

A Coast Guard 29-ft Response Boat–Small underway. Even small, fast boats now carry radar, and it earns its keep the first time the fog rolls in. *1

NAVIGATION / COLLISION AVOIDANCE

Marine Radar — Practical Operation & Collision Avoidance

A plain-language guide to reading the screen, setting it up right and using it to stay clear of other boats, rocks and pot buoys.

Radar is the one instrument aboard that shows you what is actually out there, whether or not it carries AIS, shows a light or appears on a chart. It is also the most misunderstood. This guide explains how radar works, what the brochure numbers really mean, the difference between a dome and an open array, how to tune the picture, and how to use EBL, VRM, CPA and MARPA to decide early whether another vessel is a threat. It closes with false echoes, weather, pot buoys and a fog routine.

AT A GLANCE

Line of sight Radar cannot see over the horizon. Antenna height, not the brochure range, sets how far you see low targets.	**Dome vs open array** A narrower beam separates targets better. Bigger antenna, narrower beam.
Tune it Gain, sea clutter and rain clutter decide whether small targets show up or disappear.	**Steady bearing** A target whose bearing stays the same while the range closes is on a collision course.
CPA / TCPA How close it will pass and when. Decide early; any change should be large and obvious.	**Pot buoys** If you see one, look for more. They usually run in a line.

*General guidance only. Always follow vessel manuals, current regulations and the judgment of the vessel's master. * See photo & reference credits.*

How Radar Works

A radar antenna sends out a very short burst of microwave energy and then listens for the echo. Radio energy travels at a known speed, so the time until the echo returns gives the **range**; the direction the antenna was pointing at that instant gives the **bearing**. The antenna turns about once every two seconds or faster, and the display paints each echo as a spot on a round picture called the **PPI** (plan position indicator), with your boat at the center[1].

What comes back depends on the target. Large, tall, hard and metal surfaces facing the antenna return strong echoes; steel ships, bridges, steep cliffs and buildings paint brightly. Fiberglass, wood, low sand beaches, rubber and foam return weak echoes or none at all. That is why a 30-ft fiberglass boat without a reflector can be harder to see than a steel buoy half its size[1,4].

Term	What it means on the screen
Range	Distance from you to the echo, measured with range rings or the VRM
Bearing	Direction to the echo, measured with the EBL from the heading line or from north
Heading line	The line from the center straight up (in head-up), showing where your bow points
Echo / target / contact	Any spot of returned energy: a boat, buoy, shoreline, rain cell or clutter

X-Band and S-Band

Recreational and small commercial radars are **X-band** (about 9.3–9.5 GHz, a 3 cm wavelength). Large ships usually carry an X-band set plus an **S-band** set (about 3 GHz, a 10 cm wavelength). X-band gives a sharper picture with a smaller antenna; S-band sees through rain and heavy seas better and is less bothered by clutter. Racons and search-and-rescue transponders are built to answer X-band radars[1,11].

Magnetron and Solid-State Radars

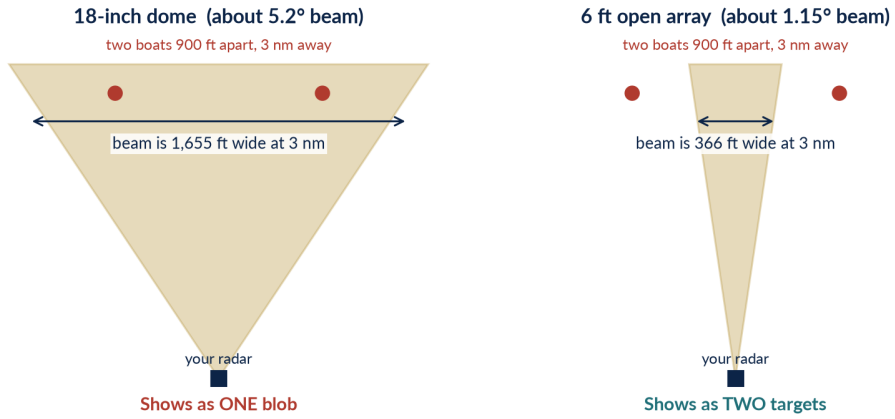
Older and many current radars use a **magnetron**, a tube that fires a powerful, short pulse. Magnetrons need a warm-up of a minute or more before transmitting and wear out over the years. Newer **solid-state** radars send longer, lower-power pulses and use pulse compression (sometimes called CHIRP) to sharpen the result. Their practical advantages are near-instant start-up, very low radiated power, better close-in performance and, on many models, **Doppler** coloring that paints approaching targets one color and receding targets another[5,6]. A separate type, broadband or FMCW radar, transmits continuously at very low power and is excellent at very short range, but has less long-range punch.

