Radar Tool Kit
(April, 2017)

Radar: An acronym for "Radio Direction and Range." Radar works by sending a narrowly focussed pulse of RF energy and then looking to see if any of it is reflected back. The direction from which the reflection (if any) comes gives the "Direction." The time required for the reflection to make it back translates into the "Range." If the antenna continues to rotate and send out pulses, the returns give a bird's eye view of targets surrounding the sender.

Note that the type of radar use on boats and ships is technically ASR ("Area Surveillance Radar") and is distinguished from such radar applications as Weather Radar, Fire Control Radar, Ground Penetrating Radar and others.

Radar Frequency: Various types of radars operate in various bands. Marine ASR operates on a nominal center frequency of 9.41 GHz. For comparison purposes: police radio operates on 0.4 GHz; your cell phone operates most likely on 1.8 GHz; and WiFi operates on either 2.4 or 5 GHz. Is this important? Who knows, but one significance is that at 9.41 GHz, one cannot generate the RF signal by the same means as a radio or cell phone; instead you have to use a device called a "magnetron," which (a) has to be located at the antenna (cannot be connected to the antenna by cable) and (b) consumes a relatively large amount of power. This may become relevant later.

Doppler Radar: If a radar pulse is reflected by a target, the frequency of the reflected signal will be: (a) the same as the transmitted frequency if the target is still, (b) slightly higher than the transmitted frequency if the target is moving toward us, and (c) slightly lower than the transmitted frequency if the target is moving away from us. A radar set that employs the Doppler effect can display targets differently, such as red for those closing on us and green for those opening. This is a comparatively new feature on small boat radars.

Bearing: A means of designating the direction in which an object lies relative to our vessel. Various ways of doing this:

> **True Bearing:** the direction to the object relative to cardinal "north." Technically means relative to True North.
>
> **Magnetic Bearing:** bearing relative to Magnetic North.
>
> **Compass Bearing:** bearing relative to what our steering compass shows as North; essentially the same as Magnetic Bearing except not corrected for compass errors.
>
> **Relative Bearing:** unlike True Bearing, Magnetic Bearing, and Compass Bearing, Relative Bearing is the direction to the object relative to which way our bow is pointing.

Example: Our boat is located near Mosher’s Ledge and is pointed toward Woods Hole, which is 105ºT or 120ºM. There is another boat that lies directly off our starboard beam. That other boat bears to us 195º True Bearing, 210º Magnetic Bearing, and 090º Relative Bearing. In fact, an object lying directly off our starboard beam will be at 090º Relative regardless of which way our boat is pointing.

“Clock” Bearing: an informal but useful way of communicating an approximate relative bearing. It is described relative to an imagined clock face oriented so that our bow is pointing to the noon position. Thus, an object lying directly off our starboard beam is at “3:00.” The advantage of this approximation is that it is quick; one doesn’t have to look at the compass or pelorus. This mode of articulating relative bearing is the source of such phrases as “12:00 High” (a target is dead ahead) or “Check Your Six” (watch out for what is coming up behind you).

Motion: This is important:

> **True Motion:** describes the movement of an object relative to the face of the earth, usually in terms of direction relative to north (could be True North or Magnetic North and usually doesn’t make any such distinction) and speed in terms of movement over the face of the earth.
>
> **Relative Motion:** describes the movement of one moving object relative to the changing position of another moving object.

If you were to plot the changing position of a moving vessel on a chart, your plot would show the vessel’s true motion. If you watch (or plot) the changing position of a moving vessel as displayed on the radar PPI of a moving vessel, you would see (or plot) the other vessel’s relative motion.

Example: Our vessel is moving south at 6 knots, and it is two miles north of a buoy. The True Motion of the buoy is zero knots, direction null. The relative motion of the buoy to us is North at 6 knots. Hang on; this will become clear (or clearer) when we get to PPI plotting.

