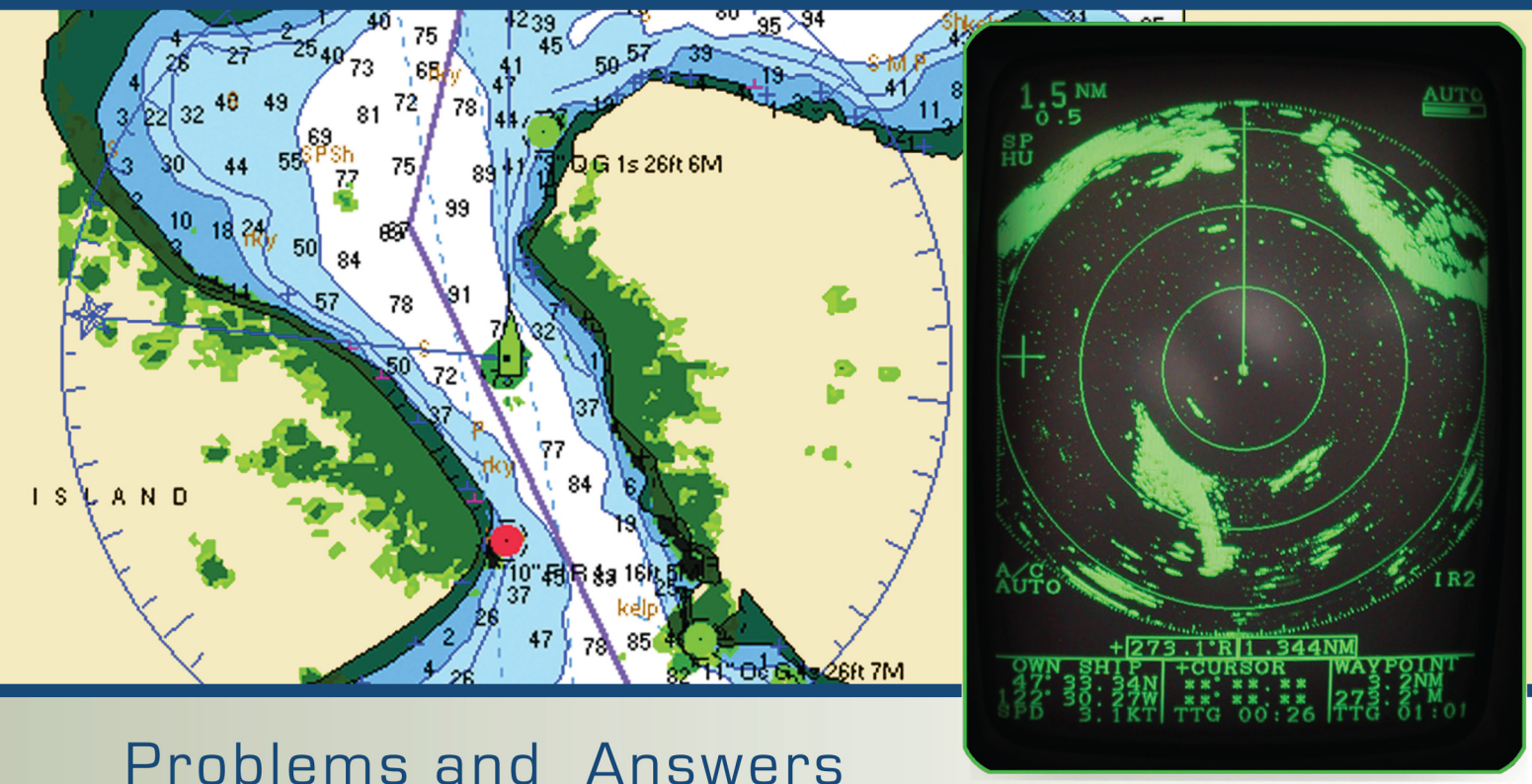
RADAR WORKBOOK



Problems and Answers in Marine Radar Operations

DAVID BURCH and LARRY BRANDT

Radar Workbook

— Problems and Answers in Marine Radar Operations

by
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and Larry Brandt

STARPATH®

Illustrations and design by Tobias Burch and Larry Brandt.

Cover includes a Nobeltec radar image overlaid on a chart in Visual Navigation Suite ECS, with a screen shot from a Furuno radar.

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TABLE OF CONTENTS

Foreword

This Workbook is designed to be used in classroom or online courses in radar, or for individual study outside of the classroom. The Lesson structure follows that used by several schools in the US, based on the background reader *Radar for Mariners* (McGraw Hill, 2005) by David Burch.

An annotated slide show presentation and *Instructor's Guide* are also available from Starpath Publications for schools using the book.

The Starpath Radar Trainer PC radar simulator is recommended for classroom demonstrations or personal study. It is available at navigation outlets worldwide or online at www.starpath.com.

