# Radar Plotting Refresher

The USCG requires that Radar Observer Certification be renewed every five years. Since modern electronics are so agile, many mariners have not done an actual radar plot in those five-year intervals. To brush up for the brush up, here is a quick refresher on Radar Plotting procedures.

We'll begin with the vector triangle. As is the case with all triangles, this one has three sides.

- Side **e→r** represents the true course (direction) and speed (length) of our ("er") vessel **("we are e-r.")**
- Side **e→m** represents the true course and speed of the other ("them's") vessel.
- Side **r→m** represents the relative motion vector, the direction and speed of the other vessel's "apparent" movement.

Letter "**e**" is anchored in the plot. "**m**" may and "**r**" certainly will be relocated, but "**e**" does not move.

Next, terminology:

- **CPA**: Closest point of approach. If the line of relative motion is extended, the CPA is the shortest distance from that line to the center of the plotting sheet (where our own ship is located). If the CPA is 0, we are on a collision course with the other vessel.
- **RML**: Relative Motion line
- **NRML**: New Relative Motion line.
- **SRM**: Speed of relative motion (length of **r→m**)
- **DRM**: Direction of relative motion (direction of **r→m**)
- **$M_x$**: The position of the other ship on RML at planned time of evasive action; point of execution.

Radar Plotting used to be referred to as Rapid Radar Plotting, with an emphasis on "Rapid." In order to make the procedure quick and mathematically painless, contacts are usually observed at intervals of 6 minutes, 12 minutes or 15 minutes. Calculating speeds and/or distances is extremely easy at these intervals. For example,

- if a vessel is traveling 18.2 knots, that is, 18.2 nautical miles per hour, she will travel 1/10 of that speed (1.82 miles) in 6 minutes (1/10 of an hour).
- if a vessel has traveled 1.2 miles in 6 minutes, her speed is 10 times that, 12 knots.

The table below shows the distances traveled in 6-minute and 12-minute intervals at a speed of 15 knots.

| | |
|---|---|
| 15.0 knots | 60 minutes |
| 1.5 miles | 6 minutes |
| 3.0 miles | 12 minutes |

We'll work a standard 6-minute plot, step-by-step.

Your ship is on course 345°. Speed is 15.0 knots. You note the following radar contact:

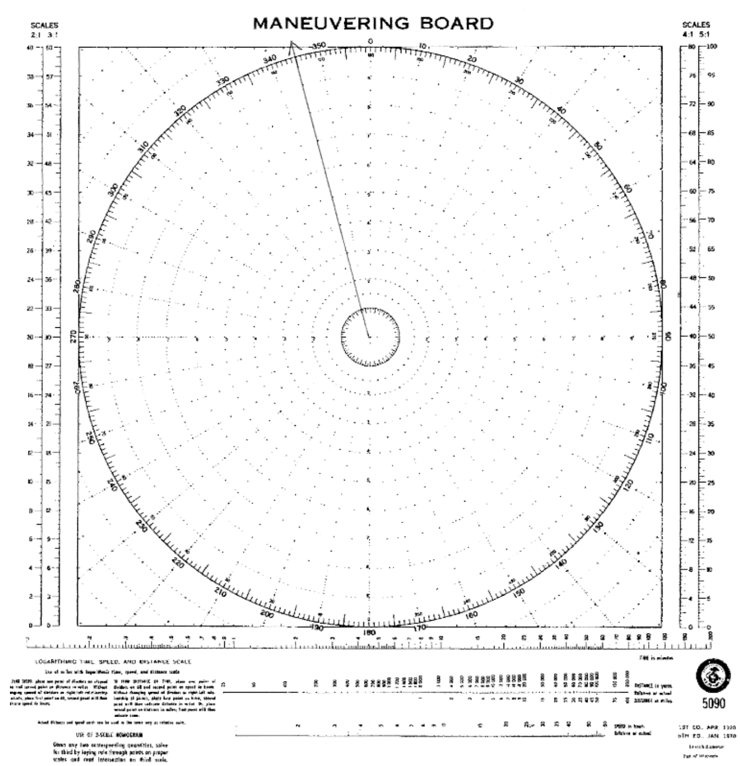
At 0830 the contact bears 329° at a range of 9.0 miles.