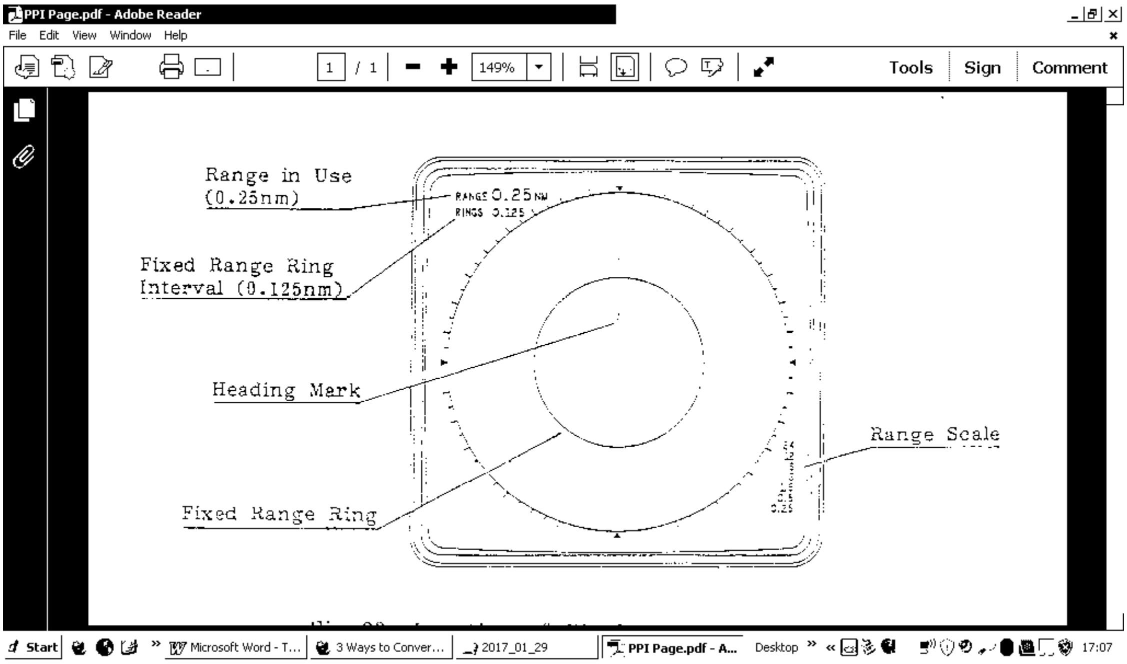
PPI: Stands for the term “Plan Position Indicator,” which is the circular display of targets common to all radar sets. The PPI typically has these features:

> **Center Dot:** A big dot in the center of the display, which represents where we are (or, more specifically, where the radar’s antenna is).
>
> **Heading Bug:** A symbol (usually an inverted triangle) at the periphery of the display and at the 12:00 position. Symbolizes the direction in which our bow is heading (assuming the set was properly installed and calibrated).
>
> **Heading Line:** A solid line running from the Center Dot to the Heading Bug.

Bearing Scale: A series of ticks and numbers at the periphery of the display dividing the periphery into 360 degrees of relative bearing.

Range Rings: A series of circles of centered on the Center Dot, showing the distance from us (or our radar antenna). The value of the rings will vary with the "Scale" setting. Usually the Range Rings can be turned on or off, and often the display is easier to monitor with the rings off.

A typical PPI display might look like this:



Radar Set Settings and Controls: Different radar sets will have different labels and controls, which means that for any particular set you have to study the operator's manual for your set, but typically you will have most of these functions:

Tx On/Off: A radar set takes a while to turn on and warm up. With the transmitter on, the set draws significantly more power; with the transmitter off (but the set otherwise on), power draw is much less. However, if the set is on and warmed up, flicking the transmitter from "off" to "on" will give us a display of targets immediately. So when underway, when you leave the radar to go topside, you can conserve power by turning the transmitter off while still having the ability to drop below and make a quick check for targets without waiting for turn on and warm up.

Range: This function controls the maximum range of targets that will be displayed on the PPI; think of it as analogous to "zooming" in or out on a computer or chart plotter. Reducing range will yield a more useful display of nearer targets;

increasing range will display further targets. In real life, the crewman assigned to watching the radar should more or less continually zoom in and out.

A note about radar "range." The typical small boat radar set will go as high as 12 or 24 nautical miles of available range. Take these values with a grain of salt. Point #1: no target will give an indication on the display unless it reflects some minimal amount of the transmitted pulse; the coefficient with which any target reflects a radar pulse is know as its "radio density." Small wooden boats and small fiberglass outboards typically have low radio density. Steel hulled boats, sailboats with aluminum spars, and any boat that has deployed a good radar reflector will have greater radio density. Point #2: the energy of the transmitted pulse dissipates with distance (both going and coming back), and more so in a dense (such as foggy) atmosphere. Bottom line: always remember this: the *absence* of a blob on the PPI is not positive indication that there is no target there! And this *caveat* increases in significance as the radar set's "Range" is increased.

IR On/Off: "IR" stands for "Interference Rejection." All marine radar sets operate on the same frequency, and if it is foggy out, all the other boats out there are likely to have their radars on and transmitting. If your radar receives signals transmitted by someone else's radar, it will display these receptions even though they are not reflections of your own transmission, and, therefore, do not reflect valid "targets." (Typically, this interference will appear on the PPI as spirals emanating from the Center Dot.) Turning "IR" on minimizes such interference display.

