WELCOME TO
NAUTILUS EDUCATION SYSTEMS, Inc.
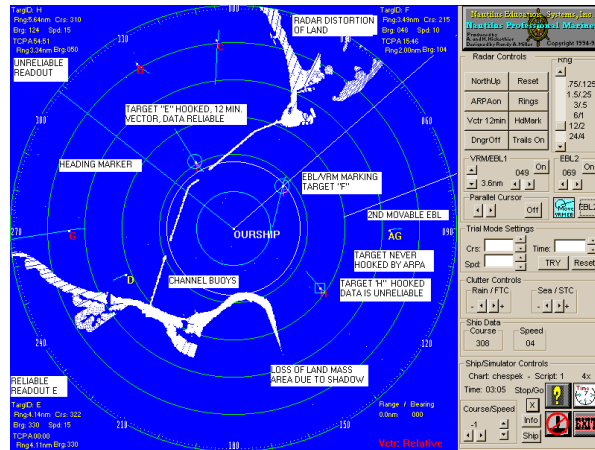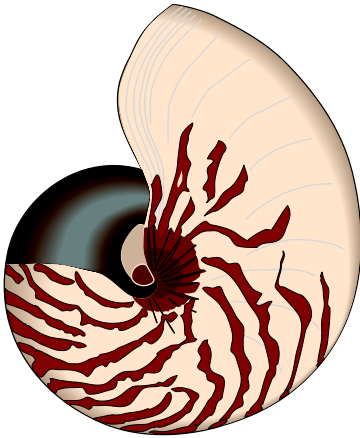
Let (a_n) be a sequence if $a_1 = 1$, $a_2 = 1$
$$a_n = a_{n-1} + a_{n-2} \text{ when } n \geq 3$$

NAUTILUS MERCHANT MARINE TRAINING SIMULATORS™
NAUTILUS FULL (FBS) ADVANCE RADAR AND ARPA SIMULATOR ™
Ver. 3.0

Certificate of Inspections and Tests

This is to certify that

Nautilus (FBS) Advanced Radar and ARPA Simulator^{TM} ver 2.5

Manufactured by

Nautilus Education Systems, Inc.

and described in the attached schedule has been tested and found acceptable for the purpose of complying with the requirements of the IMO STCW95 Specification for a Marine Navigation Equipment Simulator and is acceptable for the purpose of providing simulator based training and assessment as part of a programme for gaining and demonstrating competence in compliance with STCW 1995 A-I/12 part 1 for

1. **Navigation at the operational level (A-II/1)**

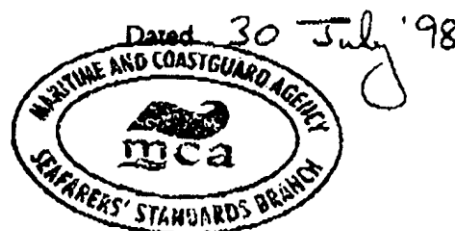   Use of radar and ARPA to maintain safety of navigation.

2. **Navigation at the management level (A-11/2)**

   Use of radar and ARPA to assist in command decision making.

Signed
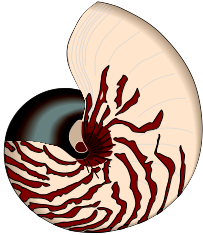
Date

Capt R Towner
Examiner of Masters and Mates

Dated 30 July '98

Bay 2/11, Spring Place

Tel: 00 44(0)1703 329243
Fax: 00 44(0)1703 329252

INTRODUCTION TO THE FUNCTIONS AND TECHNICAL DATA OF THE NAUTILUS RADAR SIMULATOR

Nautilus Education Systems will design, program and implement Educational Software and Simulation Systems in response to the changing needs of the marine and education industry. The software has been designed to meet or exceed STCW95 Radar and ARPA simulator requirements found in sections AI/12, AII/1, AII/2, and B-I/12 paragraphs 8 to 17 and 32 to 35 inclusive, of the Seafarers' Training, Certification and Watchkeeping (STCW) Code. (Numbers in brackets are CFR 164.38)

The first software product to be completed is **Nautilus (FBS) - Advanced Radar and ARPA Simulators (NRAS)™.** It has been used in **USCG Approved Radar Observer Training Course at all levels. (Unlimited, Inland, Rivers and ARPA)** since 1994.

