
U.S. Department of
Homeland Security
**United States
Coast Guard
Auxiliary**



**RADAR Familiarization
Guide**

National Response Directorate



Disclaimer

- This guide is not a substitute for applicable policy.
- The best practices presented in this guide should augment and support the safe completion of our surface operations responsibilities.
- Applicable instructions and/or local regulations from your OIA and chain of leadership must always be followed.





Audience

- This program is designed for all crew regardless of experience as a starter course or a review.
- It is a general overview of how radar works and how to interpret the radar display when standing watch.
- This is not a substitute for formal radar observer training.





Why?

- NAVRULE 7 states “*Proper use shall be made of radar equipment if fitted and operational.*”
- That means if you have it you must use it (even on clear days).
- NAVRULE 5 expects prudent mariners to avail themselves “*of all available means appropriate...as to make full appraisal of the situation*”.





RADAR

- Radar stands for Radio Detection and Ranging.
- The basic idea behind radar is very simple:
 - A signal is transmitted
 - It bounces off of an object
 - The reflected signal is picked up by a receiver
 - The result is displayed on a visual screen





Radar

- The radar we use on boats is used to determine three things;
 - Range (from pulse delay)
 - Velocity (from Doppler frequency shift)
 - Angular direction (from antenna pointing)
- And has two uses;
 - Position fixing or confirmation (piloting)
 - Collision avoidance



How Radar Works

- Radar is simply a radio. It sends out a pulse, bounces it off of something and measures the time it takes to make the round trip. The shorter the time the closer the target.
- Radar uses two things, echo and Doppler shift. You hear these every day.

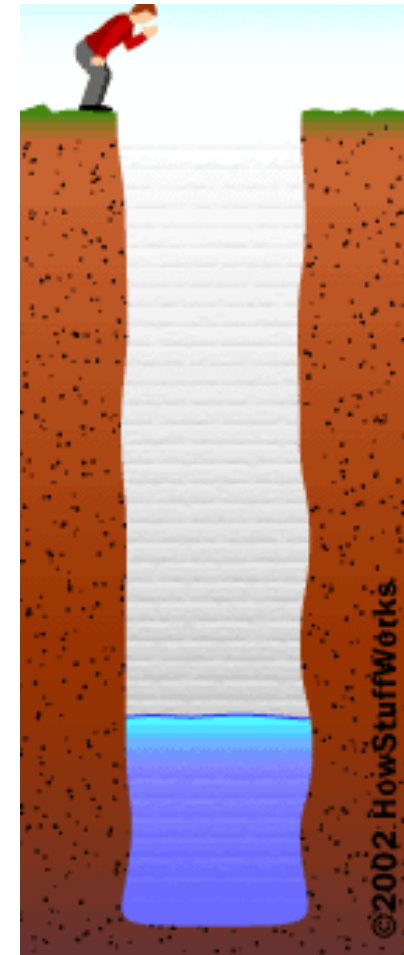


Echo

If you shout into a well or a canyon, the echo comes back a moment later.

The echo occurs because some of the sound waves reflect off the surface and travel back to your ears.

The length of time between the moment you shout and the moment you hear the return is determined by the distance between you and the surface.





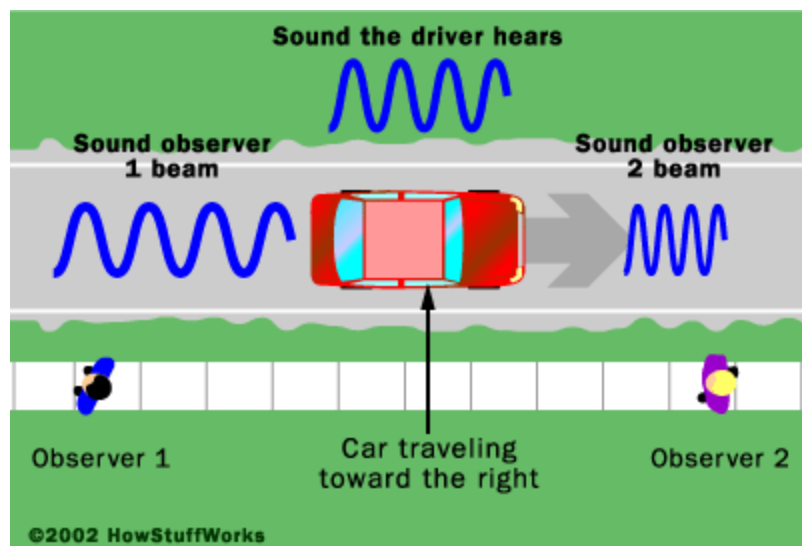
Pulse Repetition Rate

- For accurate range determination a pulse must be transmitted and reflected before the next pulse is transmitted.
- Slower pulse rates allow the radar to accurately measure a longer distance.
- Two primary marine radar bands
 - S-Band = smaller antenna, shorter range.
 - X-Band = maximum range, good accuracy.





