Radar Considerations

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Radar (radio detection and ranging) is used for more than locating other vessels and hard objects such as islands in the dark and fog. It is also used to negotiate twisting channels, to find fixed-gear markers like longline buoy reflectors, to identify intense weather phenomena, and even to spot birds that may indicate the presence of fish below. New systems integrate radar with other tools such as GPS, plotters, and depth sounders to present sophisticated multidimensional interactive images for navigation.

Recent developments make modern sets more versatile, easier to use, and more reliable; but despite more than a half-century of refinement, the basic radar function has changed little. A revolving antenna or scanner sends out a concentrated beam consisting of pulses of microwave energy, then receives them as they bounce back off hard surfaces. The return signals then are sent to a processor in the display unit that translates them into a pattern on the screen. Typically, waves are one and a quarter inch long and have a frequency of about 9,500 MHz.

Most radar screens are activated digitally by technology known as “raster scan” and use CRTs (cathode ray tubes) for the screens. Raster-scan technology presents the image on the screen like a TV set, reading the page left to right and top to bottom at very high speed. Unlike older radars where the targets were bright but quickly faded as the scanner made its sweep, on a raster-scan screen the targets remain visible through the entire sweep. A CRT screen is bulky and requires a hood to shield it from direct sunlight for good viewing, but it presents a sharp picture.

Many compact, lower-priced units use LCD (liquid crystal display) screens. LCD units are smaller and don’t require a hood for daylight viewing, and many models are splash-proof or even waterproof so they can be used in the cockpit or on the flying bridge. One possible downside of LCD is that the display is made up of hundreds of individual pixels that are activated by the unit’s processor, so any line on the screen other than straight horizontal or vertical will have jagged or stair-step edges. The more pixels on the screen the smoother those lines will be, so pixel count, horizontal and vertical, is a measures of the quality of an LCD set.

Factors to consider when selecting a radar, besides price, include:

Antenna. Open array or covered (“radome”), the size of the antenna greatly influences performance. Covered antennas don’t have to stand up to wind and weather, so they can be lighter and less expensive. However, the larger the antenna the more target discrimination (see beam width, below). Larger antennas are all the open-array type. Small-boat antennas typically are 12 to 24 inches while the bigger units are four to eight feet or more. Most scanners rotate at 24 or 25 rpm, but high-speed scanners (42 or 50 rpm) are available on some more expensive (over $8,000) units that are used on fast boats because they update the picture twice as often.

Horizontal and vertical beam width. Vertical beam width ranges from around 40 degrees on the smallest dome scanners to 25 degrees on large open arrays, and is only a consideration when rolling or healing where the signal may be aimed above the water. Horizontal beam width influences target discrimination, particularly where two targets are close together. The narrower the beam the better the set’s ability to separate them. Radome horizontal beam width varies considerably from one model to another, from four to seven degrees. Large open-array antennas of about eight feet can achieve horizontal beams of less than one degree.

Power. Options range from 1.5 to 6 kW nominal transmit power on small radars and up to 25 kW on large units. It would be logical to assume that power equals range, but that is only partly true; range is largely a function of antenna height (see below). Power does influence the ability of the unit to penetrate rain and fog and allows the set to see small and weak targets better.

Display type and size. LCD screens are thinner and lighter and afford better daylight viewing, whereas CRT screens have better resolution and can achieve as many as eight levels of signal strength (quantization). CRT color is available on high-end models. A “semi three-dimension” feature on some models improves target discrimination. Screen size is measured diagonally.

Watch mode. Most modern units have a watch mode that triggers both audible and visual signals when a target enters or leaves a pre-set zone. This feature can prevent collisions and can serve as an anchor watch.

Other features. Most modern radars have an electronic bearing line (EBL) that measures the relative bearing from your position to a target, and a variable range marker (VRM) that measures the distance. Most also have an auto gain or auto-tuning feature that adjusts the gain as you change the range. Interference rejection is a common feature that blanks out signals from other radars in the area. Most units now also allow you to put the position of your boat off-center on the screen so that you can use a lower range and more effectively examine the space between the boat and other objects such as the shore. A zoom function also allows you to study a particular area in more detail. “Lollipop waypoints” is a feature that allows you to transfer GPS waypoints to your radar screen and marks them with a little circle-and-post symbol. Some units have an on-screen help menu.

NMEA interface. Increasingly, electronics are designed to talk to one another to provide the operator a more comprehensive picture of his or her situation. The interface that allows, for example, the GPS to put position data together with depth data from the sounder and project it on the radar screen over a detailed chart image from the plotter is, by agreement among manufacturers, under the auspices of the National Marine Electronics Association. Currently the most popular interface is NMEA 0183.