STC: Stands for "Slow Time Constant;" sometimes referred to as a "Sea Clutter" control. In essence, this reduces the display of pulses that have been reflected by nearby waves in heavy seas, at some risk of diminishing or eliminating the return of true nearby targets. Usually one control will turn STC on or off, while another adjusts the depth of the effect. Use with caution.

FTC: Stands for "Fast Time Constant." Similar to STC, the FTC control reduces the display of pulses that have been reflected by precipitation, either heavy rain or (for those who go sailing in snow storms) snow. Usually just an on or off control. Not used often.

Tune: It is the nature of the beast that radio transmitters and radio receivers do not hold to their nominal frequency perfectly; they can wander based on temperature, time on, and a zillion other factors. In order to get the best display, it is desirable to adjust the center frequency of your radar's receiver to whatever frequency your radar's transmitter is in fact emitting at the moment. This may be a manual function: sweep the control until the picture seems to be sharper and valid targets seem to be stronger; sometimes you will have an "automatic" option.

Gain: The Gain control increases or decreases the amplification of received RF pulses; think of it at the RF equivalent of a volume control. If gain is set too low, indistinct targets (caused by targets with poor radio density) may disappear, while if gain is set to high, target blobs will grow brighter and larger and may obscure other targets. Setting the gain control requires practice.

In my experience, the best thing to do is this: (a) adjust the gain down so that targets appear to dim, then (b) sweep the tune control until the targets appear brightest, then (c) adjust gain up as needed to make targets distinct again.

EBL: Stands for "Electronic Bearing Line." We see a blob on the PPI, signifying that there is probably a target out there. A glance at the Bearing Scale at the periphery of the PPI display gives a quick approximation of the relative bearing of the target, which the operator may or may not remember (or write down). If you turn on the EBL, your radar will turn on a solid line emanating from the Center Dot, and you can then use the controls to rotate the EBL until it passes through the target. Now the display will show, in degrees relative, a more precise relative bearing. And if you leave this line on, you will get a quick and more or less certain indication of how this target is moving relative to the EBL.

Note: the EBL is probably the most important function on a small boat radar to understand and use. If, after putting the EBL on a target, if the target appears to move above this line, it will pass over your bow, and if the target appears to move below this line, it will probably pass under your stern. **If the target appears to slide down the EBL toward the Center Dot, it will collide with you!**

VRM: Stands for "Variable Range Mark." Similar in concept to the EBL: turn on the VRM and another range ring (often dashed or dotted to distinguish it from the fixed range rings, if on) appears. Using the controls, you can expand or contract this ring until it lies over a target. The display will depict the range of the ring in nautical miles. Useful if you need a more precise estimation of the range to a target.

Note: if you turn on both EBL and VRM and center both on a target, the intersection between the two will effectively "plot" the initial position of the target on your screen. This will make indication of how the target moves with time easier to see.

CBDR: This is not actually a radar term, though the concept is central to using radar for collision avoidance. "CBDR" stands for "Constant Bearing, Declining Range." CBDR defines a collision situation. If two objects are moving such that the relative bearing of the other object remains constant while its range (distance from us) is decreasing, and if nothing changes over time, **that object will collide with us!**

The bottom line essence of collision avoidance at sea is detecting CBDR and, if detected, doing something about it. More on this to follow.

CPA: Stands for "Closest Point of Approach." Means the smallest distance that there will be between two converging objects. If CPA is large, the other object won't ever get close enough to us to worry about. If CPA is small, pay attention. If CPA is (or approaches) zero, we have an impending collision.

TCPA: Stands for "Time of Closest Point of Approach." Means the amount of time between now and when CPA occurs. If TCPA is long, we have time to figure out whether we have to worry about the other object and, if so, to figure out what to do about it. If TCPA is short, get on the stick pronto.

Radar Reflector: A radar reflector is a device employed to increase the radio density of a vessel, so that it will reflect a better target to any other radar sets in the vicinity. A common form is a three-ordinal dihedral: essentially three circular disks oriented one slices left and right, one fore and aft, and one up and down; on a foggy day, the radar reflector is hoisted from a sailboat's spreader on a flag halyard. Radar reflectors are typically constructed of aluminum; sometimes, made of foil-covered foam. There are other designs available. Historically, tests have shown that some commercially available radar reflectors work and some do not, and the most expensive reflectors are not the ones that do the best job. But in any event, some form of radar reflector is better than none.

ARPA: Stands for "Automatic Radar Plotting Assistant." A feature available on the sort of radars that are found on large ships. You are not likely to ever see one.

