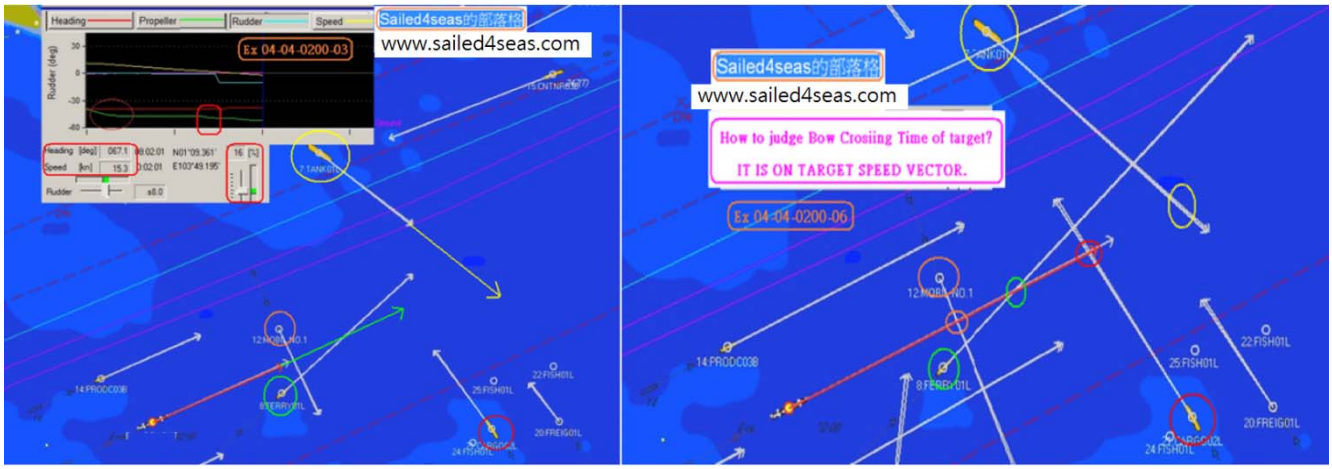
In three minutes maneuvering, we only have one heading available to avoid collision.

9-09 避碰知覺操演 – 19 輕鬆愉快

9-22 目標船通過本船船頭，取決於她的速度向量線動態

就像圖形 9-16，本船速度是 18.6 節，航向 063.8 度，3 分鐘速度向量線的距離長度是 9.3 CABLE，情勢知覺如下：

- 本船有兩條右舷的橫越船，紅色圓圈，距離未知。
- 右舷被追越船跟本船同速。
- 3 條左舷的橫越船，黃色的圓圈，距離未知。
- 左舷的被追越船比本船速度慢。



圖形 9-25 速度向量線 3/6 分鐘，2 分鐘的時間之後

經過兩分鐘的操演時間過後，

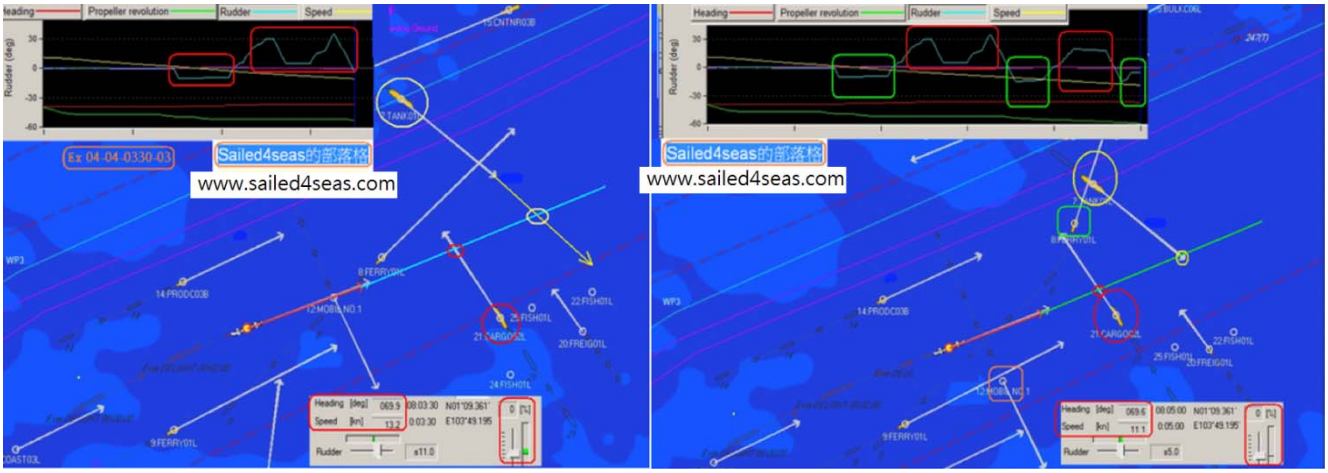
- 本船的速度是 15.3 節，這是從 18 節開始減下來。開始的時候主機出力減到 60%，在 1 分半鐘再減到 16%。
- 先降低主機出力，先然後觀察目標的方位變化，如果方位變化不夠，進一步的減低主機的船出力。
- 本船的航向向右轉了 4 度，到 067.1 度，“右舵 10 度”的舵角，

情勢知覺如下：

⇒ 左舷的橫越船將會通過本船的船頭，在 1 分鐘後，橘色圓圈，端點對中點，一半安全。
⇒ 右舷的追越船將本船的船頭通過，在 1 分半鐘後，端點對目標，三分鐘的安全間隔。
⇒ 碰撞點在目標船速度向量線上的位置，是她最後 3 分鐘的速度向量線的中點，這是我們的觀測。
⇒ 右舷橫越船有碰撞危機，5 分鐘之後，紅色的圓圈，端點對中點，一半的安全。
⇒ 本船的這一個碰撞點，在 5 分半鐘，安全間隔只有 0.5 分鐘，是不夠的，需要採取一些行動來避免碰撞。
⇒ 一條被追越船在左舷正橫，仍然比本船慢。
⇒ 第二條在左舷的橫越船會通過本船船頭，在 5 分鐘之後，黃色圓圈，這一條船跟本船沒有碰撞危機，在這 6 分鐘的時間。

目標船通過本船的船頭，取決於它速度向量線的動態，而不是取決於本船的速度向量線。請參考圖形 9 之 25。

⇒ 右舷的追越船在綠色的圓圈，會通過船頭，在一分半鐘的時間。
⇒ 左舷的橫越船在橘色的圓圈，一分鐘後會通過時間。
⇒ 右舷的橫越船在紅色圓圈，在 4 分半鐘後會通過。
⇒ 左舷的橫越船黃色圓圈，5 分鐘後會通過。



圖形 9 之 26 本船速度向量 3/6 分鐘 3 分半鐘跟 5 分鐘的時間之後

經過 3 分半鐘的操演之後

- 本船的速度是 13.2 節，這是從 15.3，18.0 節而來，出力從一開始的 60%，進一步降低到 16 %跟 0%。在第三分半鐘的操演時間後，船速仍然緩慢的減少。

- 本船的航向已經右轉 3 度至 069.9 度，從 067.1 度，06 3.8 度轉過來，使用“左滿舵”來停止向右舷的回轉，在最後一分鐘。

情勢知覺如下

⇒ 左舷橫越船已經通過，橘色圓圈。
⇒ 右舷追越船也已經通過，綠色方塊。
⇒ 右舷橫越船在兩分半鐘後會通過，紅色圓圈，端點對目標，三分鐘的安全間隔。
⇒ 左舷的橫越船通過本船船頭，在 4 分半鐘之後，黃色圓圈。這兩條船的速度向量線在 6 分鐘內，都沒有相交，表示在這 6 分鐘沒有碰撞危機。

9 – 09 Collision Awareness Exercise – 19 Nice and Easy

9-22 Target vessel pass ownship’s bow depends on her speed vector movement.

As figure 9-16 (this is the scene where double grounding case happened) Ownship speed is 18.6 knots and course is 063.8 degrees at beginning. With 3 minutes speed vector in 18.6 knots, this vector length is about 9.3 cables long. The situational awareness is:

1. Ownship have two crossing vessels at starboard side (red circle), distance unknown. (sighted)
2. One overtaken vessel at starboard side has same speed as ownship. (skill by comparing vector length)
3. Ownship have three crossing vessels at port side (yellow circle), distance unknown. (sighted)
4. One overtaken vessel at port side slower than ownship. (skill by comparing vector length)

The situational awareness with 6 minutes speed vector is:

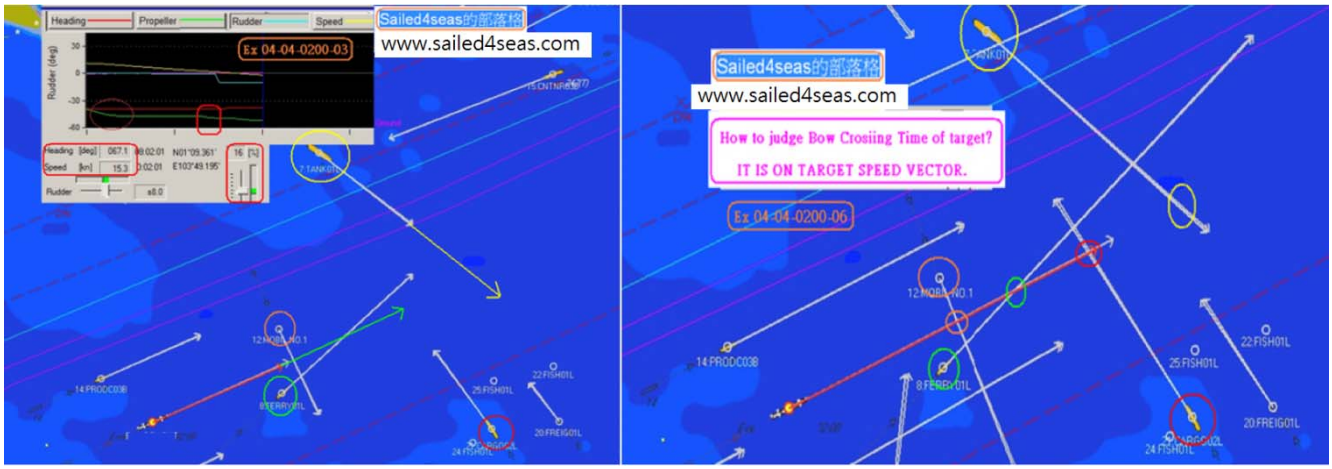


Figure 9-25 Ownship speed vector in 3/6 minutes at 2 minutes time

In figure 9-25 left picture, after 02 minutes exercise time lapsed:

1. Ownship speed is 15.3 knots which had decreased from 18.0 kts with engine output 60% reduced from beginning and further reduced to 16% at 1.5 minutes time.
2. Reduce engine first then observe the bearing change of target. If bearing change not enough reduce engine again.
3. Ownship course had altered 4 degrees to 067.1 degrees from 063.8 degrees with rudder angle “starboard 10” now.

The situational awareness is:

- Port side crossing vessel is about to pass ownship's bow after one minute (orange circle). (Middle to Target: Caution in turning)
- One overtaking vessel at starboard side is about to pass after 1.5 minutes (end to target, 3 minutes safety).
- Crossing vessel (red circle) at starboard side has collision risk after 4.5 minutes. (End to Middle. Caution)
- Ownship TTC time to collision to her is 6 minutes. (safety margin 1.5 minute which need great caution in actions to avoid collision)
- One overtaken vessel at port side is still slower than ownship. (skill)
- One crossing vessel at port side will pass ownship bow after 5 minutes (yellow circle). (no collision risk with her)
- The time target vessel pass ownship's bow depends on her speed vector movement; not depends on ownship speed vector.(refer to figure 9-25 right picture with 6 minutes speed vector. Collision points in their speed vector)
    - Starboard side green overtaking vessel in green ring will pass after 1.5 minutes.
    - Port side pink crossing vessel in orange ring will pass after 1.0 minutes.
    - Starboard side crossing vessel in red ring will pass after 4.5 minutes.
    - Port side crossing vessel in yellow ring will pass after 5.0 minutes.

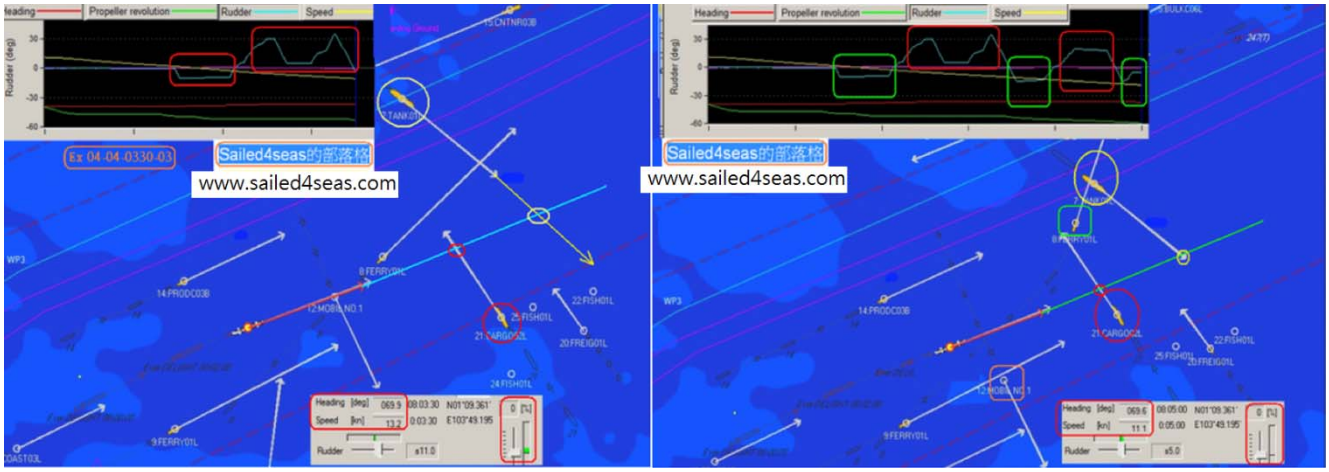


Figure 9-26 Ownship speed vector in 3/6 minutes at 3.5 and 5 minutes time

In figure 9-26, after 03 minutes 30 seconds exercise time lapsed:

1. Ownship speed is 13.2 knots which had decreased from 15.3, 18.0 kts with engine output 60% from beginning and further reduced to 16% and 0% since 1.5 minute before. Speed still reduced slowly.
2. Ownship course had altered 3 degrees 069.9 (T) to starboard side from 067.1, 063.8 (T). Ownship had used "Hard Port" rudder to stop the starboard side turning rate in last minute.

The situational awareness is:

- 1st Port side crossing vessel passed, at our bow. (sighted)
- 1st Overtaking vessel at starboard side passed (green square). (sighted)

- Red Crossing vessel at starboard side has no collision risk. (no collision point in 3 minutes speed vector)
- One crossing vessel at port side will pass ownship bow after 4.5 minutes (yellow circle). (No collision within this 6 minutes)

9-23 如果本船必須減速，最好先穩住船首向

經過 5 分鐘的操演時間過後，

⇒ 本船的速度是 11.1 節，13.2，15.3 ，18.0 節而來，主機的出力從開始減到 60%，然後是 16%，三分鐘前減到 0%。
⇒ 本船的航向是 069.9 度，這是從 067.1 度轉過來的，船長知道的很清楚，如果本船必須減速，最好先將本船的船首向先穩定住。
⇒ 雖然本船主機已經減速很久，但是本船仍然對船首向的控制良好，這是觀念正確，雖然已經停俥 3 分鐘。

情勢知覺是所有的船隻，現在都沒有碰撞危機，除了一條在分道航行制之外的慢速船隻，比較前一個船長花了那麼多時間跟精力，這一個操演是輕鬆又愉快，對一個年輕的當值船副，他不知道差別何在？他們曾經經歷過什麼樣的場面，但他總是能夠感覺得到，有些東西是不太一樣。

9-23 If ownship have to reduce speed it is better to steady ownship heading first.

In figure 9-26, after 05 minutes 00 seconds exercise time lapsed:

- Ownship speed is 11.1 knots which had decreased from 13.2, 15.3, 18.0 kts with engine output 60% from beginning and further reduced to 16% and 0 % since 3 minutes before.
- ♥ Ownship course is steady in 069.9 (T) to starboard side from 067.1 (T). This captain knows this well.
  "If ownship have to reduce speed it is better to steady ownship heading first."
- Although ownship had reduced engine for long time ownship is still in very well control of heading.

The situational awareness is: all vessels had no collision risk now except one slow vessel outside the TSS. Comparing with last captain wasted so many efforts, **this exercise is nice and easy**. For a young OOW,

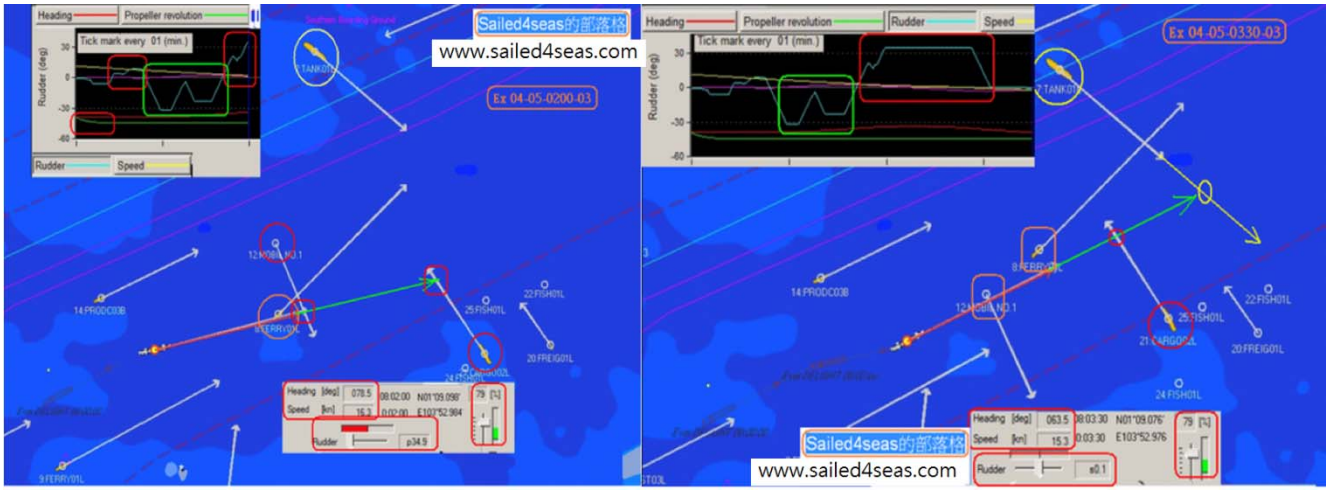
He cannot tell the difference but he can feel something is not the same.

9-10 避碰操演知覺 – 20 失去舵效

9-24 使用滿舵，並不代表會失去舵效

就像圖形 9-16 本船的速度是 18.6 節，航向 063.8 度，從開始的時候。3 分鐘的速度向量線長度是 9.3 CABLE 的距離。情勢知覺如下：

- 有兩條右舷橫越船，紅色圓圈距離未知。
- 右舷追越船跟本船同速。
- 左舷三條橫越船在黃色的圓圈，距離未知。
- 左舷正橫的被追越船比本船的速度慢。



圖形 9-27 速度向量線 3/6 分鐘 操演兩/三分鐘之後

在兩分鐘操演的時間過後，速度是 16.3 節，從 18 節減下來的，主機的出力，從開始的時候降到 79%。本船的航向右轉 15 度到 078.5，從 063.8 度而來，使用右舵 20 度跟右滿舵，在第一分鐘的時間，現在的舵角是左滿舵。

情勢知覺如下：

⇒ 本船將右舷的追越船當作第一優先來避碰，雖然她比本船的速度要快，本船降低主機的出力到 79%，使用大舵角“右舵 20 度”跟右滿舵向右轉，現在本船使用左滿舵的舵角，也許船長注意到左舷的橫越船。
⇒ 左舷的橫越船在 3 分鐘後有碰撞危機，這是紅色圓圈的船隻，端點對端點。
⇒ 右舷追越船會通過本船的船頭，是沒問題的。橘色圓圈
⇒ 另一條右舷的橫越船會通過本船船頭，在 3 分鐘後，紅色圓圈的，這是使用 6 分鐘速度向量線的技術。
⇒ 一條被追越船在左舷正橫，比本船慢的，是 OK。
⇒ 1 條左舷的橫越船在黃色圓圈內，現在很遠很難講，先不管他。

在 3 分半鐘的操演時間過後，

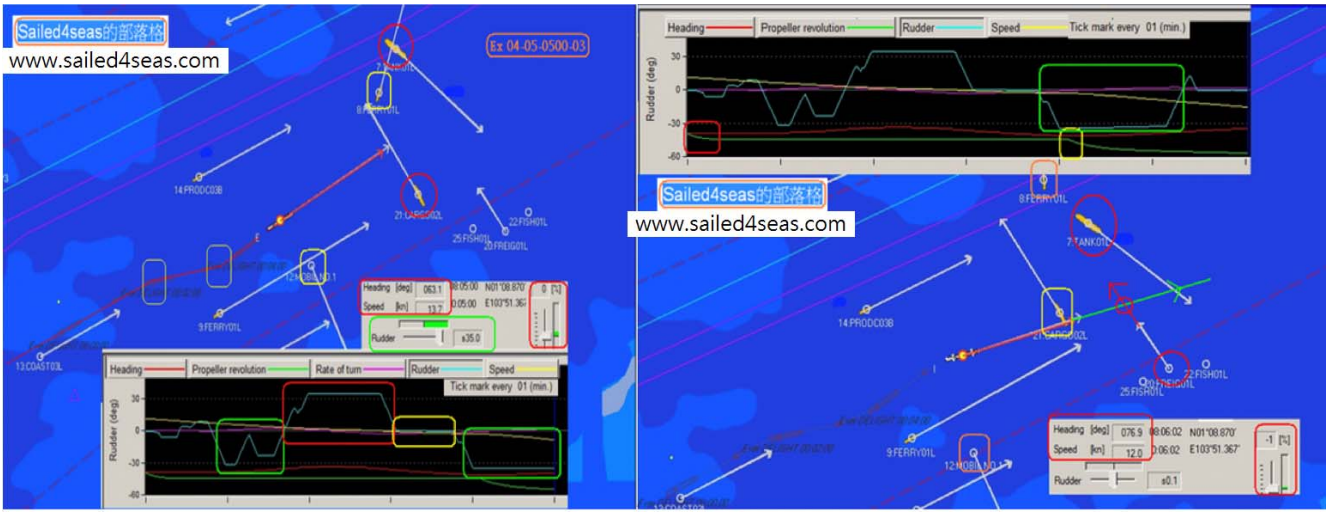
- 本船的速度是 15.3 節，這是從 16.3，18.0 節減下來的，主機的出力，仍然是開始時的 79%。
- 本船的航向左轉 15 度到 063.5 度，從 078.5 度轉來，右舵 20 度，右滿舵，使用一分鐘，左滿舵，在第 2 分鐘使用，

情勢的知覺如下：

- 本船減速的非常慢，只少了一節的船速，現在可能在做迴圈舵的操作，因為使用了滿舵。
- 左舷的橫越船要通本船船頭的時候，本船就“正舵”了，中點對目標，只有一分半鐘的安全間隔。
- 滿舵並不代表失去對船速與航船首向的控制，這就是船藝。
- 船長控制回轉速率，在每分鐘 15 度，這是堅強的信心。

⇒ 右舷追越船已通過本船的船頭，這是橘色的方塊船隻。

⇒ 右舷的橫越船將會在兩分半鐘後通過，這是紅色圓圈，可能的端點對目標，3 分鐘的安全間隔。
⇒ 左舷的橫越船將要通過本船船頭，在 4 分半鐘，就是黃色圓圈，這是端點對中點，1 分半鐘的安全間隔。



圖形 9-28 速度向量線 3/6 分鐘 6 分鐘之後

在五分鐘的操演時間過後。本船的速度是 13.7 節，這是從 15.3，16.3， 18.0 節而來，因為主機的出力，開始時是 79%，在最後一分鐘前，減到 0%，本船的航向穩定在 063.5 度，在左滿舵的操作之後。“正舵”一段時間了，然後再度使用右滿舵，也已經有 1 分鐘了。

9-25 先穩定船首向然後停止主機的出力

情勢知覺是：

- 本船停止主機的出力，已經有 1 分鐘的時間，這一分鐘的時間，並不足以減速，或是改變航向。這是我們所知道的。
- 應該穩定本船的航向，在停止主機出力之前。
- 這是對領港的一般通則，但是對當值船副或是船長，卻是不太瞭解這一點，港內操船，這是一個重點。

⇒ 本船也許擔心右舷的橫越船。因為安全間隔只有 1 分半鐘，就像 1 分鐘前所預測的。
⇒ 經過了 1 分半鐘，兩條橫越船，一條從左舷，一條從右舷會通過本船的船頭，這是我們的技術。
⇒ 本船航行的軌跡，顯示我們對航向的控制非常精確，這是我們看到的。
⇒ 船長以一般航道流通的相同方向前進，只有移動船位（黃色的方塊）來避免碰撞。

在操演 6 分鐘過後，

- 本船的速度是 12 節，這是從 13.7，15.3 ，16.3，18.0 節而來，主機的出力 79%，然後進一步在第 4 分鐘降到 0%，速率是每分鐘減 1.7 節。
- 本船的航向向右轉 14 度，現在是 076.9 度，從 063.1，078.5，063.8 使而來，現在用的舵角是右滿舵，

情勢知覺如下：

⇒ 本船使用了 1 分鐘的右滿舵，以每分鐘 14 度的速率向右轉向，雖然主機的出力是 0%。

⇒ 在這船長製造了兩個新的碰撞危機，跟右舷的橫越船跟右船艉的追越船，本船使用右滿舵 1 分鐘。主機的出力在最後兩分鐘是 0%，這是我們看到的。

⇒ 本船再一次右轉了 14 度，也是我們看到的，**向右舷做滿舵回轉是沒有必要的，如果在第五分鐘的操演時間，船長具有雷達瞭望的技術**。因為那時候的情況是端點對中點，具有 1 分半鐘的安全間隔。

⇒ 在船首向 076.9 度，本船創造了新的碰撞危機，跟在航行巷道之外的船隻，跟右舷的一條慢速橫越船與一條快速追越船。

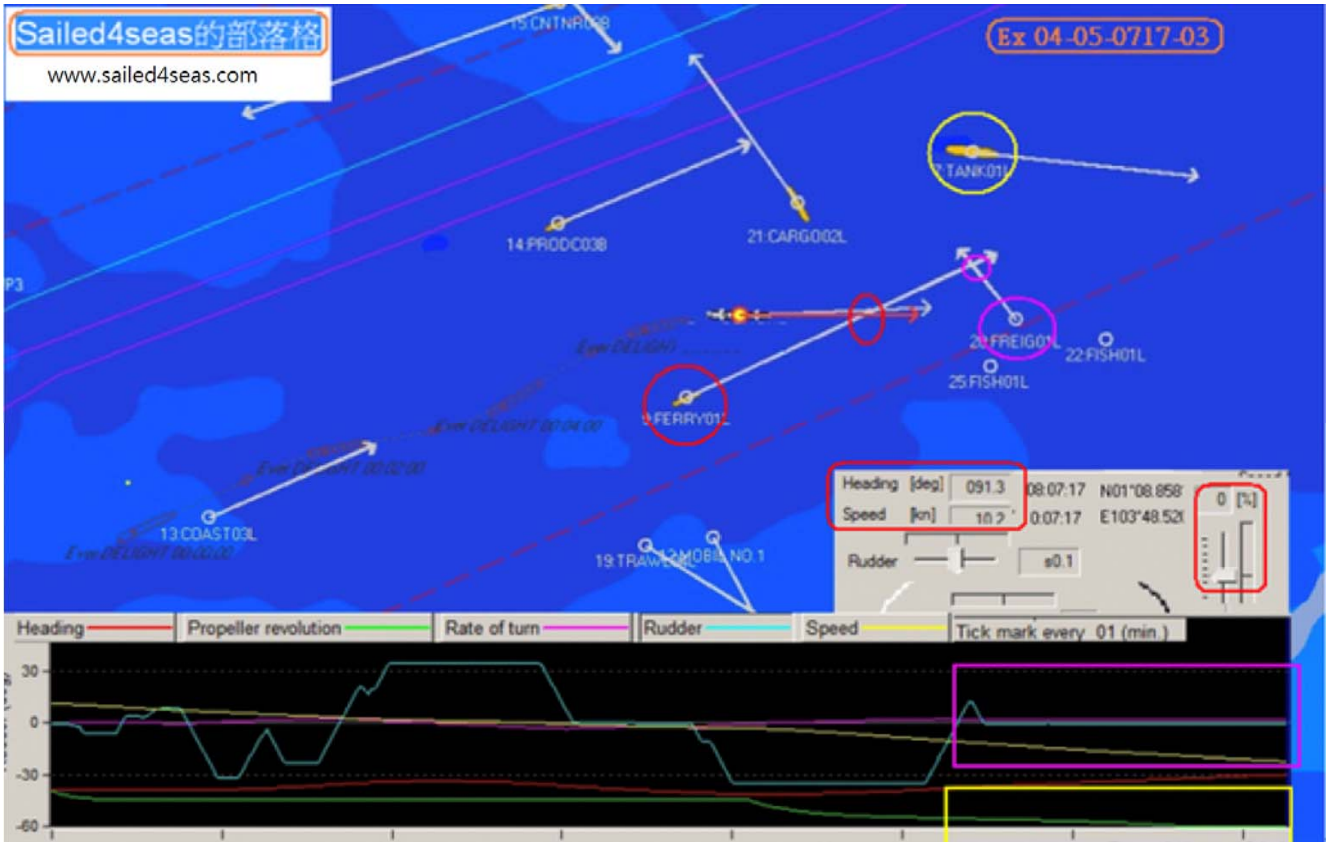
⇒ 雖然船長的操舵技術不錯，但是基本的概念還是不夠，船首向在第的 5 分鐘的時間，已經是在最完美的航向。