At 0836 the same contact bears 326° at a range of 6.0 miles.

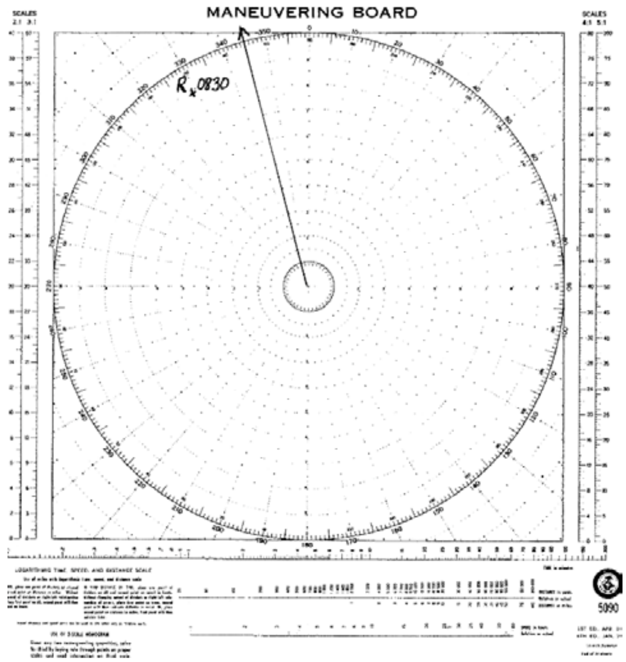
- What will be the CPA?
- What is the contact's relative speed?
- What is the contact's true speed?
- When the range to the contact drops to 4.5 miles, you want to change course, contact passing you on your port side, with a new CPA of 2 miles. What is your ship's new course?

Step 1:

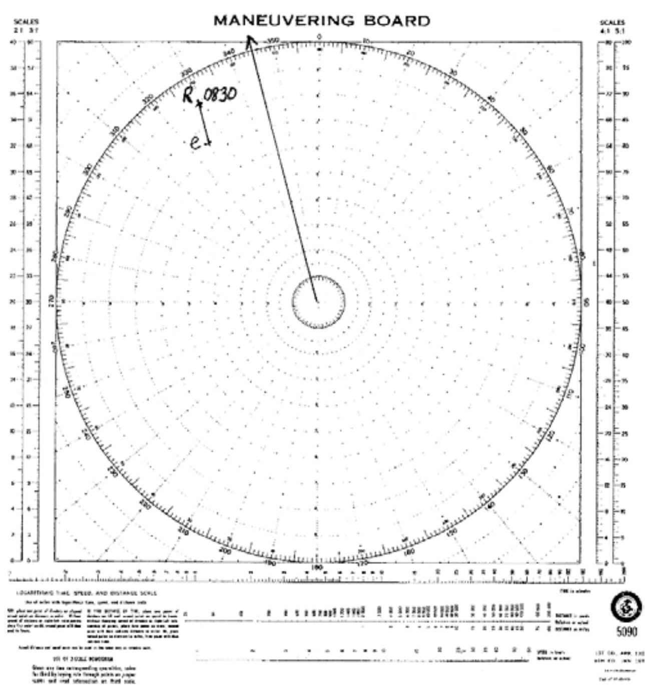
Notice that the plot is a 6-minute plot. Speeds, distances and time will be based on a factor of 1/10. Using a Maneuvering Board or a Radar Transfer Plotting Sheet, draw a line from the center (our ship) in the direction the vessel is heading. This represents the heading flasher. In this case, our course is 345°.