Doppler Shift



Doppler shift occurs when sound is reflected off of a moving object.

Imagine a car moving at 60 mph and blowing its horn. You will hear the horn playing one “note” as the car approaches, but when the car passes you the sound will suddenly shift to a lower note.

The horn is making the same sound the whole time. The change you hear is caused by Doppler Shift.





Add It Up



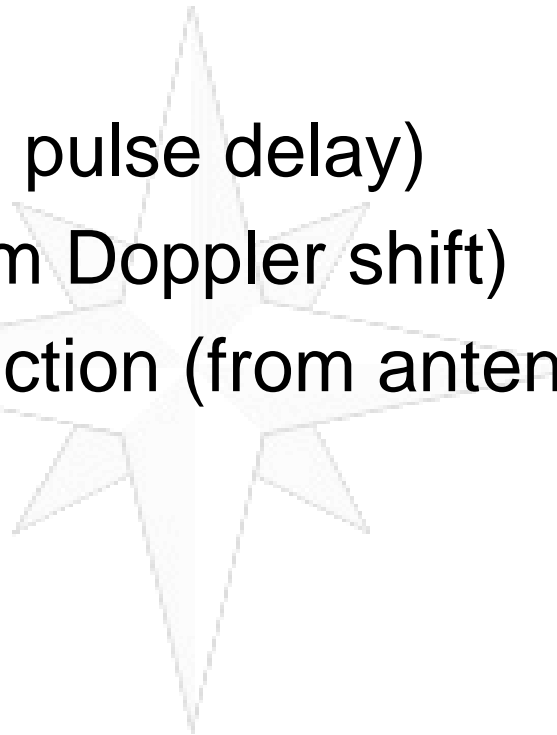
If you combine the echo return with the Doppler shift you can determine the speed of the car.





Putting it all Together

- So radar combines three elements to paint your picture
 - Range (from pulse delay)
 - Velocity (from Doppler shift)
 - Angular Direction (from antenna pointing)





Warning

- The radar signal needs something solid to bounce off of.
- Fiberglass, plastic or rubber hulls do not reflect well.
- Sailboats often fly radar reflectors because of this.
- That 60' fiberglass yacht may not show up at all!





Interpretation

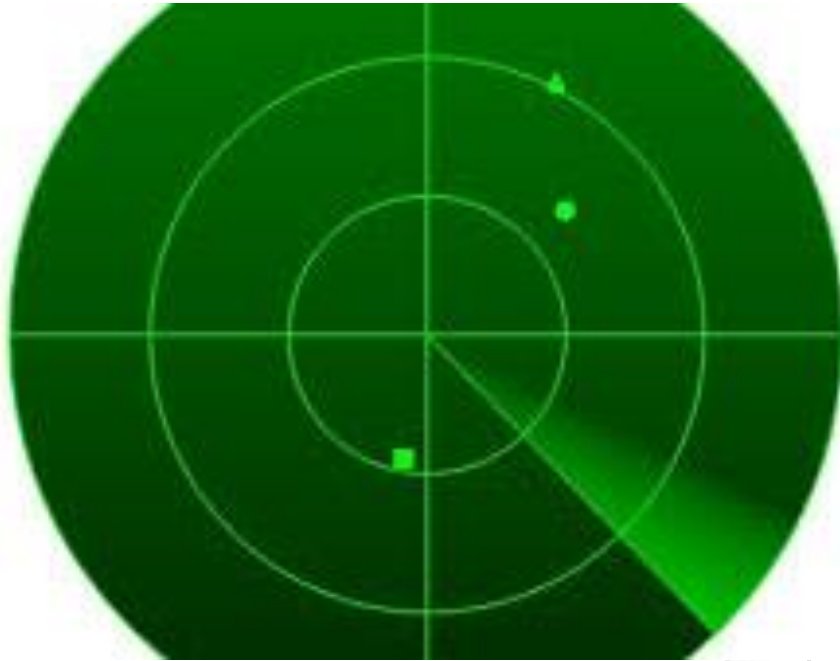
The radar picture is a plain picture of the ships surroundings.