⇒ 再轉向跟其他船隻產生碰撞危機，這是我們在第 5 分鐘做的雷達瞭望不佳。

⇒ 在 4 分半鐘之後，右舷的橫越船跟本船有碰撞危機，這也是追越船會追上本船的時間，這是使用 6 分鐘速度向量得知。

⇒ 本船應該把船首向，儘快的穩住，然後檢查右舷目標船的情況如何？這是我們懷疑的地方。

⇒ 對於限制水域裡面的慢速船隻，使用安全的相對方位概念，可以通過慢速船隻的船頭，也許是更適當的，但也不能確定行不行。



圖形 9-29 速度向量線 3 分鐘 在 7 分半鐘的操演時間過後

經過 7 分 17 秒的操演時間過後，船速是 10.2 節，這是從 12 節來的，主機出力維持在 0%，已經 3 分鐘。速度降低的效率，是每分鐘 1.7 節，在最後 3 分鐘。航向右轉 14 度到 91.3 度，從 076.9 度，063.1 度，“正舵”已經超過兩分鐘，回轉速率仍然是每分鐘 14 度，這個回轉速率維持了兩分鐘，雖然沒有任何主機的出力與排出流。

9-26 失去舵效的程式，主機短進俥增加舵效

情勢知覺如下：

⇒ 以每分鐘 14 度的回轉速率，本船再一次向右舷快速轉向，這是我們看到的，是失去本船船首向控制的徵兆。**術語叫做“鐵達尼效應”：沒有主機的排出流的協助下，進行滿舵回轉產生的效應**

⇒ 本船在 063 度的時候，對船首向控制得很好，當時主機的出力是 79%，現在本船已經對任何舵角，沒有反應，當主機的出力，在最後的 3 分鐘時間，減到了 0%。

⇒ 碰撞危機跟在航道之外的慢速船，已經清除，因為本船的回轉，這是我們看到的。速度相量線已經沒有相交，但是這一條船可能不會進入分道航行制之內。 這條船就跟雙擱淺案件裡面的那條工作船一樣，只是沿著航行巷道的外緣航行。

⇒ 船長使用滿舵非常順手。但是對失去舵效，如何處理的經驗不足，失去舵效跟舵機失效不同，舵機失效是操舵的機械失去功能。失去舵效是船隻對於舵角不會產生回轉，滿舵也不會產生任何反應。

⇒ 本來應該向左快速轉向，在使用左滿舵之後，並沒有辦法使本船產生向左的回轉。

⇒ **如果沒有主機的出力，我們需要將主機短暫快速的進車，來啟動向左舷轉向的動量，這些就是失去舵效的程式**。如果只有一分半鐘時間，也許不能及時轉向左邊。

⇒ 右邊的追越必須採取行動來避免碰撞，這是我們懷疑的地方。

⇒ 在航向 091.3 度，**這個是與航道的一般流通方向，相差將近 30 度，這是明顯的有問題**。

⇒ 這樣本船的側面積會變得巨大，而且擋倒追越船的航路，本船應該加車，然後使用左滿舵，立刻啟動快速的向左轉向，來避免追越船隻從右船尾而來，來只要能夠快速地回到原始航向，對航道外面的橫越船的碰撞危機，並不是問題。以安全相對對方位的概念來說。

⇒ 但是本船現在已經對船首向失去控制，並且有很大的危險。

9 – 10 Collision Awareness Exercise – 20 Lost Steerage

9-24 Hard Over Rudder is not necessarily come with lost control of ownship.

As figure 9-16 Ownship speed is 18.6 knots and course is 063.8 degrees at beginning. With 3 minutes speed vector in 18.6 knots, this vector length is about 9.3 cables long. The situational awareness is:

1. Ownship have two crossing vessels at starboard side (red circle), distance unknown. (sighted)
2. One overtaken vessel at starboard side has same speed as ownship. (skill by comparing vector length)
3. Ownship have three crossing vessels at port side (yellow circle), distance unknown. (sighted)
4. One overtaken vessel at port side slower than ownship. (skill by comparing vector length)

The situational awareness with 6 minutes speed vector is:

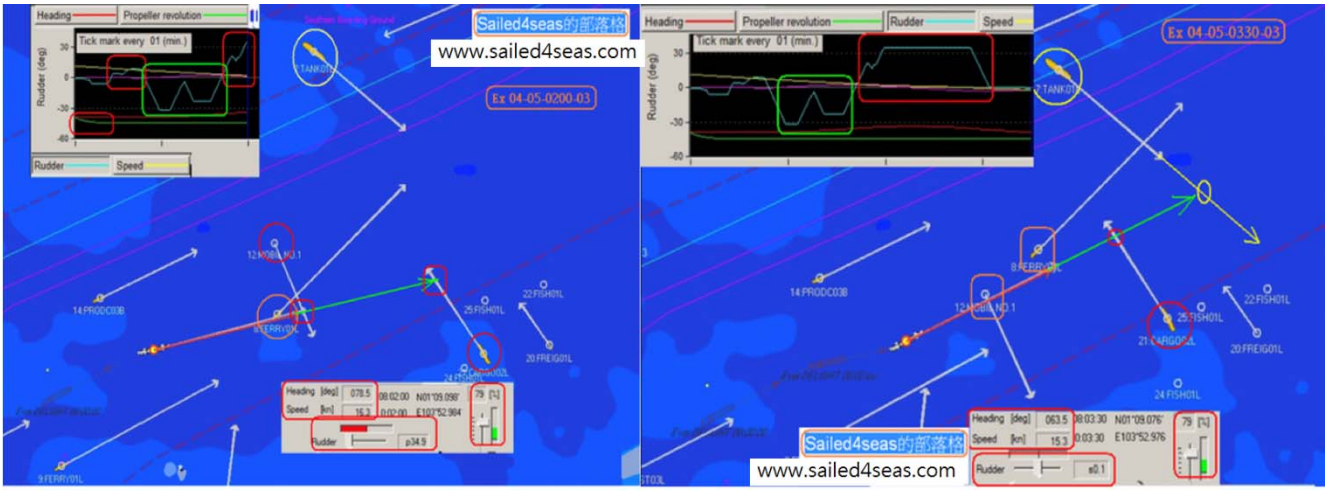


Figure 9-27 Ownship speed vector in 3/6 minutes at 2 and 3 minutes time

In figure 9-27 left picture, after 02 minutes exercise time lapsed:

1. Ownship speed is 16.3 knots which had decreased from 18.0 kts with engine reduced output 79% from beginning.
2. Ownship course had altered 15 degrees starboard side to 078.5 (T) from 063.8 (T) with rudder angle "starboard 20" and "Hard Starboard" at one minute time, right now is hard port.

The situational awareness is: ownship take starboard side Orange overtaking vessel as first priority in collision avoidance although she is faster than ownship. (Wrong assumption, No skill)

- Ownship reduced engine output a little to 79% and bold rudder angle "starboard 20" and "Hard starboard" used. (sighted)
- Right now ownship use " Hard Port" rudder decisively. (maybe port side crossing vessel come to captain's attention.)_
- Red Port side crossing vessel is in collision risk after 3 minutes. (end to end, refer to 9-08)
- Orange overtaking vessel at starboard side passed ownship bow is OK. (end to target)
- 2nd Crossing vessel at starboard side has no collision risk (red circle). (skill)
- One overtaken vessel at port side still slower than ownship is OK. (sense)
- One crossing vessel at port side is hard to say now (yellow circle). (just leave it now)

In figure 9-27 right picture, After 03 minutes 30 seconds exercise time lapsed:

1. Ownship speed is 15.3 knots which had decreased from 16.3, 18.0 kts with engine output 79% from beginning.
2. Ownship course had altered 15 degrees port side to 063.5 (T) from 078.5, 063.8 (T) with rudder angle "starboard 20" / "Hard Starboard" one minutes and "Hard Port" over one minute.

The situational awareness is:

- Ownship reduced speed slowly. (sighted only one knot less)
- Ownship might do rudder cycling maneuvering now. (Hard over rudder used)
- Ownship had midship the rudder after port side crossing vessel about to pass ownship's bow. (Middle to Target, Caution 1.5 minutes)

- Hard over Rudder is not necessarily come with lost control of ownship. (seamanship)
- Captain controls the turning rate within 15 degrees per minutes with confidence. (sighted)
- One overtaking vessel at starboard side passed ownship bow (orange square). (sighted.)
- Crossing vessel at starboard side is OK (red circle). (no collision point in 3 minutes)
- One crossing vessel at port side is about to pass ownship bow after 4.5 minutes (yellow circle). (end to middle by last 3 minutes speed vector, 1.5 minutes margin, caution)

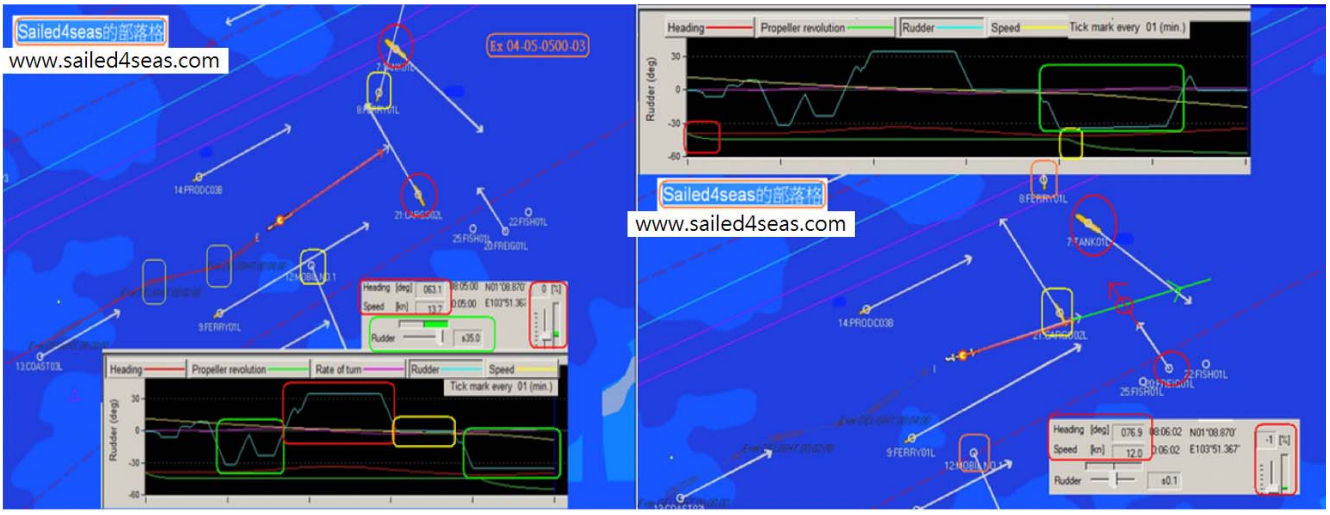


Figure 9-28 Ownship speed vector in 3/6 minutes at 5 and 6 minutes time

In figure 9-28 left picture, after 05 minutes 00 seconds exercise time lapsed:

1. Ownship speed is 13.7 knots which had decreased from 15.3, 16.3, 18.0 kts with engine output 79% from beginning and further reduce to 0% over last minute.
2. Ownship course is steady at 063.5 (T) after "Hard Port". Ownship midship the rudder for some time and "hard Starboard" again for one minute already.

9-25 Steady the course before stop engine.

In figure 9-28 left picture, The situational awareness is:

- Ownship stopped engine output for one minute with 0%. (sighted)
- One minute time is not enough for speed reduction or course changing. (sense)

Steady the course before stop engine.

- This is basic seamanship to Pilot but not so familiar to OOW and Master.
- Ownship may worry about starboard side crossing vessel. (ownship safety margin time is 1.5 minutes as predict one minute ago)
- After 1.5 minutes, two crossing vessels: one form port side and one from starboard side will pass ownship bow (red ring). (end to middle, caution)
- Ownship sailing track had shown very precise control of our course line (yellow line in maneuvering box). (sighted)
- Master proceeded with general direction of traffic lane only shift position to avoid collision point.

In figure 9-28 right picture, After 06 minutes 02 seconds exercise time lapsed:

1. Ownship speed is 12.0 knots which had decreased from 13.7, 15.3, 16.3, 18.0 kts with engine output 79% from beginning and further reduce to 0% in last 2 minute. Reducing rate is 1.7 knots per minutes.
2. Ownship course is altered 14 degrees to starboard side 076.9 (T) from 063.1, 078.5, 063.8 (T) with rudder angle "Hard Starboard".

The situational awareness is:

- With one minute in "Hard Starboard" ownship did it again- alter 14 degrees per minute to starboard side although engine output is 0%.
- Here Master had created two more collision risks with starboard side crossing vessel and starboard quarter overtaking vessel.
- Ownship used "Hard Starboard" one minute and 0% engine output in last 2 minute. (sighted)
- Once again, ownship conducts sharp turn 14 degrees to starboard side. (sighted)
- Hard over Rudder to starboard side is not necessarily if master has radar lookout skill in 5 minutes time. (End to Middle: Caution 1.5 minutes)
- In this heading 076.9 (T) ownship create new collision risk with vessel outside the traffic lane (starboard side) and collision risk with starboard side overtaking vessel. (once slower and now is faster)
- Although captain is good at steering but the basic concept is not enough. (Ownship already in perfect course at 5 minutes time.)
- Not necessary course change will create new collision risk with another vessels. (sense)
- After 4.5 minutes, starboard side crossing vessels will have collision risk with ownship. it is about the time overtaking vessel will catch us too. (skill by using 6 minutes vector)
- Ownship should steady the heading as soon as possible and check the situation with starboard side target vessel. (suspect)
- For slower vessel in confined area use SRB safety relative bearing concept to pass slower vessel's bow may be more appropriated. (suspect)

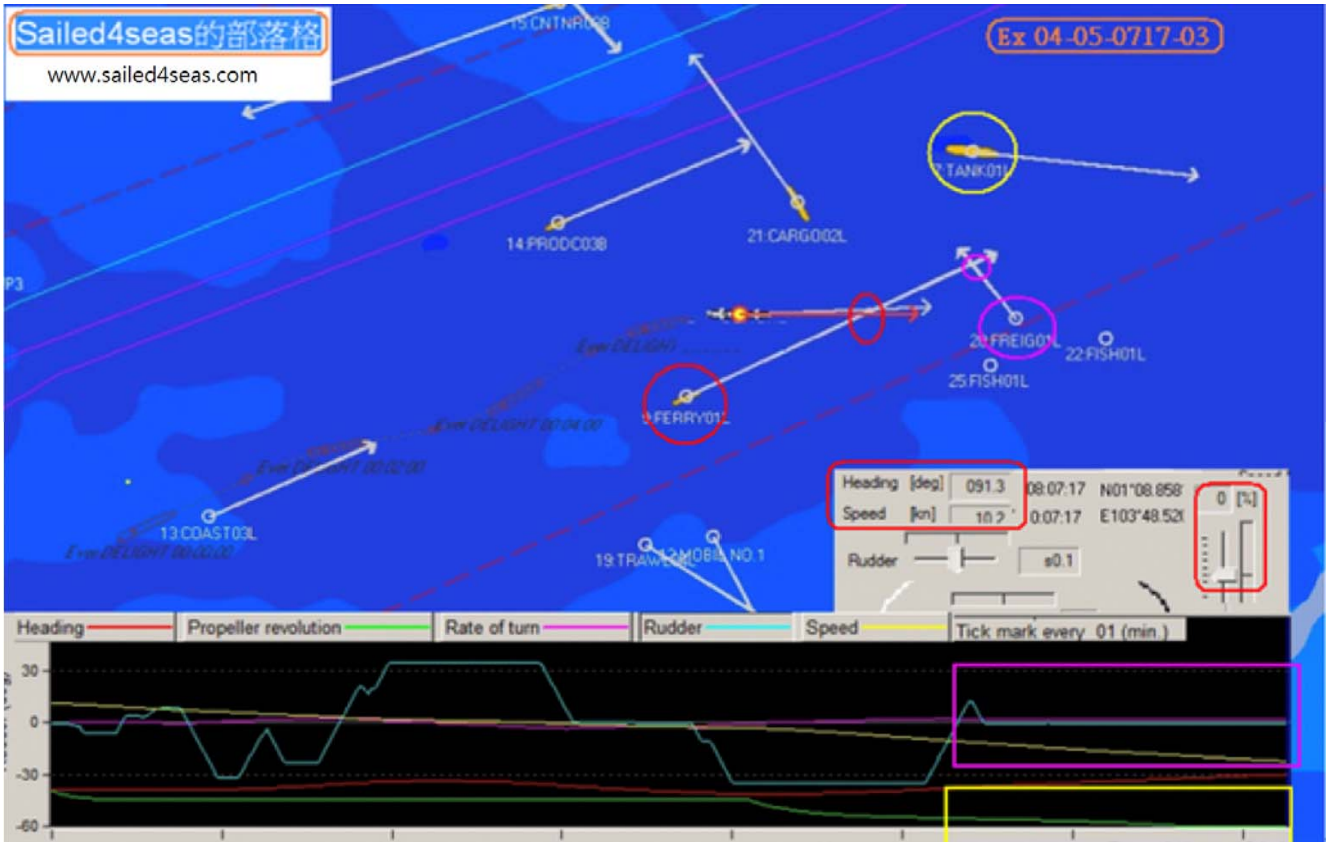


Figure 9-29 Ownship speed vector in 3 minutes at 7.3 minutes time

In figure 9-29, After 07 minutes 17 seconds exercise time lapsed:

1. Ownship speed is 10.2 knots which had decreased from12.0, kts with engine output to 0% in last 3 minute. Speed reducing rate is about 1.7 knots per minute in last three minutes.
2. Ownship course is altered 14 degrees to starboard side 91.3 (T) from 076.9, 063.1(T) with rudder angle "midship" in last two minutes. turning rate is 14 degrees per minute. This turning rate has last two minutes although no engine output.

9-26 Lost steerage procedures: Kick engine ahead to increase rudder effect.

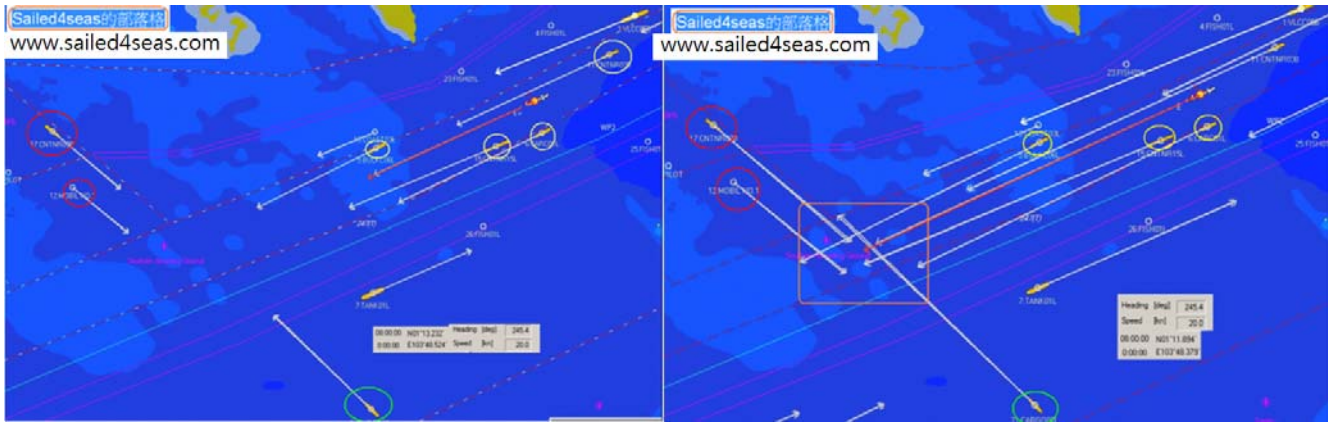
The situational awareness is:

- Once again, ownship conducts sharp turn with 14 degrees per minutes turning rate. (sighted)
- This is a sign of lost control of ownship's heading what they called **Titanic Effect while vessel has No engine expels current to assist Full rudder's turning effect.**
- Ownship had controlled the heading well in 2 minutes time at 063^0 (T) while engine output is 79%. But, now ownship will not response to any rudder order effectively with engine output reduce to 0% in last 3 minute.
- New collision risk with vessel outside the channel is cleared due to ownship turning. (sighted in speed vector but she may not enter TSS)
- Collision risk with starboard side overtaking vessel is imminent in 1.5 minutes. (sighted)
- Captain is good at Hard over rudder and speed control but the experience of lost steerage is not enough. Lost steerage is not the same as lost steering which is refer to lost steering gears. Lost steerage is vessel not response to hard over rudder order in time.

- Ownship should conduct sharp turn to port side. Only Hard Port rudder will not turn ownship when there is no engine output. **We need to kick engine ahead to start the turn to port side immediately.** (Emergency maneuvering.) Only 1.5 minutes time may not enough to alter course to port side in time.
- Kick engine ahead might be condemned in final collision verdict as COLREG violation. (in court, they say safe speed, not safe course.)
- For Starboard side overtaking vessel, we have to take action to avoid collision. (suspect)
- Ownship is on course of 091.3 (T) now which is about 30 degrees against general direction of traffic lane. (sighted)
- Ownship will create broader profile in our ship's hull and block the headway of overtaking vessel. (sighted).
- Ownship should increase engine and Hard Port rudder immediately and conduct sharp turn to port side to avoid the overtaking vessel from starboard quarter. (sense)
- Ownship has lost control of heading and in great danger now.

9-11 避碰知覺操演 21 7 條船通過碰撞面

9-27 解讀本船在碰撞面裡的位置



圖形 9-30 速度向量線在 3/6 分鐘在開始的時候

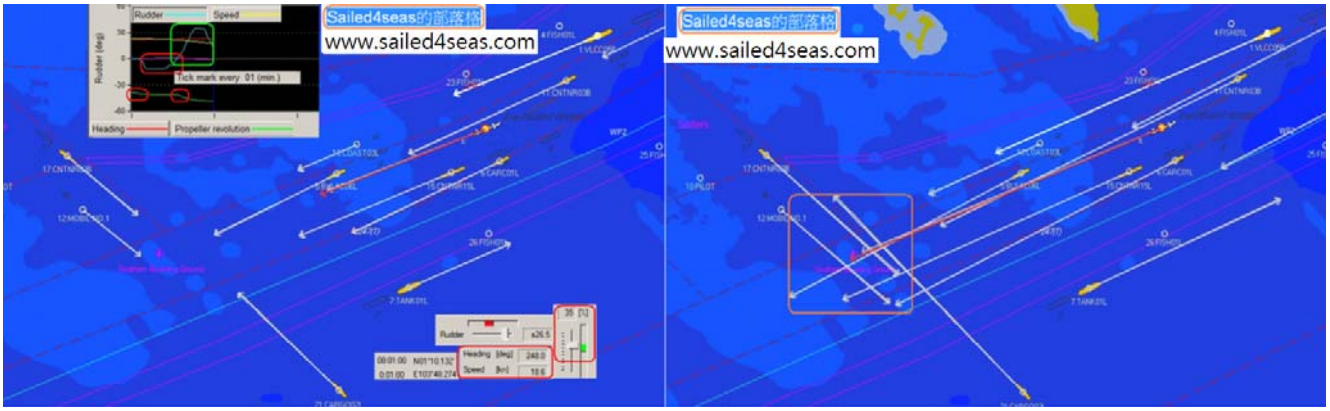
請參考圖形 9-30 本船的速度是 20 節，航向是 254.5 度,在開始的時候,情勢知覺如下：

⇒ 在右舷有兩條橫越船，紅色圓圈，距離未知。
⇒ 右船頭一條被追越船，速度比較慢。
⇒ 左舷一條橫越船，綠色圓圈，距離未知。
⇒ 兩條被追越船在左舷，比本船慢，這是比較 6 分鐘速度向量線。
⇒ 使用 6 分鐘速度向量線以後，我們發現一個碰撞面的危機，總共有 7 條船在碰撞面裡面，圖上的橘色方塊。

我們沒有時間記得哪一條船在前面？還是後面？還是左邊來？還是右邊去？這個我們只能懷疑。本船隻知道這裡有一個碰撞面，需要回避要去避開。不是哪一條船，這個是我們現在應該要有的常識，或是感覺。

♥ 那本船要怎麼走呢？可能要使用我們的直覺，沒有速度向量線，或是安全間隔，或是其他任何的概念，可以幫助我們。

- ♥ 向右走，就是跟左舷的橫越船（綠色圓圈）競爭海域，因為那就是他們要走的地方。
- ♥ 向左走，我們又是在跟右舷的橫越船（紅色圓圈）在競爭安全水域，這都是我們看到的。
- ♥ 要做一個 360 度的回轉？航行巷道裡面還有很多的其他船隻，就會牽涉到太多的碰撞危機。
- ♥ 本船唯一的選擇，就是儘快地減速，然後慢一點到達碰撞面的危機，這是我們思考的地方。
- ♥ 避碰的知覺：在碰撞面裡面，在這個情形下，本船的位置應該何在？



圖形 9-31 速度向量線 3/6 分鐘 在 1 分鐘時間過後

1 分鐘的操演時間過後，本船的速度是 18.6 節，這是從 20 節減下來的，主機的出力減了兩次，開始的時候減到 65%，然後在 30 秒的時間進一步減低到 35%，應該是相當於慢速前進速度。降低的速率是 1 分鐘的時間減 1.4 節。

本船的航向向右轉了 2.6 度，到 248 度從 245.4 度，使用迴圈舵，右舵 10 度跟左滿舵，在最後的 1 分鐘。

9-28 判斷在碰撞面裡，本船的碰撞危機

3 分鐘速度向量線給我們的情勢知覺如下：

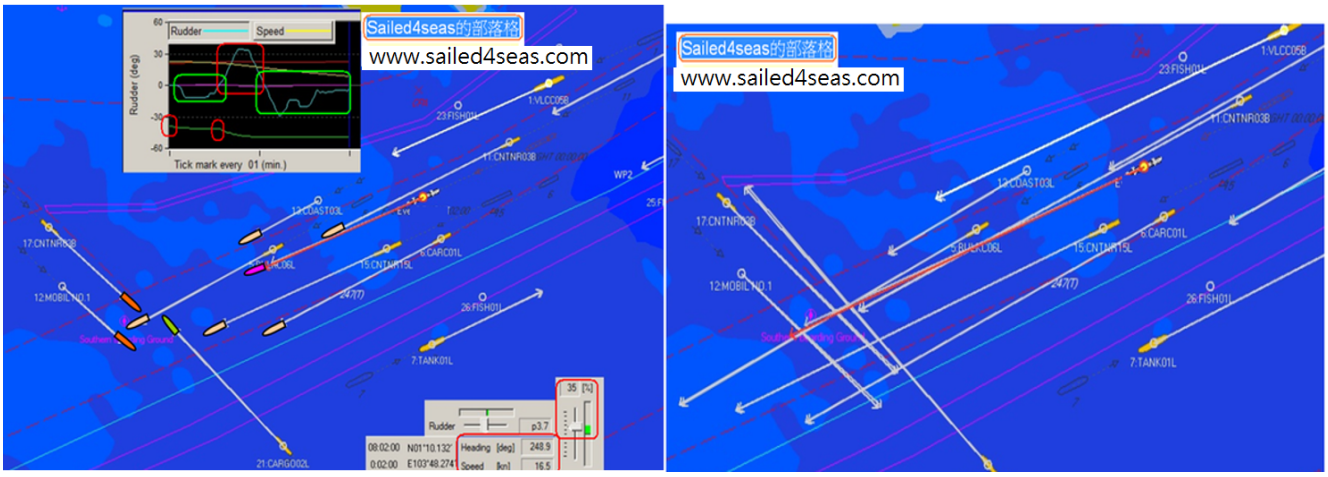
右舷的橫越船比左舷靠近，右舷的橫越船比左舷的速度來得快，如果本船必須使用迴圈舵，從左舷來做是比較合適，何況右舷還有兩條追越船很近，這是就速度向量線的位置長短來判斷，這是直覺。

