



NAV 100

Part I

Basic Piloting Techniques

# Introduction

- Four sessions: 21, 22, 27 & 29 Jan 09
- This session:
  - Admin
  - Overview
  - Chart highlights
  - The Plotting Problem
  - Basic Plotting Techniques

# Admin

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# Introduction

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# Overview

- Session 1: The Chart & Basic Techniques
- Session 2: Technique Practice
- Session 3: Technique Integration with Nav Log & Bearing Book (Practical Problem at slow speed)

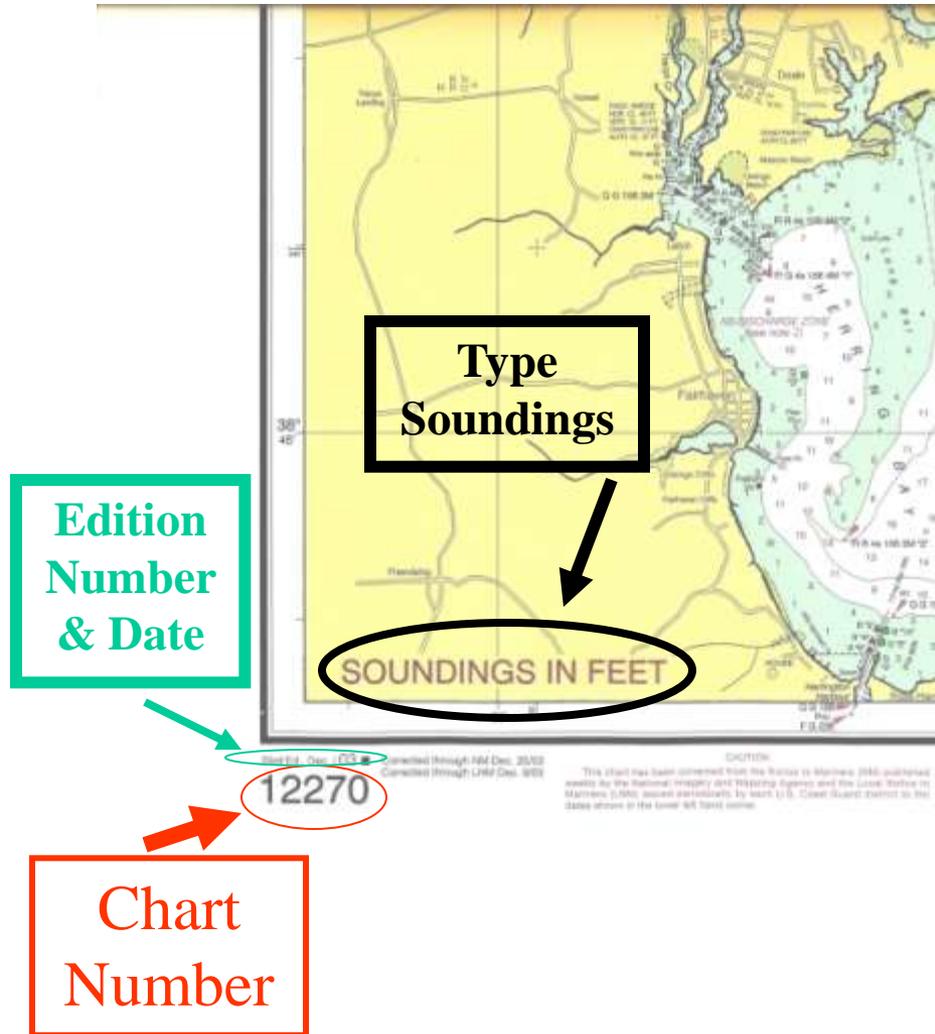
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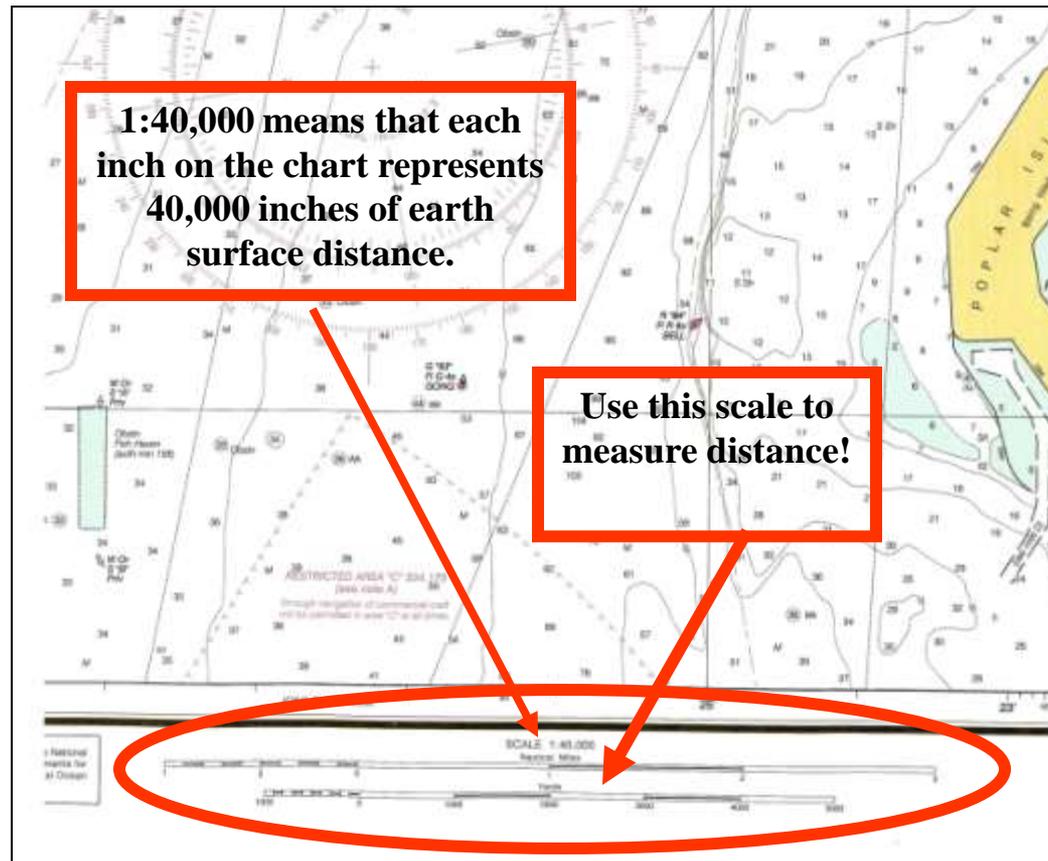
# Chart Highlights