	Magnetron (pulse)	Solid-state (pulse compression)
Start-up	Warm-up period before transmit	Ready almost immediately
Close range	Good with short pulse; small blind zone around the boat	Very good; minimum range as low as about 20 ft on some domes[5]
Moving-target help	Trails and MARPA	Trails, MARPA and Doppler target coloring on many models
Radiated power	Higher peak power	Much lower peak power
Upkeep	Magnetron is a wear item	No magnetron to replace

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Dome or Open Array?

The single biggest number for picture quality is **horizontal beamwidth**, how wide the radar beam is as it sweeps. A radar cannot separate two targets that sit inside the same beam at the same range; they paint as one blob. A longer antenna makes a narrower beam. Domes (18–24 in) hide a short antenna inside a radome; open arrays (3.5–6 ft) are longer bars that spin in the open.



Why beamwidth matters. Two boats 900 ft apart, 3 nm away: an 18-in dome's 5.2° beam is about 1,655 ft wide and paints them as one echo, while a 6-ft open array's 1.15° beam is about 366 ft wide and shows two.

Antenna (example)	Horizontal beam	Beam width at 3 nm	Notes
18-in dome (Garmin Fantom 18x)	5.2°[5]	about 1,655 ft	Light, compact, fine for small cabin boats
24-in dome (Garmin Fantom 24x)	3.7°[5]	about 1,180 ft	Noticeably sharper than an 18-in dome
24-in dome (Furuno DRS4D-NXT)	3.9°[6]	about 1,240 ft	Maker quotes about 2° with RezBoost processing
4-ft open array (Raymarine Magnum)	1.85°[7]	about 590 ft	Common on sportfish and trawler hardtops
6-ft open array (Raymarine Magnum)	1.15°[7]	about 366 ft	Best separation; needs mast or arch room

Choosing. A dome makes sense on sailboats, center consoles and small express boats: it is light, draws little power, has nothing to snag lines or people and can sit under a hardtop. An open array is better wherever there is room and power for it: it separates boats from buoys and buoys from the jetty, it holds a sharper coastline at long range, and it generally does better on small targets in clutter. Either one is only as good as its mounting height and tuning.



A Raymarine open array on a yacht's mast. The two white domes beside it are satellite TV and phone antennas, not radar; a dome is not always a radar. *2

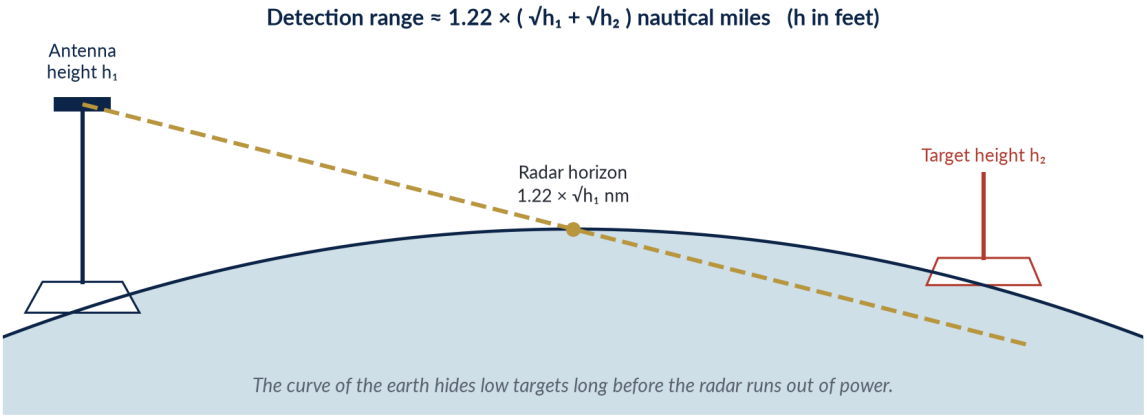


A Garmin radar and communication antennas on a wheelhouse roof. Mount radar clear of masts and other antennas to limit blind sectors. *3

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What a "24-Mile" Radar Really Means

Radars are sold as 12, 16, 24, 36, 48, 72 or even 96-mile units[7]. That number is the longest **range scale** the set will display, not how far you will actually see a boat. Radar travels in nearly straight lines, bending only slightly more than light, so the curve of the earth hides low targets. The usual rule for radar horizon in nautical miles is **1.22 × √(antenna height in feet)**, and the same again for the target's height, added together[1].