The NAUTILUS SIMMULATOR is used at 4 colleges/universities, 3 high schools, and more than 20 private schools. This product has several unique features that are not found in other simulators on the market today. These features are as follows:

PROGRAM HIGHLIGHTS FULL BRIDGE ARPA VER 2.5
(Jun. 1, 1998)

(Full bridge ARPA ver. 2.5)

124 different functions can be activated using the buttons and drop down menus.
Hundreds of automatic functions are implemented, such as anomalies that exist because of the tangential beam echo returned, diffraction, attenuation, refraction radar shadow, beam width and pulse length being simulated.

Every function necessary to meet the IMO (STCW95) exercise objectives is present.

The student has the ability to operate every function and control on the radar simulator.

The student can interact with the equipment and the simulated environment using all the controls as they can with real radar.

- **Real Life Radar Controls:** The display has trackball-activated buttons similar to those commonly used on a modern shipboard radar

- **Five Display modes:** Heads-up (True Brg and Relative Brg), North-up and True Motion (Land and Sea Stabilized). (CFR 164.38, 3.4.6)

- **Two Training Modes:** Normal Radar Display and ARPA Display. ARPA mode password activated for security.

- **True Tangential Radar sweep:** The Simulator displays the accurate characteristics of land. (Not Smoke and Mirrors land)

- **Real-time Display:** All targets and display elements are in real time.

- **Multiple Charts and Land Mass modules:** Harbors and Waterways available to train Large and Small vessel Masters. **Small Boat Harbors** (Miami, FL and Newport Beach, CA) **Major Shipping Harbors** (Los Angeles, Seattle and San Francisco, Ca) **Inland Ferry Routes** (Puget Sound - Bremerton to Seattle and Seattle to Tacoma, WA) **Rivers** (Columbia River Entrance). Charts can be up dated or the instructor can have his chart editions match the USCG Training charts.

- **Land Mass and Display Accuracy:** The accuracy of the land masses and display programming used are such that your ship's position can be acquired using ranges obtained and plotted on the appropriate NOAA chart. Using proper plotting technique accuracy consistent with that of IMO compliant Radar's can be achieved by the average student. (see technical pg. III) Buoys, Daymarkers, and any other object that would show on real radar will be displayed on the simulator screen.

- **Network Interactive Mode:** The network manager allows up to 40 Ships that can be assigned to the students operating in real time mode. The students can maneuver their ship independently within the same virtual world having a radar view from their assigned ship.

- **Set Time mode.** When not in Network Mode you can change the elapsed time. Real Time 1x, Double Time 2x and Quad Time 4x. The time display will read out at the new rate.

- **True Data interpretation:** The program evaluates Land introduces shadows and land distortions caused by low laying land, effect of antenna positioning, etc.

- **Available ship types:** The Maneuvering characteristic of all major ship types from 5 to 100,000 Gross Tons can be implemented. **The instructor from a menu in the script wizard can select any number of ships for use** (see ship's characteristics tables)

- **Range Scales:** .75 to 24 nautical miles.

- **Range Rings:** on/off

- **VRM and EBL Controls:** TWO Movable EBL's. One of the EBL's also has a VRML.

- **Vectors:** Head vectors are available as **relative vectors** in all relative modes**. This means that both true and relative head leaders are available.** They are available in 3,6,9 and 12-minute lengths. The drop down menu allows selection of true or relative motion vectors. The vector type selected is displayed in the lower right hand corner of the screen in **RED**. The display in the right hand corner insures the student will always know which vectors are being displayed. The true and relative motion vectors are approximately correct showing a trend rather than accurate information for the first minute or more. Maneuvering by any ship with a vector displayed will show movement of the vector but it will not show accurate data until after the ship has steadied on course for a period of time. This is also true of the Data display if the contact is manually hooked by the student. Vectors are only displayed on ships that have been manually or automatically acquired. (CFR 164.38, 3.4.7)

- **Course (Rudder) and Speed Controls.** The students can control their course and speed with the Trackball or **Joystick.**

- **Parallel Cursor Controls.** This allows additional parallel indexing methods to be taught.

- **Trackball controlled:** All functions of the simulator are trackball or other pointing device controlled. The student doesn't need to learn any keyboard strokes or overlays.

- **Sea and Rain Clutter control:** Controls that change the intensity for true simulation of FTC and STC implementation.

- **Danger Areas:** The student can preset a danger area that will provide an audible alarm when violated. When ARPA is in use any vessel that enters the danger area that is not already hooked will be automatically acquired. If vectors are turned on at the time a vector will be displayed. the vectors are approximately correct showing a trend rather that accurate information for the first minute or more. Maneuvering by any ship with a vector displayed will show movement of the vector but it will not show accurate data until after the ship has steadied on course for a period of time. This is also true of the Data display if the student manually hooks the contact. (CFR 164.38, 3.4.12, 3.5.1, 3.5.2)

- **Racon Buoys:** Charted Racon buoys will show on the radar screen with their appropriate signal. The instructor can place an additional Racon Buoy and signal for training purposes on charts without Racon's.