- Number & Edition
- Chart Scale
- Datum
- Soundings Scale
- Lat/Lon Scale

# Chart Number, Edition & Soundings



# Distance Scale

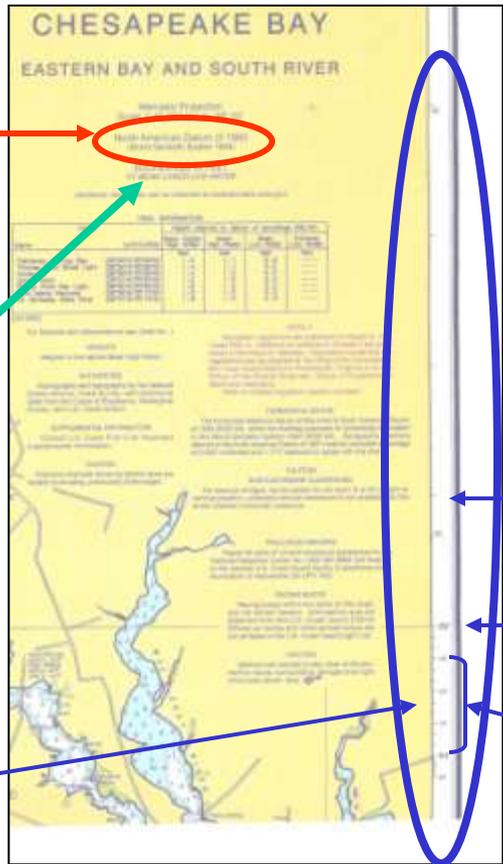


# Datum & Lat/Lon Scale

**Chart Datum:**  
**NAD83 =**  
**WGS84**  
**GPS must match**  
**chart!**

**Soundings**  
**measured**  
**from Mean**  
**Lower Low**  
**Water.**

**Lat/ Lon**  
**measured in**  
**degrees-minutes-**  
**seconds (d-m-s).**  
**Some charts are**  
**d-m.m.**



**38° 56' N**

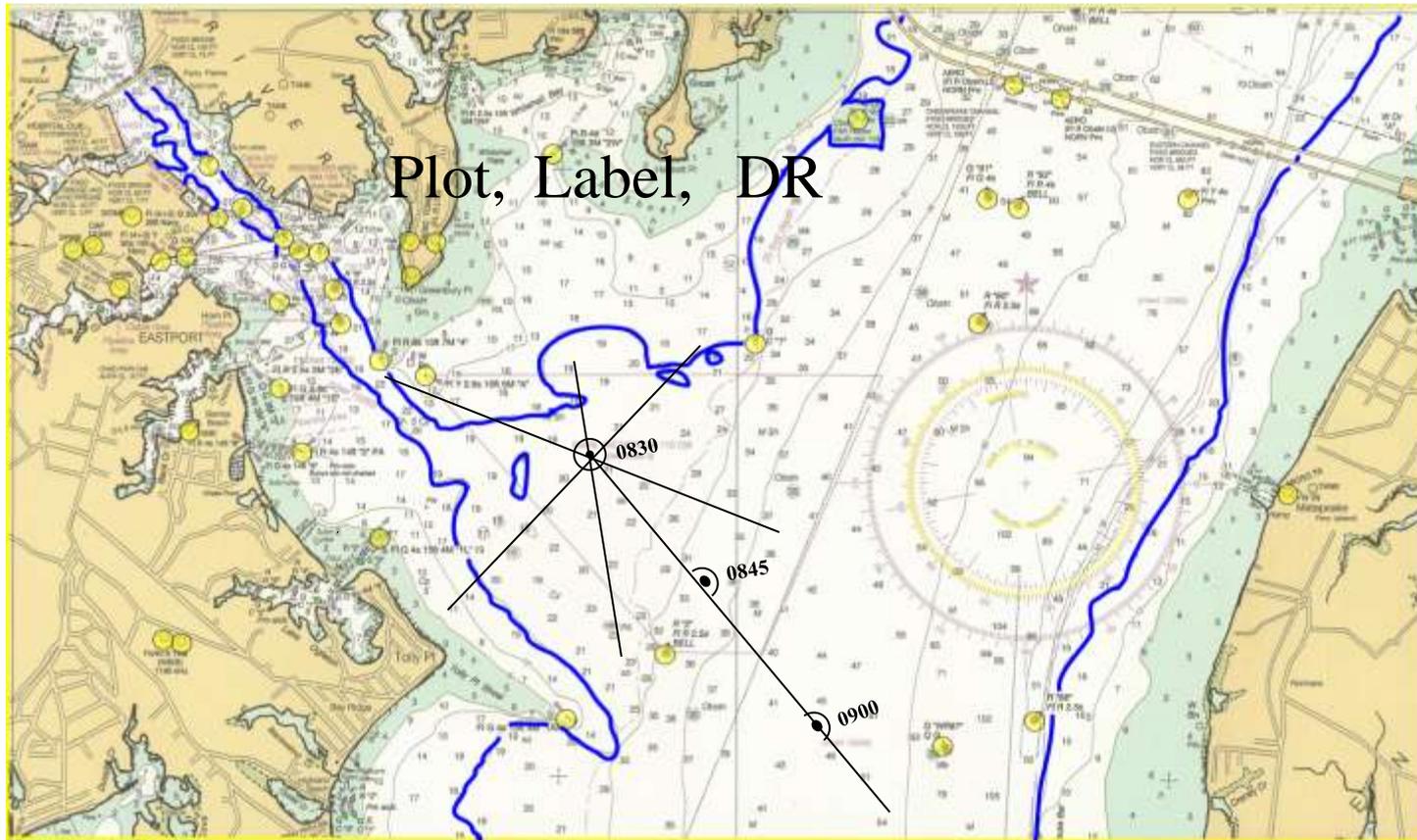
**38° 55' N**

**45'' (seconds)**  
**of Lat**

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# The Plotting Problem: Plot, Label, DR



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# Basic Plotting Techniques