Radar range is limited by the horizon. Add the antenna's radar horizon to the target's radar horizon to estimate the farthest detection.

Antenna height	Radar horizon	Low target (4 ft buoy)	20-ft target	100-ft ship or cliff
10 ft (small center console)	3.9 nm	about 6.3 nm	about 9.3 nm	about 16.1 nm
15 ft (express cruiser hardtop)	4.7 nm	about 7.2 nm	about 10.2 nm	about 16.9 nm
20 ft (sportfish tower / flybridge arch)	5.5 nm	about 7.9 nm	about 10.9 nm	about 17.7 nm
30 ft (trawler mast)	6.7 nm	about 9.1 nm	about 12.1 nm	about 18.9 nm

These are the best-case geometric limits. Whether a small target actually paints depends on its size and material, sea state and your tuning. The international performance standard for ship radars, with the antenna 15 m above the water, expects a 10-m boat without a radar reflector to be detected at only about **3.4 nm** and a navigation buoy at about **4.6 nm** on X-band in clear conditions[3]. A higher-power set does not see over the horizon; what it buys you is a stronger picture on weak targets, in rain and on tall land and weather well out.

PLAIN ANSWER FOR OWNERS

On a typical 30-ft boat, the radar **may** detect another small fiberglass boat at roughly 2–4 nm in calm water, and much closer or not at all in a chop; target construction, sea state and tuning matter enormously. Large steel ships typically show at 10–16 nm and high land beyond that. Set the working range to 3 nm in traffic and 6 nm for the bigger picture, and step out to 12 nm now and then to see what is coming.

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The Controls in Plain English

Control	What it does	How to set it
Gain	Overall receiver sensitivity, like the volume knob	Turn up until a light speckle appears in open water, then back off slightly
Sea clutter (STC)	Reduces echoes from waves close to the boat	Just enough to break up the bright clutter near center; too much erases small boats and buoys
Rain clutter (FTC)	Breaks up broad echoes from rain and snow	Use only in precipitation; it also weakens shoreline and large targets
Tune	Matches the receiver to the transmitter	Leave on Auto on most sets; check that weak targets look strongest
Range / rings	Sets the scale and the distance circles	Know the ring spacing at each range (e.g. 0.5 nm on a 3 nm scale)
Pulse length	Short pulse for detail; long pulse for distance	Usually automatic with range; short for harbors and pot fields
Interference rejection (IR)	Removes spiral or dotted streaks from other radars nearby	Normally on; turn off briefly if you suspect it is hiding a weak target
Target expansion	Enlarges small echoes	Helpful for buoys; it also enlarges clutter and merges close targets
Trails	Leaves an afterglow behind moving echoes	Use true trails to see who is moving; relative trails to see who is closing

Orientation. Head-up puts your bow at the top, so the picture matches the view out the windshield, but it smears every time the boat yaws. **North-up** matches the chart. **Course-up** keeps your intended course at the top and is a good compromise underway. North-up, course-up, chart overlay and MARPA all need a **heading sensor** feeding the radar[8].

Motion. In **relative motion** your boat stays fixed at the center and everything else moves relative to you, even buoys and land. In **true motion** your boat moves across a fixed picture, and land stays still. Relative motion is what you want for collision avoidance: a target moving straight at the center is a collision course.