6 分鐘速度向量線的情勢知覺如下：

與 3 分鐘速度向量線，就速度向量線的位置長短來判斷不同，現在我們要以碰撞點來判斷，右舷的橫越船比左舷先通過碰撞點，右舷的橫越船比左舷的速度來得快，如果本船必須使用迴圈舵，從右舷來做是比較合適，後面還有一條追越船需要注意，這就是技術，考慮到碰撞距離與時間。

- ♥ 本船的速度降低 1.4 節是不夠的，一分鐘減的速度太慢，本船的速度向量線端點，還是在碰撞面裡面。請參考圖形 9-31。
- ♥ 只有一條右舷來的橫越船在碰撞面裡面，是在本船的右舷，所以我們向右邊開一點，或是向右做迴圈舵的操作，整個碰撞面的情勢，可以簡化程與這一條橫越船避碰應該是 OK，可以的。

♥ 本船的速度還是太快，因為我們跟右舷橫越船可能同時到達碰撞面。

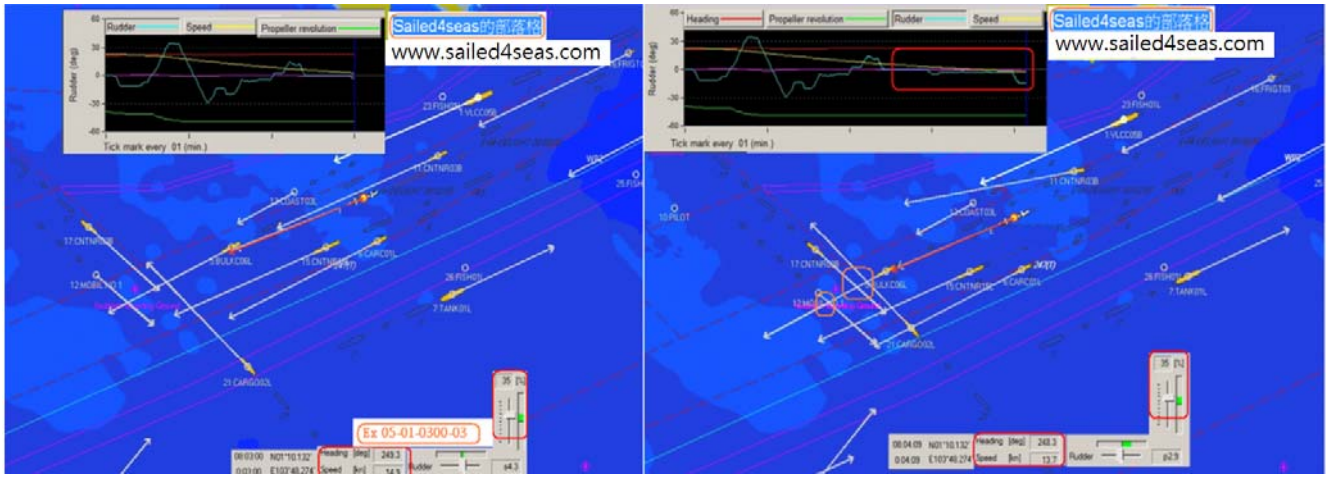


圖形 9-32 速度向量線在 3/6 分鐘在第 2 分鐘的操演時間過後

經過兩分鐘的操演時間過後，本船的速度是 16.5 節，這是從 20 節而來，主機出力降低了兩次從 65%降到 35%，在這這兩分鐘時間，減下來的速度是 3.5 節。本船的航向，右轉 0.9 度到 248.9 度從 245.4 度，使用右舵 10 度跟左滿舵，然後是右滿舵，右舵 20 度等等。整體的情勢看來還好，3 分鐘的速度向量線看來是好的，如果我們把速度向量線的端點，都看成是 3 分鐘後目標傳的位置，這是我們的觀測。

⇒ 所有橫越船都會通過本船的船頭，在 3 分鐘前後，端點對中點，本船有一分半鐘的安全間隔。
⇒ 本船應該集中於減速的努力，如果沒有其他船隻改變航向或是航速。
⇒ 在本船船尾的船隻，現在速度已經比本船快了，這是我們看到速度向量線長度的變化。（眼睛已經太花了，用分規罷。
⇒ 在 6 分鐘的速度向量線上，我們可以看到追越船 6 分鐘後，以現在的速度，仍然在我們的船艉。
⇒ 整體的情勢看來很混亂，在這 6 分鐘的速度向量線。
⇒ 使用更長的速度向量線，當船隻眾多時，只會使情況更複雜，這是我們的感覺。

3 分鐘的速度向量線就足以代表跟其他船隻的碰撞危機，這就是我們的規律。



圖形 9-33 3 分鐘速度向量線在 3/4 分鐘的操演過後

經過 3 分鐘操演時間過後，本船的速度是 14.9 節，這是從 16.5，18.6 ，20 節減下來。主機的出力減了兩次，從開始減到 65%，然後在 30 秒後再減到 30%，在這 3 分鐘的時間，速度減下 5.1 節。本船的航向穩定在 249.3 度，從 248.9 248.0，245.4 度，在前一分鐘。

3 分鐘的速度向量線，現在看起來沒什麼問題。

⇒ 本船會晚 1 分半鐘到達碰撞面，比兩舷其他的橫越船都慢 1 分半鐘，這是我們的安全間隔，這是我們看到的。
⇒ 所有橫越船 3 分鐘後，都會通過本船的船頭。
⇒ 追越船非常接近，但是還是有相當的距離之外，這是我們看到的。

在 4 分鐘的操演時間過後，本船的速度是 13.7 節，從 20 節而來，主機出力降低到 35%，速度是 4 分鐘減了 6.3 節，速率是以每分鐘 1.5 節的速率降低，本船的航向穩定在 248.3 度，已經有兩分鐘的時間。

橫越船隻有兩條是端點對中點，一條是端點對目標，追越船右轉，在這 3 分鐘速度向量線看起來，是良好情勢。

先前認為情況似乎是不可能操作的，在減速度以後，就變成非常容易的操演。當然這是對老馬船長而言。

9 – 11 Collision Awareness Exercise – 21 7 vessels in Collision Area

9-27 Read ownship's position inside Collision Area.

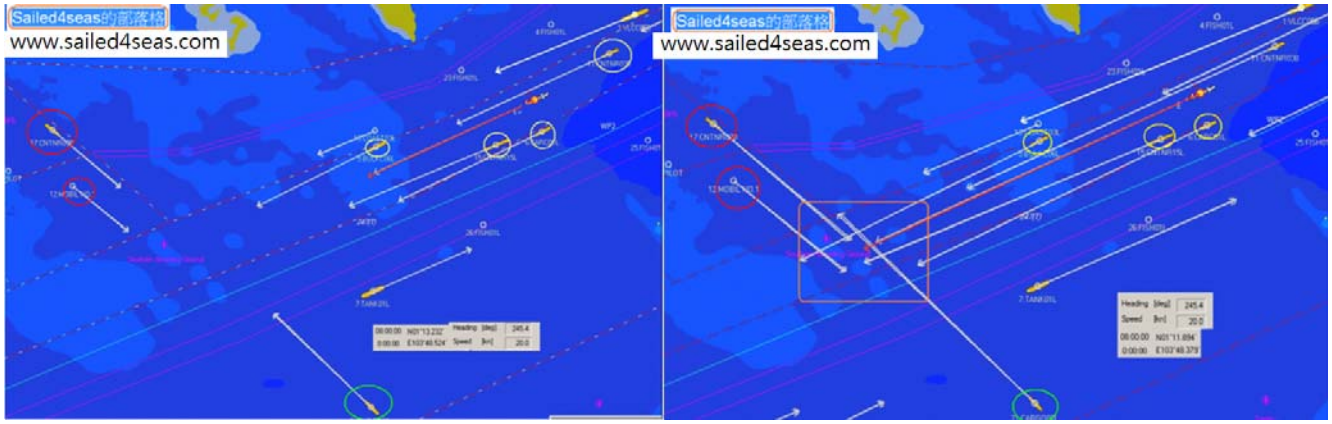


Figure 9-30 Ownship speed vector in 3/6 minutes at beginning

The situational awareness is:

- Ownship have two crossing vessels at starboard side (red circle), distance unknown. (sighted)
- One overtaken vessel at starboard bow has slower speed. (skill by comparing vector length)
- Ownship have one crossing vessel at port side (green circle), distance unknown. (sighted)
- two overtaken vessels at port side slower than ownship. (skill by comparing vector length)

With 6 minutes speed vector we found one collision area risk.

- There are 7 vessels inside the Collision Area (Orange square). (sighted)

- There is no time to remember which vessel is ahead or behind, which vessel is on starboard side or port side? (suspect)
- Ownship now knows that "It is Collision area to be avoided, not the vessels" (the sense you should have now)
- Where to go for ownship? (use your instinct, not speed vectors or safety margin or whatever)
- To starboard side, we are competing the ground where port side crossing vessel are going (green ring). (sighted)
- To port side, we are competing the ground where starboard side crossing vessel are going (red ring). (sighted)
- To make a 360 degrees turn is impossible due to many vessels inside the traffic lane. (too many collision risks while turning)
- Ownship has only option to reduce speed as fast as possible to arrive Collision Area later. (suspect)

Collision awareness in a collision area is to identify where ownship's position inside it.

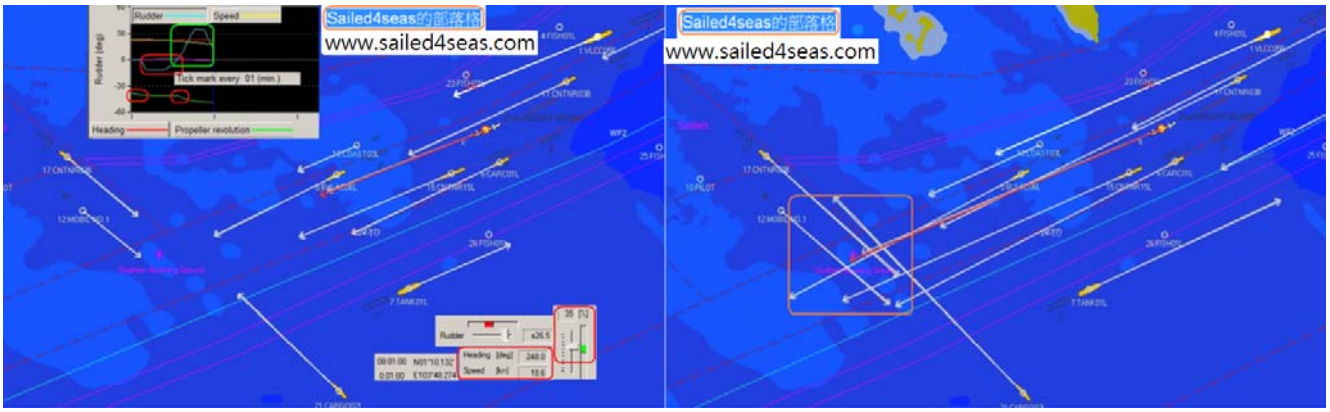


Figure 9-31 Ownship speed vector in 3/6 minutes at 1 minute time

After 01 minutes exercise time lapsed:

- Ownship speed is 18.6 knots which decreased from 20.0 kts with engine output reduced twice 65% from beginning and further reduced to 35% after 30 seconds. Speed reduces 1.4 knots over one minute's time.
- Ownship course had altered 2.6 degrees starboard side to 248.0 degrees from 245.4 degrees with rudder cycle from "starboard 10" and "Hard Port "in last minute.

9-28 Read ownship's collision risks inside Collision Area.

The situational awareness in 3 minutes speed vector is: Port side overtaking vessels distance are closer than starboard side. And port side crossing vessel is faster than starboard side. If ownship have to use rudder cycling starboard side first is better for port side is too crowded.

The situational awareness in 6 minutes speed vector is:

- Ownship Speed reduces 1.4 knots is not enough? (ownship speed vector's end is in middle of collision area. See figure 9-31 right picture.)
- Only one vessel inside collision area is at ownship's starboard side. (A little bit to starboard side might be OK or rudder cycling to starboard side)
- Ownship speed is still too fast as ownship arrive Collision Area about the same time with crossing vessels. (sighted)

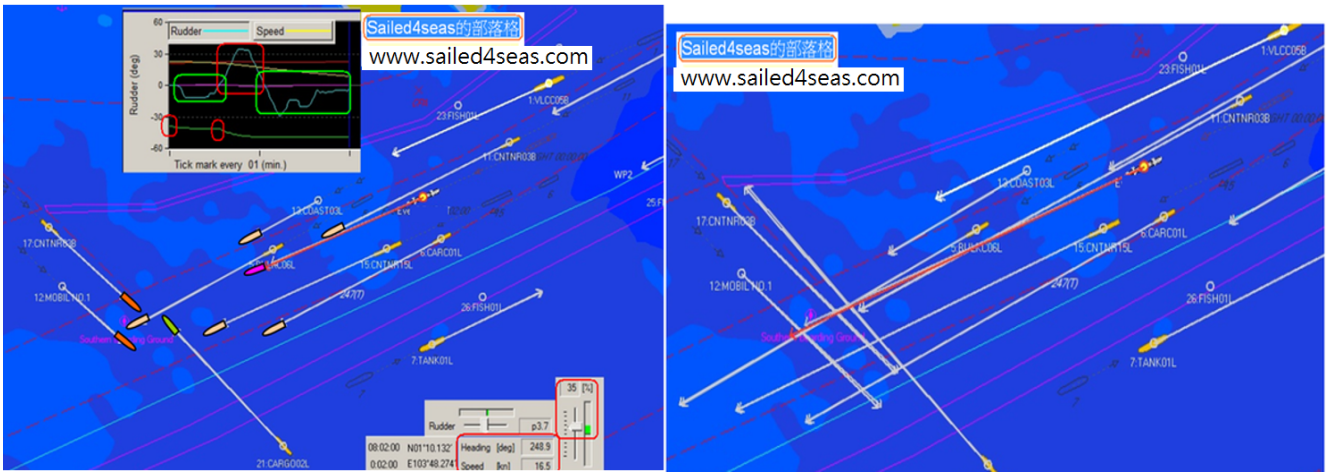


Figure 9-32 Ownship speed vector in 3/6 minutes at 2 minutes time

After 02 minutes exercise time lapsed:

- Ownship speed is 16.5 knots which decreased from 20.0 kts with engine output reduced twice 65% from beginning and further reduced to 35% after 30 seconds. Speed reduces 3.5 knots over two minute’ s time.
- Ownship course had altered 0.9 degrees starboard side to 248.9 degrees from 248.0, 245.4 degrees with rudder cycle from “starboard 10” and “Hard Port “ and “ Starboard 30,20,5 …” .
- Overall situation looks good in three minutes speed vector. If we marked all speed vector end with vessel shape, crossing vessels will arrive collision area in more or less than 3 minutes while ownship have about 2 minutes time to arrive. (sighted by estimation)
- All crossing vessels are about to pass ownship bow after 3 minutes. (no collision points in 3 minutes)
- Ownship should concentrate on speed control if no vessel will change course or speed. (Priority)
- The vessel at ownship stern is faster than us. (sighted)
- In 6 minutes, speed vector, we can see overtaking vessel still behind ownship. (sighted)
- Overall situation looks pretty mess in this 6 minutes speed vector. However, if we check it carefully we can still verify its collision risk clearly. (sighted)
- Use longer speed vector while vessels are plenty will complicate the case. (sense)

Three minutes speed vector represent ownship collision risk with other ship. (rule)

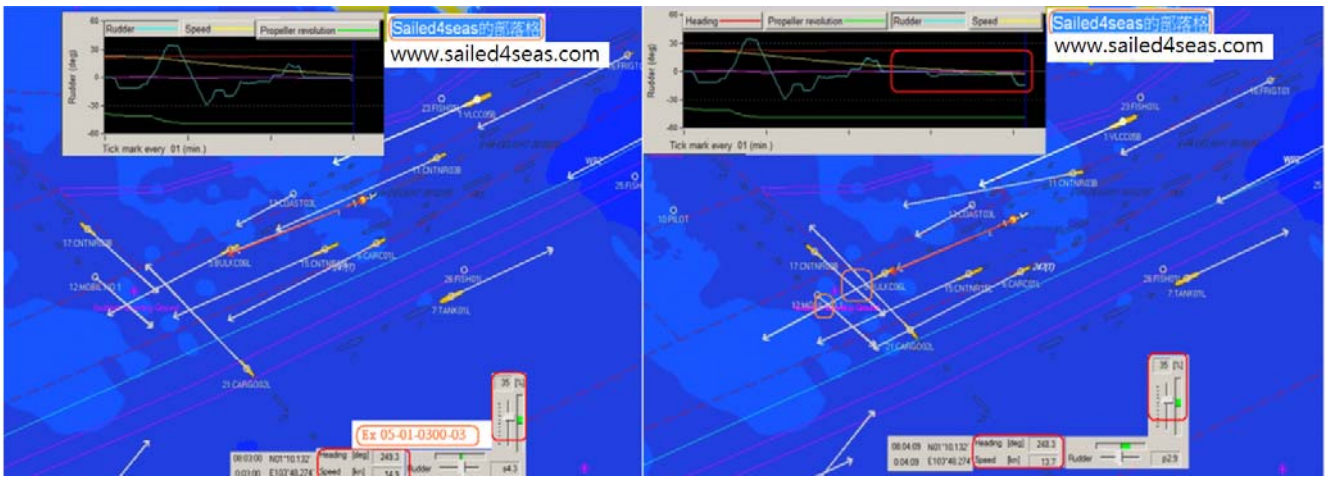


Figure 9-33 Ownship speed vector in 3 minutes at 3 and 4 minutes time

In figure 9-33 left picture, After 03 minutes exercise time lapsed:

- Ownship speed is 14.9 knots which decreased from 16.5, 18.6, 20.0 kts with engine output reduced twice 65% from beginning and further reduced to 35% after 30 seconds. Speed reduces 5.1 knots over three minute’ s time.
- Ownship course had steady in 249.3 degrees from 248.9, 248.0, 245.4 degrees in last minutes.
- Ownship 3 minutes speed vector looks good in this time.
- Ownship will arrive collision area 1.5 minutes later than crossing vessels from both sides. (sighted)
- All crossing vessels are about to pass ownship bow after 3 minute. (sighted)
- Overtaking vessels are very close but in proper distance away. (sighted)

In figure 9-33 right picture, After 04 minutes 09 seconds exercise time lapsed:

- Ownship speed is 13.7 knots which decreased from 20.0 kts with engine output reduced twice 65% from beginning and further reduced to 35% after 30 seconds. Speed reduces 6.3 knots over 4 minute’ s time. Speed reduction rate of 1.5 Knots per minute
- Ownship course had steady in 248.3 degrees from 248.9, 248.0, 245.4 degrees in 2 minutes.
- Crossing vessels: two are End to Middle situation and one is End to Target.)Overall situation looks good in this three minute speed vector.)

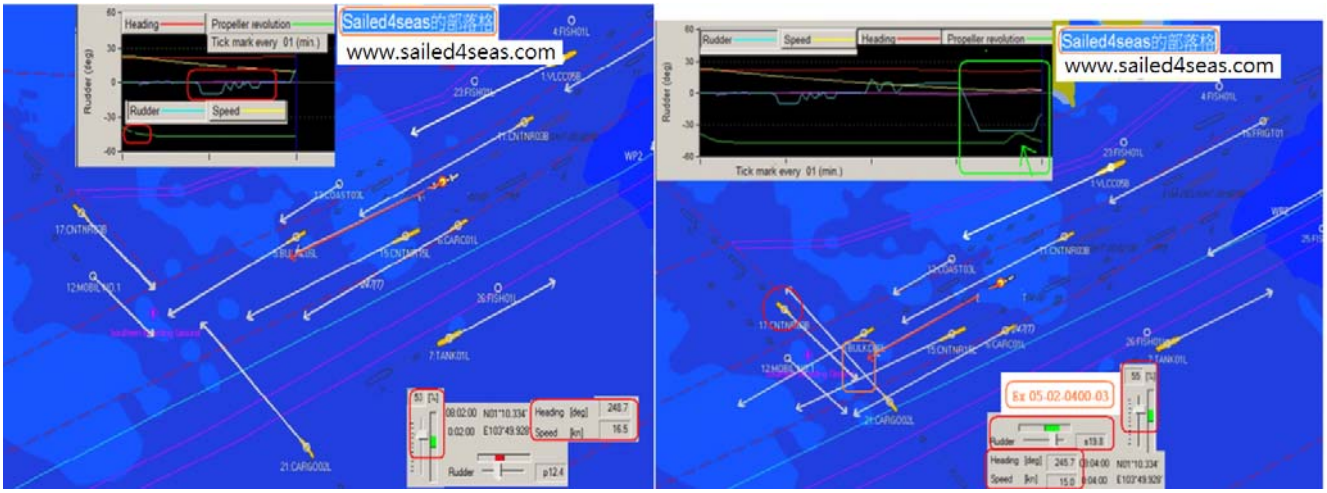
Once the situation seems impossible become much easier by speed reduction

9-12 避碰知覺操演 – 22 3 分鐘的碰撞警告

9-29 為什麼船長使用主機來停止回轉

參考圖形 9-30 本船的速度是 20 節，航向是 245.4 度。情勢知覺如下：

⇒ 在右舷紅色圓圈有兩條橫越船，距離未知。
⇒ 被追越船在右船頭，速度比較慢。
⇒ 左舷的橫越船綠色圓圈，距離未知。
⇒ 左舷兩條被追越船，比本船速度慢。
⇒ 使用 6 分鐘的速度向量線，我們發現一個碰撞面的危機。裡面有 7 條船在橘色的方塊裡。



圖形 9-34 3 分鐘的速度向量線在 2/4 分鐘操演過後

經過兩分鐘的操演過後，本船的速度是 16.5 節減下來的，主機減到 53%，從開始的時候，本船隻有減速一次。兩分鐘的時間，速度減了 3.5 節。

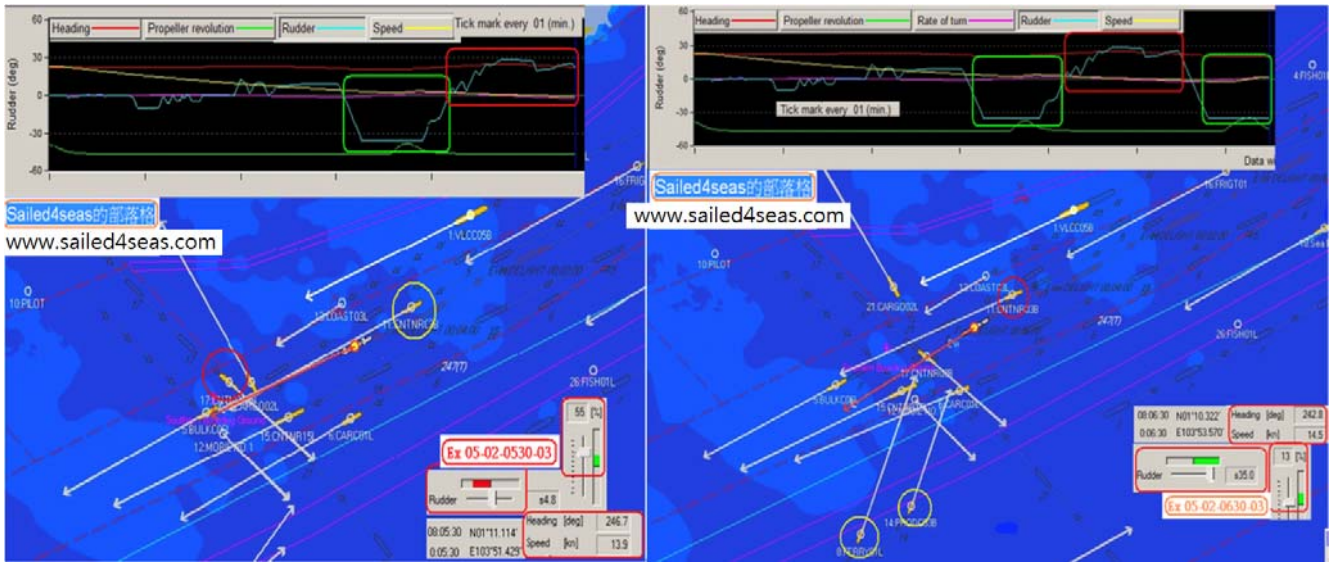
⇒ 本船的航向右轉 2.6 度到 248 度從 245.4 度，使用適度的舵角，在最後一分鐘。情勢知覺在 3 分鐘的速度向量線是 OK 的。使用 6 分鐘的速度向量線，就是非常的混亂。如果我們瞭解速度向量線的特性，使用太長的速度向量線會造成解讀與判斷困難。
⇒ 所有的橫越船隻會到達碰撞面，都比本船快。這是我們看到的。

在 4 分鐘的操演時間過後，本船的速度是 15 節，這是從 16.5 節，20.0 節而來，開始時主機的出力降低到 55%，在 3 分半鐘的時候，主機的出力增加到全速。船速在 4 分鐘後，減了 5 節的速度

⇒ 本船的航向向左轉了 2.3 度，到 245.7 度，從 248.0 245.4 度，使用舵角是右滿舵 40 秒，船長比前面的船長多了 20 秒的時間，等待舵效產生。
⇒ 船長對右滿舵的舵效，失去耐性，就直接加車來增加舵效。
⇒ 本船現在的情勢，是完全依賴減速來避免碰撞。所以船長使用主機加速來停止回轉，只會增加本船的船速？

在 3 分鐘速度向量線的情勢知覺如下：

一條紅色圓圈的右舷橫越船有碰撞危機，端點對端點，3 分鐘後會有碰撞發生。



圖形 9-35 速度向量線 3 分鐘，在 5 分半鐘跟 6 分半鐘的操演時間

5 分半鐘時間過後，本船的速度是 13.9 節，這是從 15.0，16.5 20.0 節而來。主機的出力，從開始時降到 55%，在 3 分半鐘時本船加車到全速一下子，在 5 分半鐘的時間後速度減少 6.1 節。本船向右轉了 1 度到 246.7 度，從 245.7 度，248.0， 245.4 度使用迴圈舵，在最後的兩分鐘。船長也許是使用小角度的迴圈舵操船，向左右回轉 3 度，這是我們懷疑的地方。

⇒ 從右舷來的橫越船（紅色圓圈），在前 1 分鐘看來有問題的，現在看起來應該是 OK。
⇒ 一條黃色圓圈的追越船跟本船在 3 分鐘後有碰撞危機，這是我們看到的。

經過 6 分半鐘的操演時間過後，本船的速度是 14.5 節，這是從 13.9 節增加來的，主機的出力在最後一刻，減到 13%，船長又一次的使用主機的出力，在 6 分鐘的時間，當他使用了 20 秒的舵角，船長的耐性越來越少。

⇒ 本船的航向向左轉了 4.1 度，來到 242.8 度，右滿舵超過了 30 秒。
⇒ 本船在追逐右舷的橫越船，因為使用了先前的舵角。
⇒ 本船的右舷現在是清爽了，除了一條追越船以外，這就是船長為什麼使用右滿舵，而且加車前進的原因。

9 – 12 Collision Awareness Exercise – 22 3 minutes collision warning

9-29 Why captain use engine to stop the turn?