- **SART Buoy: A** Search and Rescue Transponder buoy can be added to the problems for training including giving it both set and drift.

- **Information Function:** The information function labels all targets with a unique identifier and lists the current scenario in use.

- **Ship Function:** Toggles to the view of the other vessels and allows you to take control of the other vessel in individual mode. In network mode this function is only available to the instructor

- **Multi-student bridge module:** Interactive implementation using a Local Area Network (LAN) with each student (up to 40 students) maneuvering his or her own vessel. (Interactive or Series Operation.)

NAUTILUS (FBS) – ADVANCED RADAR AND ARPA SIMULATOR.

The NAUTILUS (FBS) – ADVANCED RADAR AND ARPA simulator is capable of simulating the operating capabilities of the most modern shipboard radar's. The realism of the system meets all of the course objectives. All functions and limitations of shipboard radar are present including the following but not limited to those mentioned here. Additional functions and limitations simulated are listed through out this document.

- **Advanced ARPA Readout: The ARPA Readout Simulate problems found in real Radar readouts. The Information will be inaccurate for 1 or more minutes depending on the relative speed of the contact.**

- **Gyro failure: Gyro failure can be simulated forcing the Radar to display Heads-up only, sound a Gyro Alarm and lose all ARPA readouts. This feature will be executed by the instructor and can be activated for any or all stations. The student has the provision for manual input.**

- **Speed Log Failure: Speed Log Failure can be simulated at any or all stations. Own ship will lose speed input, show zero speed and lose all ARPA readouts. A lost speed input alarm will sound. The student has the provision for manual input.**

- **Marker Drop: The Full Bridge ARPA allows you to drop a marker. This Marker can be used to mark a Man Overboard (MOB) or any position of special interest.**

- **Lost Target: This function will cause a "locked on Target" to be lost, sounding an alarm and require it be manually relocked.**

INSTRUCTORS CONTROLS

The instructor controls and the use of the 49 MHz radio allow the instructor to control all major aspects of the exercise. The instructor can control the environment and interact with the students by radio or through the controls described below.

The instructor can control the exercise environment by three methods.

Script wizard

- Ship selection: the instructor can select from 20 **ship types** standard. Custom ships can be provided. Each ship can be used one or more times until the maximum of **40 ships** has been placed in the exercise.

- Each ship has it's own set of hydrodynamic coefficients. All environmental elements, current, wind, squat, and bank effects will interact with the ships mathematical model.

- The instructor can position each ship using Lat/Long or Range and bearing. The first ship must be positioned using Lat/Long.
- Each ship can be assigned a navigational track. The track can include timed changes including, course, speed and port and starboard turns. The navigation track will be followed during the exercise until a student takes control of the ship.

- Rain clutter can be added as part of the exercise.

Instructors Control Console

- **All ship data is displayed on the instructors console, ships designator, rudder angle, course, thrust, speed and the latitude and longitude position for every ship.**

- **Current controls** allow the instructor to input and change the current at any time. Direction 0-360 degrees. Speed 0-40 knots. The current interacts with the mathematical model of each ship according to the coefficients of that vessel.

- **Wind controls** allow the instructor to input and change the wind at any time. Direction 0-360 degrees. Speed 0-120 knots. The current interacts with the mathematical model of each ship according to the coefficients of that vessel.

- **Ourship/individual mode:** allows the instructor to assign all 40 units to "ourship" or each unit to a different ship.

Instructors Radar Console

- The instructor has a fully operational Nautilus radar simulator which has the "SHIP" function available. This function allows the instructor to move from ship to ship and see the student's view.

- Selection of the "take control" allows the instructor to take control of any ship not controlled by a student. As an example, if there are six student stations active the instructor can take control of the remaining 34 ships.

- All controls on the instructors Radar unit are fully functional.

Instructors Radio Console
- The instructor and the students are provided with radios that allow them to interact with each other and the instructor. The instructor acts as harbor control, VTS or any of the ships not manned by a student.