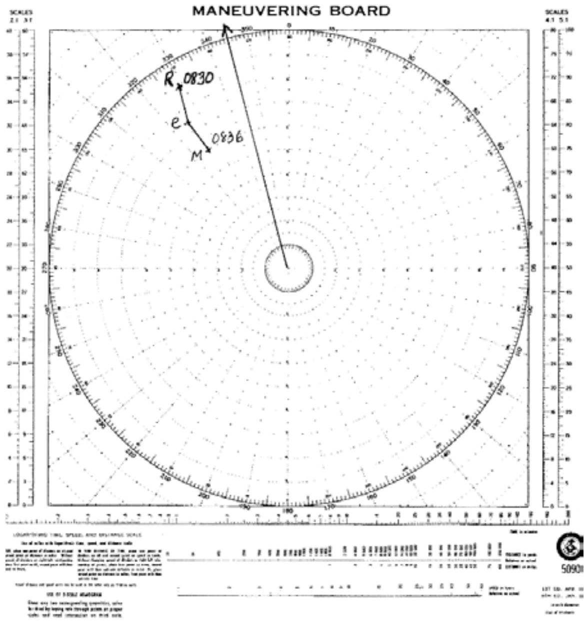
Step 2:
Plot the first (0830) contact using the 1:1 scale (the ten concentric circles on a Maneuvering Board each represent 1 mile in length) at a bearing of 329° and range of 9 miles. Label it **r**.



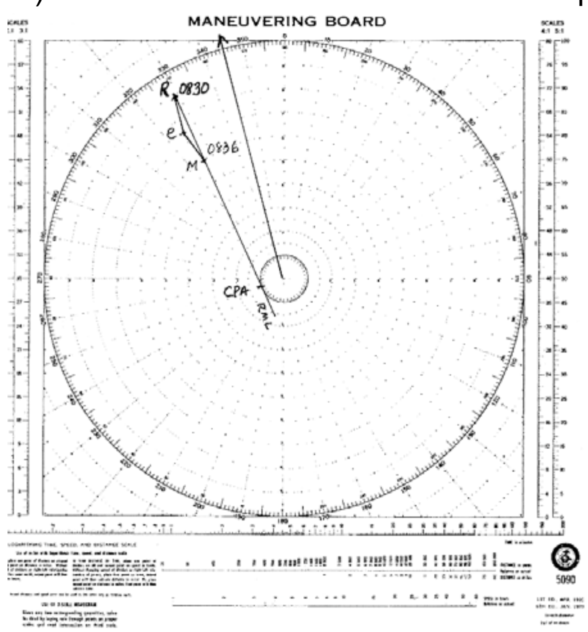

Step 3:
Locate **e** on the plot. Set dividers for the distance our vessel will travel in the interval of the plot -- in this case, 6 minutes at a speed of 15 knots is 1.5 miles. Parallel the course line (345°) over to **r** and draw it in <u>backwards</u>, away from **r**. [Remember the course is <u>from</u> **e**→**r**.] Label this position **e**.



Step 4:
Locate **m**, which is bearing 326° at a range of 6.0 miles at 0836. Now it is possible to finish the triangle and solve for the other vessel's course and speed by connecting **e → m** (approximately 146° at 16.0 knots).

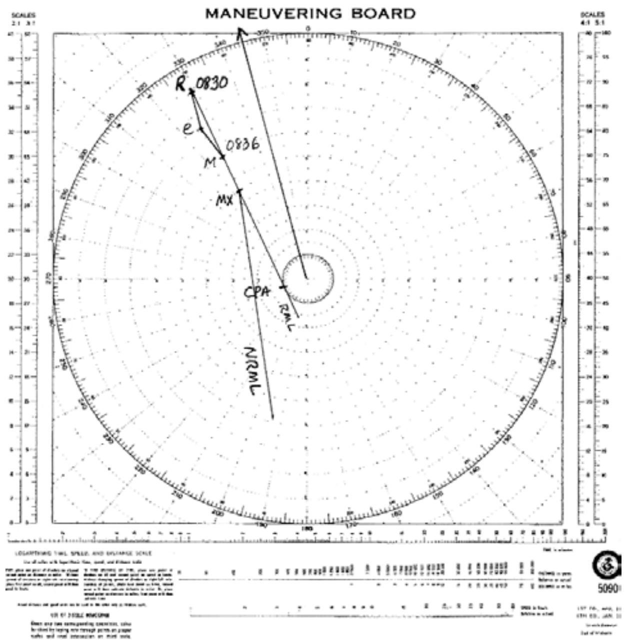



Step 5:
Draw a line from **r** through **m** and past the center of the maneuvering board. This is the line of relative motion (**RML**). The distance from the center of the plot (our vessel) to the