MARPA: Stands for "Mini ARPA." A feature (usually an add-on option) that offers some of the features of ARPA on small boat radar sets. Seldom seen in the real world, as it is expensive and requires connections to our vessel's electronic compass and some form of speed information (often via our GPS set). (Note: if you are unlikely to ever see, much less have and use, ARPA or MARPA, why are we telling you about them? Simply because if you pursue the topic of radar, you are likely to see these terms and now you know what they mean.)

Radar Plotting:

We’re going to go through this during the program, but for now we’ll set forth the basics.

If we’re sailing along (say in the fog) and there is another vessel in our area, we’ll see a target blob on the PPI. If we watch that blob move for a period of time (and, for reasons we’ll explain, the common time interval used is 6 minutes), we’ll see the blob move. What we are seeing is the vessel’s **relative motion**.

Plotting the relative position of the other vessel at the beginning and end of the time interval allows us to derive four items of data that cannot be read from the PPI directly:

> The other vessel’s **true motion**.
>
> The other vessel’s **true speed**.
>
> **CPA** (i.e., how close the other vessel will pass to us, which is a metric of whether or not it is a collision risk that bears watching).
>
> **TCPA** (i.e., how quickly the other vessel will arrive at CPA, which is a metric of how quickly we have to evaluate the collision risk potential).

In the movies, you sometimes see navigators physically marking positions on the PPI screen itself with a grease pencil. This is fiction; all you’d do is mess up your expensive radar set and, after a short while, render the screen unreadable. Rather, we do our plot on a piece of paper called a “Radar Plotting Sheet,” which is a mimic of what appears on the PPI.

Here’s how we do it.

Step 1: draw a dot on the RPS with the same relative bearing and range of the other vessel at the start time. Label this “R xx,” where xx stands for the time (minutes only) of the plot.

Step 2: after 6 minutes, draw another dot on the RPS of the other vessel’s relative bearing and range. Label this “M yy,” where yy stands for the time (minutes only) of the plot.

Step 3: Draw a line that starts at point R and runs through point M and past the Center Dot. This line is known as the “DRM” (for “Direction of Relative Motion”).

Step 4: Find where the DRM comes closest to the Center Dot and mark this point “CPA.” Measure the distance between CPA and the Center Dot, based on whatever scale you used to plot the other vessel’s range. This is CPA. If CPA is less than your threshold for concern, start paying attention. (Note: everyone has their own values for CPA concern. For what it might be worth, mine are half a nautical mile if the other vessel is likely to be a large ship and a quarter of a mile if it is another sail boat, in either case for a crossing situation.)

Step 5: Take the distance the other vessel moved during the time interval (in nautical miles), multiply it by ten (assuming we used 6 minutes as the time interval), and this is the vessel's SOG or speed made good over the ground, in knots.

Step 6: Measure the distance between point M and point CPA, divide that by the other vessel's SOG, and multiply the value (which is usually a fraction of one) by 60. This is TCPA, in minutes.

Step 7: draw a line from Point R straight down for a distance that is one-tenth our own vessel's speed in knots. Label this point "T yy," where "yy" is the time at which you observed the other vessel at point M. Draw a line from T through M. This line represents the true motion of the other vessel during the time interval. Using a set of parallel rules, find out the direction (relative to our bow) of the TM line, correct it for our own vessel's heading, and this is the other vessel's COG (or Course Made Good over the time interval).

All of this sounds more complicated than it really is; there is a depiction of a radar plot in the Images section below. Even without making fine measurements (and assuming the range rings are half a mile apart), we can see that the other vessel will pass over our bow with a CPA of about a quarter of a mile in about 18 minutes. Keep a sharp eye, but no need to panic.

What does all of this tell us? Well, CPA tells us if we are in danger, and TCPA tells us how quickly we have to deal with the impending danger. TM tells us the direction in which the other vessel is actually moving, which is important if we want to call the "Vessel moving on a course of [whatever heading], near [whatever ATON or other geographic point]." SOG gives us some indication of what type of vessel the target may be.

OK, all of this sounds fine, but in the real world, on a small sail boat with a short-handed crew, who is actually going to sit in front of the radar set for an extended period drawing plots? You got me; not too many folks. But the point is that understanding how to do radar plots gives you far more understanding of the significance of what you're seeing on the PPI than most people have.

For instance, if you've followed what we've said so far, you've recognized that by putting the EBL on the target at time zero, what we've actually done is plot (on the PPI itself, with no grease pencil used) the RM line of a zero CPA. Watching the target move for any amount of time tells us very quickly, in at least a qualitative sense, whether or not we have a CPA concern. If the target moves quickly and decisively off the EBL, we're probably safe. If it stays on the EBL, well time to figure out what we're going to do.