NAUTILUS (FBS) – ADVANCED RADAR AND ARPA SIMULATOR DISPLAY
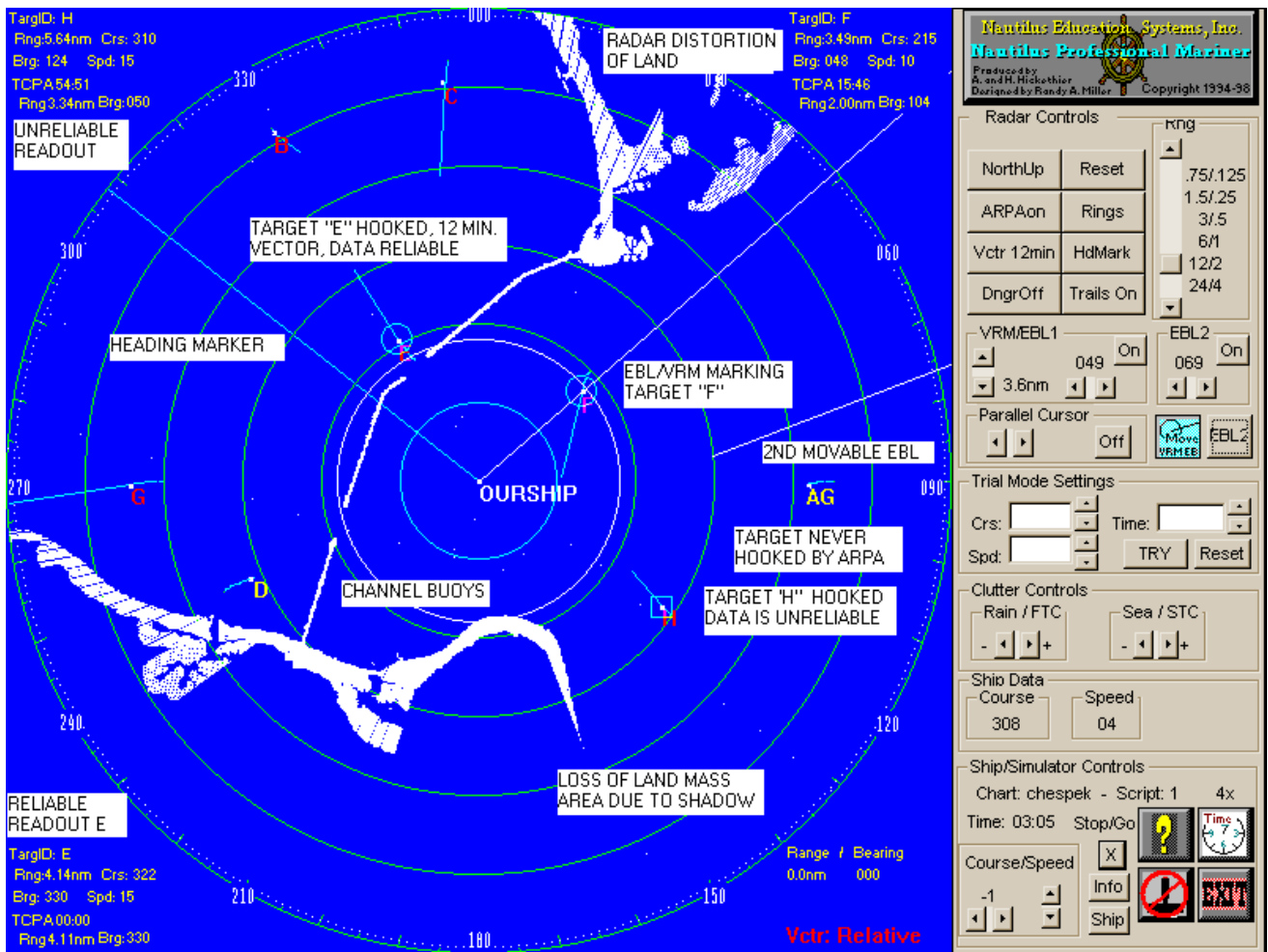## (ANNOTATED)

CHESAPEAKE BAY ENTRANCE PROBLEM

VER. 2.5

40 CONTACTS A through AL (SOME OUT OF RANGE)

12 NM RANGE, HEADING MARKER ON, 1ST AND 2ND EBL and VRM ON

INFORMATION FUNCTION ON

ARPA ON, Trails (non-time spaced) on, 12 min vectors relative vectors on

The **Nautilus (FBS) Advanced Radar and ARPA Simulator Ver. 2.5** is an integrated system that has been designed to incorporate the features found on today's ARPA-radar.