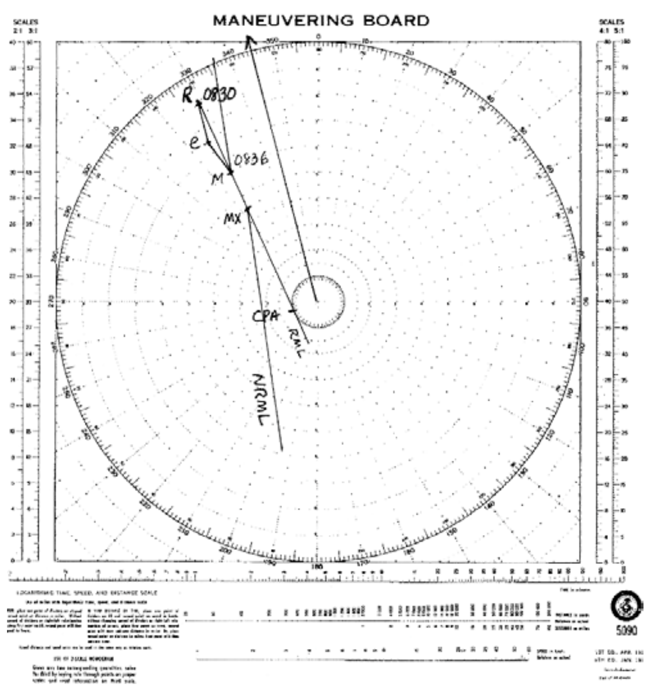



closest point (a perpendicular) on the RML is the CPA (closest point of approach). In this case, the CPA is about <u>one mile</u>. Measure the length of **r→m** to find the contact's relative speed. Here it is approximately <u>30 knots</u>.

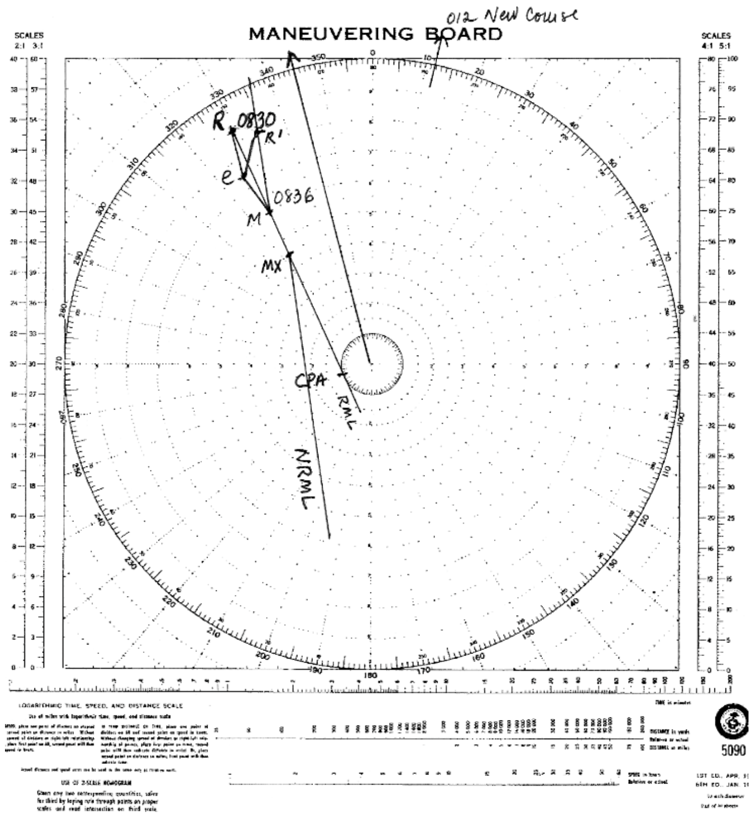
Step 6:
According to the problem, when the range to the contact drops to 4.5 miles, we are to change course so that the contact will pass on our port side with a CPA of 2 miles. The next step then is to mark on the **RML** the point at which the contact reaches a range of 4.5 miles from us at the center. Label this point **$M_x$**. From **$M_x$** draw a line tangent to (touching) the two-mile circle. When we change course, this will be the **NRML** (new line of relative motion).