The book is intended for all radar users, recreational and professional. It covers the use of radar for chart navigation, blind pilotage, and for collision avoidance.

The Appendix on advanced radar plotting has been added for professional mariners who seek more practice on interpreting ARPA output by working out the vector solutions themselves. The ability to manually interpret the radar interactions seen on the screen independent of electronic solutions is in keeping with the fundamental tenet of good navigation and seamanship that we should not rely on any one aid alone.

— Lesson 1 —

How Radar Works

Terms and Concepts

- Radar target
- Open array and radome
- Horizontal beam width
- Range and range rings
- Heading line
- Cursor
- EBL and VRM
- Relative bearing
- Head-up, North-up, and Course-up
- Brilliance and Gain
- Portable range scale

Class Notes:

Lesson 1 Questions

1-1. When you first turn on a radar unit, what is the typical warm-up time before you can transmit?

- ❑ (A) None required
- ❑ (B) 30 seconds
- ❑ (C) 1 to 2 minutes
- ❑ (D) 10 to 12 minutes

1-2. Your heading is 050 M. The EBL is set on a target bearing 325 R. The magnetic bearing to the target is?

- ❑ (A) 325 M
- ❑ (B) 050 M
- ❑ (C) 275 M
- ❑ (D) 015 M

1-3. The typical horizontal beam width of an 18-inch wide antenna is about?

- ❑ (A) 2°
- ❑ (B) 6°
- ❑ (C) 10°
- ❑ (D) 18°

1-4. Your scanner is 16 ft high, a large target is 36 feet high, how far off might you first see this target on radar?

- ❑ (A) 6 nmi
- ❑ (B) 10 nmi
- ❑ (C) 24 nmi
- ❑ (D) 36 nmi

1-5. When you turn your vessel, your heading line rotates on the radar screen. What display mode are you in?

- ❑ (A) Head-up only
- ❑ (B) Course-up or Head-up
- ❑ (C) Course-up or North-up
- ❑ (D) North-up only

1-6. At night, for the best picture you usually have to....

- ❑ (A) Turn the Brilliance up
- ❑ (B) Turn the Brilliance down
- ❑ (C) Turn the Gain up
- ❑ (D) Turn the Gain down

Lesson 1. How Radar Works — Points to Ponder

Background reading is RFM chapters 1, 2, and 3, with parts of 7 and 8.

Review the background reading and class notes to formulate your understanding of these points, as if you were preparing to explain the concepts to a friend. Strive to distill your thoughts to two or three key sentences.

1. What are the characteristics of a good radar target?

2. What is the relationship between antenna width and radar beam width?

3. Explain the difference between Brilliance and Gain controls.

4. List three ways to measure the range to a radar target with their merits.

5. List three uses of the cursor on a radar screen.

6. Explain the differences between Head-up and North-up display modes.

7. Explain the difference between North-up and Course up display modes.

8. List three major specifications of a radar system.

Terms and Concepts

- Anti clutter sea and STC
- Anti clutter rain and FTC
- Tuning control
- Plots and wakes
- Electronic Range and Bearing Line (ERBL)
- Pulse length
- Pulse repetition Interval
- 6-minute rule

Class Notes:

Lesson 2 Questions

2-1. The most appropriate initial radar-picture adjustment sequence is usually...

- ❑ (A) Brilliance, Gain, Range
- ❑ (B) Gain, Range, Brilliance
- ❑ (C) Brilliance, Range, Gain
- ❑ (D) Range, Gain, Brilliance

2-2. The normal setting of the Anti-clutter Sea control is

- ❑ (A) Full on till sea clutter reduction is called for
- ❑ (B) Full off till needed
- ❑ (C) Half scale till adjustment is called for
- ❑ (D) Set to match the Anti-clutter Rain control

2-3. At 1230 a target has range 8.5 mi, bearing 050 R and at 1236 the range is 7.5 mi at bearing 050 R.

- ❑ (A) Its speed of relative motion is 10 kts
- ❑ (B) Its speed of relative motion is greater than 10 kts, depending on our speed
- ❑ (C) Its speed of relative motion is less than 10 kts, depending on our speed
- ❑ (D) Its speed of relative motion cannot be known without knowing our speed

2-4. A 3-minute target wake is 1.2 miles long. What is its speed of relative motion?

- ❑ (A) 4.0 kts
- ❑ (B) 6.0 kts
- ❑ (C) 12.0 kts
- ❑ (D) 24.0 kts

2-5. A short pulse length would typically be about how long...

- ❑ (A) 3 yards
- ❑ (B) 30 yards
- ❑ (C) 100 yards
- ❑ (D) 300 yards

2-6. To recognize a tug and tow as two targets rather than one, you would be best to...