- Lat & Lon from/ for location
- Measure a direction
- Draw a Line Of Position (LOP) given an origin and a bearing
- Measure and draw a distance
- Calculate distance, speed, or time given the other two
- Create a visual fix from 2, then 3 LOPs (w/ sounding)
- Create a Dead Reckoning (DR) plot
- Determine the latest time for the next fix
- Six rules of DR with examples



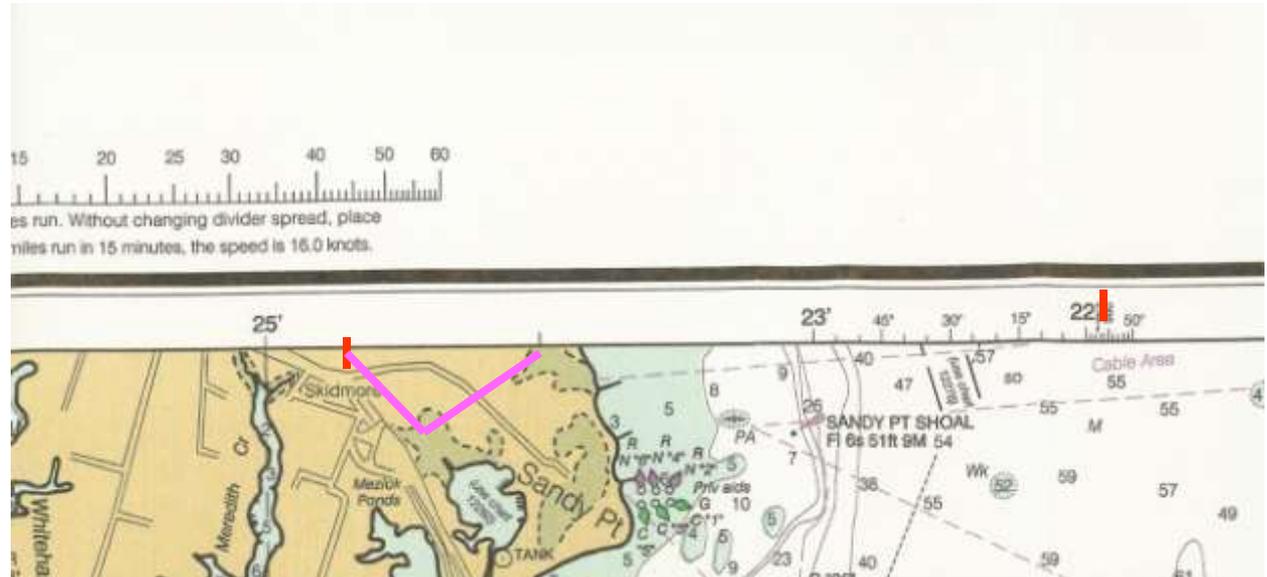
# Using the Lat & Lon Scale

-Tic mark tells you the degrees and minutes  
[076 degrees 24  
minutes.]

-With your dividers, measure from the whole minute tic to the position tic.

-Transfer the dividers to the seconds scale with the left point of the dividers on the appropriate 5-second tic [40 + ?].

-Read the additional seconds to add [+3 = 43 seconds].