Training and repetition will lead you to interpret the radar picture quickly and accurately as well as to identify different targets.





Radar Display



This shows the display basics

- Bearing Lines

- Range Rings

- Radar Trace

- the line moving around the screen

- Targets





Target Factors

- Important radar Range Parameters
 - Antenna Height
 - Height of the Target
 - Size of the Target
 - Target Reflecting Area
 - Materials of the Target
 - Shape of the Target
 - Weather Conditions





Blind Sectors

- If the antenna is not placed at the vessels highest point structures will create blind sectors in the radar screen.
- These are easy to plot with during a period of high sea clutter. The blind sectors will be seen as distinctly dark sectors in the clutter.
- Plot these on a plotting sheet and keep near the radar.



Accuracy

- Coastal Navigation requires experience and vigilance all the time.
- The range accuracy of radar is generally better than the bearing accuracy.
- When bearings have to be taken choose isolated targets of relative small size. The smaller they are the more precise the location, giving you a better plot.





Heading Marker Errors

- When the heading marker on the screen does not exactly line up with the ships heading.
- When the echo from a target dead ahead does not lie exactly on the heading line we have a heading marker error.
- These may have serious effects on the radar picture and have been the cause of many collisions.





Heading Marker Errors

- Most modern radar units have the ability to correct for heading errors.
- The owner determines the error and enters that into the settings. The radar then corrects the display.



Pilotage

- Radar is a great tool for navigation in narrow waters.
- Knowledge and experience are essential in order to distinguish clearly between stationary and moving objects.





Clutter

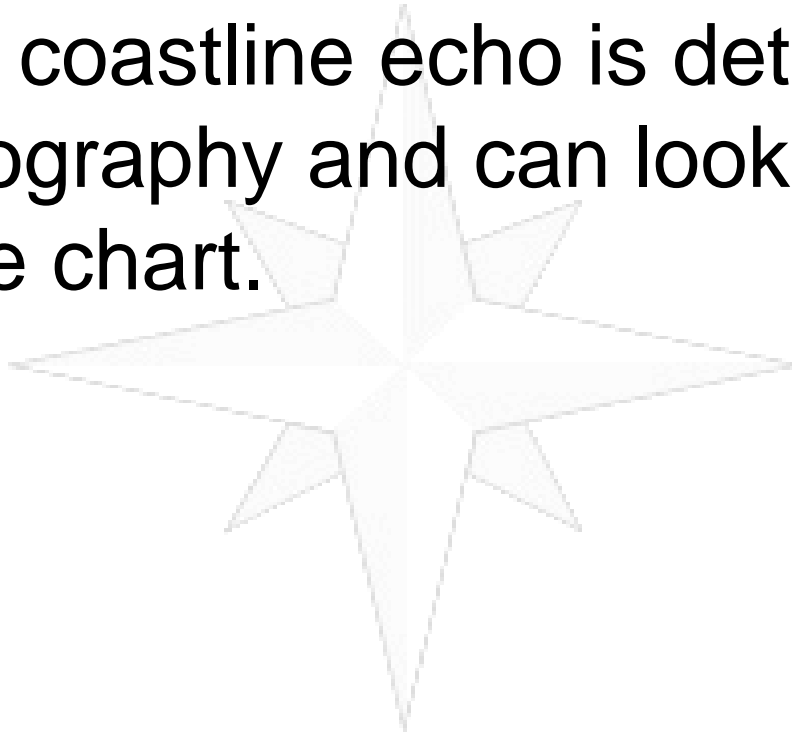
- Rain and waves can reflect radar waves
- Radar units have “sea” and “rain” clutter settings that will reduce this...
 - But it also can reduce your ability to see a target
 - Only use as much as you need and no more





RADAR Shadow

- Radar waves travel in a straight line.
- A radar coastline echo is determined by the topography and can look very different from the chart.