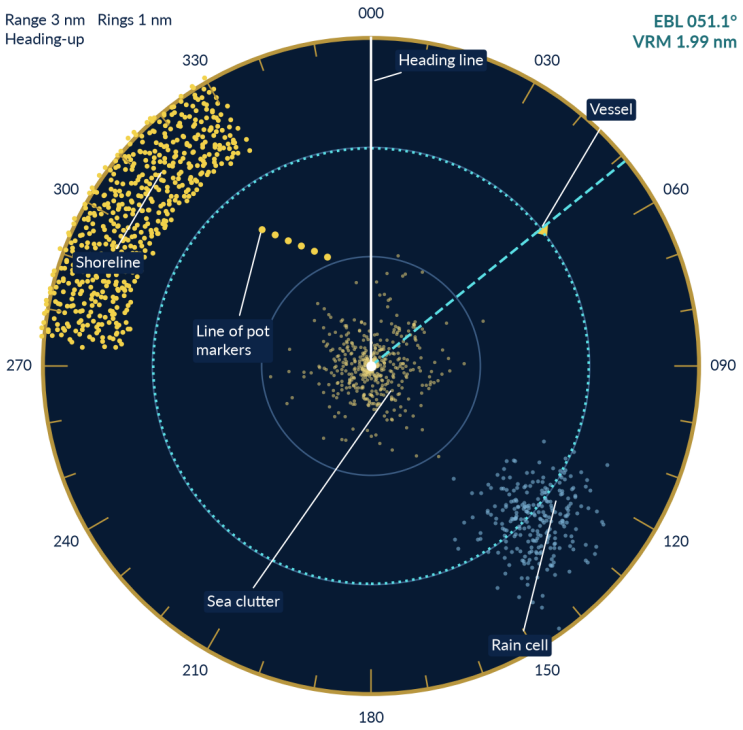
Start-up routine before leaving the dock or in clear weather:

01	Power on and transmit (allow warm-up on a magnetron set). Choose a 1.5 or 3 nm range.
02	Set gain, sea and rain clutter as above. Start in Auto Harbor or Coastal mode, then trim by hand.
03	Check the **heading line**: aim the bow at a buoy or point you can see and confirm the echo sits on the line.
04	Check **range**: put the VRM on a charted object you can identify and compare with the chart or plotter distance.
05	Check **overlay**: echoes of jetties, bridges and buoys should sit on top of their charted symbols.
06	Match settings at every station (flybridge and lower helm) so everyone is reading the same picture.

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EBL and VRM: Measuring Bearing and Range

The **EBL** (electronic bearing line) is a line from the center that you swing onto a target to read its bearing. The **VRM** (variable range marker) is a circle you expand until it touches the near edge of the echo to read its range. Together they put an exact bearing and distance on any echo.



A radar picture, head-up on the 3-nm scale with 1-nm rings. The EBL is on a vessel at 051° and the VRM reads 1.99 nm. Note the line of pot markers, the sea clutter at the center and a rain cell to the southeast.

THE SINGLE MOST USEFUL RADAR HABIT

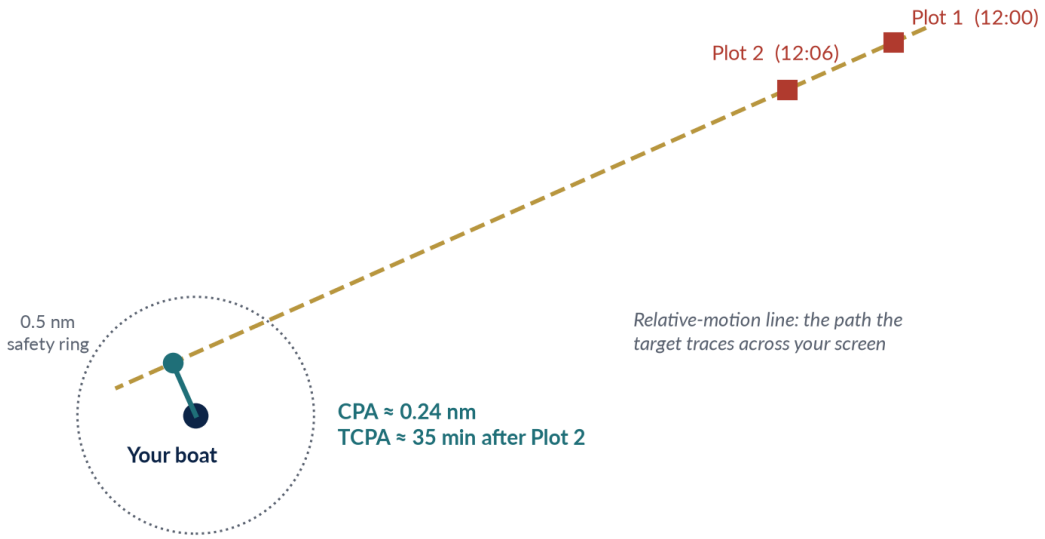
Put the EBL and VRM on an approaching vessel and watch for a few minutes. If the echo slides **along the EBL** toward you and the bearing does not change while the range closes, you are on a collision course. The Rules say exactly this: risk of collision exists if the bearing of an approaching vessel does not appreciably change[9]. If the echo walks off the line, it will pass ahead or astern. Big ships and tows can still be a risk at close range even when the bearing moves.