Refer to figure 9-30, Ownship speed is 20.0 Knots and course is 245.4 degrees at beginning.

The situational awareness is:

- Ownship have two crossing vessels at starboard side (red circle), distance unknown. (sighted)
- One overtaken vessel at starboard bow has slower speed. (skill by comparing vector length)
- Ownship have one crossing vessel at port side (green circle), distance unknown. (sighted)
- Two overtaken vessels at port side slower than ownship. (skill by comparing vector length)
- With 6 minutes speed vector we found one collision area risk: There are 7 vessels inside the Collision Area (Orange square). (sighted)

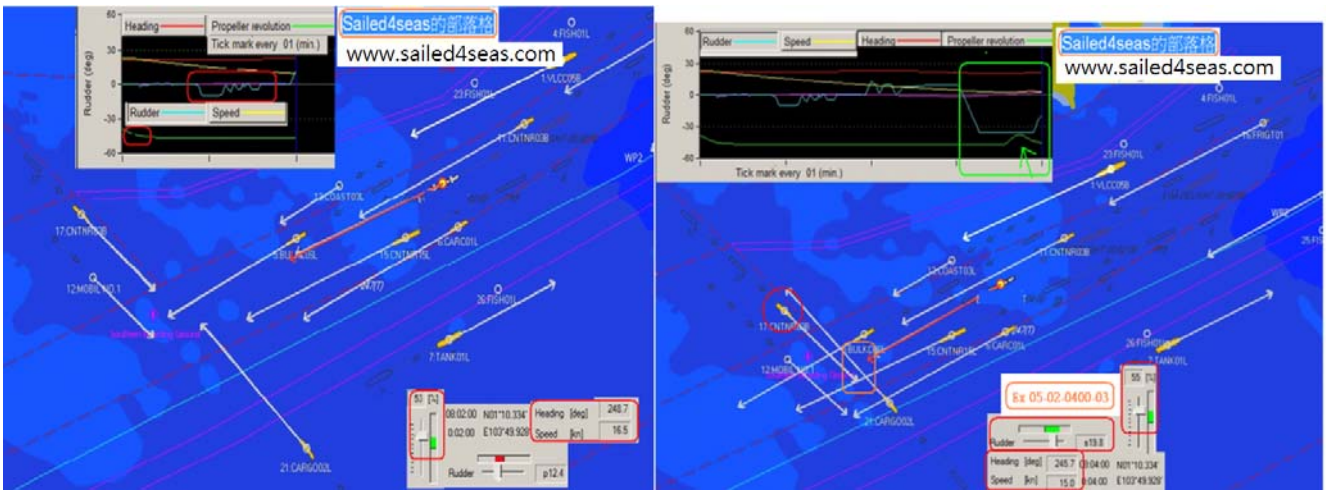


Figure 9-34 Ownship speed vector in 3 minutes at 2 and 4 minutes time

In figure 9-34 left picture, After 02 minutes exercise time lapsed:

- Ownship speed is 16.5 knots which decreased from 20.0 kts with engine output reduced to 53% from beginning. Ownship reduced speed once with less engine output 53%. Speed reduces 3.5 knots over 2 minute's time.
- Ownship course had altered 2.6 degrees starboard side to 248.0 degrees from 245.4 degrees with moderate rudder used in last minute.
- The situational awareness in 3 minutes speed vector is good. (sighted)

- The situational awareness in 6 minutes speed vector is pretty mess. (better not to try if we know the characteristics of speed vector well)
- All crossing vessels will arrive collision area ahead of ownship. (sighted)

In figure 9-34 right picture, After 04 minutes exercise time lapsed:

- Ownship speed is 15.0 knots which decreased from 16.5, 20.0 kts with engine output reduced to 55% from beginning. Ownship increased engine output to full once in 3.5 minutes. Speed reduces 5 knots over 4 minute's time.
- Ownship course had altered 2.3 degrees port side to 245.7 (T) from 248.0, 245.4 (T) with rudder order "Hard starboard" for 40 seconds. (we see captain have 20 seconds more patient in waiting rudder effect than exercise Nice and Easy.)
- Captain is inpatient in waiting ownship answer to "Hard starboard" rudder order. (Captain increase engine to increase rudder effect.)
- Ownship now is in a situation depend totally on speed reduction to avoid the collision. (Why captain use engine to stop the turn?)
- The situational awareness in 3 minutes speed vector is: One crossing vessel (red ring) from starboard side has collision risk. (it's an **end to end touched in speed vector which means 3 minutes collision warning**.)

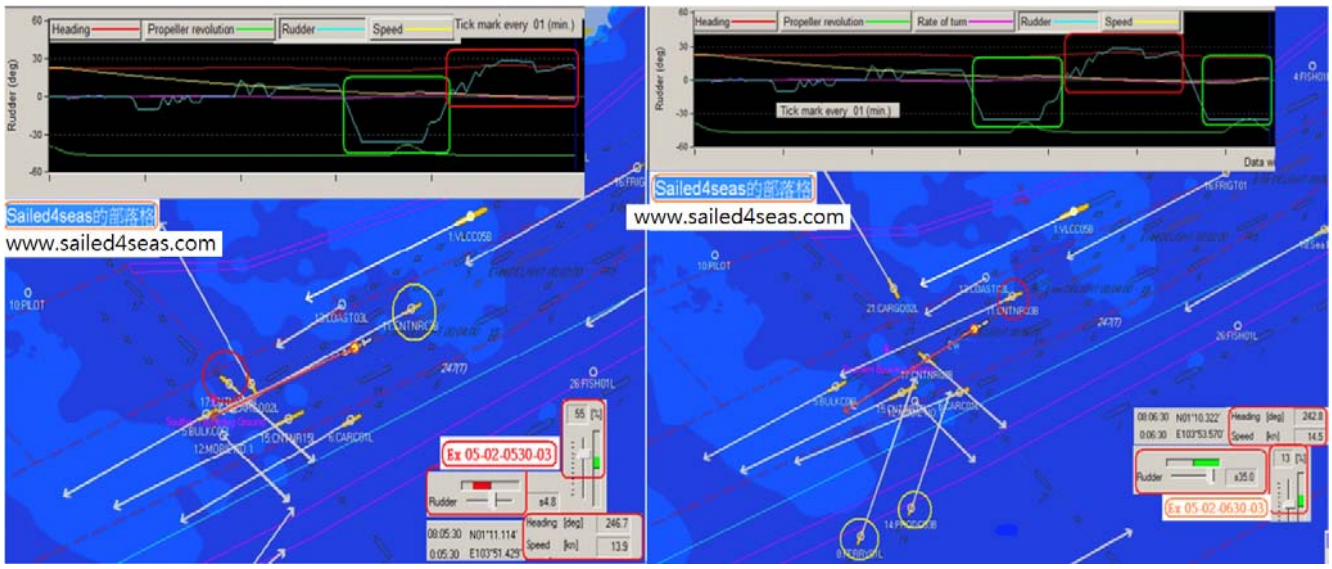


Figure 9-35 Ownship speed vector in 3 minutes at 5.5 and 6.5 minutes time

In figure 9-35 left picture, After 05 minutes 30 seconds exercise time lapsed:

- Ownship speed is 13.9 knots which decreased from 15.0, 16.5, 20.0 kts with engine output reduced to 55% from beginning. Ownship increased engine output to full once in 3.5 minutes. Speed reduces 6.1 knots over 5.5 minute's time.
- Ownship course had altered 1.0 degrees starboard side to 246.7 degrees from 245.7 248.0, 245.4 degrees with rudder cycling over last 2 minutes. Captain may conduct a small scale rudder cycling with 3 degrees to each side. (suspect)
- Crossing vessel from starboard side (red circle) has collision risk in 4 minutes time seems OK now. (sighted: middle to target)

- One overtaking vessel (yellow circle) has collision risk after 3 minutes. (sighted)

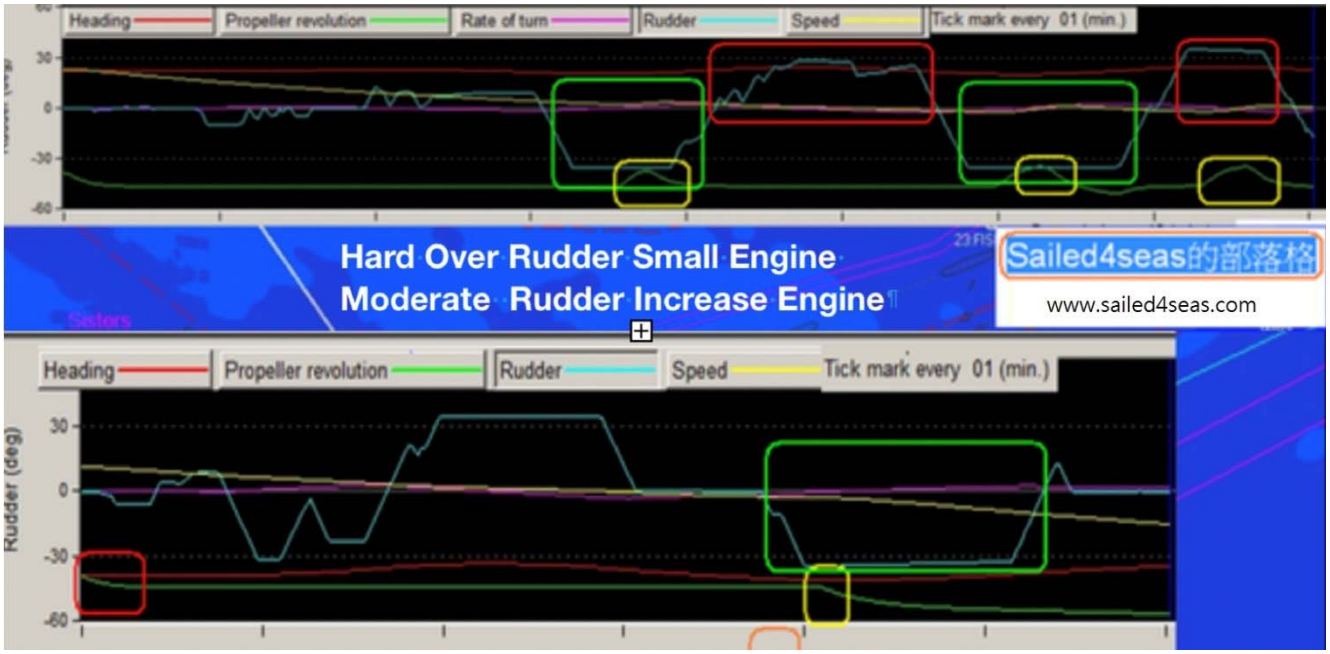
In figure 9-35 right picture, After 06 minutes 30 seconds exercise time lapsed:

- Ownship speed is 14.5 knots which increased from 13.9 kts with engine output reduced to 13% in last moment. Captain had kicked the engine again in 6 minutes time after wheel over 20 seconds. (Less patience)
- Ownship course had altered 4.1 degrees port side to 242.8 (T) from 246.7, 245.7 248.0, 245.4 (T) with rudder "hard starboard "over 30 seconds.
- Ownship is chasing starboard side crossing vessel by previous port rudder used. (sighted)
- Ownship starboard side is clear except overtaking vessel that's why captain increase speed with Hard Starboard rudder.

9-30 慢速操船的"老馬"還是"沒理"？

慢速操船是船長技術的終極考驗。

- ♥ 老馬就是使用滿舵 Hard Over Rudder Small Engine HORSE，大舵小俥的船長，船速控制非常良好。
- ♥ 沒理就是使用 Moderate rudder increase engine MORIE，小舵大車，船速居高不下。不會用滿舵，利用增加主機的出力，來處理船首向。
- ♥ 沒理船長增加速度來增加舵效，停止左旋的回轉速率。這是我們看到的
- ♥ 沒理船長沒有意識到何舷是上風，或是下風？這是我們懷疑的地方
- ♥ 船長想要用主機來改善沒有舵效，在繁忙的水域。這是我們看到的
- ♥ 不知道本船哪一舷上風，在情況良好的時候，是愚蠢，在情況不佳的時候，不知道哪一舷上風，就是一個災難。這就是規則
- ♥ 船長應該知道哪舷上風，在我們踏上駕駛台，進入駕駛台的第一步。這就是我們的技術
- ♥ 用舵點是需要兩倍船長的進距，才會產生快速的回轉，這是對快速船隻來說，像是貨櫃船。慢速船是圓船，像油輪，需要 1 倍船長的距離，才會開始快速回轉。
- ♥ 對 300 米長的快速船，貨櫃船兩倍船長就是 600 米。對於 20 節的船隻來講，600 米也需要 1 分鐘的時間，才能夠跑到這麼長的距離。
- ♥ 速度 15 節的船就需要 1.3 分鐘的時間，才能產生舵效。
- ♥ 請參考圖形 9-36 水準軸是一分鐘的時間間隔，哪一個船長是老馬，哪一個船長是沒理，"沒理"的來源是閩南語的發音。
- ♥ 老馬船長用舵等了 60 秒，在第一次。然後第二次等了 70 秒，因為本船的速度已經降低了，這就是老馬識途，知道本船的回轉性能。
- ♥ 沒理的船長等了 30 秒，然後就開始加車，這個就是舵角用太小，所以沒有舵效，利用加車來增加舵效，造成船速居高不下，過高，這個就是慢速操船的技術。這是我們看到的



圖形 9-36 老馬跟沒理船長在慢速操船的差異

9-30 HORSE or MORIE in slow steaming skill?

Slow steaming is the ultimate test of Master's shiphandling.

- HORSE is the Captain use Hard Over Rudder and Small Engine which is good in speed and course control.
- MORIE is the Captain use MOderate Rudder and Increased Engine to handle the situation by 1st degrees ship handling skill.
- Ownship increased speed to increase rudder effect to stop or increase turning rate. (is reasonable)
- Ownship need to have the clue what side is upwind or windward? (suspect)
- Ownship should rectify dangerous situation in most dense traffic area with simplest maneuvering. (suspect)
- Not knowing your current windward is foolish in good days, not knowing it in bad time is disaster. (rule)
- Ownship should always know windward at first moment we stepped in bridge. (Skill)
- Wheel over point is about 2 ship's length advances for sharp ship like container and one ship length for round vessel like tanker. (sense)
- For 300 meters container vessel, 2 SL is 600 meter,
    - 600 meters need 1 minute run for 20 Knots vessel.
    - 600 meters need 1.3 minute run for 15 Knots vessel
- Refer to figure 9-36, the horizontal axis is one minute time span. Which Captain is Horse and which is Morie?
    - HORSE Captain wait 60 seconds in first time and 70 seconds in second time (green square in hard starboard rudder) when ownship speed had reduced (although captain kick about 10 seconds time in yellow square).
    - MORIE Captain wait 90 seconds (in hard starboard rudder green square) and reduce engine output in yellow square.
- This is slow steaming skill. (sense) In this figure 9-36,
    - Hard starboard rudder is more likely the leeside which rudder effect is not obvious.
    - In second maneuvering diagram, it is more like a rudder cycling with speed reducing process.

- However, ever since 1st chapter we should be very familiar with the use of “ Hard Over Rudder” and understand the disadvantages of “Small Rudder with Elevated engine speed”.

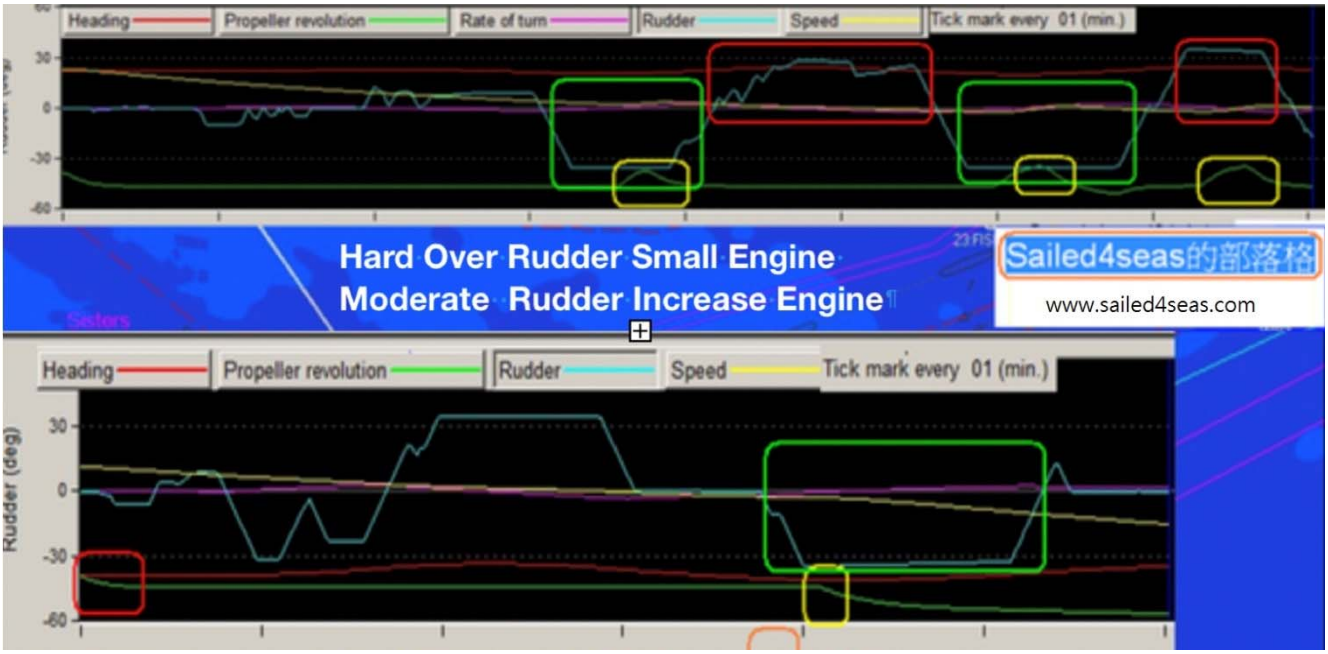


Figure 9-36 HORSE and MORIE captain in slow steaming

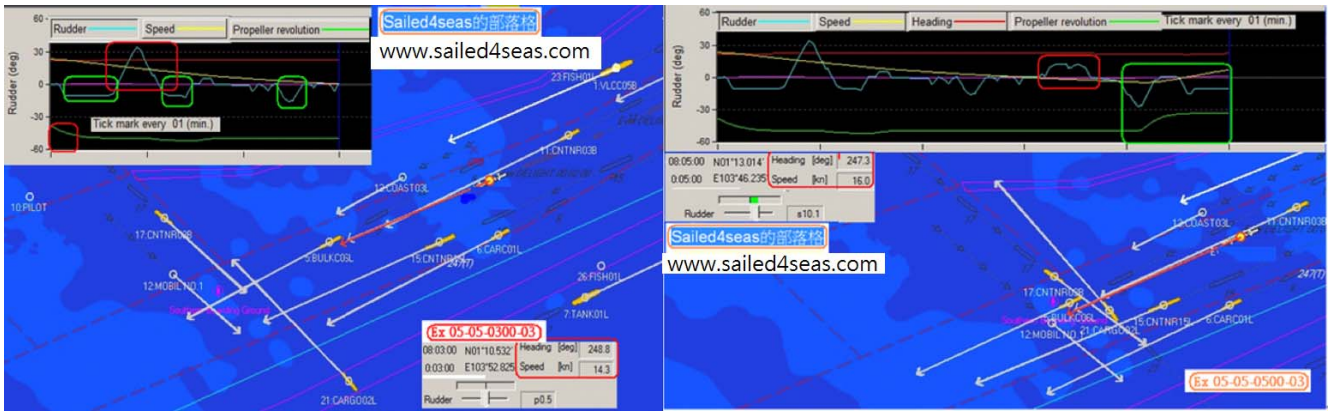
9-13 避碰知覺操演 – 23 有效的減速

9-31 大膽用舵可以有效的減速

請參考圖形 9-30，在開始的時候，速度是 20 節航向是 245.4 度。情勢知覺如下？

⇒ 在右舷有兩條橫越船，距離未知。被追越船在右船頭，速度比較慢。本船左舷有一條橫越船，綠色圓圈，距離未知。左舷的兩條被追越船速度比本船慢。

⇒ 使用 6 分鐘的速度向量線後，我們發現一個 7 條船牽涉其中的碰撞面危機，橘色的方塊裡面。



圖形 9-37 本船的速度向量是 3 分鐘，5 分鐘操演時間之後

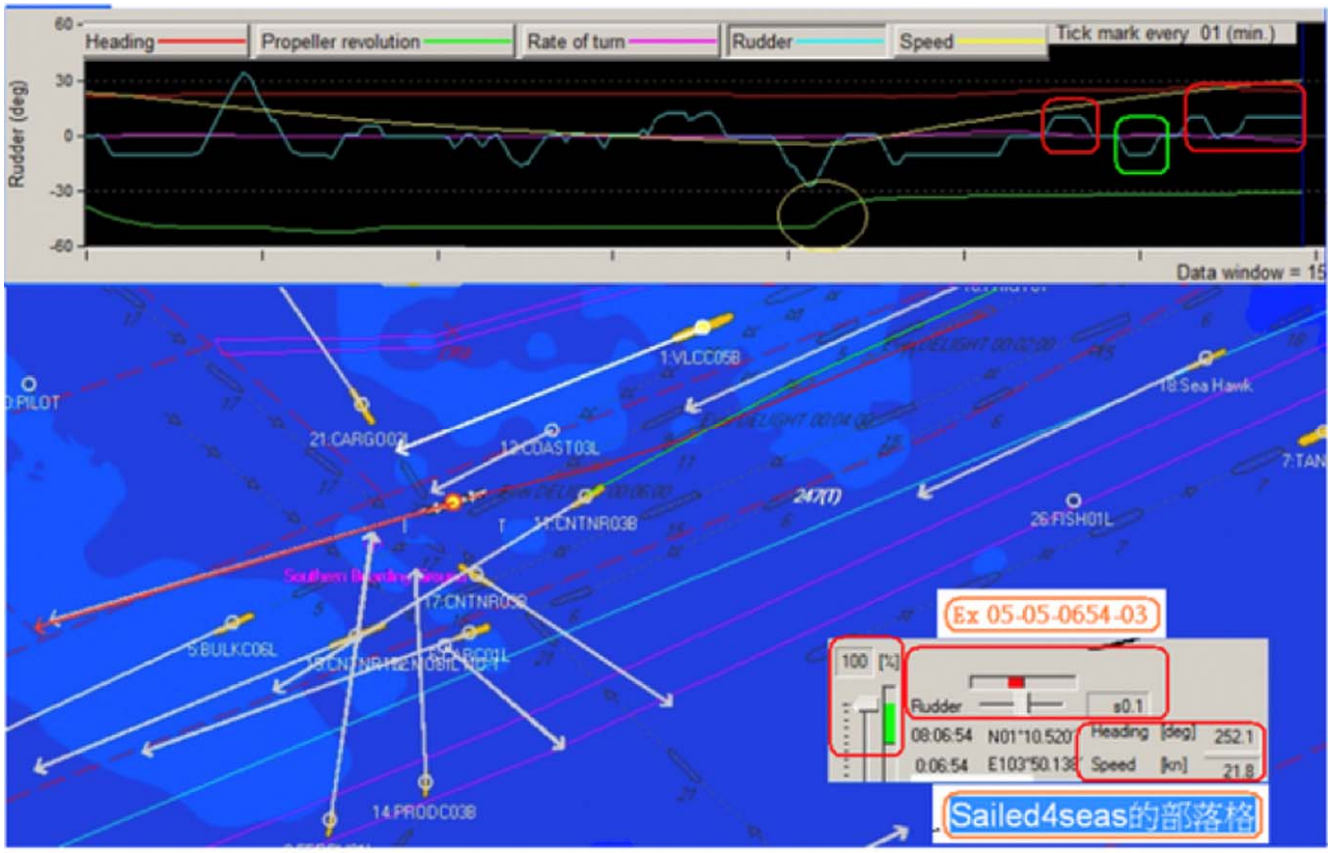
3 分鐘操演時間之後，本船的速度是 14.3 節，這個是從 20 節而來，主機的出力，從一開始減到 55 %。在 3 分鐘的時間，減了 5.7 節的速度，減速的速率是每分鐘 1.9 節，不錯。

⇒ 本船的航向向右轉了 3 度，到 248.8 度，從 245.4 度。使右舵 10 度比較久，左滿舵比較短，在過去的 3 分鐘時間。
⇒ 所有的橫越船隻在 3 分鐘後都會通過，因為船首向右轉 3 度到 248.8 度，我們觀察安全間隔都在一分半鐘以上。
⇒ 對所有的橫越船來說，看起來是 OK。但是對於追越船在右舷，是有點麻煩，因為他比本船的速度快。這是我們看到的

9-32 沒理船長的例子

經過 5 分鐘的操演時間過後，船速是 16 節，這個是從 14.3 節來的，兩分鐘之前增加來的，主機的出力是 100%。

⇒ 當所有的橫越船看起來都 OK 啦，本船也許想要增加船速來避免追越的船隻。
⇒ 船速過快使得情況變得更加複雜，本船應該做的就是保持跟追越船隻同樣的航向，畢竟我們只是協助避碰，而不是要去比追越船速度快。
⇒ 本船的航向向左轉了 1.5 度，到 247.3 度，從 248.8 度。使用短暫的右滿舵，然後是右舵 10 度，在最後的最後的 1 分鐘。
⇒ 船長增加主機的出力，當使用右舵的時候，可能是對右舵的舵效沒有信心。
⇒ 本船可以緩慢向右轉，因為左舷的橫越船速度比較快，所以不需要增加主機的出力，除非船長認為碰撞危機已經過去了，現在已經不會碰撞。
⇒ 本船在兩分鐘的時間之內，即將進入碰撞區域，此時前面還有 3 條橫越船隻。這是我們看到的
⇒ 本船的速度現在是 16 節，這 5 分鐘的減速時間，速度的降低，沒有產生應該有的功效。
⇒ 增加主機的出力，並不是一個很好的主意。



圖形 9 之 38 3 分鐘的速度向量線，6.9 分鐘的操演時間過後

經過 6.9 分鐘的時間操演之後，

⇒ 本船的速度是 21.8 節，這是從 16 節，兩分鐘之前增加而來的。（類比機的加車程式不對），主機的出力增加到 100%，在真實的海上，這是不可能的事。
⇒ 本船的航向是右轉 4.8 度到 252.1 度，從 247.1 度而來，舵效是兩分鐘之前的，現在本船用左舵，要穩定在這航向。
⇒ 本船用左舵 10 度來控制船隻的回轉。看到的
⇒ 兩條左舷的橫越船會通過本船的船艉 ，在 3 分鐘後，這是我們瞭望的技術。
⇒ 本船轉向到右舷 4.8 度，主機全速前進 100%的出力。
⇒ 本船想穩定在 252 度，來避免橫越的船隻。
⇒ 本船的速度比追越船快，這是我們技術。
⇒ 這個操演給我們的感想，就是小的航向改變，對國際避碰規則裡是不被推薦的，但是在船隻繁忙的區域，大角度的改變航向，對所有在場的船隻，都是可能的危險。

使用滿舵並不代表劇烈的航向改變，只是表示船長知道舵效不夠，所以使用滿舵並不是要造成大角度轉向，或是快速的回轉。現在本船唯一的避碰選項，就是減速。滿舵可以協助而有效的降低船速。這個操演，就是沒理船長的例子。

9 – 13 Collision Awareness Exercise – 23 Reduce speed effectively

9-31 Bold rudder angle can help reducing speed effectively.

Refer to figure 9-30, Ownship speed is 20.0 Knots and course is 245.4 degrees at beginning.