076 degrees 24 minutes 43 seconds W

[076-24-43 W]

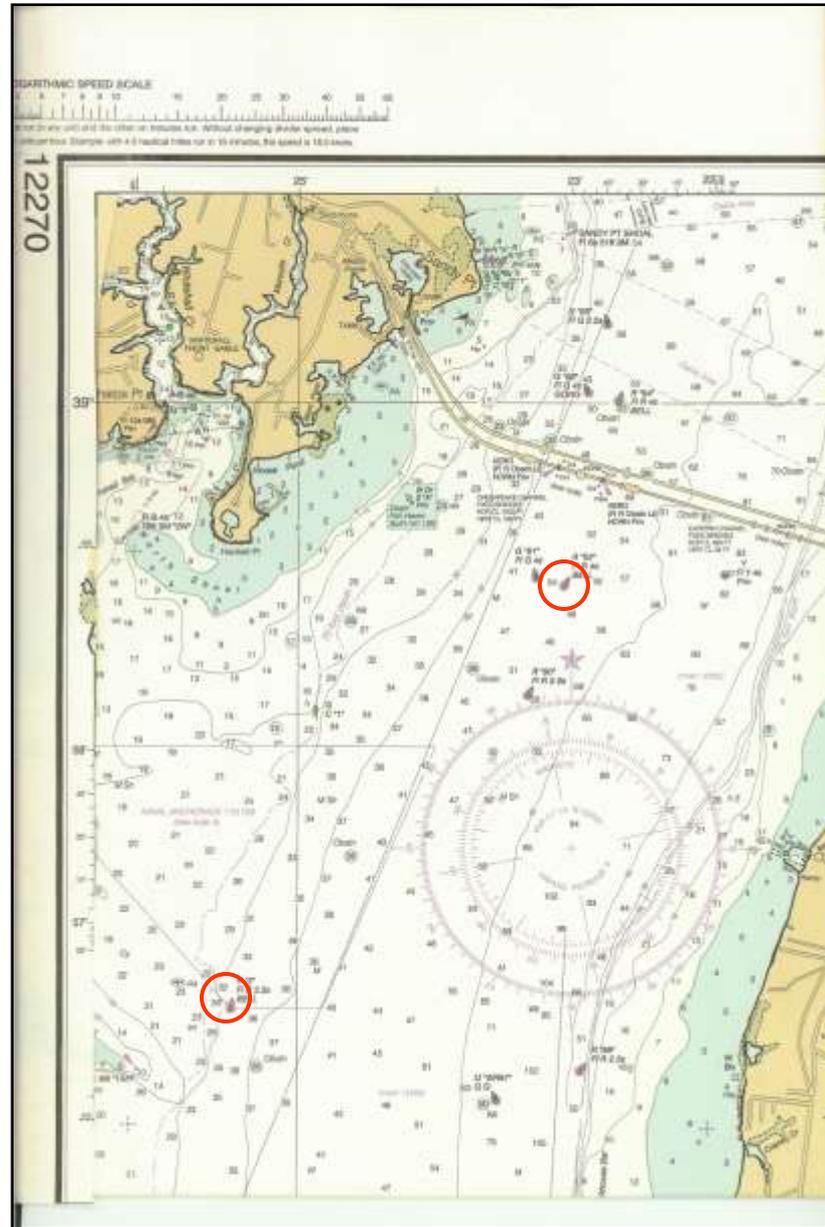
# Lat & Lon from location

- Find the Lat & Lon for buoy  
R”92.”

38-58-56 N/ 076-23-04 W

- Find the Lat & Lon for buoy  
R “2.”

38-56-30N/ 076-25-29W



# Lat & Lon from location

- Find the Lat & Lon for the  
Horn on the Bay Bridge

38-59-36 N/ 076-22-56 W

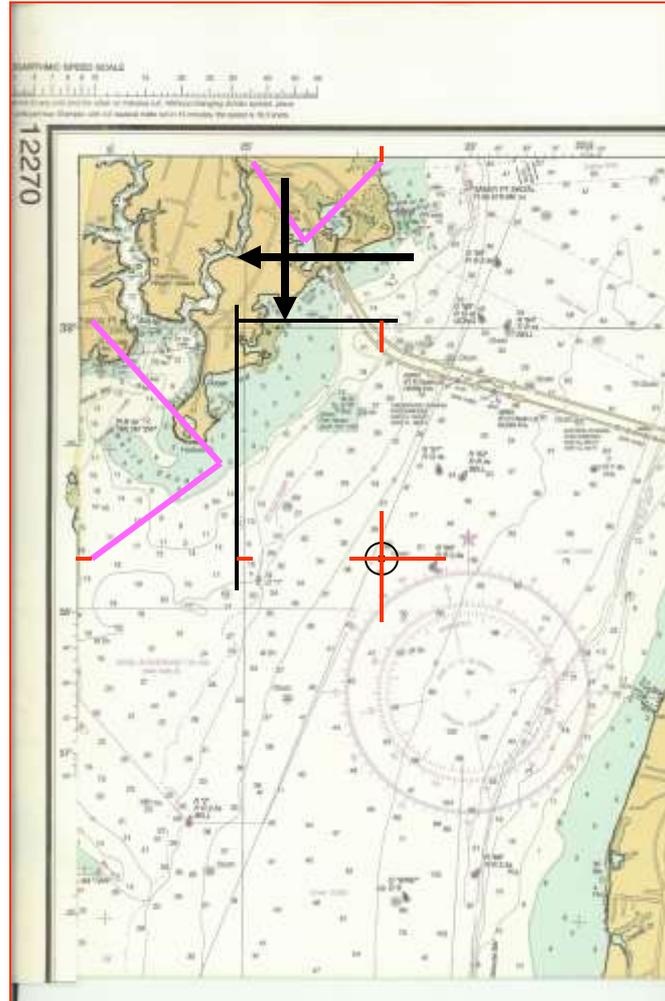
- Find the Lat & Lon for green  
can "1."