- ❑ (A) Turn up the Gain
- ❑ (B) Turn down the Gain
- ❑ (C) Switch to the lowest range that still shows the target
- ❑ (D) Use the Offset to move the target to the outer edge of the screen

Lesson 2. Radar Operation — Points to Ponder

Background reading is RFM chapters 1, 2, and 3, with parts of 7 and 8.

Review the background reading and class notes to formulate your understanding of these points, as if you were preparing to explain the concepts to a friend. Strive to distill your thoughts to two or three key sentences.

1. Describe the structure of a radar beam—its physical dimensions and electronic frequencies.

2. Rain clutter versus sea clutter… what are these?

3. Explain the role of the Anti-clutter Rain control and how it can be used besides rain clutter control.

4. Explain the role of the Anti-clutter Sea control and how it can be used beyond clutter control.

5. List reasons for changing pulse length (when you have the option).

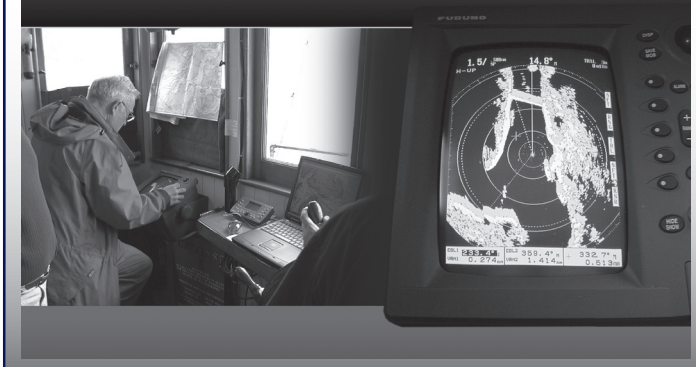
6. Explain the difference between an EBL and an ERBL.

7. Explain the role of target trails and wakes.

8. Explain how you would measure how fast a target is moving across the radar screen.

— Lesson 3 —

Interpreting the Screen



Terms and Concepts

- Horizontal shadows
- Vertical shadows
- Effect of beam width on display
- Use of ECS for radar orientation
- Side lobe interference
- Radar to radar interference

Class Notes:

Lesson 3 Questions

3-1. You can see a dinghy just 200 yards away, but it does not show up on the radar. What might cause this?

- ❑ (A) Interference Rejection has been left on
- ❑ (B) Anti-clutter Sea set too high
- ❑ (C) Anti-clutter Rain set too high
- ❑ (D) Your antenna is too high

3-2. You are travelling along a shoreline and see a large target on the radar just off the shoreline, but none is there. What are you likely seeing?

- ❑ (A) The effect of radar shadows on a shoreline feature
- ❑ (B) Side lobe interference
- ❑ (C) An effect of your beam width
- ❑ (D) An effect of your pulse length

3-3. As you pass an anchored ship with its radar still running your radar image of the ship smears out around the screen along the range to the ship. What is most likely taking place?

- ❑ (A) Your radar signal is bouncing back and forth between you and the ship causing multiple targets
- ❑ (B) The ship's radar beam is saturating your antenna and distorting its image
- ❑ (C) You are experiencing side lobe interference and need to turn down the Gain
- ❑ (D) You have reached the minimum range of your radar unit and this cannot be avoided

3-4. When you use the EBL to measure the bearing to the left-hand side of a small island, you can expect that bearing measurement to be...

- ❑ (A) About right if your compass is adjusted
- ❑ (B) Slightly too high
- ❑ (C) Slightly too low
- ❑ (D) This depends on whether we are in Head-up or North-up display mode

3-5. Transient spiraling streaks or fields of dashes on your radar screen are caused by

- ❑ (A) Poor tuning
- ❑ (B) Side lobe interference
- ❑ (C) Power line interference
- ❑ (D) Radar to radar interference

Lesson 3. Interpreting the Radar Screen — Points to Ponder

Background reading is RFM chapters 1, 2, and 3, with parts of 7 and 8.

Review the background reading and class notes to formulate your understanding of these points, as if you were preparing to explain the concepts to a friend. Strive to distill your thoughts to two or three key sentences.

1. Describe the steps you would go through when you first look at the radar to get oriented with the picture it shows.

2. Give a few examples of how horizontal beam width distorts the radar picture.

3. Describe what determines the minimum echo (pip) size we can see on the radar screen. (Think of radial vs. azimuthal dimensions of the target image on the radar screen .)