Watch the reference. In head-up the EBL reads a **relative** bearing (from your bow), so it changes every time you alter course; set it to **true** (with a heading sensor) to get a bearing you can lay on the chart.

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CPA, TCPA and MARPA

CPA (closest point of approach) is how near another vessel will pass if neither of you changes course or speed. **TCPA** is the time until that happens. You can work them out by hand: mark the target at one time, mark it again a few minutes later, draw a line through the two marks and extend it past the center. The closest that line comes to your boat is the CPA, and the speed along the line gives the TCPA.



1 grid unit = 0.5 nm. Here the target will pass inside the safety ring: act early and make it obvious.

A manual radar plot. The target was marked at 12:00 and 12:06; the extended line passes 0.24 nm from your boat in about 35 minutes. That is inside a 0.5-nm safety ring, so act early and make it obvious.

MARPA (mini automatic radar plotting aid) does the same work on a recreational radar. You select a target and, after about a minute of tracking, the radar shows its course, speed, CPA and TCPA and can alarm when CPA falls below a set limit. Recreational sets typically track around 10 targets, and MARPA needs a heading sensor[8]. **ARPA** is the type-approved version fitted on ships, which can acquire and track targets automatically to international performance standards[3].

- MARPA is only as good as its heading input. A poorly calibrated compass gives wrong target courses.
- After you or the target alters course, give it a minute or two to settle before trusting the new numbers.
- Targets can be swapped or lost when two echoes pass close together, or in heavy clutter.
- Do not act on scanty radar information. Watch the trend, then make one large, early change of course or speed[9].

Radar Overlay on the Chartplotter

Overlay lays the radar picture on top of the electronic chart. When it is right, the echo of the breakwater sits on the charted breakwater and buoy echoes sit on buoy symbols, and anything that does not match is a boat, a new obstruction or a chart error. Overlay requires a heading sensor, and the radar's **bearing alignment** must be set at installation. If echoes sit consistently to one side of their charted objects, the alignment or heading sensor needs calibration; if they sit off by a fixed distance, check the GPS and the chart. Turn overlay off now and then and look at the raw radar picture: overlays can hide weak echoes under chart colors.

False Echoes and Blind Spots

What you see	Cause	How to recognize it
An arc or ring of echoes at the same range as a strong close target	Side lobes: weak energy leaking sideways from the antenna	Disappears when gain or sea clutter is reduced slightly
Several equally spaced echoes beyond a big close target	Multiple echoes: energy bouncing between you and a ship or bridge	Spacing equals the range of the real target; they move together
An echo on the bearing of your own mast or stack	Indirect echo reflected off your own structure	Same bearing as the obstruction; range matches a real target elsewhere
A dark wedge where nothing ever paints	Shadow (blind) sector behind a mast, arch or antenna	Fixed relative bearing; check by turning the boat
Nothing very close around the boat	Minimum range and sea clutter	Look out the window; radar does not replace the lookout
Dotted spirals or radial streaks	Interference from another radar	Changes every sweep; interference rejection removes it
Bridge echo hiding boats underneath	Strong target masking weak ones	Reduce range and gain; watch for echoes emerging

Large ships, bridges and breakwaters cause most false echoes. Bowditch's chapter on radar navigation covers these effects in more detail[1].

