**RADAR ARPA**

**Exercise: Maneuvering with One Target using ARPA**

**Introduction:**

**Objective:**

The objective of this exercise is to familiarize participants with the principles and operation of Automatic Radar Plotting Aid (ARPA) systems. Participants will gain practical skills in utilizing ARPA to enhance situational awareness, track targets, and make informed decisions for collision avoidance.

**Exercise Steps:**

* Introduction to ARPA
* Overview of ARPA and its role in modern maritime navigation.
* Explain the benefits of ARPA, such as automated target plotting and tracking, collision avoidance features and improved situational awareness.
* Explain the functions and features of ARPA systems, such as target acquisition, target tracking and collision prediction.
* Familiarize participants with the various elements displayed on an ARPA system, including own ship's position, target vectors and collision warning indication.
* Explain how to interpret target information provided by ARPA, such as target ranges, bearings, courses, speeds, closest points of approach (CPA), time to closest points of approach (TCPA).

**ARPA Operation and Settings:**

* Demonstrate the operation of an ARPA system, including system initialization, acquisition of radar targets, adjustment of display settings and trial manoeuvre.
* Discuss the importance of properly configuring ARPA settings, such as radar offset, target vectors, CPA and TCPA alarms in order to suit the operational requirements.

**Practical ARPA Exercises:**

* Utilize real or simulated radar data and ARPA systems or simulators to conduct practical exercises.
* Guide participants in using ARPA to track targets, determine target courses and speeds, CPA and TCPA, predict potential collisions and make informed navigational decisions.

**Collision Avoidance Strategies assisted by ARPA:**

* Discuss collision avoidance strategies using ARPA, including the utilization of International Regulations for Preventing Collisions at Sea (COLREGs).
* Present different collision scenarios and guide participants in using ARPA to assess the situation, calculate CPA and TCPA, evaluate risk of collision and take appropriate evasive actions.

**Theoretical Part:**

ARPA operates based on the following principles:

* ARPA is a computerised additional feature to the Radar. ARPA takes feed of the own ships course and speed, and target’s course and speed, and calculates the collision avoidance data and simplifies the need for the users to calculate the data themselves. ARPA provides various other additional features and controls as well.
* When the target is detected well in advance the actions to be taken by the ship will be a lot easier. It will also help to avoid close quarter situations and to avoid collision.
* The system is able to acquire automatically and constantly monitor number of targets, plot their speeds and courses, present these as vectors on the display screen, updated with each sweep of the antenna, and calculate their closest points of approach to own ship and the time before that will occur.
* The knowledge of Radar and ARPA controls is highly significant. A full advantage of the equipment can be made only if the radar user has the right knowledge about it.
* Therefore, the controls of Radar and ARPA should be thoroughly familiarised for using the equipment effectively.
* The OOW should be able to set-up and configure the radar settings if needed, such as clutter controls – Rain, Gain, Sea, Pulse Controls, Range Controls, Manual Tuning.

ARPA is a sophisticated radar system that assists mariners in target tracking, collision avoidance and enhancing situational awareness. ARPA utilizes radar data and advanced algorithms to automatically track and plot targets, providing valuable information for safe and efficient navigation. Conducting ARPA exercises enables mariners to develop proficiency in utilizing ARPA features and interpreting ARPA data effectively.

In order to improve the standards of collision avoidance at sea, ARPA should reduce the workload of observers by enabling them automatically to obtain information about plotted targets and to provide continuous, accurate and rapid situation evaluation. The ARPA should be able automatically to track, process, simultaneously display and continuously update information on at least 20 targets, whether automatically or manually acquired.

**Target Acquisition and Tracking:**

* ARPA manually or automatically detects and tracks targets based on radar echoes received.
* It identifies individual targets and maintains continuous tracking, providing real-time updates on target positions, courses, speeds and other relevant data.
* “True Motion” display allows mariners to visualize targets' actual movement, courses and speeds, aiding in collision assessment and decision-making.
* “Relative Motion” display represent targets' movements relative to the stationary radar antenna, aiding in collision assessment and decision-making.

**Data Integration:**

* ARPA integrates radar data with navigational information, such as own ship's position, heading and speed, in order to compute true or relative targets' motion and provide accurate target data and track.

**Alarms and Warnings:**

* ARPA systems incorporate alarm functions to alert mariners of potential collision threats, target deviations, or violations of user-defined parameters.

**ARPA Exercise Techniques:**

The following techniques are commonly used in ARPA exercises:

* ARPA System Familiarization - participants should become familiar with the specific ARPA system used, including its display, controls, and available functions. Understanding the system's capabilities and limitations is crucial for effective utilization.
* Advanced ARPA Features - participants should explore advanced ARPA features, such as target trail history (true and relative), target vectors (true and relative) and representations of target data. These features enhance situational awareness and aid in making accurate predictions of target behavior.
* Target Maneuvering and Predictive Analysis - participants should analyze target tracks and use ARPA to predict future target positions and potential collision scenarios. It helps to develop skills in assessing target intentions and making informed navigational decisions.
* ARPA Alarms and Interpretation - the ARPA should have the capability to warn the observer with a visual and audible signal of any distinguishable target which closes to a range or transits a zone chosen by the observer. Participants should understand the significance of ARPA alarms and warnings. They should practice interpreting alarm notifications, responding appropriately, and taking necessary actions to mitigate collision risks.