38-58-12N/ 076-24-52W



# Location from Lat & Lon

- Mark lat & lon position on edges of chart
- Find closest lat line on chart
- Measure length from position lat to lat line with dividers
- On closest lon line, transfer length from lat line and mark with tic
- Lay parallel or rolling rule on lat line and move parallel to tic
- Draw light line parallel to lat line
- Do similar for lon
- Intersection of light lines is location



# Location from Lat & Lon

What is the navaid at  
38-55-58 N / 076-23-33 W?

G “WR87”

What is the navaid at  
38-58-18 N / 076-23-19 W?

R “90”



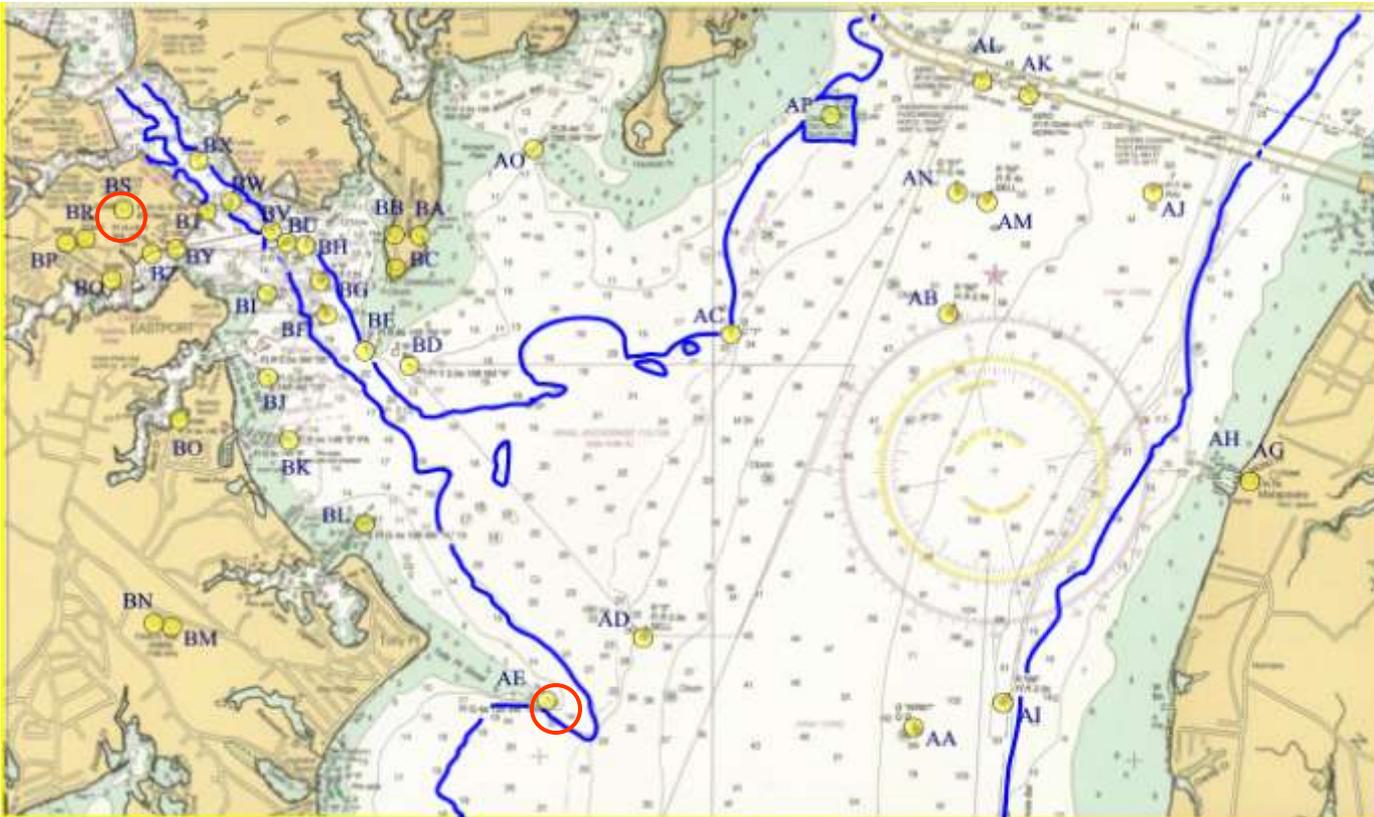
# Location from Lat & Lon

What is at 38-58-53 N /  
076-29-11 W?