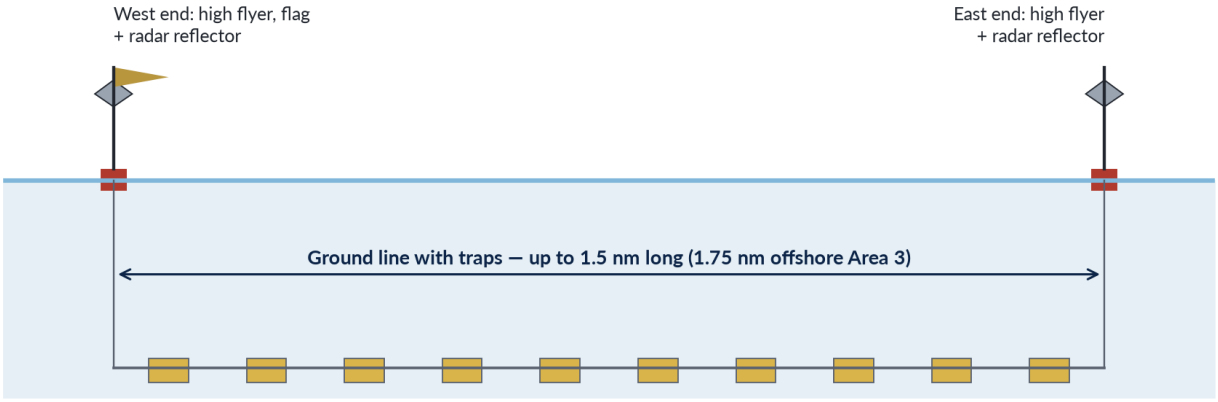
Weather, Rain and Squalls

Rain, hail and snow reflect radar. A squall line or thunderstorm shows as a broad, soft-edged smear, often with a sharp leading edge, that grows and moves across the screen. That makes radar a good short-range weather tool: watch the cell's track and speed, and you can often slip behind it or wait it out. The catch is that heavy rain hides everything inside it, including boats and buoys, and it weakens echoes from targets beyond it. Use rain clutter (FTC) to see into the cell, switch to a shorter range and slow down. X-band is affected more by rain than S-band, so expect the picture to shrink in a downpour[1].

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Small Targets: Pot Buoys, Kayaks and Debris

In calm water a good radar on a short range will often show lobster, crab and fish-pot buoys, especially the taller high-flyers with metal reflectors that mark the ends of a trawl. Plain foam and plastic buoys return little energy and vanish in even a small chop or under sea clutter. Federal rules for American lobster in offshore waters require a radar reflector and a flag on the west end of each trawl and a radar reflector on the east end, with trawls up to 1.5 nm long (1.75 nm in Area 3); state rules differ[10].



A lobster trawl: many traps on one ground line, with high-flyers and radar reflectors at each end. Between the ends there can be a mile or more of line on the bottom.

CAPTAIN'S RULE FOR POT FIELDS

If you see one, look for more. Pots are set in strings, so buoys usually run in a line. When one buoy or a short row of faint echoes shows up, look for the next one along the same line, by eye and on the radar, and pass around the end of the string rather than between two close buoys. Run the radar on a short range with the shortest pulse, ease the sea clutter, and post a lookout. At night or in fog in pot country, slow down: a wrap costs a prop, a shaft seal or a tow.



*Lobster buoys in Kennebunkport, Maine. Foam and plastic floats like these are weak radar targets. *4*



*Traps, line and buoys ready to set. Each string can carry many traps between its end buoys. *5*

The same applies to anything small and low: kayaks, paddleboards, swimmers, fiberglass skiffs and floating logs may not paint at all. Radar is an aid to the lookout, never a replacement for one.



*An octahedral radar reflector hoisted in a sailboat's rigging. Mount it as high as possible, in the "catch-rain" position. *6*



*Steel channel buoys carry built-in radar reflectors and paint far better than a fiberglass hull. *7*

Help others see you. Most small craft are weak targets. A properly sized reflector or an active radar target enhancer, mounted high, makes your boat much easier to detect on other vessels' radar[4].

Navigating in Fog and Restricted Visibility

The Navigation Rules define restricted visibility as any condition, such as fog, mist, falling snow, heavy rain or sandstorms, that reduces visibility[9]. Rule 19 applies to vessels **not in sight of one another** in or near an area of restricted visibility. There is no stand-on or give-way vessel under Rule 19: each vessel must judge the situation and act for itself. Once you are in sight of the other vessel, the ordinary steering and sailing rules (Rules 11–18) apply again.