**Trial maneuver**

The ARPA should be capable of simulating the effect on all tracked targets of an own ship manoeuvre with or without time delay before manoeuvre without interrupting the updating of target tracking and display of actual target alpha-numeric data. The simulation should be indicated with the relevant symbol on the display. The operating manual should contain an explanation of the principles underlying the trial manoeuvre technique adopted including, if provided, the simulation of own ship's manoeuvring characteristics. It should be possible to cancel a trial manoeuvre at any time.

**Discussion**:

* Facilitate participants to share insights, challenges and lessons learned from the practical ARPA exercises.
* Summarize the key points of ARPA operation, target tracking and collision avoidance strategies.
* Emphasize the importance of regular training and maintaining situational awareness by utilizing ARPA effectively.
* Address any remaining questions or concerns raised by participants.

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

**Scenario Maneuvering with One Target using ARPA**:

Target vessel at starboard is crossing own course with danger of collision with CPA 0,1NMi. Own ship alters her course to Starboard side to pass at safety distance for Open Sea 2.0NMi.

**Exercise description:**

Radar and ARPA target tracking typically includes the following steps:

1. Set up the radar display and adjust the settings for optimal performance.
2. Identify the targets on the radar display and activate ARPA tracking for each target.
3. Monitor the target's speed, course, and closest point of approach (CPA) to the ship.
4. Use the information provided by ARPA to make course and speed adjustments to avoid collisions and maintain safe navigation.
5. Continuously monitor the targets and adjust as necessary.

**Entry conditions:**

1. Area: Bulgaria/North coast
2. Trainee ship: Motor Vessel „Arcona”

* Type: Bulk Carrier
* Underway using engine.
* PSN: ϕ = 43° 09.1′ N λ= 028° 15.0′Е
* HDG - 000°
* SPD – 15.0 kts

1. Target Ship: Motor Vessel “Pacific Line “

* Type: Container Ship
* Underway using engine.
* HDG - 290°
* SPD – 16.0 kts
* PSN: ϕ = 43° 13.7′ N λ= 028° 24.1′ Е

1. Weather Conditions:

* Start Тime = 11:58 LT
* Wind N - 5 kts
* Sea Waves Height – 0.4 m
* Visibility - 10 n.mi.
* Current - none
* Sunny

1. Preset Conditions: Trainee Ship “Arcona” is on “manual steering” Autopilot track control is forbidden. No communication. GPS works correctly. AIS data unavailable. RADAR and ARPA fully operational.

Video exercise has the following prerequisite: Relative motion. Relative vectors. Radar screen orientation: North Up. ARPA on. Own ship course 000 degr, own ship speed 14.9 kn. One target tracking by use of ARPA. Target keep steady her course and speed. In addition, there will be showed execution of own ship maneuvering, observing safety distance of 2.0 NMi.

**Tasks**:

1. Acquire the target at PSN: Range 4.9NMi, T BRG 54°.
2. Set relative vectors to 6 min.
3. Wait ARPA to calculate target’s moving parameters, CPA and TCPA.
4. Take decision and make maneuver to pass at minimum safety distance of 2NMi
5. When it is safe, return own ship to original course.

**Conclusion:**

ARPA exercises provide mariners with practical experience in utilizing ARPA systems, tracking targets, interpreting ARPA data and making informed navigational decisions. By developing proficiency in ARPA operations, mariners can and will enhance situational awareness, improve collision avoidance capabilities, and ensure safe navigation in challenging maritime environments.

**Radar and ARPA target tracking (ONE TARGET)**

Questionnaire with answers (in bold):

1. What does ARPA stand for in RADAR technology?

a) Advanced Radio Positioning Array

**b) Automatic Radar Plotting Aid**

c) Adaptive Range Precision Analysis

d) Advanced Reflection Pattern Assessment

1. Which of the following is the primary purpose of ARPA?

a) Tracking air traffic

b) Monitoring weather patterns

**c) Assisting with navigation and collision avoidance**

d) Detecting submarine activity

1. Which of the following parameters is crucial for RADAR azimuth resolution?

a) Echo strength analysis

b) Antenna vertical beamwidth

c) Doppler shift measurements

**d) Antenna horizontal beamwidth**

1. Which data input is crucial for accurate ARPA operation?

a) GPS coordinates

**b) Radar range and bearing**

c) Sea surface temperature

d) CPA and TCPA

1. What does the term "Target Acquisition" refer to in ARPA?

**a) Locating and tracking potential threats**

b) Activating radar transmitters

c) Determining the ship's position

d) Adjusting antenna gain settings

1. Which of the following is a common display format used by ARPA systems?

**a) Polar plot**

b) Frequency-time graph

c) Spectrogram

d) Amplitude-time graph

1. Which of the following parameters is NOT ARPA output?

a) CPA

b) Target Speed

**c) Bearing**

d) Bow crossing range

1. What is the maximum number of targets that an ARPA system can typically track simultaneously?

a) only one target

b) up to 5 targets

**c) 50 or more depends on the system**

d) there is no limitation

1. How does ARPA handle the problem of target overlapping on the radar display?

a) By adjusting the antenna elevation

b) By increasing the radar transmitter power

**c) By using signal processing techniques**

d) By changing the radar pulse width

1. Which international maritime regulation mandates the use of ARPA on certain vessels?

**a) International Convention for the Safety of Life at Sea (SOLAS)**

b) United Nations Convention on the Law of the Sea (UNCLOS)

c) International Convention on Oil Pollution Preparedness, Response, and Cooperation (OPRC)

d) Convention on the International Regulations for Preventing Collisions at Sea (COLREGS)