Step 7:
Parallel the **NRML** from **$M_x$** to **M** (not to **e**, not to **r**, to **M**!) Draw the paralleled line <u>away</u> from **M.**



Step 7:
We are going to change our course but maintain our speed. Place one leg of the dividers on **e** and place the other leg on **r**. Swing the dividers so that the **r** leg (remember **e** never moves), crosses the **NRML.** Label the point of intersection **r[1]**. The direction from **e→r[1]** is our vessel's new course. In this case, that new course is approximately 012°.




Plots generally allow reasonable tolerances for answers, hence the "approximately" used throughout this explanation.

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The finished plot for the following problem is on the next page.

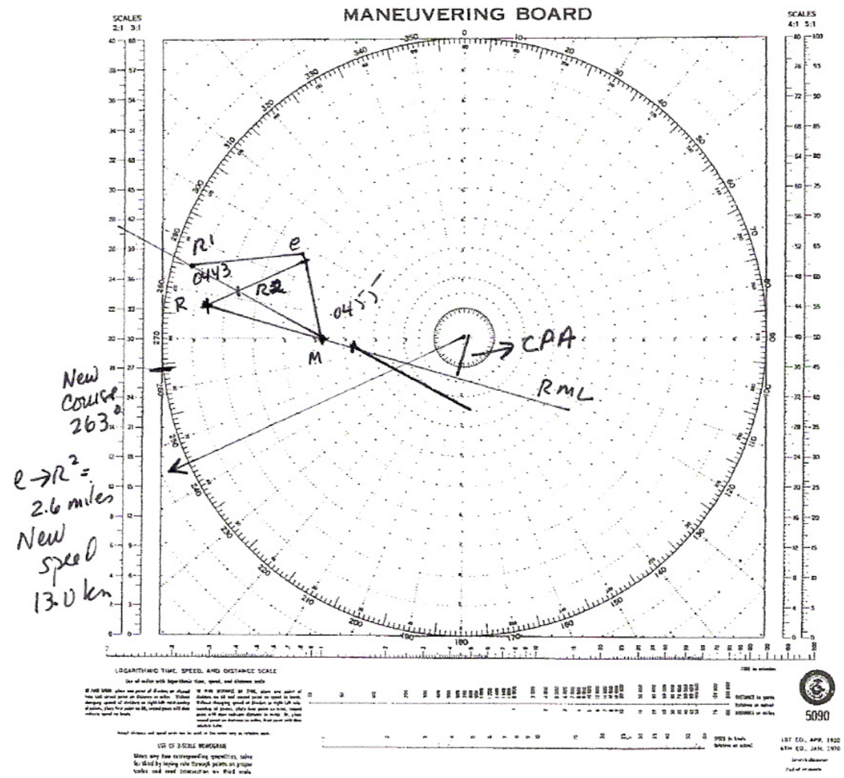
Your ship is on course 245°. Speed is 18.0 knots. You note the following radar contact:

At 0443 the contact bears 277° at a range of 8.5 miles.

At 0455 the same contact bears 270° at a range of 4.7 miles.

- What will be the CPA?
- What is the contact's true course?
- What is the contact's true speed?
- At 0458, you want to change course, contact passing you on your port side, with a new CPA of 2 miles.
- What is your ship's new course?
- You cannot change course, so at 0458 you want to change speed, contact crossing your bow, with a CPA of 2 miles.
- What is your ship's new speed?

This is a 12-minute plot, so speeds are divided or multiplied by 5.




- The original CPA is about 1.3 miles.
- The contact's course is approximately 170°.
- The contact's true speed is approximately 13.5 knots.

