**RADAR PLOTTING**

**Exercise Description: Radar Plotting**

**Objective:**

The objective of this exercise is to develop the participants' skills in radar plotting, enabling them to accurately interpret and plot radar information on a chart for navigation and for collision avoidance purposes.

Materials Needed:

● Radar system (real or simulated)

● Traditional plotting sheet, Chart, Navigational plotter

● Plotting tools (pencil, parallel rulers, dividers, navigational triangles or protractor)

● Training data sets (if using simulated radar)

Duration: The duration may vary based on the participants' level of experience.

Exercise Steps:

1. Introduction to Radar Plotting:

● Provide an overview of radar plotting and its significance in maritime navigation.

● Explain the purpose of radar plotting, which includes tracking targets, assessing their courses and speeds, and maintaining situational awareness.

2. Radar Display Interpretation:

● Familiarize participants with the components of a radar display, such as range rings, bearing scales, and target echoes.

● Explain the interpretation of radar information, including true and relative bearings, range measurements, and target characteristics.

3. Basic Radar Plotting Techniques:

● Demonstrate the proper use of radar plotting tools, such as parallel rulers and dividers, to measure target ranges and bearings accurately.

● Explain the principles of radar plotting, including the concept of own ship's position, ship’s target true and relative motion.

4. Radar Plotting Procedures:

● Introduce participants to standard radar plotting procedures, such as plotting target positions, determining target courses and speeds, and updating own ship's position.

● Discuss the importance of maintaining a continuous plot and the need for periodic updates based on new radar observations.

5. Collision Avoidance Techniques:

● Discuss collision avoidance strategies using radar plotting, including the application of collision avoidance rules (e.g., International Regulations for Preventing Collisions at Sea).

● Provide examples of collision situation scenarios and guide participants in plotting target tracking and determining closest points of approach (CPA) and time to CPA.

6. Practical Radar Plotting Exercises:

● Distribute navigational charts or plotting sheets to participants.

● Using either real or simulated radar data, conduct practical exercises where participants plot target positions, determine their courses and speeds, and make appropriate collision avoidance decisions.

● Encourage participants to discuss their plotted solutions and compare them with other participants' interpretations.

7. Discussion and Conclusion:

● Facilitate a discussion to share insights, challenges and lessons learned from the practical exercises.

● Summarize the key points of radar plotting techniques and emphasize the importance of regular practice and maintaining situational awareness.

● Address any remaining questions or concerns raised by the participants.

**Note:** If access to a real radar system is not feasible, the exercise can be adapted to use radar simulators or pre-recorded radar data sets for practical exercises.

**Theoretical Part: Radar Plotting**

**Introduction:**

Radar plotting is a fundamental skill used in maritime navigation to interpret and plot radar information accurately. It involves analysing radar echoes, determining target positions, and tracking their movements relative to own ship. Radar plotting enhances situational awareness, aids in collision avoidance and enables effective decision-making in challenging navigation scenarios.

**Basic Principles of Radar Plotting:**

Radar plotting relies on the following principles:

1. Radar Display:

● The radar display provides a visual representation of the surrounding area, including own ship and detected targets.

● The display has availability of concentric circles called range rings and radial lines representing bearings. Radar ranges can be obtained by VRM (Variable range marker) and radar bearings can be obtained by EBL (Electronic bearing line), VRM and EBL are tools facilitating accurate plotting.

2. Relative Motion:

● Targets displayed on radar move relative to own ship's position.

● Understanding the concept of relative motion is crucial for accurately assessing target trajectories and potential collision risks.

3. True and Relative Bearings:

● True bearing: The angle between a target and the reference direction, typically true north.

● Relative bearing: The angle between a target and the ship's heading.

● Radar displays usually provide true bearings, but relative bearings are a relevant for plotting targets in relation to own ship.

4. Range and Range Scaling:

● Range represents the distance between the radar and a target.

● Range scaling allows adjusting the display's range to focus on nearby or distant targets.

● Understanding range scaling helps maintain an appropriate radar scale for accurate plotting.

**Radar Plotting Techniques:**

The following techniques are commonly used in radar plotting:

1. Manual Plotting:

● Manual plotting involves observing the radar display, noting target bearing and distance, and plotting their positions manually on a paper chart or plotting sheet.

● Targets are typically plotted using their true or relative bearings and range information.

2. Target Tracking:

● Target tracking involves monitoring and plotting the movement of detected targets over time.

● By tracking targets, their courses and speeds, the potential collision risks can be assessed more accurately.

3. Determine the closest point of approach (CPA) and time to CPA (TCPA) between own ship and a target.

● Systematic observations shall be made of the bearing

and range of a displayed echo.

● The positions are plotted on a traditional plotting sheet or electronic plotter.

● The line joining the plotted positions will depict the target’s apparent (relative) motion, which if extended will enable a measurement of the target’s closest point of approach, CPA. These lines on the plotting sheet or on the radar display help the operator to assess if the target's course intersects own ship's track.

● The time to closest point of approach, TCPA, can be obtained by stepping off the rate time between observations, extended to CPA. This does of course assume that both vessels maintain their present courses and speeds. If this condition is not met, the apparent motion will not be uniform, i.e. the echo will not move across the screen in a constant direction at a constant rate.

4. Collision Avoidance:

● Radar plotting plays a critical role in collision avoidance.

● Targets are classified as: hazardous, potentially hazardous and non-hazardous.

● By analysing target plots, assessing their courses, speeds, and potential collision risks, informed navigational decisions can be made to avoid potential collisions by application of collision avoidance rules (e.g., International Regulations for Preventing Collisions at Sea).