- Chapel Dome

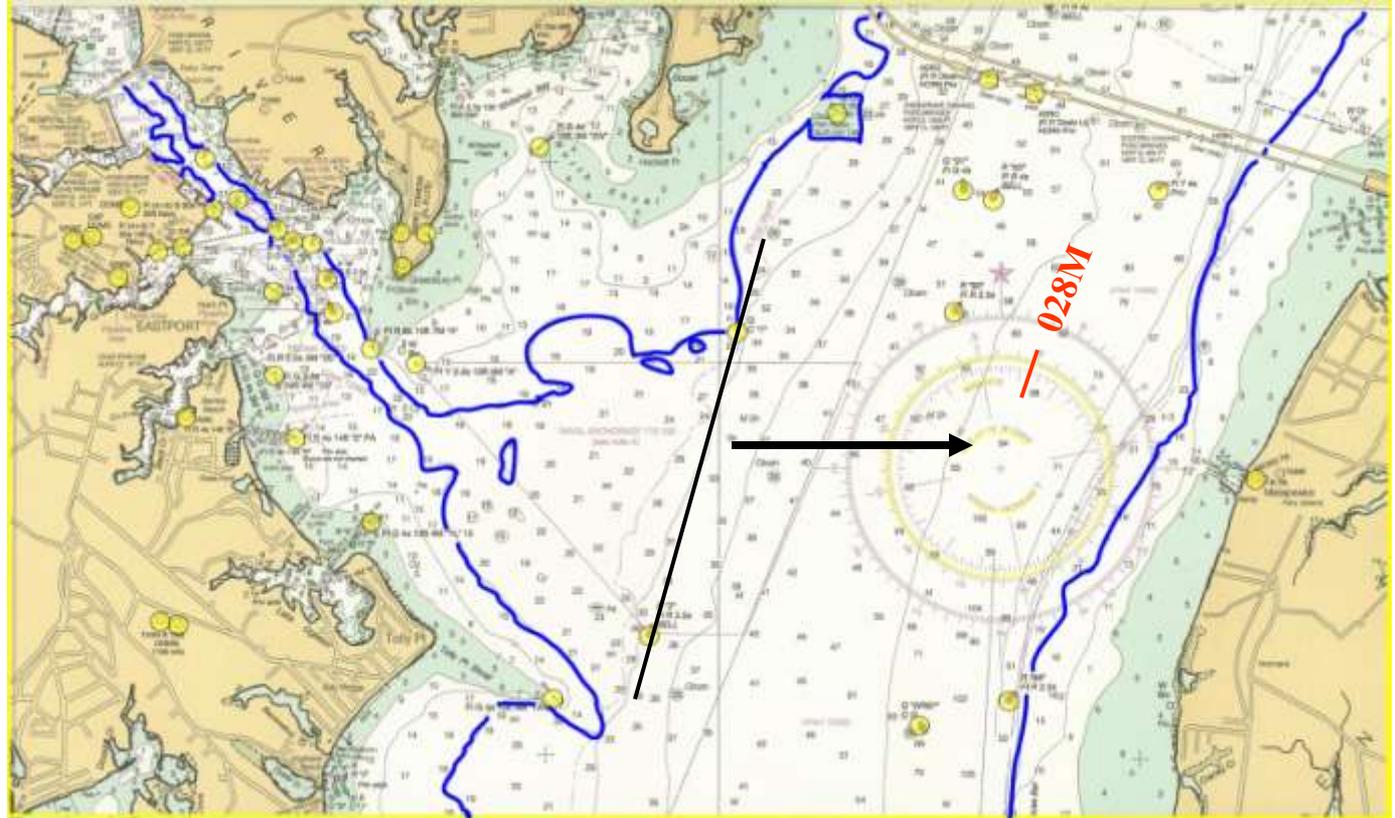
What is the navaid at 38-56-09 N/  
076-26-12 W?