To find **$M_x$** , note that since this is a 12-minute plot and since 0458 is 3 minutes from the 0455 position of **M** and since 3 minutes is ¼ of 12, eyeball the distance to **$M_x$** as about ¼ the length of **r→m.**

- When the **NRML** is paralleled back to **M** and the dividers (with one leg at **e**) swung to find **$r^1$**, the ship's new course is found to be approximately 263°.
- Since the problem now says that a course change is not possible, the other option is to find **$r^2$** along the original **e→r** line at the point it intersects the **NRML.** If the vessel maintains its original course of 245° but reduces her speed from 18.0 to 13.0 knots, the other vessel will cross her bow at a CPA of 2 miles.

For the final example, we'll do a 15-minute plot. As 15 minutes is ¼ hour, we will be dividing or multiplying by 4.

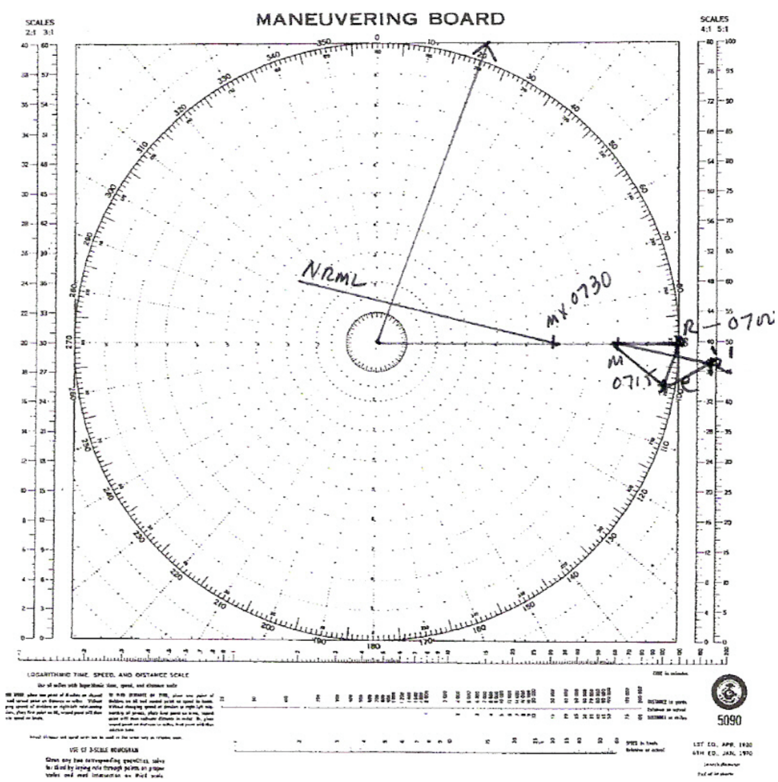
Your ship is on course 020°. Speed is 7.0 knots. You note the following radar contact:

At 0700 the contact bears 090° at a range of 10.0 miles.

At 0715 the same contact bears 090° at a range of 8.0 miles.

- What will be the CPA?
- What is the contact's true course?
- What is the contact's true speed?
- At 0730, you decide to change course to 060°.
- What will be the new CPA?
- What will be the time of the new CPA?

Here's the plot:




- The CPA is <u>0</u> (constant bearing, decreasing range, Rule 7 of the **Rules of the Road**).
- The contact's true course is approximately <u>320</u>°.
- The contact's true speed is approximately <u>8.8 knots</u>.
- **$M_x$** is 15 minutes beyond the 0715 **M** on the **RML**, which is to say, with one leg of the dividers positioned at **R** and the pivot leg at **M**, one swing of that span down the **RML**.
- The new CPA is approximately <u>1.5 miles</u>.
- The time of the new CPA is approximately 0759 (almost but not quite two swings the length of the **NRML** from **$M_x$**).

## Things That Can Go Wrong on a Radar Plot

There are a few common mistakes to watch out for when doing a radar plot.

1. Make sure to draw an **e→r** line, not an **r→e line.** It's very easy to draw the course line in backwards.
2. Double-check the plot intervals. Working a 12-minute plot as a 6-minute won't work.
3. Make sure that any course or speed adjustments are made in the triangle. **$M_x$** is not part of the triangle. The line drawn from **$M_x$** must be paralleled back to **M** in the original triangle. Always tinker in the triangle.
4. Remember that in determining times after **$M_x$**, time calculations must be made on the basis of the length of **$r^1$→m**.