The situational awareness is:

- Ownship have two crossing vessels at starboard side (red circle), distance unknown. (sighted)
- One overtaken vessel at starboard bow has slower speed. (skill by comparing vector length)
- Ownship have one crossing vessel at port side (green circle), distance unknown. (sighted)
- Two overtaken vessels at port side slower than ownship. (skill by comparing vector length)
- With 6 minutes speed vector we found one collision area risk: There are 7 vessels inside the Collision Area (Orange square). (sighted)

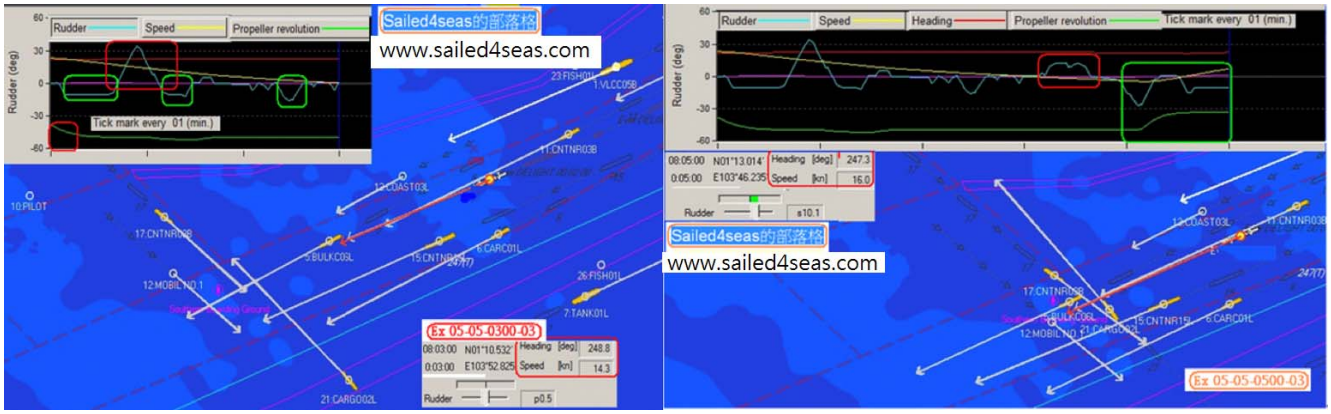


Figure 9-37 Ownship speed vector in 3 minutes at 3 and 5 minutes time

In Figure 9-37 left picture, After 3 minutes 00 seconds exercise time lapsed:

- Ownship speed is 14.3 knots which decreased from 20.0 kts with engine output reduced to 55% from beginning. Speed reduces 5.7 knots over 3.0 minute's time. Reducing rate of 1.9 knots per minutes.
- Ownship course had altered 3 degrees starboard side to 248.8 (T) from 245.4 (T) with rudder " starboard 10" longer and "Hard Port" shortly in last 3 minutes.
- All crossing vessel will pass after 3 minutes because heading change 3 degrees starboard side to 248.8 (T) from 245.4 (T). (sighted safety margin 1.5 minutes)
- Ownship looks Ok with all crossing vessels but have problem with overtaking vessel on starboard quarter which is faster than ownship now. (sighted)

9-32 Example of Captain Morie: Moderate Rudder with increased Speed

After 5 minutes 00 seconds exercise time lapsed:

- Ownship speed is 16.0 knots which increased from 14.3 knots 2 minutes ago with engine output increase to 100%.
- When all crossing vessel are OK, ownship may want to increase speed to avoid overtaking vessel.
- Excess speed complicated the case, what ownship should do is keep same course as overtaking vessel will be enough.
- Ownship course had altered 1.5 degrees port side to 247.3 degrees from 248.8, (T) with rudder "Hard starboard "shortly then "starboard 10" in last minute. Ownship turning to Port side is faster than starboard side.
- Captain increase speed while use starboard rudder may have no confidence with starboard rudder. (sighted)
- Ownship can turn to starboard side slowly as port side crossing vessel is faster. (no need to increase engine output unless captain think the collision risks are over now.)
- Ownship will enter collision area within 2 minutes with three crossing vessels ahead now. (sighted)

- Ownship had speed of 16 knots now. This 5 minute time of speed reduction had not taken effect. (Sighted)
- Sudden engine output increased is not a good idea. (suspect)

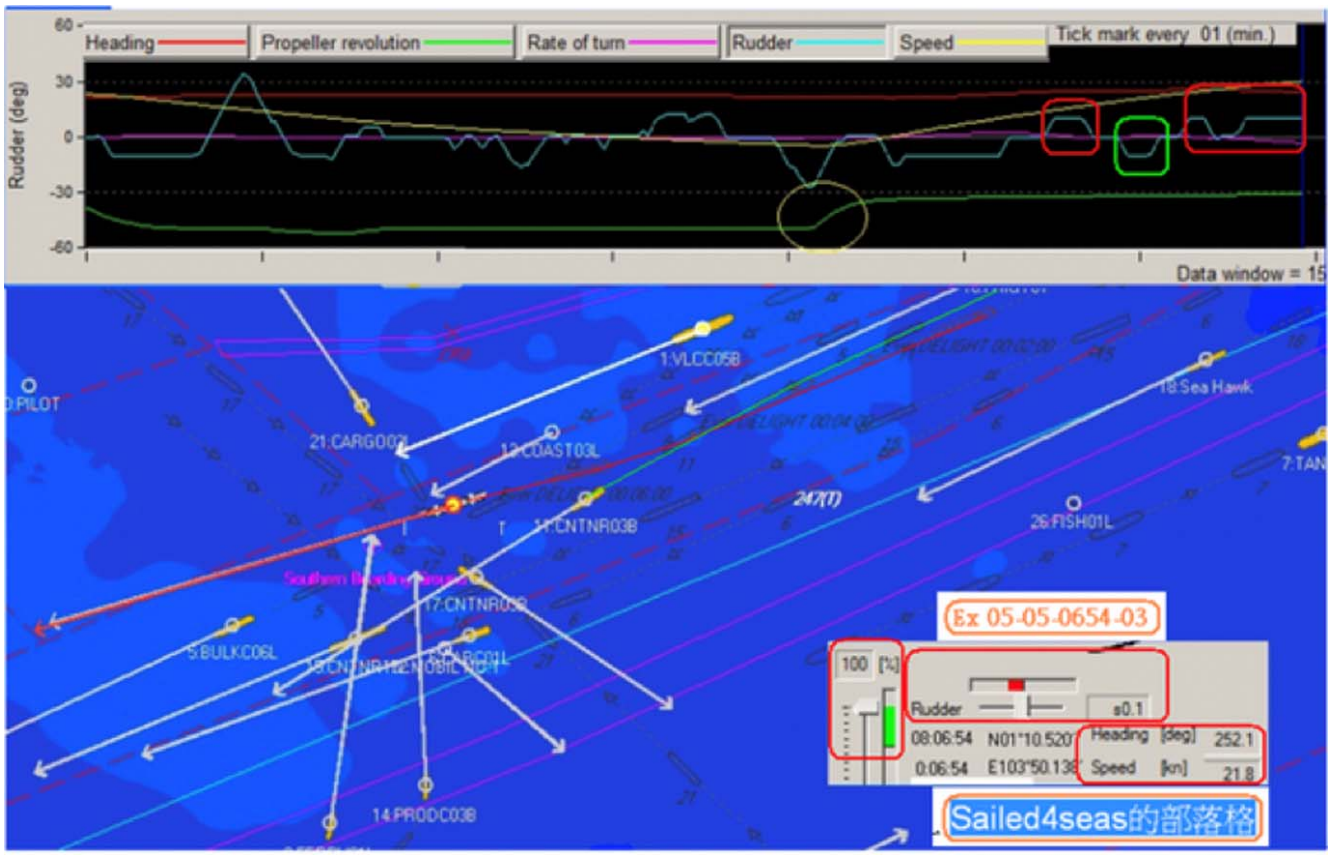


Figure 9-38 Ownship speed vector in 3 minutes at 6.9 minutes time

After 6 minutes 54 seconds exercise time lapsed:

- Ownship speed is 21.8 knots which increased from 16.0 knots 2 minutes ago with engine output increase to 100%. (This is not possible in real sea.)
- Ownship course had altered 4.8 degrees starboard side to 252.1 (T) from 247.3, 248.8, 245.4 (T) with rudder effect carry over 2 minutes ago. Ownship trying to steady on current heading now with port side rudder.
- Ownship used "Port 10" rudder to control vessel turning. (sighted)
- Two crossing vessels from port side will pass ownship stern after 3 minutes. (skill)
- Ownship altered course to starboard side 4.8 degree and full ahead engine output with 100%. (sighted)
- Ownship course steady on 252 degree to avoid overtaking vessel. (sighted)
- Ownship speed is faster than overtaking vessel now. (skill)

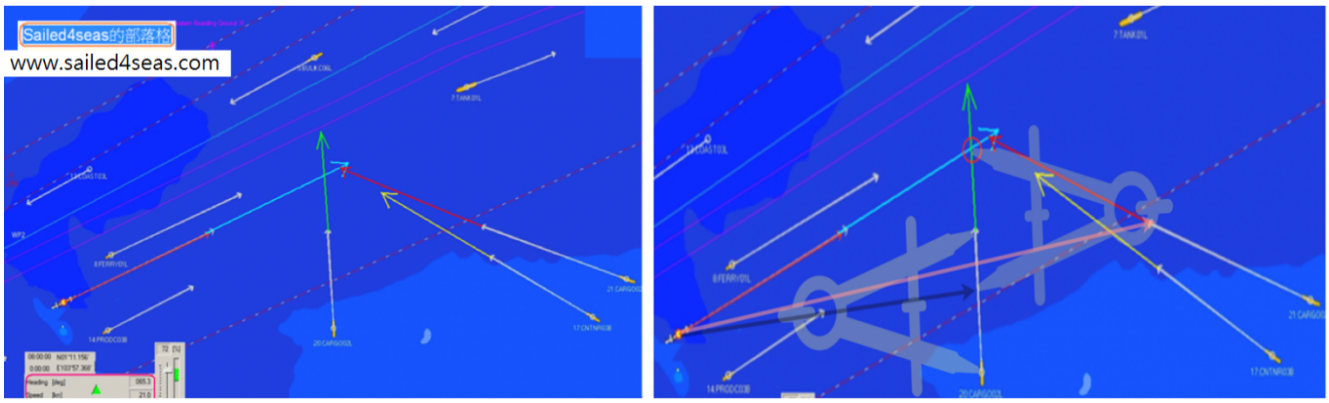
The moral of this exercise is

- ♥ Small course alternation is not recommended for collision avoidance in COLREG.
- ♥ In dense traffic, ownship large course change suddenly is dangerous to all parties at scene.
- ♥ Hard Over rudder does not mean drastic course change. It only means master knows rudder effect is not enough.

♥ The only option left for ownship to avoid collision is to reduce engine, and reduce it effectively.
This exercise is an example of Master Morie.

9-14 避碰知覺操演 – 24 3 分鐘安全間隔

9-33 如何避免碰撞線危機？



圖形 9-39 本船速度向量線在 3/6 分鐘

開始的時候，請參考圖形 9-39，本船的速度是 21 節，航向 065.3 度，速度向量線的長度是 10.5 個 CABLE。情勢知覺如下

⇒ 右舷一條被追越船速度比較慢
⇒ 左舷一條被追越船速度也比較慢
⇒ 改變速度向量線到 6 分鐘之後，兩條右舷橫越船跟本船有碰撞危機。這是我們看到的
⇒ 先跟綠色速度向量線的船隻發生碰撞，然後才是紅色速度向量線船隻的碰撞。
⇒ 這兩條船的碰撞點，幾乎是相同，這是我們看到的，這一條黃色速度向量線的橫越船在右舷，跟本船也有碰撞危機，因為安全間隔只有 1 分鐘。
♥ 如果我們想要跟所有橫越船保持 3 分鐘的安全間隔，也就是創造出端點對目標的情形，這是說 3 分鐘速度向量線的航向要是多少？
♥ 船長想要選擇一個航向，我們可以通過目標船，以 3 分鐘安全間隔的時間。
♥ 本船必須轉向，來轉移碰撞點到 3 分鐘之外。

對於紅色速度向量線的船隻，在圖形 9-39，在經過 6 分鐘之後，是端點對端點的情況，想要跟他有 3 分鐘的安全間隔，我們必須在他的速度向量線上，取出 3 分鐘的長度。這邊要注意碰撞點的轉移，是在目標船的速度向量線上。

♥ 就像我們可以看到圖形 9-39 上面的粉紅色線條，就是新的航向。
♥ 我們也可以利用這樣的概念，在圖形 9-21 來試試看，本船轉向 10 度，可以取得 3 分鐘的安全間隔。
♥ 如果本船轉向，對準他的 6 分鐘速度向量線速度中點來得到 3 分鐘的安全間隔，就像粉紅色的線條方向是 077 度，在圖形 9-39 的航向並不剛好是 3 分鐘的，因為粉紅色的線段等比本船的 3 分鐘速度向量線要長，本船會到達他 3 分鐘速度向量線的中點，比圖上顯示的要慢。
♥ 換句話說如果新的航向，可以到達目標船速度向量線中點的長度，少於本船速度向量線的長度，安全間隔將會少於 3 分鐘。

♥ 當然啦我們可以得到更精確的航向來操演，得到剛剛好 3 分鐘的安全間隔，使用適當的繪圖技巧，也許要重新丈量本船跟他船速度之間的差異，向量作圖。回頭想想，本船轉向對著橫越船 6 分鐘速度向量線的中心點，來取 3 分鐘的安全間隔是對的，對被追越船如此取，就會加速碰撞，所以要小心。下面就是解答：

那現在就讓我們再看看在另外一條具有綠色速度向量線的橫越船，就像作圖一樣，得到的結果如何？

⇒ 在他的綠色速度向量線上，標出 3 分鐘的長度，利用蠟筆或是分規，圖上就是下方的黃色分規，取出目標船 3 分鐘長度。
⇒ 從碰撞點用黃色分規的一隻腳放在碰撞點上，在速度向量線上，使用另外一隻腳反向取出 3 分鐘的長度，來找到黑色線段的標記。（黃色的分規跨度，就是這條船在碰撞點前 3 分鐘，所跑的距離）
⇒ 我們需要使用電子游標線或是游標來讀出 084 度，黑色線條的方位。
⇒ 當本船到達這一點，航向 084 度，目標船在 3 分鐘前，已經通過。

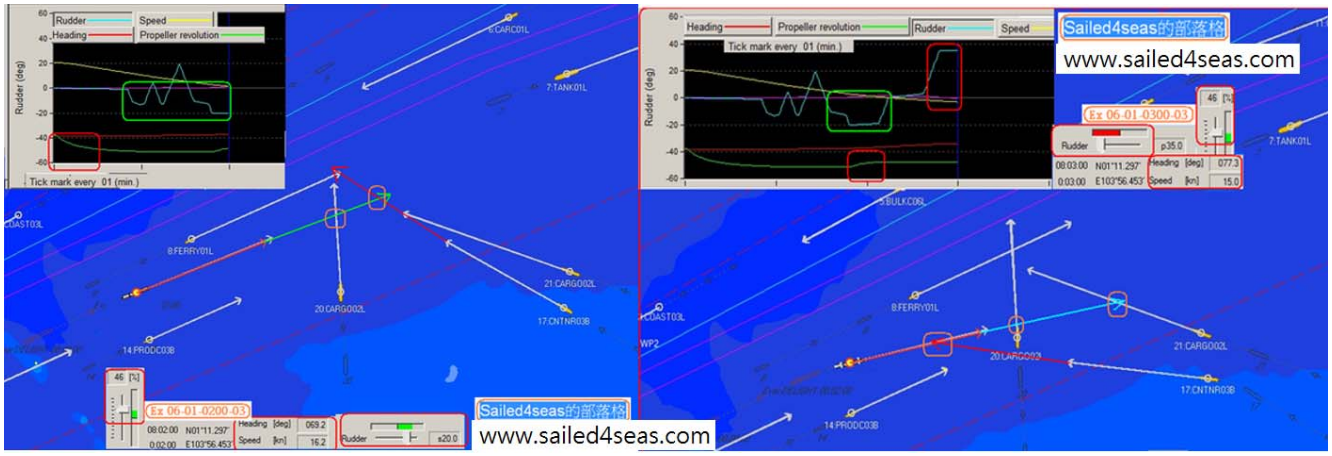
但是這些目標的位置是在航行巷道之外，船長應該要小心觀測，他們是否會進入航道？

船長應該知道本船需要慢慢回到原來的航向，一旦目標船通過本船的船頭，就像圖形 2-10 避碰的標準操作程式。

保持 3 分鐘的安全間隔，在開放水域是可以的，在沿岸或是分道航行制內，就不太可能。

只要目標船通過本船的船頭，本船就應該要立刻回到原始的航向，或是原來的航線上，因為可能會開出航道外擱淺。

這個概念跟避免碰撞是一樣的，我們保持將可能發生碰撞的船隻，在左船頭就已經足夠，不必保持太多的安全距離。因為狹窄水道，或是分道航行制內，航行巷道的寬度有限，我們要讓過她船的船身，就可以了。如果這樣都已經非常困難，就一定要採取減速的方法，才能避碰。



圖形 9-40 速度向量線在 3/6 分鐘，在 2/3 分鐘的操演時間之後

在兩分鐘的操演時間之後，本船的速度是 16.2 節，這是從 21 節而來，主機的出力降到 30%從一開始。減速是有效的，兩分鐘時間，減了 4.8 節，每分鐘下降的速率是 2.4 節。

⇒ 本船等了 1 分鐘，然後向右轉向 3.9 度到 069.2 度，從 065.3 度，使用右舵在最後的 1 分鐘。

⇒ 右舷的被追越船速度比較慢。左舷的被追越船速度已經比本船快。改變速度向量線的長度到 6 分鐘後，情勢的知覺如下：
⇒ 右舷紅色速度向量線的橫越船還有碰撞危機，因為是端點對中點，安全的間隔可能是 1 分半鐘，就像圖形 9-08。
⇒ 第一條右舷的橫越船會通過本船的船頭，在 2 分鐘之後，橘色方塊。
⇒ 第二條右舷紅色橫越船會通過本船的船頭，在 4 分鐘之後。

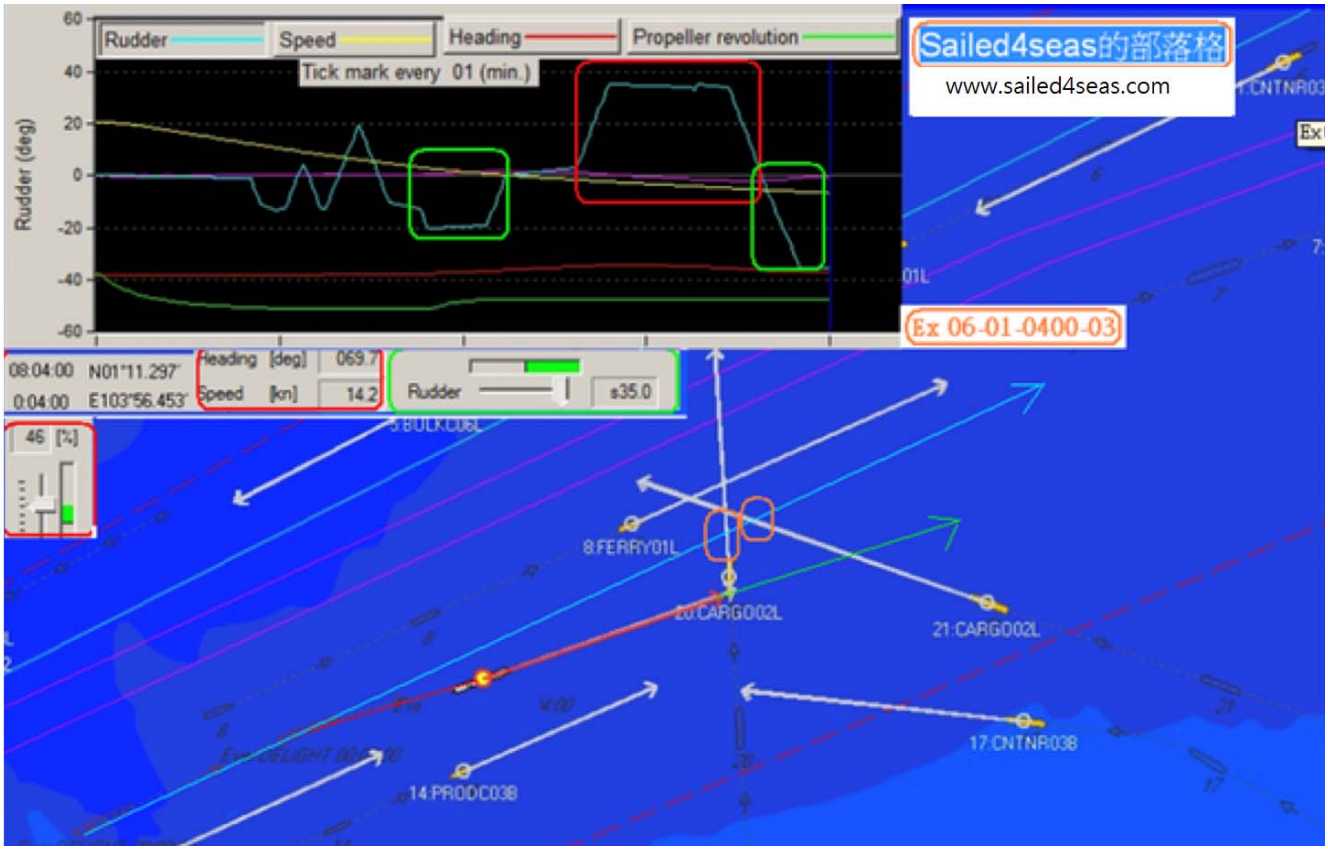
3 分鐘的操演時間之後

⇒ 本船的速度是 15 節，這是從 16.2， 21.0 節而來，主機的出力，從開始增加到 46%。
⇒ 本船增加主機的出力，在右舵 20 度之後，所以這一個船長就是沒理型的，小舵角加大車。
⇒ 本船的航向向右轉了 8 度，到 077.3 度，從 069.2，065.3 度，用右舵 20 度，然後左滿舵，將船首向穩住。
⇒ 一條被追越船在右舷，是 OK，比本船慢。一條被追越船在左舷，比本船快。這是我們比較速度向量線得知的

9-34 什麼是分道航行制內的完美航向？

改變速度向量線到 6 分鐘之後，情勢的知覺如下：

⇒ 第一條橫越船在右舷會通過本船的船頭，在現在的航向 077.3 度。
⇒ 第二條右舷橫越船經向左轉向，她的意圖不是要橫越航行巷道，會通過本船的船艉，在 6 分鐘之後。
⇒ 3 分鐘的速度向量線跟她沒有交點，本船在這 3 分鐘是安全的，
⇒ 在 2 分鐘之後，本船會通過他的船頭，（兩分鐘的時間）準確的來說，我們跟她已經沒有任何的碰撞危機。
⇒ 雖然 6 分鐘的速度向量線有交叉點，3 分鐘的速度線沒有碰撞點，可以給我們更清楚碰撞危機的指示。
⇒ 一條橫越船在右舷，將會通過本船的船頭，在現在的船首向，在一分半鐘之後，這是我們看到的。
⇒ 這個航向，就是對所有船隻來講，是個完美的航向，在 1 分半鐘，就可以通過，本船的位置仍然是在航道之內，即使過了 6 分鐘的時間，這是減速的效果。



圖形 9-41 本船的速度向量 3/6 分鐘 在 4 分鐘的操演時間之後

經過 4 分鐘的操演時間過後本船的速度是 14.2 節，這是從 15 節，21 節而來，主機的出力從第 2 分鐘開始，就是 46%。速度降低，在最後 1 分鐘沒有什麼效率。

本船的航向向左轉了 7.6 度，到 069.7 度，從 077.3 度，使用右舵 20 度，然後直接用左滿舵，現在再到右滿舵

- ⇒ 一條被追越船在右舷，是 OK 的，仍然比本船速度慢。
- ⇒ 一條被追越船在左舷也是 OK 的。
- ⇒ 兩條右舷的橫越船也是 OK 的，一條會通過本船的船頭，另外一個已經轉向向左舷而去，這是我們看到的。
- ⇒ 最後的橫越船在右舷，會通過本船船頭，在一分半鐘後，這是一個完美的航向，對所有船隻，都可以在一分半鐘後清爽的通過。這也是個完美的航向。

9-35 避免碰撞面的危機

這個操演的啟發是為什麼有兩個完美的船首向發生？一個是在 077 度，然後在 069.7 度，也是 OK 的。這個是我們要思考的地方？請參考天藍色的線條，在圖形 9-41 他是本船的原始航線，有些橫越船隻的碰撞點，在這橘色的方塊上面，這是我們看到的。

很清楚的，本船現在的航線 069.7 度是安全的，因為他已經完全避開了原來的碰撞面。

從一開始，轉向到右舷給本船足夠的空間，也就是正橫距離去避免碰撞面。

減速增加本船通過碰撞面的時間間隔，使本船比目標船晚到碰撞面。

等本船清爽了碰撞面之後，船長看起來都是很輕鬆的，只要本船不要回到原來的碰撞面，碰撞區域裡面。

請參考上面操演的圖形，碰撞的地區並沒有改變，只要目標船仍然保持原來的航向航速。

所以只要避碰的觀念正確，我們會發現自己，已經可以很好地控制本船的航向改變，即使是使用滿舵來操船，就算有幾條船的碰撞危機，同時出現。這是因為我們使用的滿舵，有足夠的舵效，這是知道是要走多少度的航向？而不是打了滿舵，再找機會突圍，那個是不太可能的事。遲早哪一天會出事。

9 – 14 Collision Awareness Exercise – 24　3 minutes safety margin

9-33 How to avoid a collision line risk?

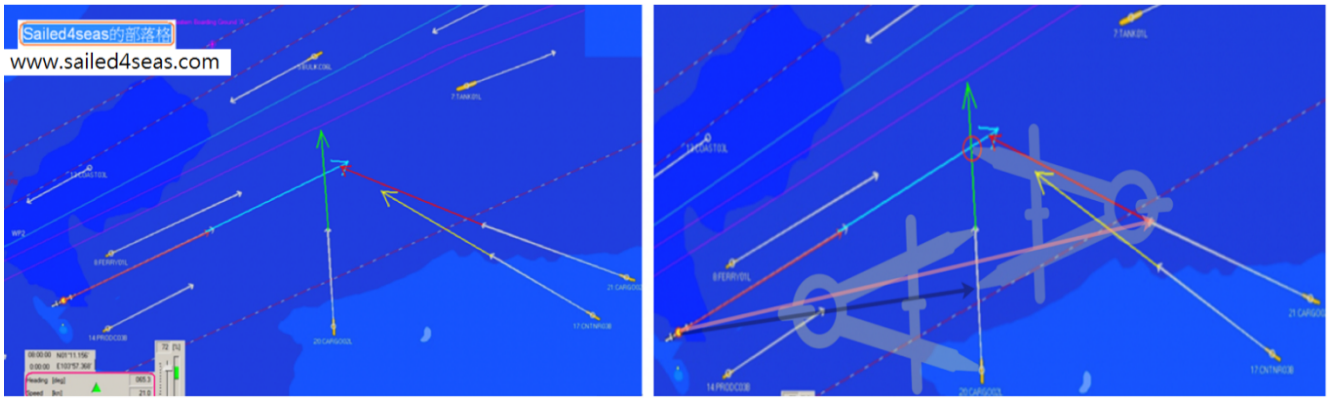


Figure 9-39 Ownship speed vector in 3/6 minutes in the beginning

Refer to 9-39 figure, ownship speed is 21.0 Knots and course is 065.3 degrees at beginning. Speed vector is 10.5 cables distance.

The situational awareness is

- One overtaken vessel at starboard side has slower speed. (sense)
- One overtaken vessel at port side has slower speed. (skill by comparing vector length)
- By change speed vector length to 6 minutes, two crossing vessels at starboard side have collision risk with ownship. (sighted)
- Collision with green speed vector vessel first then red speed vector vessel second. (sighted)
- Collision point is almost coincided. (sighted)
- One crossing vessels with yellow speed vector at starboard side have collision risk with ownship. (safety margin one minute)

How to solve collision case with 3 minutes safety margin? (Create an End to Target situation)

If ownship want to choose a course where we can **pass target vessel with 3 minutes time safety margin?**

⇒ Ownship have to alter course to shift collision point to 3 minutes away.

⇒ For red speed vector vessel in figure 9-39, she is at End to End situation after 6 minutes.

⇒ If ownship want to have 3 minutes safety margin with her we have to shift collision point in her speed vector to her 3 minutes length as we can see the pink line in figure 9-39 had indicated.

⇒ We had tried this before in figure 9-21 where ownship alter course 10 degrees to get 3 minutes safety margin.

⇒ If ownship alter course to her 3 minutes speed vector's end to get 3 minutes safety margin as pink line 077^0 (T) in figure 9-39. This course is not exactly 3 minutes safety margin as we want because pink line is long than ownship's 6 minutes speed vector. When ownship arrive, target vessel's 3 minutes speed vector will pass already.