And there is this. The RM line shows us how the vessels are moving relatively, and it is tempting to assume that a vessel that moving closer and closer to us is, in fact, pointing its bow at us. Not so in the real world and comparing the RM and TM lines makes this clear. In the depiction below, if we were heading north, the relative motion of the target on the PPI appears to be more or less southwest, whereas in real life the vessel was heading decidedly northwest. This highlights a useful rule of thumb: so long as our vessel is moving, any other vessel that is pointing its bow right at us probably isn't a collision risk (unless it is either dead ahead and coming our way or dead astern and overhauling us).

A Note about Radar vs. AIS

Those who have attended prior CANE programs on Chartplotting know that, while I am not a salesman for AIS, I am one of its cheerleaders. AIS is a powerful tool that is feasible for small sail boats, both economically and in terms of the installation hassles.

So how do radar and AIS relate to one another? Does having one eliminate the value of the other?

Simple answers:

For all the other vessels out there that are also AIS equipped, AIS gives you all the information about those other vessels that radar might give you, with greater precision and without any need for plotting or calculations. AIS also gives us the ability to hail the other vessel on the radio by name, so as to work out a crossing agreement if one is appropriate. Thus, if every vessel had AIS, radar would be completely unnecessary. At least for collision avoidance.

Problem is, not all vessels are AIS equipped. Certainly all of the big ships that ply Buzzards Bay or steam the approaches to Boston Harbor have AIS: they are required to do so by Coast Guard rules. And more and more commercial but non-AIS-mandatory vessels are installing AIS, if only because their insurance carriers require it. But if you look at the last three fatal collisions that occurred in Buzzards Bay, not one of the offending boats had AIS!

Bottom line: install and use both.

Two other observations on AIS.

#1: You have the choice of purchasing and installing either an **AIS transponder** or an **AIS Receiver.** A transponder receives and processes data on the other ships out there *and* transmits data on your vessel to other AIS equipped vessels. An AIS receiver receives and processes data on other AIS vessels but does not transmit your data to them. Go for the transponder. The incremental cost in dollars is small. The incremental value in avoiding bad situations is huge.

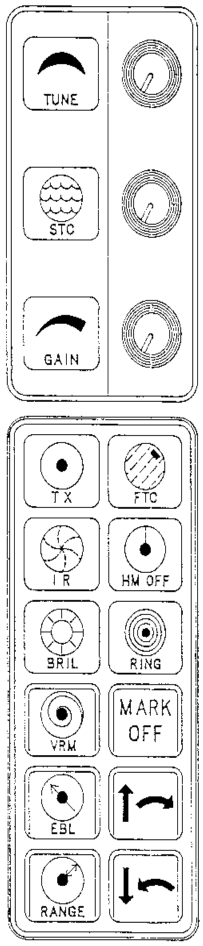
#2: An AIS transponder requires an VHF antenna over which to transmit your ship's data, and finding a suitable location for a separate antenna can be a pain. So you may be counseled instead to install an "antenna splitter," which (in theory) allows a single antenna to be shared by a VHF radio and the AIS transponder.   For reasons I will explain to anyone who has the patience to listen (if asked), do not use an antenna splitter.

If you want to see what AIS can really do for you when combined with the OpenCPN chartplotter application, see Appendix 5 of the "Glossary of Sorts" available in the Library section of the CANE website.

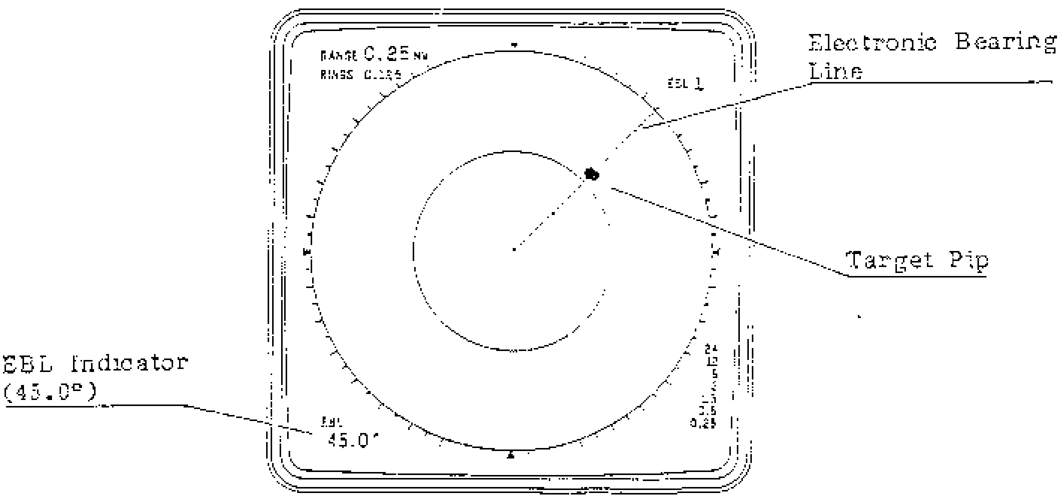
Images

Here is a depiction of the buttons and controls on a typical small boat radar:

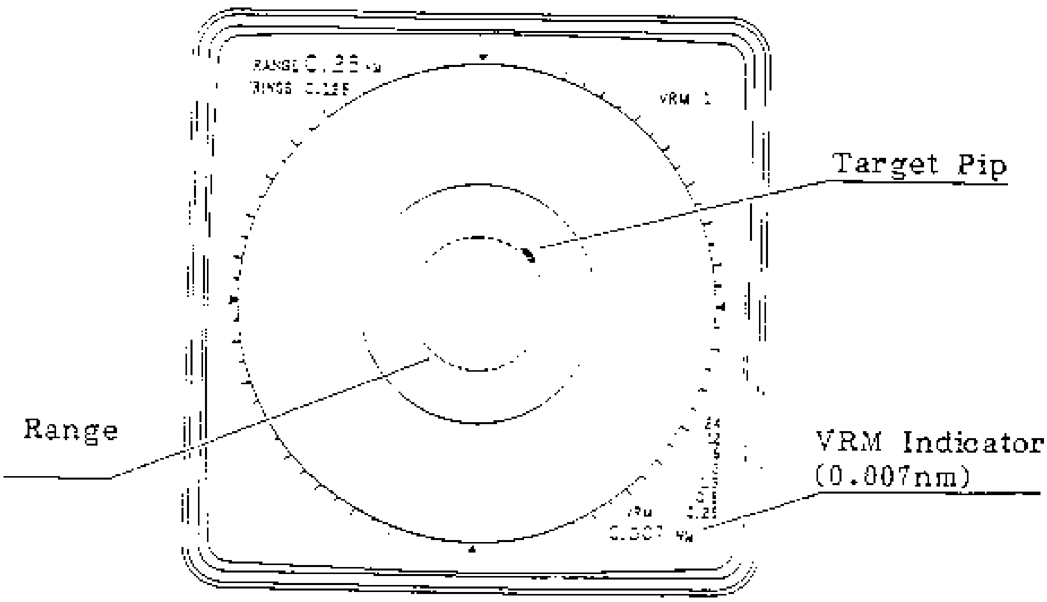
TUNE:	This control keeps the receiver tuned to the transmitter.
STC:	Used to suppress sea clutter caused by waves.
GAIN:	Adjusts the sensitivity of the receiver.
TX:	Sets the radar to either transmit or stand-by.
FTC:	Used to suppress precipitation clutter.
IR:	Eliminates or reduces interference caused by other nearby operating radars.
HM OFF:	Temporarily erases the heading mark from the screen.
BRIL:	Adjusts the brightness of the CRT.
RING:	Displays/erases the fixed range rings.
VRM:	Activates the Variable Range Marker.
MARK OFF:	Erases the VRM and/or EBL from the screen.
EBL:	Activates the Electronic Bearing Line.
RANGE:	Activates the controls used to select the range.
ARROW PADS:	Maneuvers the EBL and VRM, and selects the range.