CONTROL PANEL

The Nautilus On screen Control Panel: The control panel is designed to give the student maximum realism by having control buttons activated by the Trackball, Mouse or other pointing device and requires no keyboard templates.
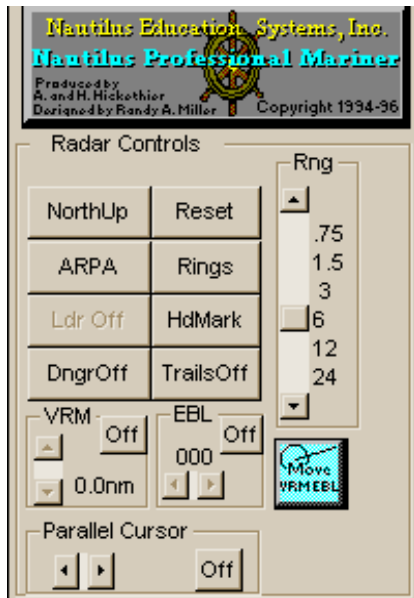
North-up   Toggles the display from North-up, Head-up Course-Up and True Motion modes. (CFR 164.38, .3.5.4)

ARPA   Turns APRA mode on/off.

Vectors   toggles the on/off heading vectors and allows the selection or true and relative vectors 3 min, 6, 9 and 12-min. vectors. (CFR 164.38, .3.4.7)

- **Enhanced Danger Areas:** Danger Areas 20, 180, 225, 360 Degrees with ranges of .25\ .5, .5\1, 1\2, 2\4 3\6 4\6 miles**. (CFR 164.38, .3.4.12)

- **A sound on / off button has been added.** (CFR 164.38, .3.5.4)

Reset   Resets the display as required in True Motion Display Mode.

Rings   Toggles Range Rings on/off.

HdMark   toggles the heading marker on/off and flashing.

Trails   Toggles trail markers on/off.

Rng   Sets the range scale to .75, 1.5, 3, 6, 12, and 24 nautical miles.

VRM   Toggles the Variable Range Marker on/off and adjusts the range of the VRM.

EBL   Toggles the Electronic Bearing Line on/off and rotates it to port and starboard.

Parallel Cursor   Toggles the Parallel Cursor Control and rotates it.

EBL/VRM Icon   Used to place the movable EBL/VRL in one of two modes, Sea or Land locked. Two movable EBLs are available.

TARGET INFORMATION

Target Information Box: Target information is displayed in the three corners of the radar screen for the targets currently hooked. This information includes: (CFR 164.38, .3.6.1)

ARPA Mode tracks 40 targets and displays digital data on the last three targets hooked:

ARPA UP-DATES ALL TARGETS EVERY ROTATION OF THE ANTENNA. 24-36 RPMS.

Range: The range or distance of the target from your ship in nautical miles.

Bearing: The bearings are in degrees true in North-up and True Motion mode and Bearings are in degrees relative in Heads-up Mode.
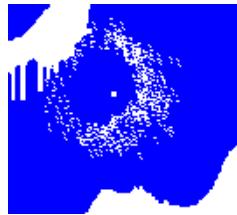
Course: The Targets Course or Relative Direction is shown in degrees true

Speed: The true or relative speed of the target is shown in knots.

**CPA:**   The targets range, bearing and Time of CPA are shown.

Clutter Controls

Controls the gain of the Rain and Sea Return. It also provides a "Sweet Spot" in the adjustment path which targets and land areas maybe lost.

TRIAL MODE

Trial Mode Box: This function is found on today's modern radars and is used to assist the operator in the evaluation of the consequences possible action contemplated. (CFR 164.38, .3.7.1, 3.8.1, 3.8.2)
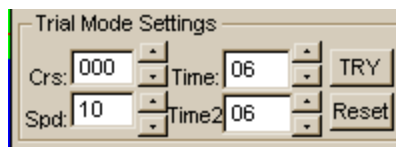
Crs	Trial Course is entered in degrees
Spd	Trial Speed is entered in knots
Time/Time2	Trial Time is entered in minutes. Time2 Execution time is in minutes.
Try	Pushing on the try button executes the trial mode and displays to results in the radar
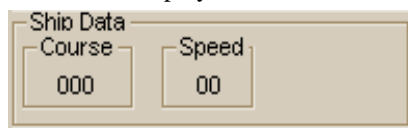
screen

Reset	Resets the display and clears the trial predictions.

OWN SHIP'S INFORMATION

Own Ships Information Box: Own ship's information is displayed at the bottom of the control panel

Course:	Own Ship's course in degrees true.
Speed:	Own Ship's speed in knots.