4. Explain the distinction between vertical shadows and horizontal shadows as seen on the radar.

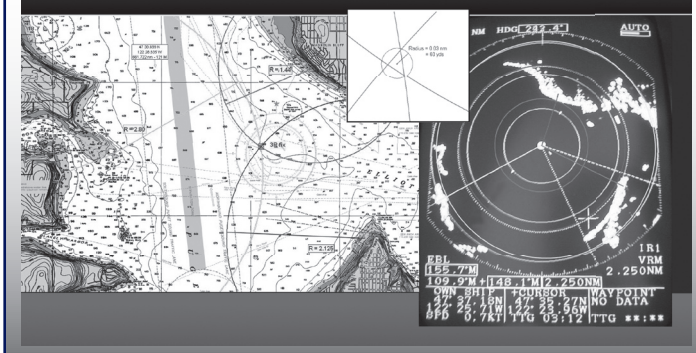
5. We see on the radar what looks like a ship anchored along a steep shore a couple hundred yards on our right but we can clearly see that no ship it there. What are we seeing?

6. Summarize the role of electronic charting options when it comes to understanding the radar picture.

7. Describe two types of common radar interference and how to remove them.

— Lesson 4 —

Position Navigation



Terms and Concepts

- Confirm GPS with radar
- Range and bearing fix
- Range and tangents Fix
- Multiple range fix
- Pros and cons of fix methods

Class Notes:

Lesson 4 Questions

4-1. One of the best possible radar targets for navigation would be

- ❑ (A) A SART signal
- ❑ (B) A large light house on the shoreline
- ❑ (C) A RACON signal
- ❑ (D) A buoy with a radar reflector on it

4-2. A range and bearing fix to a single target could be described as

- ❑ (A) Fast and precise
- ❑ (B) Fast but not as accurate as other methods
- ❑ (C) The preferred type of fix because only one target is required
- ❑ (D) The best type of fix if you have a heading sensor

4-3. The most accurate radar fix is made from.

- ❑ (A) Range and bearing to a single target
- ❑ (B) Crossed bearings from two or more targets
- ❑ (C) Intersecting ranges from 2 or more targets
- ❑ (D) Bearings to both sides and a range to the center of an isolated target

4-4. The quickest way to check your GPS position with the radar is

- ❑ (A) Range and bearing to a single target
- ❑ (B) Two crossed bearings
- ❑ (C) Two crossed ranges
- ❑ (D) A range to one target and a bearing to another target

4-5. A standard tool on electronic chart displays that helps the most with understanding the radar image is

- ❑ (A) The range and bearing tool in the chart program
- ❑ (B) A split chart screen display showing large and small scales side by side
- ❑ (C) The position projection vector on the vessel icon
- ❑ (D) Setting range rings on the vessel icon to match those on the radar

4-6. The vertical divergence of a radar beam well away from the vessel is about

- ❑ (A) 25 to 30 degrees, more or less independent of antenna size
- ❑ (B) 2 to 8 degrees depending on antenna width
- ❑ (C) Varies from 5 to 30 degrees depending on radar model
- ❑ (D) Stays at a constant profile without diverging at all in the vertical plane

Lesson 4. Position Navigation — Points to Ponder

Background reading is RFM chapters 4 and 10.

Review the background reading and class notes to formulate your understanding of these points, as if you were preparing to explain the concepts to a friend. Strive to distill your thoughts to two or three key sentences.

1. Explain how radar can be used for a quick check of the GPS position?

2. Describe several ways to get an actual chart position from radar observations?

3. Why are radar ranges more accurate than radar bearings?

4. What is the most accurate type of radar fix and how do you carry it out?

5. What are a few circumstances where a radar fix might be better than a GPS fix?

6. How do you answer the question “Is it safe to be around the radar scanner?”

— Lesson 5 —

Piloting

Terms and Concepts

- Rounding a corner
- Finding an entrance
- Following a shoreline
- Maintaining channel position
- Heading to the right channel
- Anchoring
- Effect of currents on radar observations

Class Notes:

Lesson 5 Questions

5-1. Which tool would help the most in rounding an island at a fixed distance off the shoreline?

- ❑ (A) Heading line
- ❑ (B) EBL
- ❑ (C) VRM
- ❑ (D) ERBL

5-2. Which tool would help choosing the course to an island on the starboard bow before we turn?

- ❑ (A) Heading line
- ❑ (B) EBL
- ❑ (C) VRM
- ❑ (D) ERBL

5-3. Which tool would be the most valuable for checking that our course is parallel to a shoreline?

- ❑ (A) Heading line
- ❑ (B) EBL
- ❑ (C) VRM
- ❑ (D) ERBL

5-4. Which tool would help the most to measure the width of a channel several miles in front of us?

- ❑ (A) Heading line
- ❑ (B) EBL
- ❑ (C) VRM
- ❑ (D) ERBL

5-5. Which tool might help the most to position our boat in the center of a small cove?

- ❑ (A) Heading line
- ❑ (B) EBL
- ❑ (C) VRM
- ❑ (D) ERBL

5-6. Which tool would we use to measure the bearing between two buoys, both about a mile from us?

- ❑ (A) Heading line
- ❑ (B) EBL
- ❑ (C) VRM
- ❑ (D) ERBL