5. Plotting Aids:

● Plotting aids, such as manoeuvring boards or electronic plotting systems, can enhance accuracy and efficiency in radar plotting.

● These aids provide tools for calculating target courses, speeds, CPA, and TCPA.

**Conclusion:**

Radar plotting is a vital skill for mariners, enabling them to interpret radar information, track targets, assess collision risks and make informed navigational decisions. By understanding the principles and techniques of radar plotting, mariners can enhance situational awareness and ensure safe navigation in various maritime scenarios.

**RADAR PLOTTING VIDEO TUTORIAL**

**Entry condition:**

The student has already basic knowledge of radar and radar operation. Radar plotting by using radar bearings and distances. Relative motion. Radar screen orientation: North Up. ARPA off.

Manoeuvring with one target with own course change.

Safety distance = 2.0 NM (Open Sea).

Own course 355 degr, Own speed 15.0 kn.

By condition, the target does not change its course and speed.

Determination of target course and speed, CPA, TCPA.

Determination of own ship safety course, time of return to original course and time finish manoeuvre.

**Determination of Target Data:**

Systematic observations shall be made of a bearing and range of a displayed echo, by equal stepping off the rate time between observations. The positions are plotted on a traditional plotting sheet or electronic plotter. Preferably three times by 3 minutes time spacing, because from one side it covers practical accuracy and from other side, on plotting sheet or electronic plotter, each 6 minutes distance will be vector of the speed and wise versa, provided, spacing with distance one mile (10 cables) is speed of 10 knots.

The line joining the plotted positions will depict the target’s apparent (relative) motion, which if extended will enable a measurement of the target’s closest point of approach, CPA. The time to closest point of approach, TCPA, can be obtained by stepping off the rate time between observations, extended to CPA. In our video, the measurement is as follows:

Time: Bearing: Distance:

0’ 50.0 degr 8.3 NM

3’ 49.5 degr 7.5 NM

6’ 49.0 degr 6.7 NM

Positions by bearing and distance are plotted. The line defined between 0’ and 6’ forms the relative speed of the target. The speed triangle appears after following the rules of summarizing vectors as shown on the video. Target Course determined as 292.0 degr, and target speed as15.5 kn. CPA 0.3 NM, TCPA 31.5 min by plotting RLM (relative motion line).

Target evaluated as dangerous, a crossing situation with course crossing own ship course, with CPA less than 2.0 NM.

Our task is to keep passing the target at safe distance of at least 2.0 NM. The 12th minute is the time mark for start manoeuvring. The 12th minute is predicted and plotted. From the point of the 12th minute is drown a line, which tangents the circle of our safe distance of 2.0 NM. Then this line, violet in the video, is shifted parallel from the point of the 6th minute position. The latest line will intersect the circle had been made with the vector of our own speed as shown in the video. The point of intersect marks the safety course. This mean, our own ship shall change the course from 355 to 031 degr. in order to ensure min safe passage of at least 2.0 NM. If on 12th minute, own ship has course 031 degr, the target will follow RML1. When the target rich TR(time of return) point, own ship may return to the original first course of 355 degr. Then target will follow a line, parallel to the first RML. The point TFM (time finish manoeuvre) will mark the point when the target passing own vessel relative beam. The manoeuvre with one target with own speed change is completed.

**Radar Plotting Questionnaire**

with answers (in bold)

1. What is the fundamental purpose of the marine radar?
2. Provide early warning of ships
3. Provide an early warning of ships on collision course
4. Determine the course of other ships
5. **Detection of other objects outside own ship**
6. On a radar screen, the target is assessed as dangerous when:

**A - continuation of its relative vector passes through the circle with the centre point of your own ship and a radius equal to the set safety distance**

B - continuation of its true vector passes through the circle with the centre point of your own ship and a radius equal to the set safety distance

C - continuation of its true vector passes through the place of your own ship

D - when the distance decreases

1. When measuring bearing and distance from a own moving ship to a target and the plots on the manoeuvring board are in same point, this means:

A - target is on drift

**B - target has same speed and course as own ship**

C - the target is moving on the opposite course, but twice time less in regard of own ship speed

D - The target on stop, abeam of our vessel

1. Target data necessary to know for manoeuvre consideration is:
2. CPA and TCPA
3. Course and speed of the target
4. CPA and speed of the target
5. **CPA and TCPA, course and speed of the target**
6. RML – what does it mean:
7. Relevant motion of track
8. Rear middle line
9. **Relative motion line**
10. Rescue motion line
11. Targets are classified as:
12. Hazardous and non- hazardous
13. Hazardous and potentially hazardous
14. Moving and stationary
15. **Hazardous, potentially hazardous and non-hazardous**
16. CPA (Closest Point of Approach) is called:
17. Point in the course of the vessel in which the target crosses its course on the bow
18. **The nearest point where the object will get to the own ship**
19. Distance along the bow or stem of the ship, at which a target will pass
20. Shortest distance to be in 6 minutes
21. What is the main purpose of radar plotting?
22. **Obtain information about whether danger of collision exists, CPA, TCPA, target course and speed.**
23. Obtain CPA and TCPA only.
24. Obtain target course and speed only.
25. Obtain target-calculated aspect only.
26. The time to closest point of approach, TCPA, can be obtained by:
27. **Stepping off the rate time between observations, extended to CPA and using formula S = V x T**
28. Own Ship’s particulars
29. Calling Radar manufacturer’s representative
30. The ship safety time management

1. The line joining the plotted positions will:
2. Depict the target’s true speed
3. Depict the target’s true motion
4. **Depict the target’s relative motion**
5. Depict the target’s true course