Rain Squalls and Showers

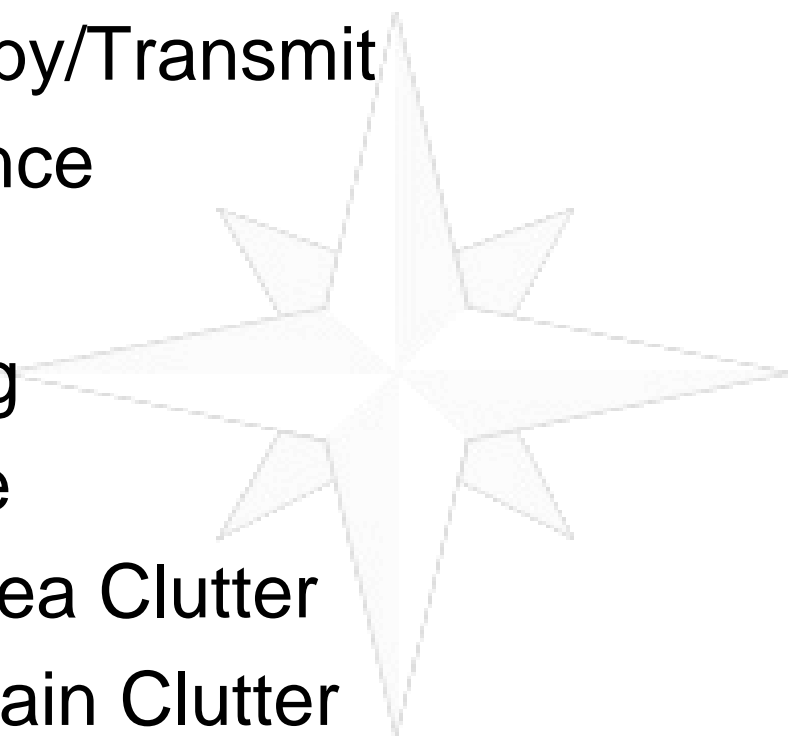
- Rain squalls and showers appear on the screen as a wooly mass.
- An intense rainstorm can be detected up to 25 miles away.
- Thunderstorms give excellent echoes.
- Rain, clutter and targets beyond the rain area will obscure echoes inside the rainstorm.





RADAR Controls

- Seven main controls for all radar units
 - Standby/Transmit
 - Brilliance
 - Gain
 - Tuning
 - Range
 - Anti-Sea Clutter
 - Anti-Rain Clutter





Standby/Transmit

- This is the “on-off” switch.
- Turning the switch to “standby” powers up the radar, but does not transmit a signal.
- “Transmit” will give you the picture.
- Use “standby” when you don’t want to “zap” people nearby.



Brilliance

- On analog radar (the picture tube kind) you can adjust the brilliance so the trace is just visible giving good contrast between echo and background.
- On raster displays (LCD's that show a chart) it regulates the brightness of the picture for day or night use.



Gain

- Gain may appear to have a similar function as the brilliance control, but it is important not to confuse the two.
- Gain affects the receiver and not the display.
- Turning up the gain will make weak echoes look stronger.



Tuning

- Tuning can be compared to an ordinary radio.
- It tunes the receiver to the frequency of the transmitter.
- It is important to frequently fine tune the set.
- Many new radars do this automatically.



Range

- Range controls the distance the display shows (not how far the signal goes).
- You change the range the same way you change charts for scale.
- The range rings change scale also and are used for measuring distance. It is important to always know what scale you are set on.



Range Rings

- Variable range rings are a great tool to measure distances quickly.
- Learn how to control those on your radar unit.
- They make it very easy to triangulate a position on a paper chart.



Sea Clutter Control

- The beam bounces off the sea around the ship creating a starburst pattern, more pronounced upwind.
- The Sea Clutter control reduces the receiver gain for a few microseconds after each pulse and gradually restores it to its former level.
- It works well, but you can lose close targets as well.





Rain Clutter Control

- The Rain Clutter control will reduce the interference on the screen due to the rain and increase the chance of seeing targets within rain showers.
- In a tropical downpour the rain can block out all echoes, at times requiring the operator to stop the vessel.





Plotting

- The Plotting Process
 - Detection – recognition of the presence of the target.
 - Selection – choosing of target requiring closer observation.
 - Tracking – the process of observing changes in target position.
 - Plotting – the whole process of detection, selection, tracking and calculations of the targets parameters.





Mark 1, Mod 0

- Remember that **nothing** ever takes the place of good old fashioned seamanship.
- A corrected chart, a straight edge and a pencil are always the primary navigation system.
- All electronic aids are adjuncts for the Navigator, not replacements.