- 1AH



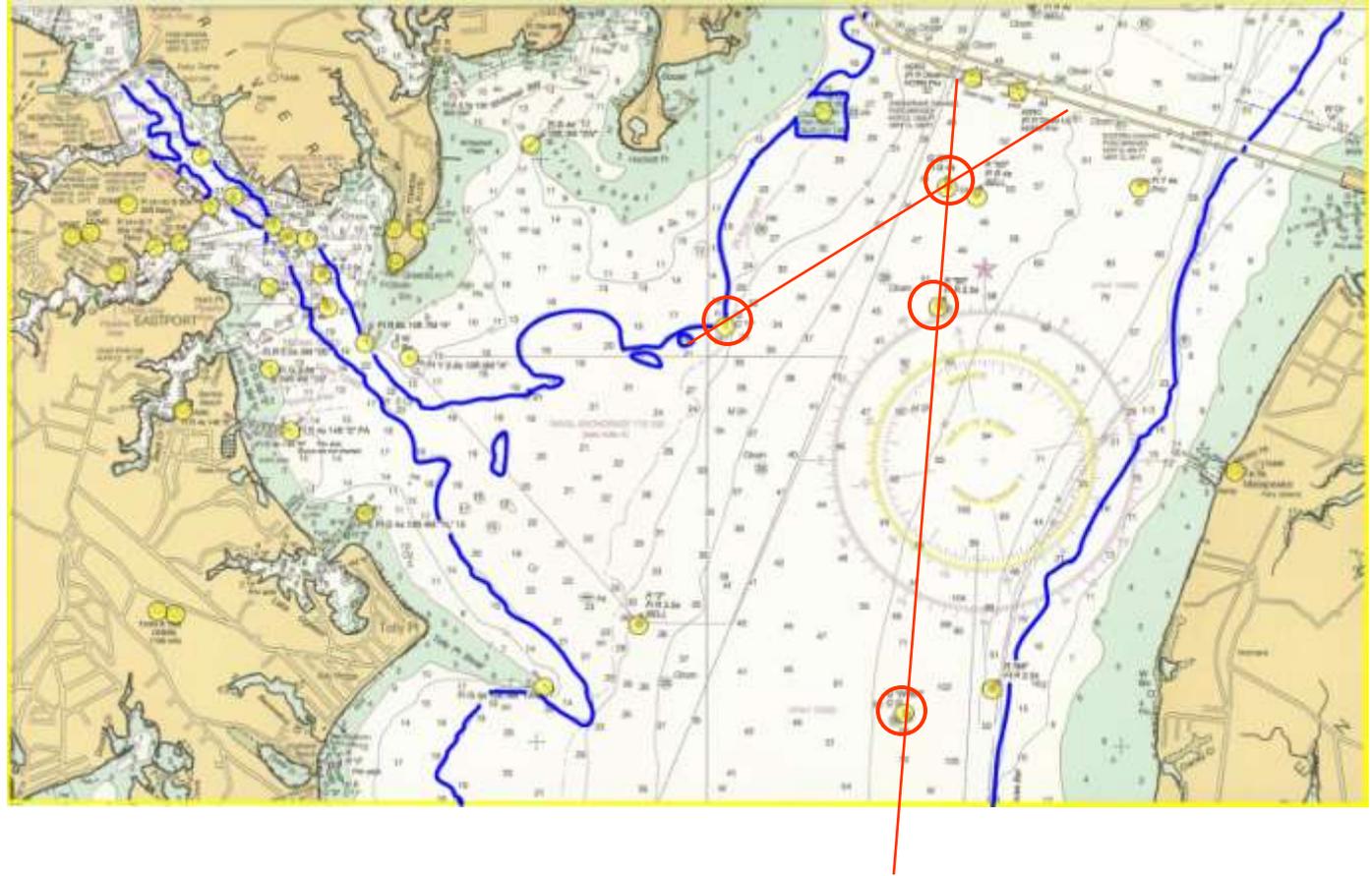
# Measure a Direction

- Lay parallel or rolling rule along direction to be measured
- Keeping rule parallel to original direction, move rule to nearest compass rose until edge touches cross at rose center
- Tic **magnetic (inner)** ring where rule touches in desired direction
- Read (interpolate) direction