⇒ In another words, if new course line to arrive target vessel's speed vector end is shorter than ownship's speed vector length, safety margin will be less than 3 minutes.

⇒ Surely, we can get more precise course to steer to get exactly 3 minutes safety margin by proper drawing techniques. Let's try on another crossing vessel with green color speed vector as left picture.

⇒ In her green speed vector, mark 3 minutes length by Pen or divider span. (lower yellow divider takes out target's 3 minutes run)

⇒ From collision point, put yellow divider's one leg on collision point. Along her speed vector, put another leg backward (3 minutes length) to find the mark for black line (yellow divider span is her 3 minutes run before collision point). Black line is the New course we need.

⇒ Use EBL or cursor to take out the bearing 084 (T) of black line.

⇒ When own ship arrives this point with course 084 (T) target vessel had passed it three minutes ago.

⇒ <u>But the location of these targets are outside TSS ownship should navigate with caution,</u>

⇒ Captain should realize ownship need to course again slowly once target vessel passed ownship's bow, as figure 2-10 SOP for collision avoidance.

⇒ Keep 3 minutes safety margin can be maintained in open sea. In coastal water or inside TSS, once target vessel passed ownship's bow ownship should course again as soon as possible.

- The concept is the same avoid the collision point, keep collision vessel on our port bow will be enough. (skill)

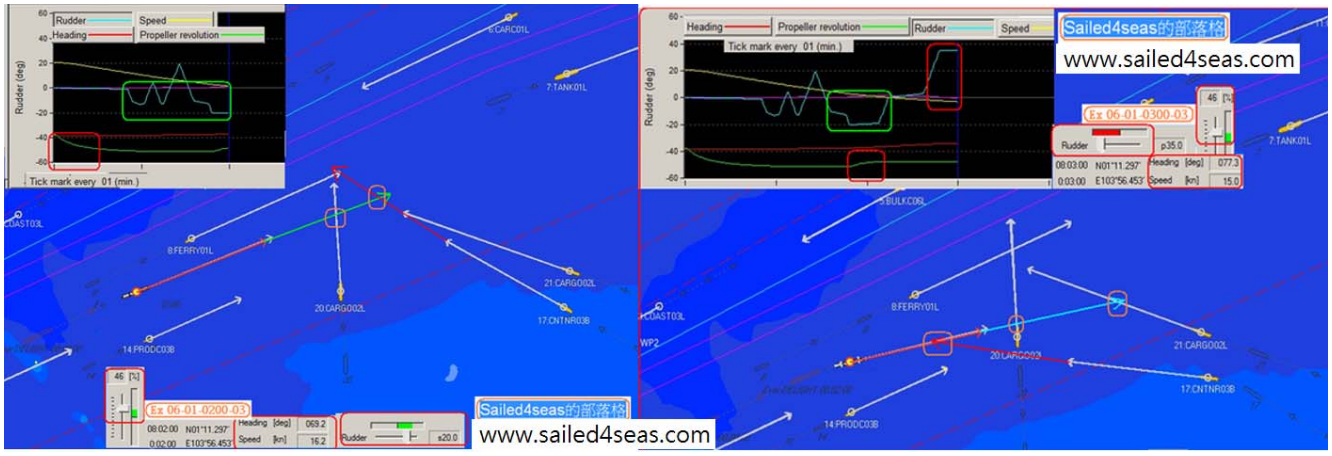


Figure 9-40 Ownship speed vector in 3/6 minutes at 2 and 3 minutes time

In **Figure 9-40 left picture**, After 2 minutes 00 seconds exercise time lapsed:

- Ownship speed is 16.2 knots which decreased from 21.0 kts with engine output reduced to 30% from beginning. Ownship reduced speed is effective. Speed reduces 4.8 knots over 2 minute's time with reducing rate of 2.4 knots per minutes.
- Ownship waited for one minute then altered 3.9 degrees starboard side to 069.2 (T) from 065.3 (T) with starboard rudder " more or less in last minutes.
- One overtaken vessel at starboard side has slower speed. (skill by comparing vector length)
- One overtaken vessel at port side has faster speed. (skill by comparing vector length)

By change speed vector length to 6 minutes, the situation awareness is

- One crossing vessels red speed vector at starboard side have collision risk with ownship for End to Middle situation. (1.5 minutes safety margin as figure 9-08)
- One crossing vessels at starboard side will pass ownship bow after 4 minutes. (last one sighted)
- One crossing vessels at starboard side will pass ownship bow after 2 minutes. (first one sighted)

In **Figure 9-40 right picture**, After 3 minutes 00 seconds exercise time lapsed:

- Ownship speed is 15.0 knots which decreased from 16.2, 21.0 kts with engine output increased to 46% from beginning. Ownship increased engine output after "Starboard 20" rudder. So, this captain is MORIE type. Moderate rudder and increase engine.
- Ownship course had altered 8.1 degrees starboard side to 077.3 (T) from 069.2, 065.3 (T) with starboard 20 " " steady" then steady with "Hard Port".
- One overtaken vessel at starboard side is OK. (still slower than ownship)
- One overtaken vessel at port side is faster now. (skill by comparing vector length)

9-34 What is a perfect heading inside a TSS?

In **Figure 9-40 right picture**, By change speed vector length to 6 minutes, the situation awareness is

- First crossing vessels at starboard side is about to pass ownship bow now at this heading 077.3 (T). (sighted)
- Second crossing vessels at starboard side had altered course to port side. Her intention is not to cross TSS at this moment. (It will pass ownship stern after 6 minutes.)
- 3 minutes speed vector has no crossed point with her, ownship will be safe for this 3 minutes.
- After 2 minutes ownship will pass her bow (2 minutes later), there will no collision risk with her any more.
- Although 6 minutes speed vector had crossed point, 3 minutes speed vector (collision line) can give us more clear picture.
- One crossing vessels at starboard side will pass ownship bow after 1.5 minutes by current heading. (sighted)
- This is a perfect heading for all vessels will clear after 1.5 minutes and ownship location is still within traffic lane after 6 minutes run. (sighted)
- After situation are more clearer, we can course again. (sense)

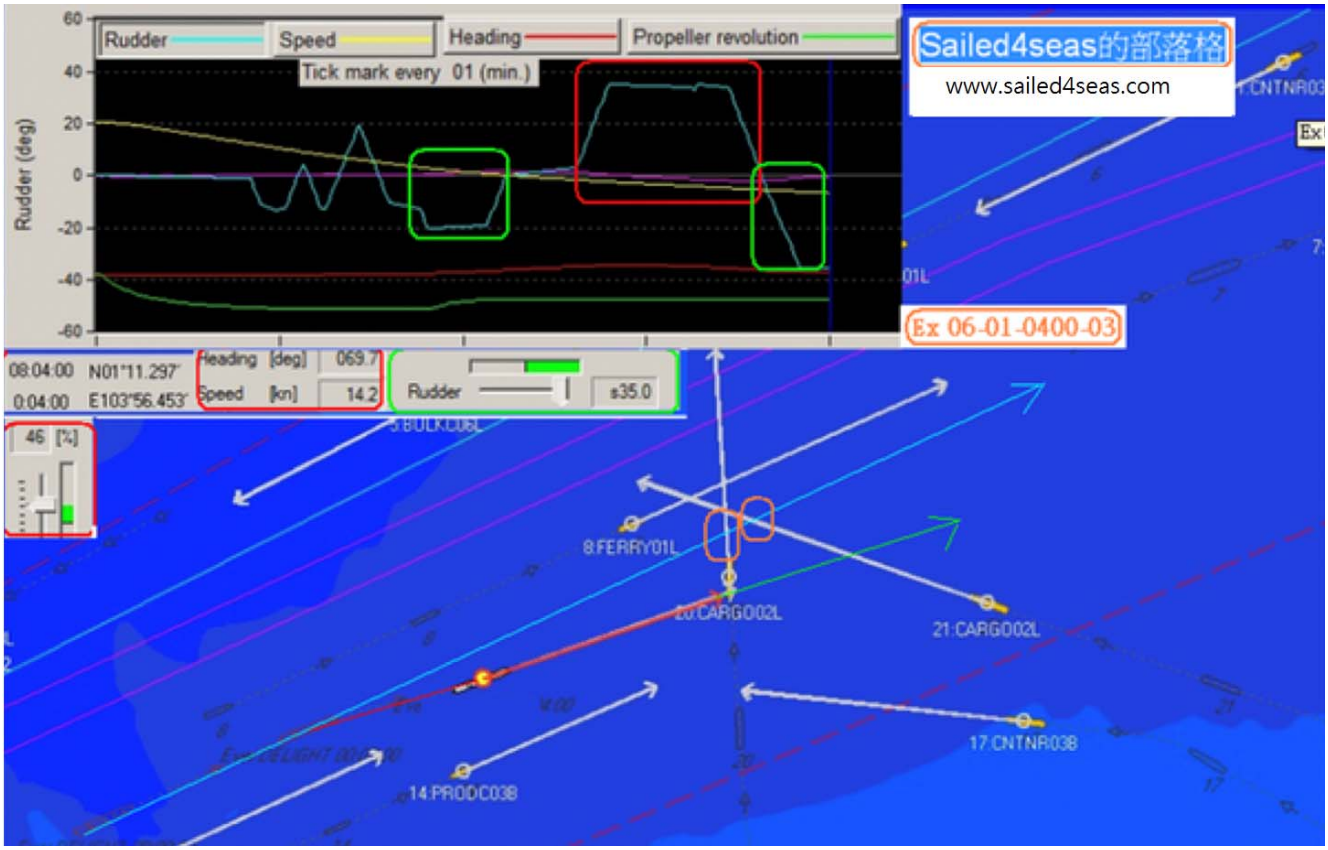


Figure 9-41 Ownship speed vector in 3/6 minutes at 4 minutes time

In **Figure 9-41 left picture,** After 4 minutes exercise time lapsed:

- Ownship speed is 14.2 knots which decreased from 15.0, 16.2, 21.0 kts with engine output kept to 46% from 2 minutes time. Ownship reduced speed is ineffective in last minute.
- Ownship course had altered 7.6 degrees port side to 069.7 (T) from 077.3 (T) with starboard 20 ° then "Hard Port" directly to " Hard Starboard" now.
- One overtaken vessel at starboard side is OK. (still slower than ownship)
- One overtaken vessel at port side is OK. (faster now)
- Two starboard side crossing vessels are OK, one passed ownship bow and other altered course to port side. (sense)
- Last crossing vessels at starboard side will pass ownship bow after 1.5 minutes. (sighted)
- This is a perfect heading for all vessels will clear after 1.5 minutes. (sighted)

9-35 How to avoid a collision area risk?

The moral of this exercise is

- Why two perfect heading happened, heading 077 degrees is OK and 069.7 degrees is OK too. (suspect)
- Please refer to light blue line at figure 9-41which is ownship's original course line. And we have these two crossing vessels' collisions point on it. (orange square). (sighted)
- It is obvious ownship current course 069.7 (T) is safe due to it had avoided original collision area at all.
- **Course alternations** to starboard side **had given ownship necessary ground (beam distance) to avoid collision area** from the beginning. (sighted)

- **Speed reduction had given ownship passing time lapse to arrive Collision Area later** then target vessel. (sighted)
- After ownship cleared collision area, everything seems easy as long as ownship don't go back to old collision area.(statement)
- Please refer to the Exercise picture above; the collision ground had not changed. (sighted: target vessels keep original speed and course)

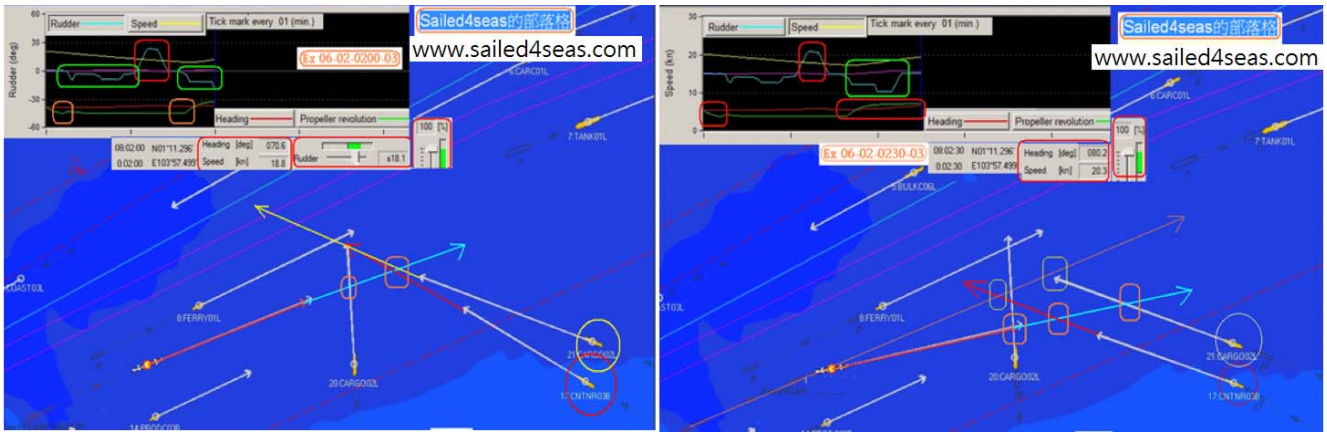
Suddenly, we can handle course change with Hard Over rudder, not by 7 ship's length limitation.

9-15 避碰知覺操演- 25 10 度右轉

9-36 碰撞點會在本船船首向前面。

請參考圖形 9-39 本船的速度是 21 節，航向是 065.3 度，速度向量線是 10.5 個 CABLE 的距離長度，情勢知覺如下：

- 右舷被追越船速度比較慢，左舷追越船也比本船慢。
- 兩條右舷的橫越船跟本船有碰撞危機，跟綠色速度向量線的碰撞先發生，然後是紅色速度向量線的船隻，這兩條船與本船的碰撞點幾乎相同。
- 黃色速度向量線的右舷橫越船與本船有碰撞危機，安全的間隔是 1 分鐘，這是在 6 分鐘速度向量線上的判斷。



圖形 9-42 速度向量線在 3/6 分鐘 兩分鐘與兩分半鐘的操演之後

經過兩分鐘的操演，本船速度是 18.8 節，這是從 21 節而來，主機出力從開始降低，然後增加到 100%，本船地減速並不徹底。本船的航向右轉 5.3 度，到 07 0.6 度，從 065.3 度而來，開始時使用小舵角，右舵 15 度，使用全速，所以我們又看到了一個無理船長的操船，這個情勢的直覺如下：

⇒ 右舷的橫越船看起來是 OK，端點對中點，有一半的安全。
⇒ 右舷的追越船比本船慢， OK。
⇒ 左舷追越船跟本船差不多速度。
⇒ 改變速度向量線到 6 分鐘的長度，右舷紅色速度向量線的橫越船，與本船在四分半鐘後，有碰撞危機，這是，端點對端點，碰撞在 4 分半鐘之後。
⇒ 右舷的橫越船（黃色速度向量線）會通過本船船頭，在 4 分鐘之後，端點對中點，我們還有 1 分鐘的安全間隔。

經過兩分半鐘的操演時間過後：本船的速度是 20.3 節，這是從 18.8 節，21 節而來，主機的出力增加到 100%，本船的速度被增加，來增加舵效。

本船的航向轉了 9.6 度，到 080.2 度，從 070.6，065.6 度而來，使用右舵已經 1 分鐘了，船長對於舵效的耐性非常有限，等待平均時間最多是 20 秒，就會開始採取行動，回轉速率是每分鐘 19.2 度，這是用大車造成的。情勢的知覺如下：

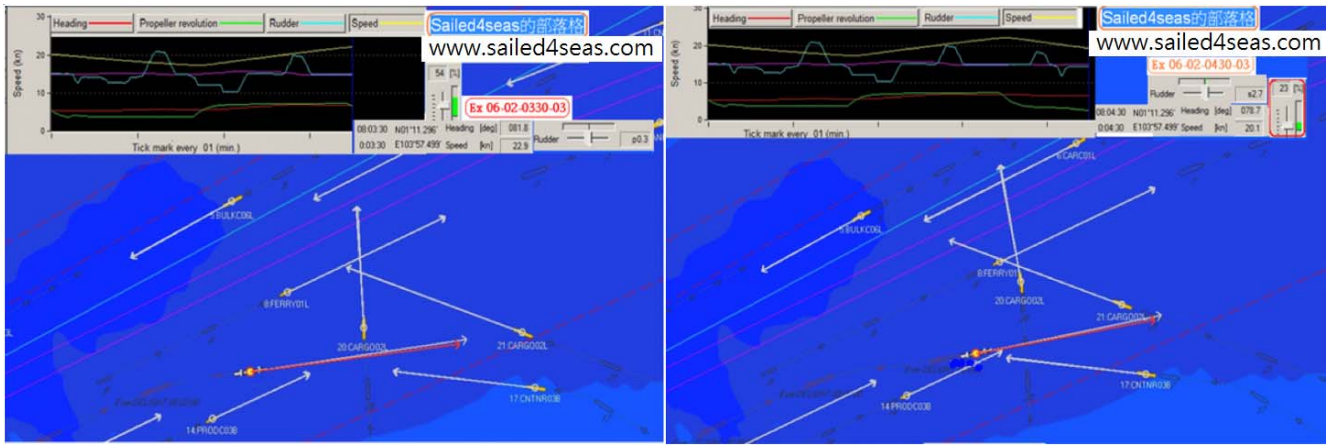
⇒ 船速增加 1.5 節在 30 秒的時間，這個是在現實海上，不太可能。這個就是模擬機的程式有問題。
⇒ 第一條橫越船的碰撞點轉移到了右邊，幾乎是端點對目標的情況，我們有兩分半鐘的安全間隔。
⇒ 第二條在右舷的橫越船，已經轉向左邊，新的碰撞點跟本船是端點對端點，在 4 分鐘後有碰撞危機。
⇒ 第三條右舷的橫越船（黃色圓圈）會通過本船的船頭，在一分半鐘後，端點對目標，或者是沒有交點的情況，本船是安全的。
⇒ 右舷的追越船是 OK，比本船慢。
⇒ 左舷的追越船現在是 OK 的，本船已經向右轉。
⇒ 是否現在的航向 080.2 度比 30 秒之前 070.6 度安全？這是我們懷疑的地方

9-37 延後碰撞時間的圖形解答

♥ 利用改變航向 10 度，本船比 30 秒之前，會有多一分半鐘的安全間隔。
♥ 所有的碰撞點會轉移到右舷，所有目標可以提早通過新的碰撞點（比本船原來航線上）。
♥ 碰撞時間的延後，取決於目標船與本船的距離，遠距離的目標碰撞時間延後，會比近距離的目標來的長。
♥ 早期的章節，我們曾經使用一些數值型的參考，做為避碰之用。
♥ 例如要保持 600 公尺的安全距離（兩倍船長的距離），這要移動碰撞點 600 米向後，必須轉向 10 度，如果目標是在兩海浬的距離之外。

在圖形 9-42，我們可以看到對於任何特定的目標船，如何找出新的航向，比原來的航向延後碰撞時間 1 分半鐘？但是本船有一個目標船轉向，在此同時，在最後的 30 秒。

⇒ 本船的碰撞點已經轉移到航行巷道的外側去了，碰撞點是由黃色的方塊移動到紅色的方塊，這是在目標船的速度向量線上。
⇒ 本船船首向對正的點，就是碰撞危機會發生的點，這是規律。



圖形 9-43 3 分鐘速度向量線 在在 3 分半鐘跟 4 分半鐘的操演過後

經過 3 分半鐘的操演時間過後，船速是 22.9 節，這是從 20.3，18.8 節而來，主機的出力是 100%，（船速的增加在過去的 1 分鐘是 2.6 節，這是類比機的錯誤）。本船的航向向右轉到 081.8 度，從 080.2 ，070.6，0 65.3 度而來。

本船的碰撞線，3 分鐘的速度向量線上沒有交點，表示至少在 1 分半鐘的時間內，沒有碰撞危機。請參考圖形 9-07 一旦目標船的速度向量線碰到本船的速度向量線，碰撞時間可能只有一分半鐘的時間，如果我們對現在雷達的畫面，感覺到舒適，就表示我們雷達瞭望的訓練，已經接近完成了。

⇒ 經過 4 分半鐘的操演時間過後，速度是 20.1 節，這是從 22.9 節而來，主機的出力減少到 23%，速度的降低，在 60 秒鐘的時間是 2.8 節。
⇒ 本船的航向向左轉了 3.1 度，到 078.7 度從 081.8 度而來。
⇒ 整體的情勢並沒有改變，從上 1 分鐘，本船正緩慢的回到原始的航道方向。（端點對目標的情勢）
⇒ 這個操演顯示了安全的船首向，就是本船速度向量線不會跟其他船隻速度向量線相交的方向，3 分鐘的速度向量線沒有交點，在 1 分半鐘的時間裡，沒有碰撞危機。

9 – 15 Collision Awareness Exercise – 25　10 degrees to starboard

9-36 Collision point will be on ownship heading.

Refer to 9-39 figure, ownship speed is 21.0 Knots and course is 065.3 degrees at beginning. Speed vector is 10.5 cables distance.

The situational awareness is

- One overtaken vessel at starboard side has slower speed. (sense)
- One overtaken vessel at port side has slower speed. (skill by comparing vector length)
- By change speed vector length to 6 minutes, two crossing vessels at starboard side have collision risk with ownship. (sighted)
- Collision with green vector vessel first then red vector vessel second. (sighted)
- Collision point is almost coincided. (sighted)
- One crossing vessels with yellow vector at starboard side have collision risk with ownship. (safety margin one minute)

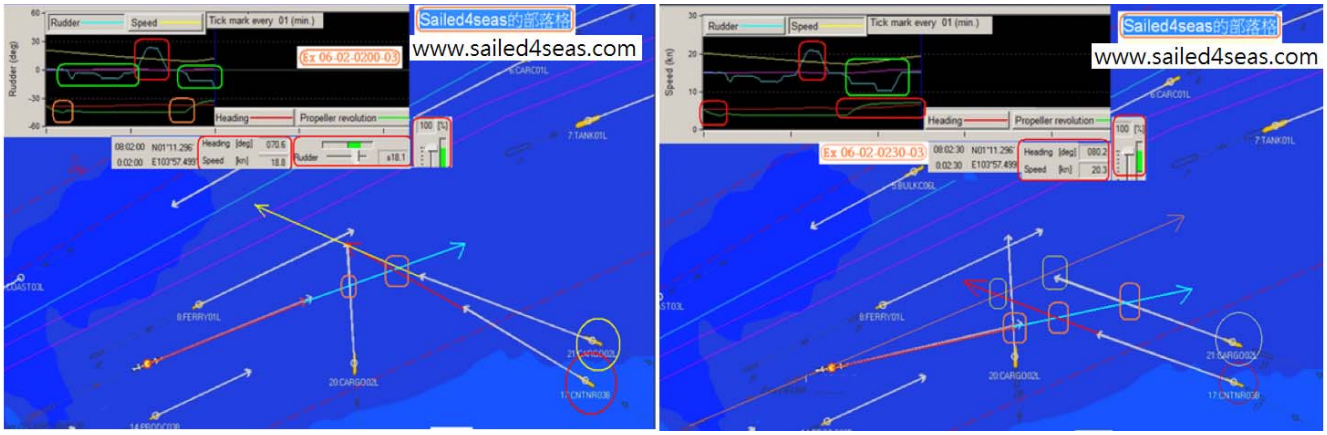


Figure 9-42 Ownship speed vector in 3/6 minutes at 2 and 2.5 minutes time

In **Figure 9-42 left picture**, After 2 minutes 00 seconds exercise time lapsed:

- Ownship speed is 18.8 knots which decreased from 21.0 kts with engine output reduced from beginning and increased to 100%. Ownship reduced speed is ineffective.
- Ownship course had altered 5.3 degrees starboard side to 070.6 (T) from 065.3 (T) with small starboard rudder (???) in beginning and further "starboard 15" (???) rudder with full engine(???). So, we got a MORIE captain again.

The situational awareness is:

- One crossing vessels at starboard side seems OK. (end to middle, Caution)
- One overtaken vessel at starboard side has slower speed. (skill by comparing vector length)
- One overtaken vessel at port side is about same speed. (skill by comparing vector length)
- By change speed vector length to 6 minutes, one crossing vessels (red speed vector) at starboard side have collision risk with ownship after 4.5 minutes. (End to End, collision in 4.5 minutes)
- One crossing vessels at starboard side (yellow speed vector) will pass ownship bow after 4 minutes. (End to Middle, one minute safety margin)

In **Figure 9-42 right picture**, After 2 minutes 30 seconds exercise time lapsed:

- Ownship speed is 20.3 knots which increased from 18.8, 21.0 kts with engine output increased to 100%. Ownship speed is increased to increase rudder effect.
- Ownship course had altered 9.6 degrees starboard side to 080.2 (T) from 070.6, 065.3 (T) with starboard rudder one minute. Captain has very limited patience in rudder effect, waiting time is averaged 20 seconds at most. Turning rate is 19.2 degrees per minute with strong engine output.

The situational awareness is:

- Speed increased 1.5 knots over 30 second time. (this is impossible in real sea. This is simulator's bugs.)
- First starboard side crossing vessels collision point shifted to starboard side. (almost end to target situation, 2.5 minutes safety)
- Second crossing vessels at starboard side had altered course to port side, new collision point with ownship. (end to end, dangerous collision at 4 minutes)
- Crossing vessels at starboard side (yellow circle) will pass ownship bow after 1.5 minutes. (End to Target or No crossing situation, safe)
- One overtaken vessel at starboard side is OK. (skill: has slower speed.)

- One overtaken vessel at port side is OK now. (ownship altered course to starboard side)
- Is this heading 080.2 (T) is better than 30 seconds before 070.6 (T)? (sense)

9-37 Graphical solution to increase Collision time safety marge.

- In Figure 9-42 right picture, By change course 10 degrees, Ownship had 1.5 minutes more safety margin than 30 seconds before.
- All collision points shifted to starboard side which make all targets passed earlier than before. (please compare the collision point on original orange course line)
- The collision time delayed depends on target vessel's distance to ownship. Distant target collision time delays more than close target.
- In earlier chapter we had established many numeric references for collision avoidance: For 600 meters safety distance (shift collision position 600 meters backward), ownship need to alter course 10 degrees when target vessel is 2 nm distance away.
    - This 10 degrees course change is not enough while target is one nm distance away. By then, ownship will need alter course 20 degrees to keep this 600 meters.
    - In dense traffic, this 10 degrees course change in one nm will created 321 meters abeam distance in proportional.
    - For 20 knots vessel, 3 minutes speed vector alter course 10 degrees will create 321 meters abeam distance.
    - For 10 knots vessel, 3 minutes speed vector alter course 10 degrees will create 160 meters abeam distance.
- In figure 9-42 right picture, we can see how to find new heading to increase collision time 1.5 minutes later than original course for any specific target vessel.
- But ownship and one target vessel altered course at the same time during last 30 seconds. (sighted)
- Collision points are moving from yellow square to red square along target vessel speed vector. (sighted)

Where ownship heading pointed is where collision risk will be. (Rule)

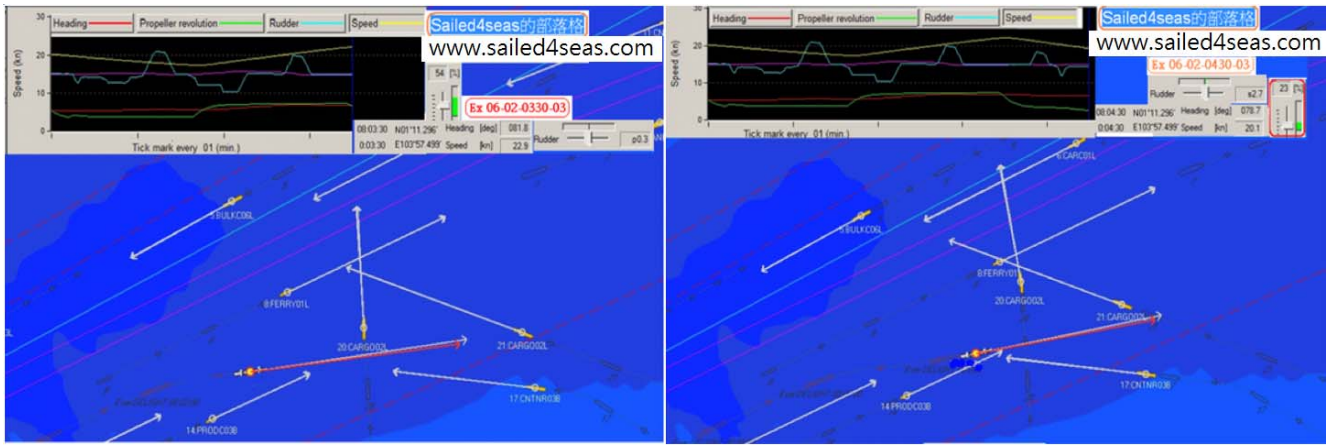


Figure 9-43 Ownship speed vector in 3 minutes at 3.5 and 4.5 minutes time

In figure 9-43 left picture, After 3 minutes 30 seconds exercise time lapsed:

- Ownship speed is 22.9 knots which increased from 20.3, 18.8, 21.0 kts with engine output increased to 100%. Speed increased 2.6 knots over 60 second time. (simulator's fault)

- Ownship course had altered 1.6 degrees starboard side to 081.8 degrees from 080.2, 070.6, 065.3 degrees.
- Ownship Collision lines (3 minutes speed vector) have no crossed points means no collision risk for at least 1.5 minutes time.(refer figure 9-07A, once target vessel speed vector touched ownship TTC time to collision may be 1.5 minutes only.)