Rule	What it requires (paraphrased)
Rule 5 — Lookout	Keep a proper lookout by sight, hearing and all available means
Rule 6 — Safe speed	Proceed at a speed that lets you avoid collision and stop in time. Radar vessels must also weigh the radar's limits, the range scale in use, sea and weather effects, and the chance that small vessels and floating objects are not detected
Rule 7 — Risk of collision	Use radar properly, including long-range scanning and plotting; no assumptions from scanty information; a steady bearing means risk
Rule 19(b)	Proceed at a safe speed for the conditions; a power-driven vessel keeps her engines ready for immediate maneuver
Rule 19(d) — Radar-only contact	Determine whether a close-quarters situation is developing or risk of collision exists. If so, take avoiding action in ample time. If that action is a course change, so far as possible avoid (i) turning to port for a vessel forward of the beam, other than one being overtaken, and (ii) turning toward a vessel abeam or abaft the beam
Rule 19(e) — Fog signal or close quarters ahead	Unless it has been determined that no risk of collision exists: if you hear a fog signal apparently forward of the beam, or cannot avoid a close-quarters situation with a vessel forward of the beam, reduce to the minimum speed at which you can hold course, take all way off if necessary, and navigate with extreme caution until the danger is over

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Rule 35 — Sound signals in or near restricted visibility, by day or night (a prolonged blast is 4–6 seconds; a short blast about 1 second):

Vessel	Signal	Interval
Power-driven, making way through the water	One prolonged blast	Not more than 2 min
Power-driven, underway but stopped (no way on)	Two prolonged blasts about 2 s apart	Not more than 2 min
Sailing; fishing; towing or pushing; not under command; restricted in ability to maneuver (and constrained by draft, International)	One prolonged, two short	Not more than 2 min
Vessel towed (last vessel of tow, if manned)	One prolonged, three short, right after the towing vessel's signal when practicable	Not more than 2 min
At anchor	Rapid ringing of the bell for about 5 s (gong aft as well if 100 m or more); may add one short, one prolonged, one short	Not more than 1 min
Aground	Anchor bell signal plus three separate strokes on the bell before and after it; may add a suitable whistle signal	Not more than 1 min
12 m to under 20 m	Not obliged to give the bell signals, but must give some other efficient sound signal	Not more than 2 min
Under 12 m (about 39 ft)	Not obliged to give the signals above, but must give some other efficient sound signal	Not more than 2 min

Source: U.S. Coast Guard Navigation Rules, International and Inland[9]. International and Inland versions differ in a few details. Read the Rules themselves; these tables are summaries.



*Fog over a harbor and jetties. In conditions like this the radar picture, the plot and the sound signals have to work together. *8*

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Fog routine aboard:

01	Slow to a safe speed before you lose sight of land or other boats, not after.
02	Start the Rule 35 signal for your situation, turn on navigation lights, have engines ready for immediate maneuver, and post a lookout who does nothing else.
03	Run the radar on a short range (1.5–3 nm) for close targets, and step out to 6 or 12 nm every few minutes to see what is coming.
04	Acquire every approaching target with MARPA or EBL/VRM and watch CPA and TCPA.
05	If radar shows a close-quarters situation developing, act in ample time. If you alter course, avoid turning to port for a vessel forward of the beam (unless overtaking it) and avoid turning toward a vessel abeam or abaft the beam; make the change large enough to show on the other vessel's radar. Slowing or stopping is often the better choice.
06	If you hear a fog signal apparently forward of the beam, slow to the minimum speed that holds your course, stop if necessary, and proceed with extreme caution until the danger is over.
07	Cross-check AIS against radar: the target without AIS is the one most likely to surprise you.
08	Log times, positions and what you did. If in doubt, stop and let the picture develop.

Radar, AIS, Racons and SARTs

AIS shows a vessel's name, course and speed from its own GPS, often before it appears on radar and even behind an island. But it only shows vessels that carry and transmit AIS, small-craft Class B units update less often, and the data can be wrong or switched off. Radar shows anything that reflects, whether or not it transmits. Use both and trust neither alone.