Pointers

- If a target moves down the screen at your speed then it is a buoy or something else anchored or dead in the water.
- If a blip does not move at all (on the screen) it is moving the same course and speed you are.
- If a target is at the same bearing (angle) but getting closer you are on a collision course!





Radar Head

- Radar units can be set for Course Up or North Up on screen.
- “Course Up” means the direction your bow is pointing is always the top of the screen. This makes it intuitive to see a target on the screen and find it out the window.
- “North Up” means the top of the screen is always north. Most professional navigators use north up.





Other Information

- Modern radar units can do plotting for you and give you a lot of information.
- CPA – closest point of approach (to target).
- TCPA – time to closest point of approach.
- Targets heading, speed and rate of turn.





Communicate!

- Importance of VHF communication
 - Always make ones intentions clear to the other vessel.
 - To arrive at a decision about avoiding tactics.
 - Use of VHF is not explicitly advocated in the NAVRLES, but implicitly (“by all available means”) its use is recommended.





AIS

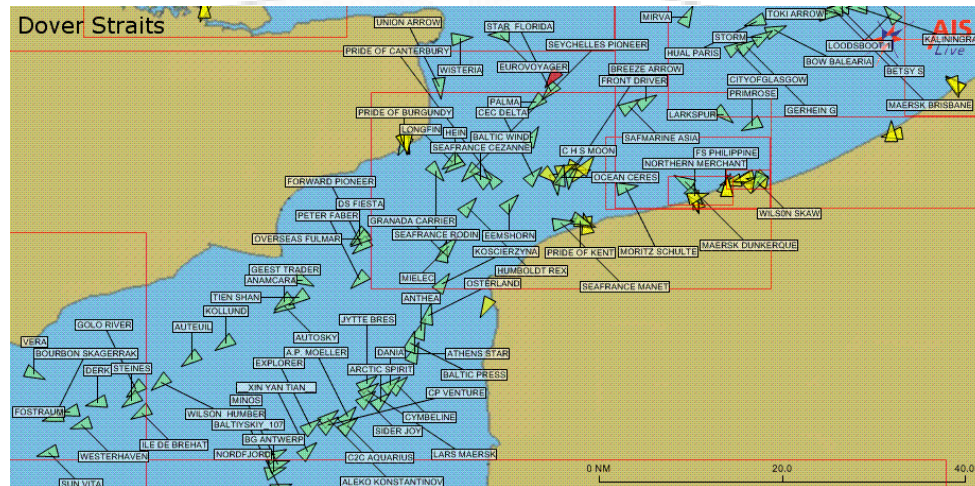
- Automatic Identification System.
- Tracking system used by ships, VTS, and others for identifying and locating ships.
- Information supplements marine radar.
- AIS information is sent via VHF radio.
- Oceangoing ships of 300 GT or more and all passenger ships must have AIS.





AIS

- Gives quick picture of area with vessel names and headings.
- Other information (speed, course, vessel type, etc) available with a “click”.





AIS/RADAR

Split Screen

- Left is RADAR with “course up”
- Right is chart with “north up”
- Note the different looks
- They are saying the same thing at the same time





AIS/RADAR

Note: AIS will not interface with older radar units.



AIS overlaid on radar. Note information on the screen. The AIS info (in white) is displayed for the target with the box around it.





WARNING!

- Remember
 - Radar (and AIS) shows the distance between the antennas, not the ships!
 - A 900 foot ship with an aft house could have almost a football field of bow in front of where AIS says it is.
 - Nothing is ever as good as the Mark One Mod Zero (human eyeball).





Summary

- Every radar is different though similar.
- Learn to use the one installed on the facility you serve on.
- Many radars have “simulation mode”. Play with it and learn before you need it.
- If you ever have doubt or a question about what you see on the screen, immediately notify the coxswain.





References

- COMDTINST M3710.4 (series)
 - Coast Guard Helicopter Rescue Swimmer Manual
- COMDTINST M16114.33 (series)
 - Boat Operations And Training Manual
- COMDTINST M16114.5 (series)
 - Boat Crew Seamanship Manual
- COMDTINST M16790.1(series)
 - USCG Auxiliary Manual
- COMDTINST M16798.3 (series)
 - Auxiliary Operations Policy Manual





Thank You

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