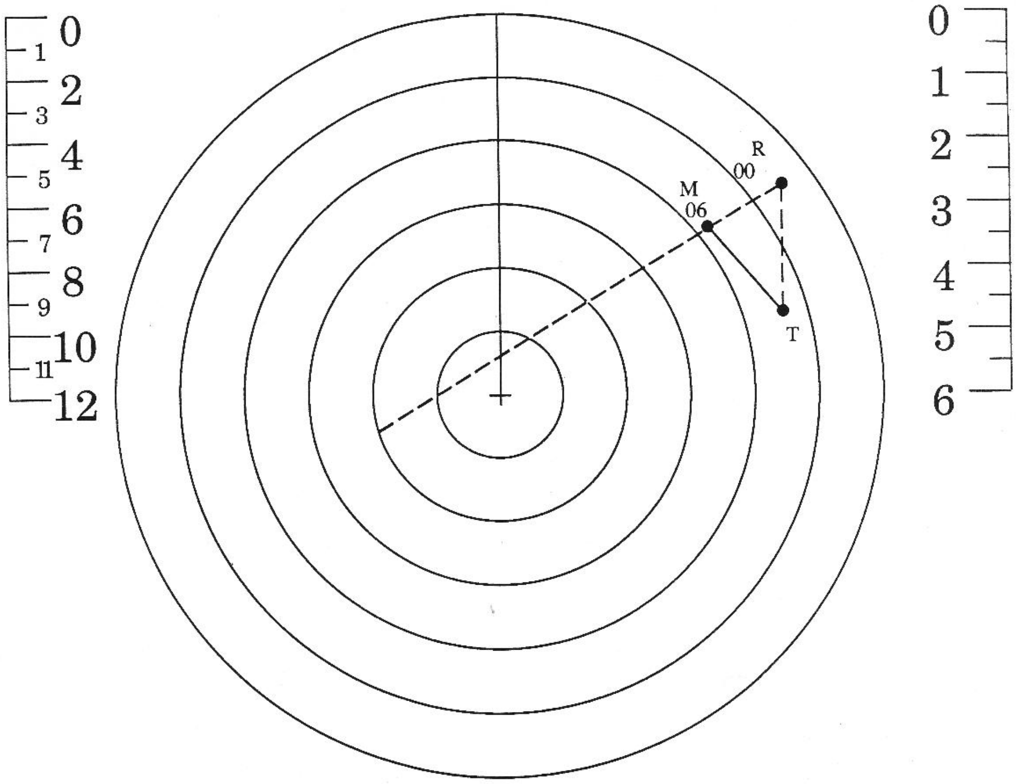
Here is a depiction of the EBL in use:



Here is a depiction of the VRM in use:



Here is a page from a course book on advanced radar topics, showing a simple radar plot:



TRUE MOTION OF THE TARGET

By incorporating our known course and speed with the DRM line we can find the course and speed of the target. "R" is the first plot of the target and "M" is the plot of the target at minute 06. "T" to "R" is our vessel's course and the distance it covers in 6 minutes (1/10 of our speed). "T" to "M" is the True Motion of the target. Multiply that distance by 10 to get the true speed (assuming a 6 minute plot as in this problem). The true course in this example is not at all similar to the DRM line. This is not unusual.

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Some General Thoughts about Sailing in the Fog

The VHF is Your Friend. You want to have one radio set for Channel 16 and a second radio set for Channel 13. (If you only have one radio, use "Dual Watch" feature; set the radio on 13.) Channel 13 is the "Bridge-to-Bridge" channel, where "bridge" means "ship's bridge," not one of those things that cars drive over.

Channel 13 is the channel on which vessels will broadcast a "Securité" message, stating their location and maneuvering intentions. Just by listening, you'll get a mental picture of what other boats are nearby and, therefore, potential problems. Channel 13 is also how you'll respond to such vessels, if you think there might be a problem. Channel 13 is also the first channel you'll use to try to hail an AIS target or radar blob, if there is need to talk to it.

Maintain Way. There is a tendency to assume, if it really gets thick, that slowing down to a drift is helpful. Actually, the reverse. Some AIS displays on other AIS-equipped boats will ignore stationary targets (targets whose SOG is less than 2 knots or so). Or, if another boat is using radar and sees you not moving, you may be taken for a buoy and ignored. Finally, if something suddenly pops out of the fog real close, your ability to make a sudden course change is drastically impaired if your forward speed is nil.

Sound Signals. Obviously, you want to use them. Most modern VHF sets have the ability to generate fog signals automatically, but you have to have connected your VHF to a speaker, preferably mounted on the mast at about the level of the lower spreaders, for this function to work. Know the various signals: one long is a vessel underway using engines; one long and two short is a sailing vessel underway using sails (only).

Radar Reflector. Whether another vessel can see you on its radar depends on how strong a reflection your vessel gives of the other vessel's radar pulses. Plastic sailboats are not the worst reflective targets out there (at least, not those with steel or aluminum spars), but they are also not the best. Deploying a radar reflector will increase your "radio density."

Note: I am not in the business of selling radar reflectors. However, some years ago, some folks whose opinions I trust ran tests on a number of radar reflectors and found that one of the most effective was the Davis "Emergency" radar reflector. This is made of foil covered foam, so it cannot be left deployed at all times, but rather has to be hoisted in the fog and then stored when the weather clears. Ironically, the Davis "Emergency" is one of the least expensive radar reflectors available. The West Marine sku is 107961. Buy two, as eventually your first one will fall apart.

Running Lights. Sometimes called "Nav Lights." Obviously to be used when sailing at night, but also worth turning on in daytime conditions of limited visibility. You will pop out of the fog a bit sooner.