If we feel comfortable with this radar picture our Radar lookout training is about to complete.

In figure 9-43 right picture, After 4 minutes 30 seconds exercise time lapsed:

- Ownship speed is 20.1 knots which decreased from 22.9, 20.3, 18.8, 21.0 kts with engine output decreased to 23%. Speed decreased 2.8 knots over 60 second time.
- Ownship course had altered 3.1 degrees port side to 078.7 degrees from 081.8, 080.2, 070.6, 065.3 degrees.
- Situation overall had not changed since last minute. Ownship come back to traffic lane course slowly. (end to target situation)
- This exercise demonstrated safe heading where ownship speed vector did not touch another vessel's speed vector.

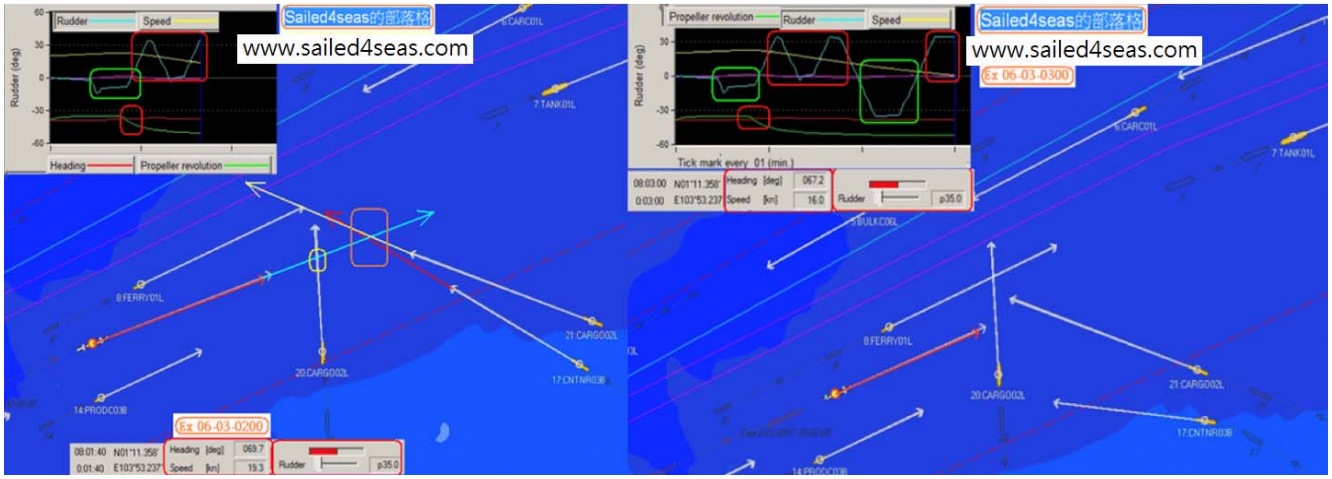
3 minutes speed vector had not crossed means no collision risk for 1.5 minutes time only.

9-16 碰撞知覺操演 -26 情勢報告的格式

請參考圖形 9-39 本船的速度是 21 節航向 065.3 度，速度向量線是 10.5 CABLE 距離長度。情勢知覺如下：右舷被追越船速度比較慢，左舷追越船速度也比較慢，改變速度向量線為 6 分鐘後，右舷的兩條橫越船有碰撞危機。

⇒ 綠色速度向量線的碰撞先發生，然後是紅色速度向量線的船隻，這兩條船的碰撞點幾乎相同。

⇒ 一條黃色速度向量線的橫越船，也有碰撞危機，安全間隔為 1 分鐘。



圖形 9-44 本船速度向量線在 3/6 分鐘 在 2/3 分鐘操演之後

⇒ 在兩分半鐘操演之後，本船的速度在是 19.3 節，這是從 21 節減下來的，主機的出力在第一分鐘時減到 50%，沒有立刻減速。在一分鐘的時間速度降低 1.7 節。

⇒ 本船的航向向右轉了 4 度，到 069.3 度從 065.3 度，使用右舵 10 度，在開始的時候，然後是左舵，在這兩分鐘之內，船長沒有決定，應該要怎麼做，本船仍然是向碰撞區域前進。

在操演開始的 3 分鐘後，我們使用 6 分鐘的速度向量線，

⇒ 右舷的被追越船速度仍然比本船慢，左舷的追越船跟本船是差不多同速，在右舷的第一條橫越船看起來 OK，黃色的方塊，端點對中點，兩分鐘的安全間隔。
⇒ 第二條右舷的橫越船，紅色速度向量線跟本船在 5 分鐘後，有碰撞危機，端點對端點，碰撞在五分鐘之後。

9-38 使用碰撞線引起的混淆，用碰撞點的概念澄清

⇒ 第三條右舷的橫越船，黃色的速度向量線在橘色的方塊裡，看起來有一點麻煩。目標船 4 分鐘後會通過，而本船會在 5 分鐘後通過碰撞點，這是中點對中點，只有 1 分鐘的安全間隔。
⇒ 本船會比目標船晚 1 分鐘到碰撞點，這是黃色速度向量線的目標船，這是我們使用碰撞點的概念，得到的情勢知覺。
⇒ 這兩條橫越船造成了一個很強的碰撞面，橘色的方塊。無論如何，本船必須想辦法避免橘色的方塊。
⇒ 這個黃色的碰撞點，可以列入碰撞面裡面，來簡化我們評估的作業。
⇒ 對追越船的碰撞危機，是比較速度向量線的長度，看一看哪一條船比較快就夠了。
⇒ 對橫越船我們需要一套情勢報告的格式，來節省溝通的工作量。我們的短期記憶容量非常有限。

9-39 情勢報告 SITREP: SITuation REPort

對橫越船而言，情勢報告，海軍叫做戰情報告，由雷達士向目視的長官報告，右舷的橫越船報告的格式應該如下：

♥ 第一條船。通過船頭 2 對 4。目標通過本船的船頭在第 2 分鐘，本船會在第 4 分鐘，通過碰撞點。
♥ 第二條船：碰撞，五分鐘。兩條船在五分鐘之後，都會同時到達碰撞點，產生碰撞。
♥ 第三條船：通過船頭 4 對 5。通過本船的船頭，在第 4 分鐘，而本船會通過同樣的地點，在第 5 分鐘的時間。

有些船隻可能會是：

♥ 通過船艉，4 對 2。代表會過本船的船艉，在 4 分鐘後，本船會在第 2 分鐘先通過。

3 分鐘的操演時間過後，本船的速度是 16 節，這是從 19.3， 21.0 節而來，主機的出力在兩分鐘前減到 50%，速度減低了 3.3 節，在最後 1 分鐘，本船的主機出力，並沒有進一步降低。但是船速下降的非常快，我們看到船長使用了迴圈舵。

⇒ 本船的航向向左轉了兩度，到 067.2 度，從 069.3 ，065.3 度，使用左舷的迴圈舵，在最後的兩分鐘。在這裡我們是有一個老馬船長。

⇒ 速度的降低速率是平常船隻的兩倍，也是 1 分鐘前下降的兩倍，由於使用了迴圈舵，我們看到的速度降低的速率是每分鐘 3.3 節，對於避碰來講是非常好的效果，本船的速度向量長度，在 3 分鐘後，比原先短了 1.6 個 CABLE 的長度，因為本船的速度下降，是以 3 分鐘可以前進的距離來做的比較。

⇒ 1.6 個 CABLE 就是 296.3 米，或是大約 300 米，這 300 米就是一條船的長度，這是我們計算所得的。

⇒ 船長創造出這 300 米的距離差距，在 3 分鐘後碰撞面的前面，是具有決定性的影響。離開目標船有 1 倍船身的距離，這是我們的觀測。

橫越船在右舷的情況如下：

⇒ 第一條：通過船頭，端點對中點，1 分半鐘的安全間隔。

⇒ 第二條：向左舷轉向，通過船尾，在 6 分鐘後。

⇒ 第三條：通過船頭，3 對 4。端點對中點，安全間隔只有 1 分鐘，這是有相當的危險。

一條被追越船在右舷是 OK 的，因為呢他的速度比較慢，被追越船在左舷也是 OK 的，速度比本船快。

9-40 減速的數值參考

經過這些操演之後，我們發現有些減速的數值，可以給我們做為評估避碰效果的依據。

♥ 船隻平均的速度降低率，每 1 分鐘是 1.5 到 2 節，這速度降低是借由主機的出力減少，術語叫滑行，沒有使用多餘的舵角來幫助減速。

♥ 如果我們加上迴圈舵的操作，船速降低的速率可以達到每分鐘 3 節，這個就是比較有效。這是我們的感覺

♥ 計算的 1.6 個 CABLE 大約是 296.3 公尺，一個船身的長度，船速的降低率 3.3 節，可以創造 296.3 公尺的距離，在 3 分鐘的之後，就像我們前面的討論，這 296.3 米就可以避免一條大型船隻，這是使用迴圈舵協助減速的情況之下。

♥ 如果船速降低的速率是每分鐘 1.5 節，三分鐘後可以創造 140 公尺的距離，在 3 分鐘之後，這個 140 公尺，可以避讓小型船隻，在沒有做迴圈舵操作的情況下

♥ 140 米對一條小型船隻是足夠，但是對大型船隻，在碰撞面前面是還不足以避碰。

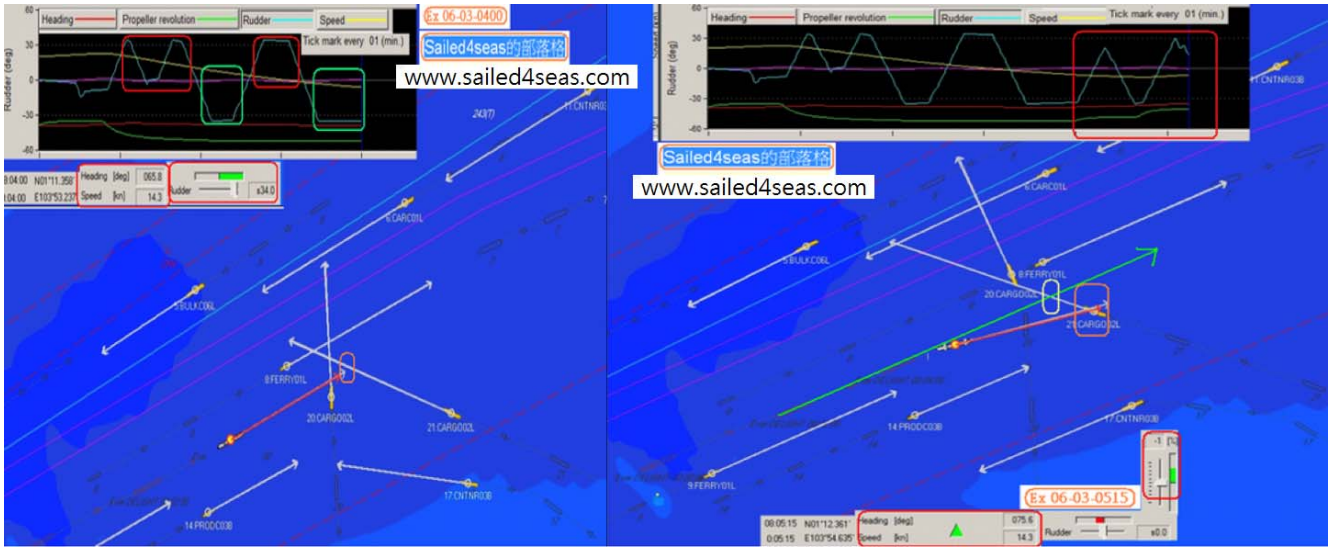
♥ 如果沒有做迴圈舵，在 3 分鐘之後，本船可能只夠降低 4.5 節速度，平均速度降低是 2.25 節，真正的船速降低，還要看主機的出力，現在是設定是多少？還有殘餘速度。

♥ 300 公尺是 0.162 海浬，對一個 17 節船速的船隻，只是減少了 0.57 分鐘的航行距離，這就代表本船可能只有延遲碰撞的時間 0.57 分鐘，比原來的碰撞時間多 0.57 分鐘來考慮。

♥ 300 米多的碰撞距離，聽起來不錯。在碰撞時間的延遲上的效果不大，船速的降低，具有一定的時間限制，就像改變航向，也是需要 3 分鐘，才能夠達到我們要的船首向。

♥ 船速降低的效率就像是回轉速率，並不是都很穩定的。

♥ 任何最後一分鐘的減速，就像最後一分鐘想要改變航向，是很難達成避碰目的，減速要及早，就像轉向要及早。



圖形 9-45 速度向量線 3 分鐘長度，在 4 分鐘與 5.25 分鐘操演之後

經過 4 分鐘操演時間之後，

本船的速度是 14.3 節，這是從 16 節，19.3 節，21 節而來。主機出力降低，第一分鐘後 50%，速度的降低，在最後一分鐘是 1.7 節。本船的航向左轉兩度，到 065.8 度從 067.2，069.3，065.3 度，使用在最後 3 分鐘的迴圈舵操作。經過最後兩分鐘的迴圈舵操作，對本船的船首像向控制非常好，情勢知覺如下

- ♥ 本船的主機出力沒有進一步降低，但是船速緩慢的下降，借由迴圈的操作舵板，這是我們看到的，船速的下降，我們使用迴圈舵還是有底線的，並沒有解決所有的避碰問題。主機的出力仍然非常高，我們看到的速度下降的效率是每分鐘 1.7 節，這個對避碰來講，還是不太足夠，整體的情勢並沒有因為迴圈舵的使用，而得到改善 。
- ⇒ 第一條在右舷的橫越船， 現在通過船頭，2 分鐘的安全間隔。這表示目標船是現在通過船頭，本船在兩分鐘之後通過碰撞點。
- ⇒ 第二條船，通過船艉，6 分鐘後。
- ⇒ 第 3 條船，通過船頭 2 對 3，安全間隔 1 分鐘，或是端點對中點，一半安全，1 分鐘。還是蠻危險的
- ⇒ 在右舷的追越船是 OK 的，速度比較慢。在左舷追越船速度比較快，也是 OK 的。
- ⇒ 本船使用了右滿舵 30 秒，想要開始向右舷的回轉，但是並沒有功效產生。

在 5 分 15 秒的操演時間過後，本船的速度是 14.3 節。在最後 1 分鐘沒有進一步降低主機的出力，反而轉數增加來增加舵效，在等待了 30 秒，滿舵沒有產生功效之後。

- 本船的航向右轉的 10 度到 075.6 度，從 065.8 度，使用右滿舵的舵角。
- 這一次再 10 度的轉向，將本船從橫越船的麻煩裡拯救出來。這是我們看到了橫越船在右舷的情況如下：第一條已經通過船頭，第二條船航向平行，第三條通過船頭，3 分鐘的安全間隔，這是 OK 的。
- 右舷被追越船是 OK 的，是同速。被追越船在左舷也是 OK 的，本船已經轉向離開了。

9-41 在這些麻煩裡面，脫身的訣竅是什麼？

圖形 9-45 的左圖 4 分鐘時間，我們可以看到一個端點對中點的情勢，對第三條橫越船，本船必須進一步加車來增加舵效，避免這一條船。幸運的是第一條跟第二條橫越船已經通過了，但是

對第三條橫越船隻有延遲 1 分鐘的碰撞時間，在第 4 分鐘，多重操縱之後，如果本船不能向右舷轉向 10 度，碰撞位置將發生在黃色的方塊，就像右圖的顯示，最後一分鐘的航向改變，使本船得到額外的安全時間間隔，所以這個操演的教訓就是，

碰撞面不會自行解散，必須採取實質的行動來離開碰撞面。

9 – 16 Collision Awareness Exercise – 26 Situations report format

Refer to 9-39 figure, ownship speed is 21.0 Knots and course is 065.3 degrees at beginning. Speed vector is 10.5 cables distance.

The situational awareness is

- One overtaken vessel at starboard side has slower speed. (sense)
- One overtaken vessel at port side has slower speed. (skill by comparing vector length)
- By change speed vector length to 6 minutes, two crossing vessels at starboard side have collision risk with ownship. (sighted)
- Collision with green vector vessel first then red vector vessel second. (sighted)
- Collision point is almost coincided. (sighted)
- One crossing vessels with yellow vector at starboard side have collision risk with ownship. (safety margin one minute)

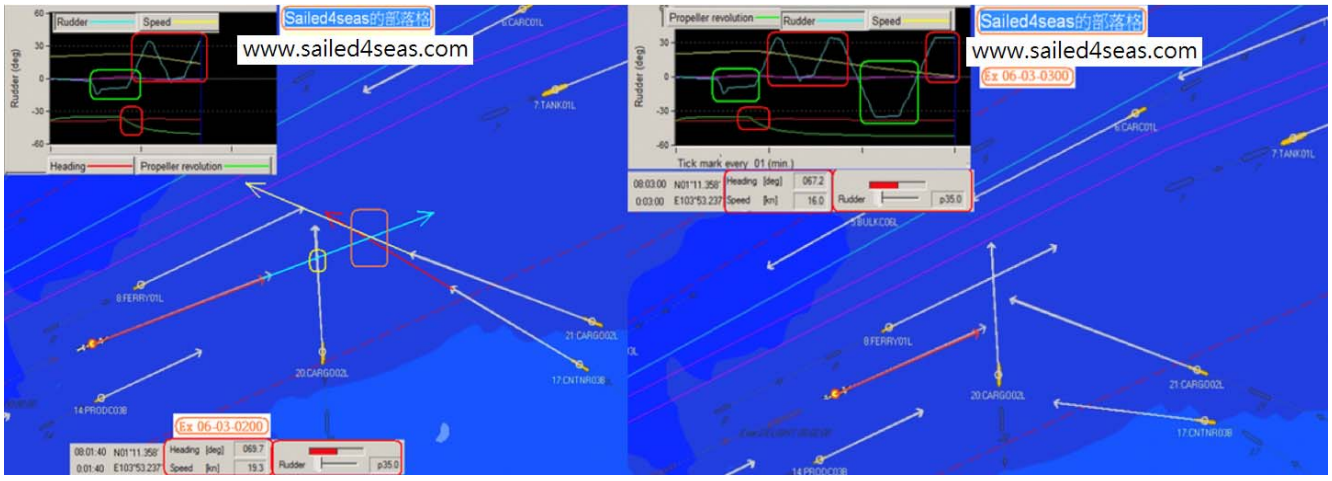


Figure 9-44 Ownship speed vector in 3/6 minutes at 2 and 3 minutes time

After 2 minutes 00 seconds exercise time lapsed:

- Ownship speed is 19.3 knots which decreased from 21.0 kts with engine output reduced from one minute before to 50%. Ownship had not reduced speed immediately. Speed reduces 1.7 knots after 1 minute's time.
- Ownship course had altered 4.0 degrees starboard side to 069.3 degrees from 065.3 degrees with starboard 10 rudder in beginning and further port side rudder. Captain had not decided what to do in these two minutes? Ownship is still heading into collision area.

The situational awareness in 3 minutes speed vectors is not clear. With 6 minutes speed vector, we have:

- One overtaken vessel at starboard side has slower speed. (sense)
- One overtaken vessel at port side is about same speed. (sense)
- First crossing vessels at starboard side seems OK. (yellow square). (end to middle situation, 2 minutes safety)

- Second crossing vessels at starboard side (red vector) have collision risk with ownship after 5 minutes. (End to End situation, collision after 5 minutes)

9-38 Confused by using collision line, try collision point concept again.

- Third crossing vessels at starboard side (yellow vector in orange square) seems a little trouble. (Target passing at 4 minutes and ownship passing at 5 minutes, Middle to Middle, one minute safety margin)
- Ownship will arrive one minute later than crossing vessel with yellow vector. (sighted by using collision point concept)
- Those two crossing vessels had binded a strong collision area (orange square). Ownship have to avoid orange square anyway. This yellow collision point can join to orange square together to ease the assessment.
- For overtaking vessel collision risk is compared the speed vector's length. (who is faster?)
- For crossing vessels, we need a set of situations report format to save the workload of communication. (our short term memory is very limited)

9-39 SITREP: SITuational REPort format for crossing vessels. (what navy called sitrep)

- **Starboard side crossing vessels, sitrep as**
- **First one: Pass bow 2 by 4.** (passed ownship bow at 2 minutes and ownship passing at 4 minutes)
- **Second: Collision after 5 minutes.** (both vessels passing collision point after 5 minutes time)
- **Third: Pass bow 4 by 5.** (passing ownship bow at 4 minutes and ownship passing same position at 5 minutes)
- **Some vessel might: Pass stern 4 by 2. (which means passing ownship stern after 4 minutes and own ship passing at 2 minutes)**

After 3 minutes 00 seconds exercise time lapsed:

- Ownship speed is 16.0 knots which decreased from 19.3, 21.0 kts with engine output reduced from 2 minutes before to 50%. Speed reduces 3.3 knots over last minute. Ownship engine output had not further reduced but speed dropped sharply. We saw "Rudder Cycling" been used by Master.
- Ownship course had altered 2.0 degrees port side to 067.2 (T) from 069.3, 065.3 (T) with Port side rudder cycling in last 2 minutes. So, we had a HORSE captain here.
- Speed reduction rate is double than one minute before due to rudder cycling. (sighted)
- Speed reducing rate of 3.3 knots per minute is very good for collision avoidance. (sense)
- Ownship speed vector lengths shorten 1.6 cables after 3 minutes due to speed reduction. (noted that speed vector is 3 minutes run)
- 1.6 cables are 296.3 meters or about 300 meters. This 300 meters is about one ship's length. (truth)
- Ownship create this 300 meter after 3 minutes run is decisive inside Collision Area to avoid target vessel one ship length. (Statement)
- Crossing vessels at starboard side are:
    - First one pass bow end to middle 1.5 minutes safety margin.
    - Second one alters course to port side, pass astern 6 minutes later.
    - **Third one pass bow 3 by 4, or End to Middle safety margin 1 minute only. (dangerous)**
- One overtaken vessel at starboard side is OK. (has slower speed)
- One overtaken vessel at port side is OK. (faster by comparing vector length)

9-40 Digital guidance in speed reduction.

After all these exercises we find some digital value in speed reduction to give us a clue to evaluate collision avoidance effective.

- ♥ Ownship have average speed reduction rate about 1.5 - 2 knots per minute by reducing engine output only. (coasting: without extra rudder order been used)
- ♥ Together with rudder cycling, speed reduction rate can reach 3.0 knots per minutes which is better. (sense)
- ♥ Speed reduction rate 3.3 knots in first minute can create 296.3 meters distance after 3 minutes as discussed above. This 300 meters is to avoid a big vessel with rudder cycling.
- ♥ Speed reduction rate 1.5 knots in first minute can create 140 meters distance after 3 minutes. This 140 meters is to avoid a small vessel without rudder cycling.
- ♥ 140 meters is enough for a small vessel but not enough for a large vessel in collision area. (statement))
- ♥ If no rudder cycling ownship may get 140 meters by reducing rate of 1.5 knots after 3 minutes.
- ♥ 300 meters is 0.162 nm. For a 17 knots vessel is only 0.57 minutes run which means ownship may only delay 0.57 minute in Time to Collision TTC.
- ♥ 300 meters sounded good in distance to collision DTC but has very little effect in collision time delay.
- ♥ Speed reduction has its time limitation same as course change which needs 3 minutes to take effect.
- ♥ Speed reduction rate is like tuning rate which is not steady all the time.
- ♥ Any last minute speed reduction like last minute course change is of no use.

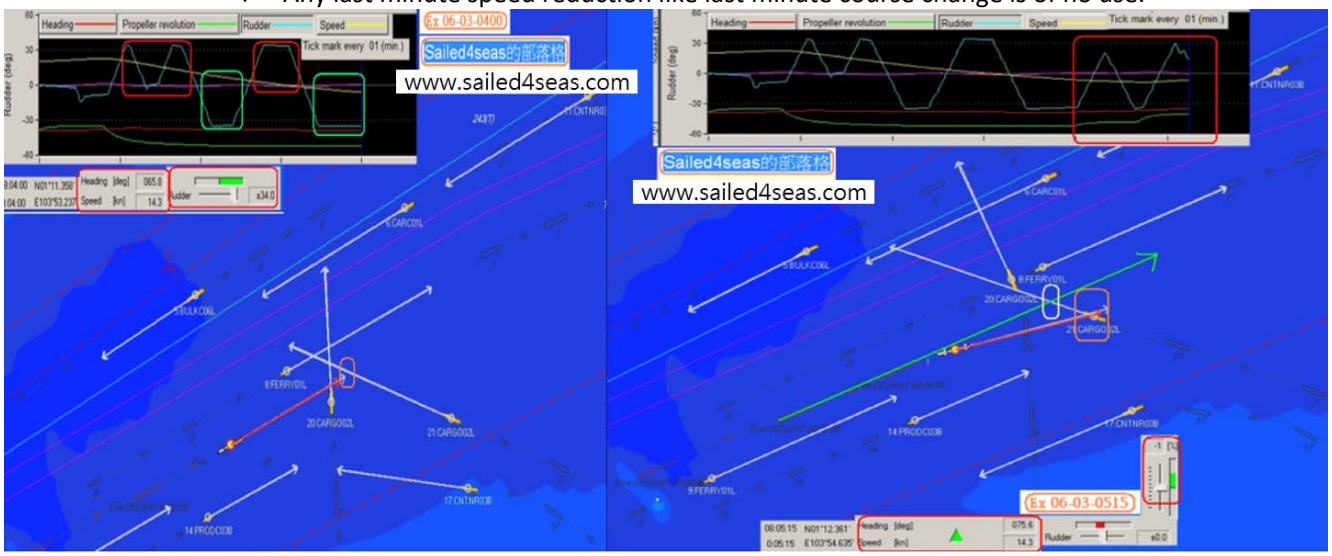


Figure 9-45 Ownship speed vector in 3 minutes at 4 and 5.25 minutes time

After 4 minutes 00 seconds exercise time lapsed:

- Ownship speed is 14.3 knots which decreased from 16.0, 19.3, 21.0 kts with engine output reduced from one minute time to 50%. Speed reduces 1.7 knots over last minute.
- Ownship course had altered 2.0 degrees port side to 065.8 degrees from 067.2, 069.3, 065.3 degrees with Port side rudder cycling in last 3 minutes. Rudder cycling in last 2 minutes with very good control of ownship's heading.