SHIP'S CONTROL and ICONS

Icons: At the bottom of the Control Panel screen there are several Icons used for the

different screens of the simulation and two ships controls for course and speed.

Course	Changes current ships course by use of a Rudder control 30° Right or Left (Standard rudder is 15°).
Speed	Changes current ship's speed.
Info	Toggles target labels and problem name on/off.
Ship	Opens the radar view dialog box and allows you to become an observer or take control of the other ships.
Help Icon	Used to answer basic questions about the Simulator.
Time Icon	Used to set Time mode. Real Time 1x, Double Time 2x and Quad Time 4x.
Joystick Icon	Activates the Joystick port.
EXIT	End simulation and returns to the problem selection screen.

ARPA FUNCTIONS ARE ACTIVATED BY A **PASSWORD AS A SECURITY MEASURE.**

This allows the Radar Simulators to be used in Rapid Radar Plotting courses and keeps the ARPA functions away from the students who are supposed to be using vector analysis to answer their questions.

- **Advanced ARPA Readout:** The ARPA Readout simulates problems found in real Radar readouts. The Information will be inaccurate for ½ to 3 minutes depending on the relative speed of the contact. Further refinements were added on 4/15/97 to reflect the current SSR radar readout functions. (CFR 164.38, .3.6.1)

- **Gyro failure:** Gyro failure can be simulated forcing the Radar to display Heads-up only and sound a Gyro Alarm. This feature will be executed by password and can be activated for any or all stations. When Gyro input is restored they will have all ARPA functions and will be able to rehook the contacts. Normal ARPA accuracy delay will be generated.

- **Speed Log Failure:** Speed Log Failure can be simulated at any or all stations. Own ship will lose speed input and show zero speed. An alarm will sound. The radar will continue to operate without ARPA functions until the speed is restored.

- **Marker Drop:** The Full Bridge ARPA allows you to drop a marker. This marker can be used to mark a Man Overboard (MOB) or any position of special interest.

- **Lost Target:** This function will cause a "locked on Target" to be lost, sounding an alarm and requiring it to be manually rehooked. The normal ARPA accuracy delay will be generated. As many as three lost target events can be generated during an exercise.

- **Exercise Recording:** Exercises can be recorded for student review by three methods

  1. **The Instructor** is provided with Radar station set to a 24-mile scale and his ship positioned so that all vessels in the exercise are visible during the entire exercise. The Trails feature will be on so that all movements and interaction by the vessels can be reviewed.

  2. **Using a** VGA to analog converter box and a VCR recorder the entire exercise can be recorded on videotape for future use.

  3. **Recorder:** The system now has a full digital recorder. Each exercise can be digitally recorded to hard disk and played back at any time. All functions of a VCR are available.

     - Play
     - Fast forward
     - Pause
     - Rewind

Trails: History trails are available as a line or as timed dots. Spacing available is as follows 15 Sec, 30 Sec, 1 min, or 3 min. There is no limit as to how long the trails can run. (CFR 164.38, .3.3.5)
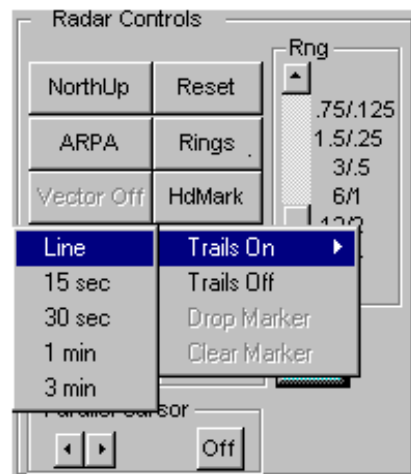
Vectors:

1. True Motion Vectors (e-m vectors) are available in all modes Heads-up, North up and in True Motion. (CFR 164.38, .3.4.7.1)

2. Relative Motion Vectors are available in Heads-up and North-up modes. (CFR 164.38, .3.4.7.4)

- **EBL:** Two movable EBLs are available. Only one of the EBLs has a VRM. The EBL / VRM marker can be moved and locked Geographically or on your ship. The left and right trackball buttons controls the function.

1. **Geographically:** The VRM/EBL is locked to a position on land or water and assumes the relative motion of the land. Both VRM and EBL can be used from this position.

2. **Ship lock:** When locked to our ship the EBL/VRM will follow our ship's movements. Such as putting the marker one mile ahead. All measurements can be taken from this point. It is commonly used by our students from a point at the head of the Barges.