Maintaining a Watch. Sailing in the fog is no time for others on the boat to be reading a book or watching the tube. Depending on how many crew you have to assign, how well they handle themselves on a boat, and how hardy they are: You want at least one person whose only job is to maintain a lookout. If you have two, at least one should keep an eye dead astern. If your engine is going, a watchkeeper on deck (out of the cockpit) has a greater chance of hearing some other vessel's sound signals.

Navigation – Use of GPS. In clear weather, some people use their electronic navigation tools (GPS, Chartplotter) all the time; others, almost never. That's fine—probably inefficient, perhaps, but otherwise OK—in clear weather. When visibility declines, though, you're confidence in your present position and what it takes to get to your destination and stay off the rocks is likely to evaporate quite suddenly. Having your nav tools up and running means a more quickly restored normal heart rate, as well as staying off the rocks.

Steering a Course – Use of the Autopilot. Under normal condition, some people use their autopilot all the time; others, virtually never. Those in the latter category have only two things to rely upon for maintaining a course (or heading): a view of the surroundings and a look at the compass. In the fog, the former will be useless. In the fog, staring at the compass means the helmsman will develop tunnel vision and be oblivious to other things. Judicious use of the autopilot in the fog makes sense. On the other hand, if you are using the autopilot, the helmsman has be aware of how to disable it, and take over hand steering, in a hurry: if something does pop out of the fog, you won't have much time to respond.

PFDs. Like the autopilot, some folks make use of life jackets religiously for all on board at all times; some, almost never. This is a debate I won't get into. However, realize two things: (1) whatever the probability of losing someone overboard might be in clear weather, it is greater (to some extent, at least) when maneuvering in the fog; and (2) however difficult it may be to recover an MOB in clear conditions, it will be immensely more difficult—and take far longer—in the fog.

Staying "Off the Beaten Path." There are certain places where boats tend to be more often than others; think of these as the marine equivalent of highways and intersections. For example, the route between New Bedford/Fairhaven and Woods Hole is heavily traveled (including by fishing boats and some tug-and-tows), and that route (and those vessels) hew closely to the line between Mosher's Ledge "4" and "5) at one end and Woods Hole "13" at the other. Now you want to sail from New Bedford to Woods Hole and it is foggy. If you set a course that runs north or south of that line—say from Mosher's Ledge to Weepecket Island or Kettle Cove—you may take a bit longer to get there, but you will not have to worry about encountering some other vessel traversing the same path. Likewise, the really big stuff traversing Buzzards Bay follows a set path from BB "8," past the "BB" buoy (where they may linger to take in wire and rig for pushgear) up to Cleveland Ledge light. You'll have to cross this path, but be aware of it and pay extra attention as you do so.

An Historical Note

The development of radar was ongoing by the militaries of the United States, Great Britain, and Germany, during the 1920s and 1930s.

By 1940, the U.S. Army had developed the SCR-270 “Mobile” radar unit. Take “Mobile” with a grain of salt, as the unit consisted of four large trucks and used a truck-mounted antenna array some 55 feet in height and mounted on an oil-well drilling derrick. Crude by today’s standards, the SCR-270 had the demonstrated capacity to detect a bomber-sized aircraft at a distance of about 150 miles.

In 1941, four SCR-270s were deployed in Hawaii, at four points around the island of Oahu. The Army was comparatively uninterested in the device, however: it was limited to operating for four hours per day and was required to be shut down by 0700. In addition, there were no procedures established for the operators to report any findings and no procedures for what should be done if something was detected.

On the morning of December 7, 1941, Army privates George Elliot and Joseph Lockhard were operating the SCR-270 serial number 012, located at Opana Point, on Oahu’s north shore. They had not shut down their unit at 0700 as ordered, because the truck that was supposed to take them to breakfast failed to show and they wanted to spend some more time learning their machine. At about 0702, Elliot and Lockhard detected a large flight of aircraft located some 130 miles NNE of Oahu, flying toward the island. Excited, Lockhard made a telephone call to the Information Center at Fort Shafter. His report was passed to the Information Center’s on-duty officer, Lt. Kermit Tyler, who apparently had received no training regarding the capability of the SCR-270 or what he should do if its operators reported having detected anything. Tyler dismissed Lockhard’s report, concluding that what he might have detected was a group of six B-17s thought to be enroute from the mainland to Hawaii.

Approximately 55 minutes later, the aircraft that Lockhard and the SCR-270 had detected bombed Pearl Harbor, which had received no warning and made no defensive preparations.

(Following the war, SCR-270 serial number 012 was loaned to the University of Saskatchewan for scientific research in the late 1940s. Today it resides at the National Electronics Museum in Linthicum, Maryland.)

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