The situational awareness is:

- Ownship engine output had not further reduced but speed dropped slowly by rudder cycling. (sighted)
- Rudder cycling is not rescue for all. Speed reduction by rudder cycling has it bottom line when engine output is still high. (sense)
- Speed reducing rate of 1.7 knots per minute is no good for collision avoidance. (sense)
- Overall situation had not changed by rudder cycling. (sense)
- Crossing vessels at starboard side are:

    - First one pass bow now by 2, 2 minute safety margin.
    - Second one pass astern 6 minutes later.
    - Third one pass bow 2 by 3, safety margin 1 minute only. Or, End to Middle, Caution 1 minutes (dangerous)
- One overtaken vessel at starboard side is OK. (has slower speed)
- One overtaken vessel at port side is faster. (OK)
- Ownship had used "Hard Starboard" 30 seconds to start the starboard Turning with no effect.(sighted)

After 5 minutes 15 seconds exercise time lapsed:

- Ownship speed is 14.3 knots over last minutes, no further reduced. Engine output had increased to increase rudder effect after waiting 30 seconds in Hard Starboard rudder.
- Ownship course had altered 10.0 degrees starboard side to 075.6 (T) from 065.8, 067.2, 069.3, 065.3 (T) with bold rudder angle.
- Once again, this 10 degree have saved ownship trouble with crossing vessels. (sense)
- Crossing vessels at starboard side are:
    - First one passed bow.
    - Second one paralleled.
    - Third one pass bow end to target, safety margin 3 minutes. (OK)
- One overtaken vessel at starboard side is OK. (about same speed)
- One overtaken vessel at port side is OK. (ownship turn away)

9-41 What the trick in all these troubles?

If figure 9-45 left picture we can see ownship have an End to Middle situation with 3rd crossing vessel. Ownship have to further increase speed to increase rudder effect to avoid her. The lucky things are 1st and 2nd crossing had passed. But, 3rd crossing vessel had only delayed 1 minutes TTC by 4 minutes multiple maneuvering. If ownship cannot alter course 10 degrees to starboard side ownship's collision position will be at yellow square as right picture. This last minute's course change can only get extra 0.5 minute in TTC. The moral of this exercise is

"Collision area will not dissolve by itself ownship have to take substantial actions to avoid it all."

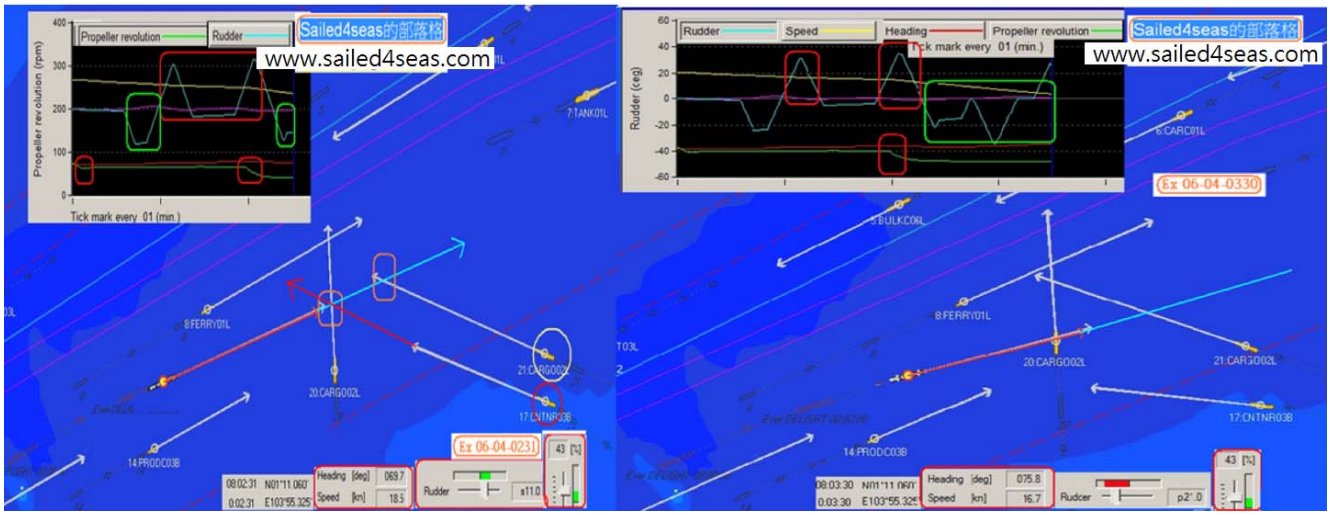
9-17 碰撞知覺操演 27 沒理的天鵝之歌

請參考圖形 9 之 39，本船速度是 21 節，航向是 065.3 度，速度向量線是 10.5 個 CABLE 的距離長度,情勢知覺如下：

⇒ 一條被追越船在右舷速度比本船慢，一條被追越船在左舷速度比半船慢。

⇒ 速度向量線改到 6 分鐘的長度後，兩條橫越船跟本船有碰撞危機，與綠色速度向量線的碰撞先發生，然後是紅色速度向量線的船隻，

⇒ 黃色速度向量線的船隻與本船有碰撞危機，1 分鐘的安全間隔。



圖形 9-46 3/6 分鐘速度向量線 2 分半鐘與 3 分半鐘操演過後

在兩分半鐘的操演過後，本船的速度是 18.5 節，這是從 21 節減下來的，主機的出力降低到 65%，從開始的時候。第 2 分鐘的時候，又減到 43%，速度下降的速率，是每分鐘 1.0 節，這是不夠的。

- ⇒ 本船的航向向右轉了 4.4 度，到 069.7 度從 065.3 度，使用右舵 20 度，在開始的時候，然後左滿舵，使用了一陣子。
- ⇒ 每一條橫越船在右舷都有危險，第一條通過船頭 一對二，這是端點對中點的情勢，只有 1 分鐘的安全間隔。
- ⇒ 第二條通過船尾 五對三，這是目標對中點，兩分鐘的安全間隔。
- ⇒ 第三條通過船頭 三對四，端點對中點，安全間隔 1 分鐘。
- ⇒ 船首向 069.7 度，向右轉了 4.4 度，並沒有解決任何碰撞情勢，這是我們感覺的。安全間隔 1 分鐘並不足夠安全。
- ⇒ 右舷的被追越船是 OK 的，速度較慢，左舷的被追越船，也是 OK 的，差不多同速，本船轉向 4.4 度，只是將碰撞點沿著目標船的速度向量線，移到右邊。

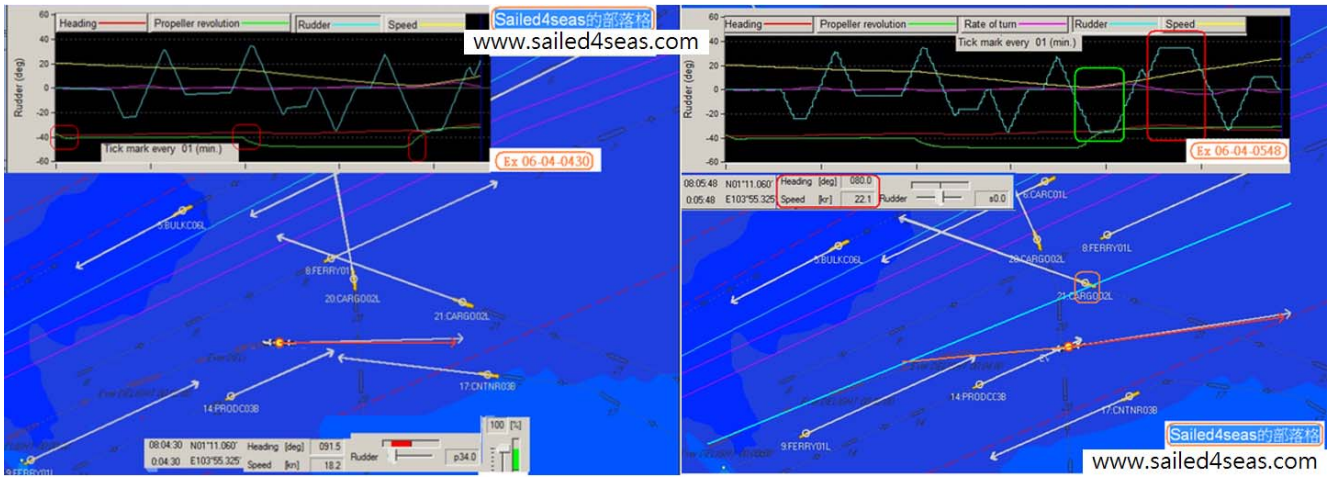
航向的改變就是要移動碰撞點的位置，減速就是要晚點到達碰撞點。

3 分半鐘的操演時間過後，本船的速度是 16.7 節，這是從 18.5 ，21 節而來，主機的出力減到 65%，在開始的時候，一分半鐘之前減到 43% ，速度下降的速率是兩分半鐘減了 2.5 節，這是不夠的。別的船隻可以在第一分鐘降低三節的船速，從高速開始降，就能做到。

本船的航向右轉，更改了 6.1 度，從 075.8 到 069.7，065.3 度而來，使用不同的右舵，大部分在非常短的時間間隔。船長並沒有等右滿舵開始產生舵效，10 秒鐘的時間後，就沒有耐性，這是一個無理船長的型態。

在右舷的橫越船的情勢如下：

- ⇒ 通過船頭 現在對二
- ⇒ 通過船艉 對六，她已經向左舷轉向。
- ⇒ 通過船頭 二對四 安全間隔兩分鐘，要感謝向右轉了 10 度產生的效果
- ⇒ 右舷的被追越船是 OK 的，左舷的被追越船也是 OK 的，他比本船快，而且本船向右轉，離開了她。



圖形 9-47 速度向量線 3/6 分鐘在 4 分半鐘與 5.8 分鐘時間過後

4 分半鐘的操演時間過後，速度是 18.2 節從 16.7，18.5， 21.0 節，使用主機的出力增加到 100%，在 1 分鐘前。就像我們預測的，一位沒理船長會加車來解決問題。

⇒ 本船的航向右轉 16 度到 091.5，從 075.8，069.7，06 5.3 度而來，使用右滿舵的舵角 ，本船的航向已經進行了一個 26 度的右轉，從 065 到 091 度。
⇒ 本船立刻加車，在右滿舵的舵角之後 ，本船在最後一分鐘，速度增加一點五節，沒有增加碰撞危機，是因為大角度的右轉，速度的增加增加了向右回轉的速率，這幾乎造成與航行巷道外船隻的碰撞危機。這是我們看到的
⇒ 所有的橫越船都已經清爽通過，每一個舵角都是大膽與短暫，這就是船長不知道船隻回轉特性的徵兆。就像圖形 1-25 可以參考第一章。

經過 5 分 48 秒的超演時間過後：

⇒ 本船的速度是 22.1 節，這個是從 18.2，16.7 節而來，主機的出力增加到 100%，在最後的兩分鐘，本船的加速非常快速。
⇒ 航向回到左舷 11.5 度到 080 度從 0 91.5，0 75.8 度等等，使用左滿舵，在最後的 1 分鐘時間。
⇒ 本船的操船看起來非常糟糕。在碰撞區域內。舵角曲線呈鋸齒狀，老馬應該是平臺型態。
⇒ 這個操演呈現了沒理船長的操作型態，頭尾不能兼顧。

9-42 界定海上的碰撞面 不論有多少條船牽涉其中

這個操演的教訓，就是不論有多條條船牽涉其中，他們只有一個碰撞區域。如果我們可以界定出哪裡是這個碰撞區域？

♥ 利用轉向避開這個碰撞面，在這一個操演，或是利用有效的船速降低減速，延遲通過的時間，在上一個操演。
♥ 決定什麼是最佳的選擇，減速對於多船隻橫越的情況，特別有效，或是轉向來避免碰撞區域（就是碰撞點集中的海域）
♥ 決定做法後，然後集中精力在手邊的工作，也就是操船，
♥ 轉向 20 度，可以有效的創造 3 分鐘的安全間隔，就像圖形 9-39。
♥ 在限制的航道，轉向 10 度可以創造 1.5 分鐘的碰撞安全間隔。
♥ 如果速度減少三節，可以在 3 分鐘後，產生 416 米的距離差距。

- ♥ 如果我們能夠及時控制本船的航向，碰撞面就可以被避免。
- ♥ 永遠要注意你的回轉速率，而且知道多少的回轉速率，會造成失去舵效，也就是對本船的船首向失去控制。

9-18 結論

在本書的最後總結，我們分析碰撞危機，利用碰撞點概念，這是對資淺船副而言，利用碰撞線概念，這對資深船副而言，利用碰撞面的處理，是船長級的操作業務。

很難相信最基本的碰撞點概念，在航運界都不被普遍認知，我們都被國際避碰規則裡面的羅經方位概念所迷惑， 碰撞點的概念，需要雷達速度向量線的適當使用，這是我們的雷達瞭望的技術。進一步考量避碰的需求，要對本船操船的限制，有所瞭解，又介紹了碰撞線的概念，這些對那些不熟悉碰撞性質與操作的人，是一種分心。如果我們不知道如何適當的使用速度向量線，將會是很大的浪費，特別是我們需要速度向量線，來決定碰撞面在哪裡？以節省我們胡亂猜測的努力。

經由小心的分析這些操演的場景，我們知道解決這些困惑的可能性，與在海上經常會犯的錯誤。利用圖形的講解，使用新的溝通理論跟解決問題的技巧，在這樣的過程中，也會產生新的工作態度。因為我們做雷達瞭望分工時，需要新的速度向量線情勢報告格式，以及目視瞭望分工時，船隻通過船頭船尾的動態報告格式。

這是在最後幾節才提出來的概念，因為在講解目視瞭望與雷達瞭望的技巧與圖片的時候，是對資淺船副講解技術與原理，可能還沒有能夠瞭解這樣的需求，只有上上下下都具有相當的瞭解與使用信心後，才能成為駕駛台團隊共同操作的基礎。

我相信能夠交互利用這些技術的團隊，現在也還沒有成形，所以我也沒有做了太多溝通的格式訓練，也就是養成良好溝通習慣的訓練，那最老實的講法，就是我本人也還沒有這些概念，各位也許能夠溝通的更好，在適當地運用之後。

在這一章，我也介紹了另外一個情勢知覺的術語，老馬與沒理船長來加深各種操船型態的印象，而且有新的橫越船報告格式，對目視望是用通過船頭船艉的動態，或是雷達瞭望的端點對端點的動態，幾分鐘安全間隔的碰撞警示，這些事情對我們的現在技術水準，都還是雜音，需要相當背景知識的培養。我們搞不清楚為什麼我們要忍受這些操演的講解，我們也許在未來永遠也沒有機會遇到這些狀況，這些就是我每天在問自己的問題？

準備這一本書重寫這些不同的概念，這些就是要養成在海上的某種儀式，就像我們對這些阿帕，電子海圖，AIS 的霓虹碰撞警報低頭鞠躬，並且在心中默禱，不論有任何的船隻，在我們的船頭前面，或是正在橫越我們的航線，我們永遠都知道我們自己操船的優先順序是什麼？以及我們在本船操縱上的弱點是什麼？借由耐心的閱讀，跟檢查圖形上的速度向量線，我們終於能夠找到方法，而不需要使用阿帕的資料區，有充分的時間給目視瞭望使用，察覺目標船立即的航向改變，在這些過程非常努力培養的是：我們的直覺，放棄廠商訓練單位提供的無效程式與短期的數位記憶，並且仔細判讀在書本上所提供的圖形知覺。

讀者也許並不清楚我個人投資了多少資源在做這些講解，希望讀者能夠改善，並改寫個人簡陋的講法，使之成為海上工作的實務與優良船藝。現在船隻已經造的越來越大，船長的技術也是一天比一天重要。以前的巨型船隻都在遙遠的海岸航行，現在巨型貨櫃船在全世界港口都市，沿岸城市來回的穿梭，我們還遺留了這麼多模糊的知識，在我們每天的工作上，這是很令人吃驚的。在海運的傳統上，任何重大的變革，都是要在重大災難之後，才會產生，雖然災難的次

數並不多。現在商船上最新的挑戰，就是無人船的引進，我不知道如果沒有碰撞面的概念，電腦船在海上，要如何處理個別的目標，尤其是在限制水域，可能需要深藍級電腦的運算能力 。現在我們可以接受 STCW 的標準，這是 OK 的，我們可以使用優良船藝與公司規定，來處理各種情勢。無論如何，駕駛台資源管理必須要有一個主導的人員，來照顧所有操作的層面，所以我們最好能讓船長具有完整的知識技術與知覺，能總管這一切，而不是在需要時，用等待與胡亂的猜測，等待情勢的好轉，在此我們消除了在駕駛台上面的疑惑，以及可能引起任何負面情緒的時刻，避免產生恐懼，憤怒或是驚惶，再站上駕駛台，看著海面上的船隻，相信一切都會不同，在我們的事業上，也可以改善我們的心理健康，這個才是本書真正的價值所在。依照人為因素來講，21 世紀是個感性的世紀，心理的健康是一切健康的根本，事業成長的基礎。筆者個人一點一點的感覺，成為完成此書的動力，各位先進學者專家，要感到有任何不妥，歡迎不吝指正，謝謝各位，全書完。

9 – 17 Collision Awareness Exercise – 27　Swansong for MORIE

Refer to 9-39 figure, ownship speed is 21.0 Knots and course is 065.3 degrees at beginning. Speed vector is 10.5 cables distance.

The situational awareness is

- One overtaken vessel at starboard side has slower speed. (sense)
- One overtaken vessel at port side has slower speed. (skill by comparing vector length)
- By change speed vector length to 6 minutes, two crossing vessels at starboard side have collision risk with ownship. (sighted)
- Collision with green vector vessel first then red vector vessel second. (sighted)
- One crossing vessels with yellow vector at starboard side have collision risk with ownship. (safety margin one minute)

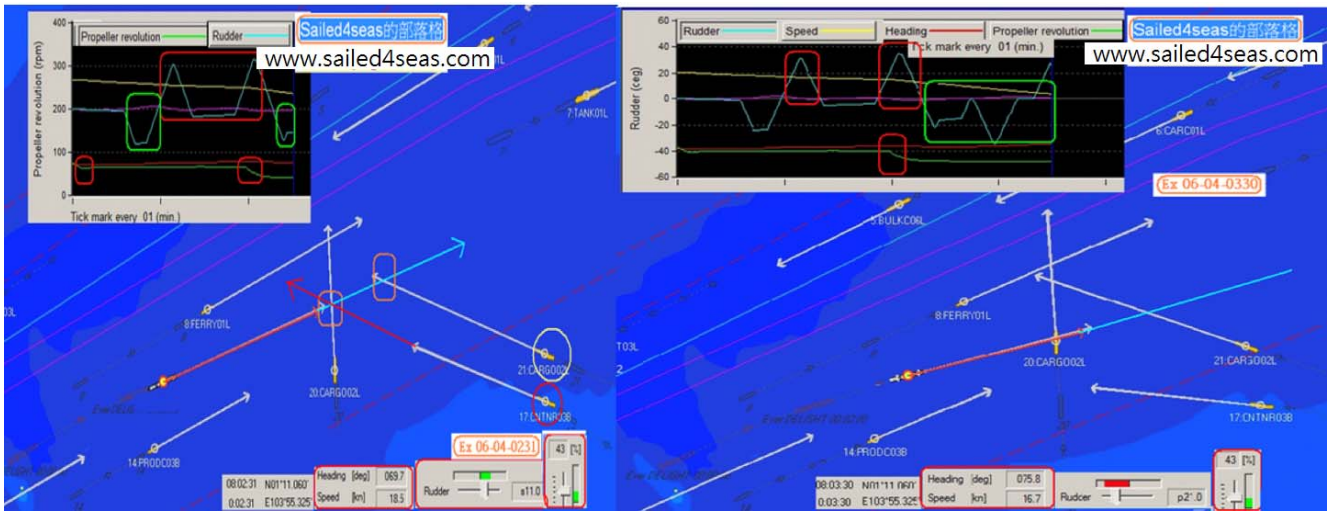


Figure 9-46 Ownship speed vector in 3/6 minutes at 2.5 and 3.5 minutes time

After 2 minutes 31 seconds exercise time lapsed:

- Ownship speed is 18.5 knots which decreased from 21.0 kts with engine output reduced to 65% from beginning and to 43% at 2 minutes time. Speed reduction rate is 1.0 knot per minute, not enough.
- Ownship course had altered 4.4 degrees starboard side to 069.7 (T) from 065.3 (T) with “starboard 20” in beginning and “Hard Port” for a while.

- Crossing vessels at starboard side are all dangerous.
    - First one pass bow 1 by 2, end to middle situation 1 minute safety margin. (
    - Second one pass stern 5 by 3, target to middle 2 minute safety margin.
    - Third one pass bow 3 by 4, End to Middle situation safety margin 1 minute.
- This heading 069.7 (T), 4.4 degrees to starboard side, had not solve anything. (sensed: TTC 1 minute is not enough)
- One overtaken vessel at starboard side is OK. (has slower speed.)
- One overtaken vessel at port side is OK. (about same speed.)
- Ownship alter course 4.4 degrees starboard side to 069.7 degrees is moving collision point to starboard side along target vessel' s speed vector. (sighted with collision point change)
- Course change is to shift collision point. (Statement)
- Speed reduction is to arrive collision point later. (statement)

After 3 minutes 30 seconds exercise time lapsed:

- Ownship speed is 16.7 knots which decreased from 18.5, 21.0 kts with engine output reduced to 65% from beginning and 1.5 minutes ago to 43%. Speed reduces 2.5 knots over 2.5 minute' s time, not enough. Some vessel can reduce 3 knots per minutes from the beginning.
- Ownship course had altered 6.1 degrees starboard side to 075.8 (T) from 069.7, 065.3 (T) with starboard rudder varied in very short interval mostly. Captain did not wait for "Hard Starboard" to take effect over 10 seconds time. Very impatience. A MORIE captain type.
- Crossing vessels at starboard side are.
    - First one pass bow now by 2.
    - Second one pass astern by 6. She alters course to port.
    - Third one pass bow 2 by 4, safety margin 2 minute. (thank for course change 10 degrees more to starboard side.)
- One overtaken vessel at starboard side is OK. (has slower speed)
- One overtaken vessel at port side is OK. (faster and away. Ownship turn away from her.)

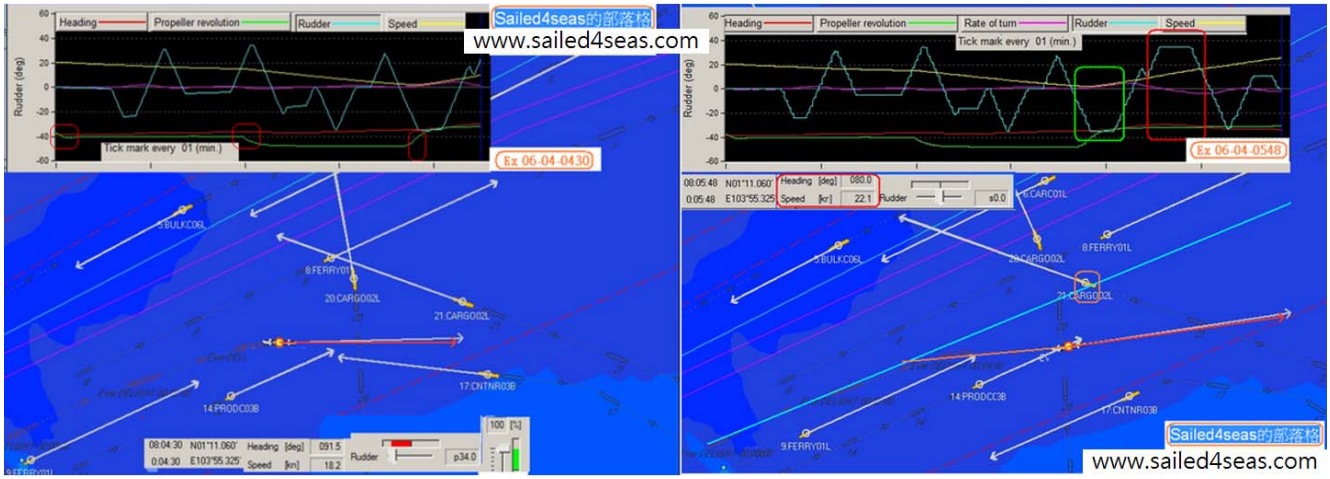


Figure 9-47 Ownship speed vector in 3/6 minutes at 4.5 and 5.8 minutes time

After 4 minutes 30 seconds exercise time lapsed:

- Ownship speed is 18.2 knots which increased from16.7 18.5, 21.0 kts with engine output increased to 100% one minute before. As predicted a MORIE captain will increase speed to solve the problem.

- Ownship course had altered 16 degrees starboard side to 091.5 (T) from 075.8, 069.7, 065.3 (T) with "Hard Starboard" rudder. Ownship had conducted a starboard side turn of 26 degrees from 065 to 091 degrees.
- Ownship had increased speed immediately after Hard Starboard rudder. (sighted)
- Speed increase 1.5 knots over last minute had not increased collision risk. (sighted)
- Speed increase had increased turning rate to starboard side which almost create new collision risk with vessel outside traffic lane. (sighted)
- All crossing vessels are clear. (sense)
- Every rudder order is bold and abrupt which is a sure sign captain don't know vessel's turning characteristics as figure 1-25. (refer to chapter one)

After 5 minutes 48 seconds exercise time lapsed:

- Ownship speed is 22.1 knots which increased from18.2, 16.7 18.5, 21.0 kts with engine output increased to 100% over last two minutes. Ownship had increased speed quickly.
- Ownship course had come back 11.5 degrees port side to 080.0 degrees from 091.5, 075.8, 069.7, 065.3 degrees with "Hard Port" rudder in last minute.
- Ownship maneuvering look awful in collision area. (rudder order zig-zagged)

9-42 Defined collision area at sea No matter how many vessels involved.

The moral of this exercise is:

- ♥ No matter how many vessels involved there is only one collision area if we can define where.
- ♥ Avoid the collision area by course alternation in this exercise or delay the passing time by effective speed reduction in last exercise.
- ♥ Decide what is best choice, reduce speed is especially useful for multiple crossing situation. or
- ♥ Course alternation to avoid where collision area is (collision points are concentrated)?
- ♥ Then focus the job at hand:
  - ⇒ Course alternation 20 degrees is good for 3 minutes safety margin as figure 9-39.
  - ⇒ In confined waterway, course change 10 degrees is good for 1.5 minutes in TTC.
  - ⇒ Speed reduction 3 knots per minutes is good for 416 meters after 3 minutes run.
  - ⇒ If we can control ownship heading in time collision area can be avoided.
- ♥ Always beware of your turning rate and knowing what rate of turn could lead to no steerage (no control of ownship's heading).

9 – 18 Conclusion

In the end, we analyze collision risk by collision point for Junior OOW, collision line for Chief and collision area for Captain. It is unbelievable that the basic of collision point is not recognized by our industrial. We all lulled by compass bearing concept in Colreg. The essences of collision point are in radar speed vector, our radar lookout skill. Further consideration of ownship's limitations we introduced the concept of collision line where a distraction to those unfamiliar with its properties. It is a waste if we don't know how to use it properly especially we need 3 minutes speed vector to decide collision area to save our efforts in wild guess. Through careful analyze of these exercise scenarios we understand the possibilities to solve our puzzle and usual mistake at sea by graphic demonstration. Also, new theory of communication and problem solve techniques are raised in these processes.
In this chapter we introduced other terms of situational awareness. We have HORSE and MORIE captain sailed on our fleet. And new sitrep formats for crossing vessel: Crossing bow 4 by 6 or End to End collision 4 minutes. New collision situation defined as: End to Target or End to Middle,…etc. These things are quite annoyed in our careers at sea. Why we have to suffer in these exercises anyway?

We may never be in these situations in the future. Well these are the questions I asked myself everyday while prepared this book.

These are kind of rituals at sea. We bow and prey to the neon threat of collision alarm at ARPA, ECDIS and AIS. No matter how many vessels ahead and crossing now we always know what is our priority in maneuvering and our weakness in lost ownship's control. By patiently reading and checking on the speed vectors on the figure illustrated we finally can find the way out without the help of ARPA data and spared enough time for visual lookout of target vessel's instant course change. These progresses come from very cheap efforts, sit and read. Reader may not know how many rescores I have devoted to it. I hope reader can improve and revise my bare thoughts into practices working habits.

These days vessels getting bigger and bigger, the skill of master is getting important day after day. It is amazing we have left so many vague knowledges in our daily works. In Marine traditions any major change always comes with catastrophic disasters even the number are few. The newest challenge in merchant marine now is the introduction of non-man vessel. I don't know without collision area concept how can a computerized vessel can handle each target at sea in confined waterway. Now, we accept current standard of STCW. It is OK as long as we can follow prudent seamanship and company rules. Anyway, the essence of Bridge Resource Management is to have a Master mind to overlook all aspects of the operation. It is better to prepare master to have ability to oversee it beforehand than wait and guess at real sea. We eliminate all puzzle on the bridge which lift all negative emotional moments like fear, anger and panic in our careers. It helps our mental health which I believe is the real virtual of this book.