- **Trial Maneuver:** Has been improved to simulate some advanced systems. The improvements include updates of the data on the displayed targets. Showing the new CPA, TCPA, range and bearing. This in addition to the trial vectors on all contacts. The student can tell that trial mode is being used by the large GREEN words TRIAL MODE in the lower left corner of the screen. (CFR 164.38, .3.7.1)

System Diagnostic: (BITE) When the system is started a diagnostic program tests all major hardware and software functions of the radar system. If all functions pass the radar enters stand-by mode. If any function fails the system stops and the student must record the malfunction in the radar log, the student can then attempt to reset the system. If upon reset the test runs successfully the system will enter standby mode. (CFR 164.38, .3.10.1)
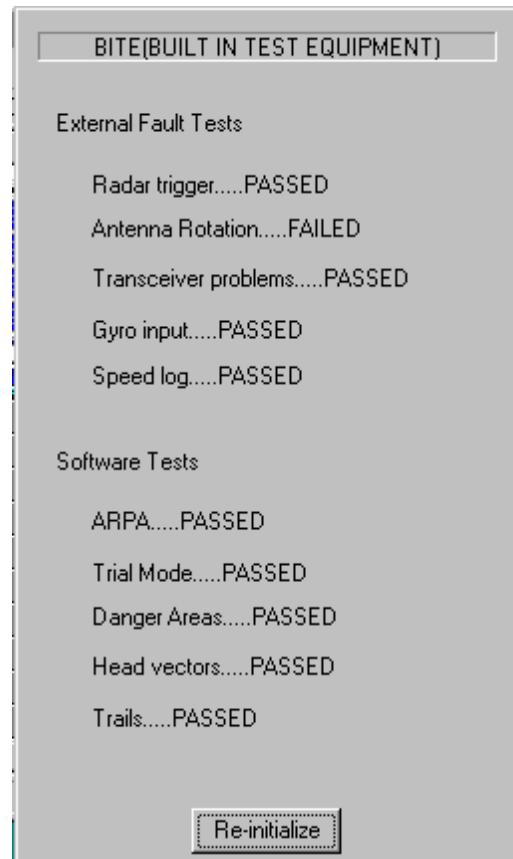
- **Target Acquisition:** Has been improved to simulate new models of radar. When a target is manually acquired its symbol (letter) color is changed to red. All 40 targets can be acquired and continue to be up dated **on Each Sweep. (24-36 RPM antenna)**

- **Automatic** Target Acquisition: Targets that enter a marked danger area are automatically hooked and an alarm is sounded. (CFR 164.38, .3.5.1, 3.5.2)

Echo display anomalies: Anomalies such as side lobe effects, multiple echoes, and indirect echoes. Can be programmed by the instructor using the Script Wizard. Buoys and other very small objects will fade on some sweeps or will be lost. This will be more pronounced on long-range scales and at long distances.

- **Low Reliability data marker:** When a contact is first marked with ARPA turned on the contact will show a square on the screen to indicate that the data readout is likely to be unreliable. As the data becomes more reliable the square is replaced by a circle(CFR 164.38, .3.4.12, 3.32)


Cancel Target: A new feature has been added that allows the student to cancel a target by right clicking on an acquired target. (33 CFR 3.21)

Exclusion Areas: The system allows the construction of exclusion areas. The area is constructed by placing a series of dot that are automatically connected together to form the exclusion area. If ourship enters the area an alarm is sounded. The sound can be deactivated.
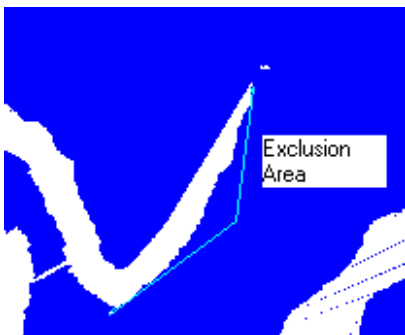
- **Enhanced Danger Areas:** Danger Areas 20, 180, 225, 360 Degrees with ranges of
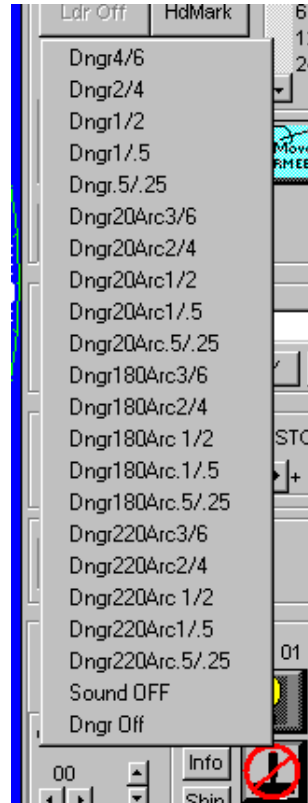
.25\ .5, .5\1, 1\2, 2\4 3\6 4\6 miles**.** (CFR 164.38, .3.4.12, 3.5.1, 3.5.2)