A new standard, NMEA 2000, is coming on line next year that, manufacturers claim, will have about 20 times the capacity of NMEA 0183. This means that more types of electronic inputs can be accommodated simultaneously, and processing time will be less. The new connection will be able to carry signals from as many as 50 units at one time and apparently is being developed to address the interests of the increasing numbers of users who employ personal computers as part of their navigation package. Indeed, one manufacturer (Si-Tex) now markets a radar without a display unit; it has an interface that connects the scanner directly to a PC equipped with radar interface software.

Antenna height. A feature not of the radar itself but of its installation, antenna height is the chief determiner of range on small boats. Because radar waves are line-of-sight, it doesn't matter how much energy is transmitted by the antenna—the set can see only about 7% farther than the horizon. The horizon is remarkably close; for example, an antenna mounted 14 feet above the water can detect an object at the water level only out to about 4.5 miles. If that object itself is 14 feet high, the detection range is extended to nine miles. A mountain, of course, can be detected clear out at the far end of the set's nominal range, but the foreland at its base may remain invisible. According to Alaska Voc Tec electronics specialist Dennis Lodge, the range at which a radar can detect a target can be calculated by the formula R = (1.23 × square root of h) + (1.23 x square root of H), where R is the range in nautical miles, h is the antenna height in feet, and H is the target height in feet.

A 30-degree beam width means that objects more than 15 degrees below the center of the signal also won't be seen, which is why typically there is a blind spot immediately around the boat even when the set is on the lowest range. The higher the antenna the farther out this zone extends, but the increase in range is greater than the loss.

Radar Installation

Smaller radars are actually designed to be installed by the owner, although there is a range of abilities of owners, and warranties don't cover problems that result from incorrect installation. Mount the scanner unit securely above the boat and the display inside where visibility is good, and plug the two together. Connect the display unit to a clean source of power using wire of adequate gauge to allow no more than a 3% voltage drop, through a breaker panel and the vessel's master switch. Be sure to get the polarity right. By carefully following the instructions, an owner should be able to make final adjustments to the set, but it is always a good idea to have a qualified technician at least check your work. Where the interconnect cable comes through the cabin roof, be sure to put a "drip loop" in the cable so that when the inevitable leak occurs the sea water will drop harmlessly to the cabin sole and not run down the cable and into the set.

Radar energy cannot penetrate steel or other solid materials, so any object with a diameter greater than the one-inch wavelength of the transmitter, such as stovepipes, exhaust stacks, or mast A-frames, can create a "shadow zone" or a blank spot on the screen where no return shows. The smaller the antenna the greater this problem can be. Obstructions also can cause "ghost echos" opposite the point on the rotation of the antenna from where the obstruction actually is.

Also, remember that the antenna emits radio energy that is quite concentrated at short range, so put it well above head height; you'll avoid any risk of eyesight damage and get better range. Those neat flybridge dodger installations that position the scanner at hip level to an operator standing or sitting at the controls are only for people who have already had all the children they want.

Currently there is some discussion about the merits of tilting the scanner down slightly, particularly on fast boats that run with the bow up. Some operators also believe that a downward tilt (five to 15 degrees) eliminates the close-range limitations imposed by the vertical beam width and allows them to track gear markers, for example, right up to the boat.

Maintenance and Repair

Unless you are an electronics technician, there's not much you can do to maintain or repair your set beyond replacing a fuse. Just keep the display unit dry, cool, and clean. Keep the scanner unobstructed and clean off any accumulations of soot.

If your set doesn't work, you can try disconnecting the cable to the scanner and turning on the display unit. If the screen displays all its normal symbols but no picture, there is a good chance the problem is in the scanner.

Technicians normally can't repair main boards, only replace them; and boards for older sets may be hard to get. Manufacturers build a certain amount of spares at the time a particular model is made, and when that model goes out of production so do the boards, so your service technician may have difficulty getting the parts to repair a set more than five to 10 years old. Many shops and service centers keep junker sets for parts or can track down parts at other locations.

Technicians can repair scanners, replace magnetrons, and tune older sets to restore their performance. When a set gets old, the magnetron can get weak and the tuning point changes; a technician can retune the receiver to the same frequency as the magnetron, or replace the magnetron.

For the vessel operator, more important than maintenance is proper use. Some apparent problems with the set can be simply a matter of the operator not understanding how to correctly adjust the gain, sea clutter, and other features. Use just enough gain to get a sharp picture with very few speckles on the screen. Read the instructions, then practice, practice, practice. In good visibility, use all the set's functions so that you can get a visual image of what is out there compared to what the screen shows. ✥

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