A **racon** is a radar beacon on a buoy, light or bridge that answers your radar with a Morse-code character, starting with a dash, painted just beyond the echo of the structure and often a mile or more long. Buoy racons are commonly keyed on and off in 20-second cycles[11]. Racons are for identification only and have no lateral significance; they are also used to mark bridge spans[12]. A **SART** (search and rescue radar transponder) carried in life rafts shows as a line of dots radiating outward on an X-band radar; the dot nearest you marks the survivor craft[13].

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Radar Systems at a Glance

Type	Strengths	Limitations
18–24 in dome (X-band)	Small, light, low power; safe on sailboats and under hardtops	Wider beam; targets merge at range
3.5–6 ft open array (X-band)	Narrow beam, sharp coastline, better small-target and long-range picture	Size, weight, power and windage; needs clear mounting
Solid-state / pulse compression	Instant-on, Doppler coloring, strong close-in detail	Processing can make a picture look cleaner than reality
Broadband / FMCW	Very fine close range, very low power	Weaker long range and in heavy rain
S-band (ships)	Sees through rain and sea clutter	Large antenna; ship installations only
AIS	Identity, course and speed of equipped vessels	Not everyone transmits; data can be wrong
Thermal / night camera	Sees people, kayaks and pot buoys at night at short range	Short range; fog and heavy rain cut it sharply



*A dedicated radar display showing a coastline. Bright, solid echoes are land; learn what your own coast looks like on a clear day. *9*



*The bridge of a bulk carrier with ARPA displays. Ships plot you automatically; make your intentions obvious. *10*

RADAR SAFETY

Do not stand or sit at antenna height close to an open array while it is transmitting, and keep heads away from a transmitting dome on a low hardtop. Follow the manufacturer's safe-distance figure in the installation manual[5], put the radar in standby when people are working on the hardtop or arch, and stay clear of a spinning open array.

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Terms and Acronyms

Term	Meaning	Term	Meaning
AIS	Automatic Identification System; vessels broadcast identity, position, course and speed.	**MARPA**	Mini ARPA; manual target tracking on recreational radars.
ARPA	Automatic Radar Plotting Aid; ship-grade automatic target tracking.	**PPI**	Plan position indicator; the round radar picture.
Bearing discrimination	Ability to separate two targets at the same range; set by beamwidth.	**Pulse compression**	Solid-state technique that turns a long, low-power pulse into fine detail.
Blind / shadow sector	Area hidden from the radar by masts, arches or other structure.	**Racon**	Radar beacon that answers with a Morse character.
CPA / TCPA	Closest point of approach; time to closest point of approach.	**Radar horizon**	Farthest line-of-sight distance for radar; about 1.22 × √(height in ft) nm.
Doppler coloring	Colors echoes by whether they approach or recede (solid-state radars).	**Range discrimination**	Ability to separate two targets on the same bearing; set by pulse length.
EBL	Electronic bearing line; measures bearing to a target.	**Relative / true motion**	Own boat fixed at center, or own boat moving over a fixed picture.
FTC (rain clutter)	Fast time constant; reduces broad echoes from rain.	**RTE**	Radar target enhancer; active device that strengthens your boat's echo.
Gain	Receiver sensitivity.	**SART**	Search and rescue radar transponder; shows as a line of dots.
Guard zone	An area that alarms when a target enters it.	**STC (sea clutter)**	Sensitivity time control; reduces wave echoes near the boat.
Heading line (SHM)	Line showing the bow direction on the display.	**Trails**	Afterglow showing where echoes have moved.
Head-up / North-up / Course-up	Display orientations: bow, north or planned course at the top.	**VRM**	Variable range marker; measures range to a target.
IR	Interference rejection; removes other radars' interference.	**X-band / S-band**	Radar frequency bands near 9.4 GHz (3 cm) and 3 GHz (10 cm).
Magnetron	Tube that generates the pulse in conventional radars.		

CAPTAIN'S NOTE

Turn the radar on at the dock and check it against things you can see: the heading line on a piling, the VRM on a charted marker, the overlay on the breakwater. Tune it again once outside. In fog, slow down early, plot everything that moves and make your intentions obvious. The radar does not keep a lookout; it gives the lookout a second set of eyes.

*General guidance only. Always follow vessel manuals, current regulations and the judgment of the vessel's master. * See photo & reference credits.*

Further Reading & Official Sources

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