- **A sound on / off button has been added.**

Clicking on the North-up button now allows the selection of:

North-up
Head-up
Course up
True Motion

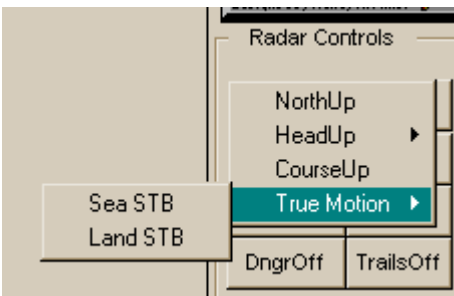Head-Up has a dropdown menu that allows the selection of Head-up True or Relative bearing.

Course-up
When Course-up is selected the CourseUP box will appear in the Ship Data area

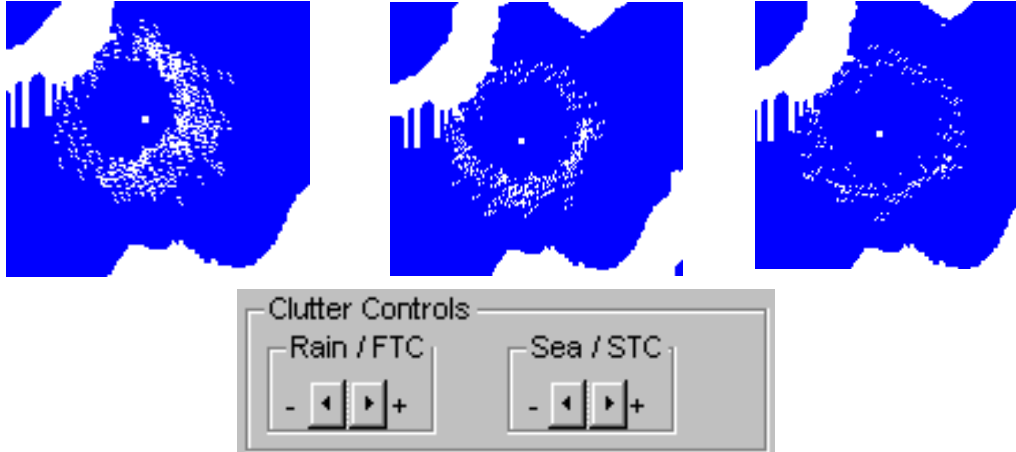True Motion mode now allows the selection of Sea or Ground Stabilized modes.

Sea Clutter:

The Sea clutter has been reprogrammed to give a more realistic presentation on the screen. When the control is adjusted the sea return is reduced from the center out.

Buoys:

Up to 20 Buoys can be placed on the chart using latitude and longitude from the chart or the Light List/List of Lights.

Each Buoy can be acquired and evaluated by the ARPA.

Heading Flash:

The heading Flash control has been improved. The Head Flash can no longer be turned off permanently it will only stay off for a short period.

The charts used in our program have been developed to provide **full real time rendering** that produces all-important information needed by the software and the user inter-face. The original data is from NOAA charts of appropriate scale.

Charts Available:

Major Waterways, Rivers and Small Boat Harbors:

1. Various Mississippi routes (Morgan City, Lafourche, New Orleans Area, etc.)
2. Puget Sound between Bremerton to Seattle
3. Puget Sound between Seattle to Tacoma
4. Port Angeles to Vancouver B.C.
5. Panama Canal
6. Miami, Florida
7. Columbia River to Astoria, Washington
8. Various Alaskan Waterways

Major Shipping Harbors and Rivers:

1. Los Angeles, Long Beach and Seal Beach Harbor, California
2. San Diego Harbor, California
3. San Francisco Harbor, California
4. Block Island Sound
5. Long Island Sound, Eastern Part
6. Chesapeake Bay Entrance
7. Chesapeake Bay Southern part
8. New York Harbor, New York
9. Cherry Point, Puget Sound, WA
10. Boston Harbor Entrance
11. Galveston Bay
12. Mobile Bay
13. Hong Kong

Near Coastal:

1. Channel Islands, Southern California
2. Los Angeles to Catalina Island, California
3. Columbia River Entrance, Oregon