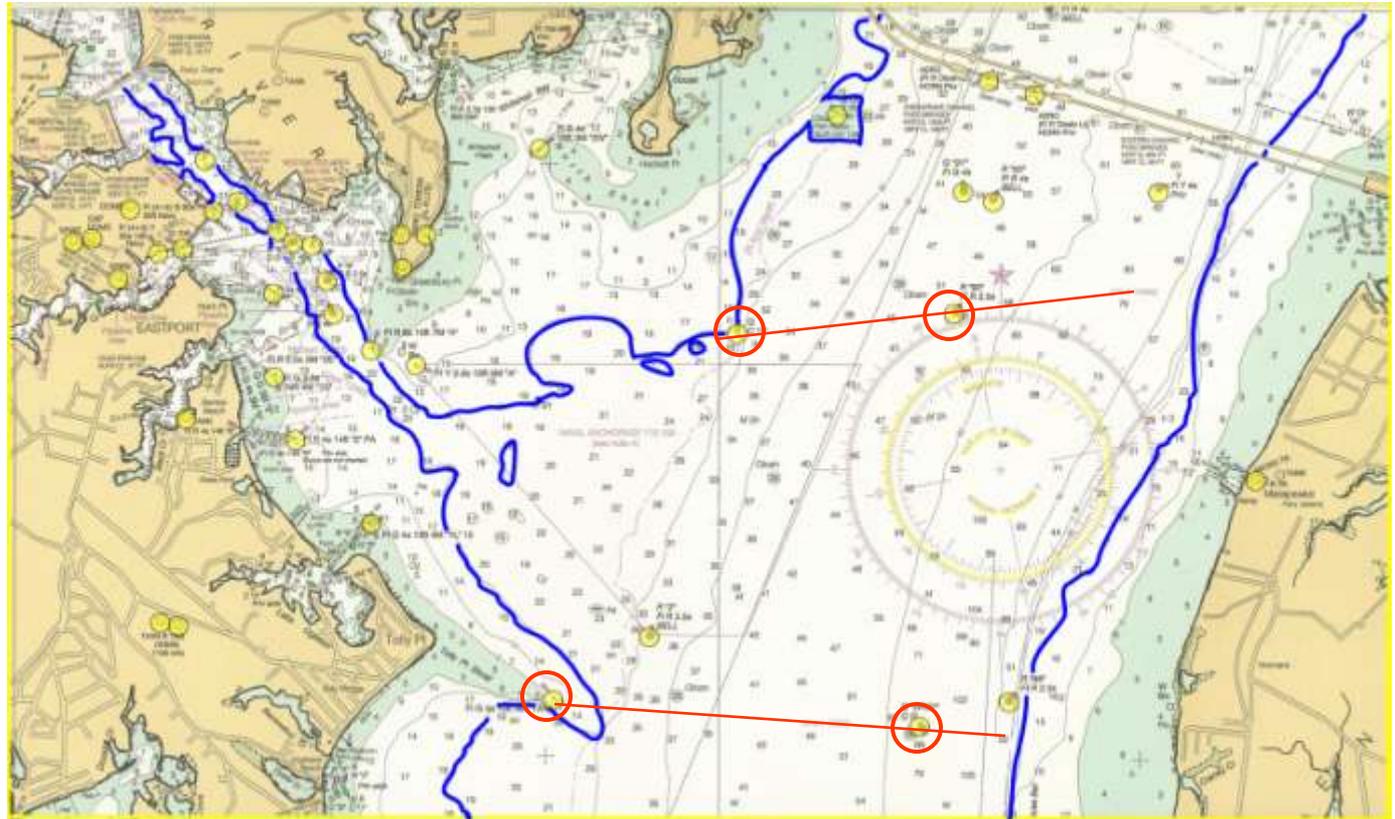
# Measure a Direction

- What is the direction from G “91” to G C”1”?
- 249M
- What is the direction from R “90” to G “WR87”?
- 195M



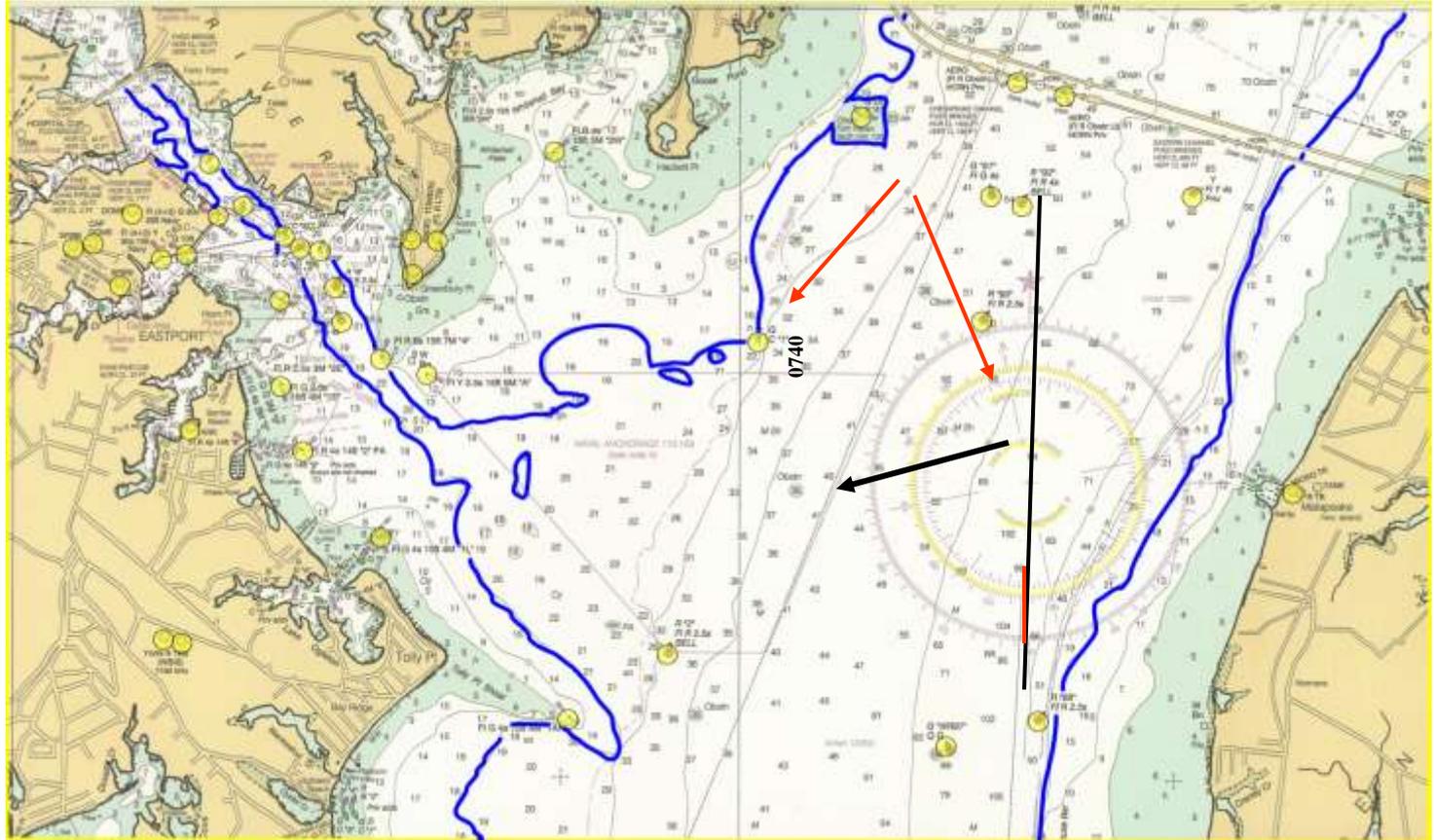
# Measure a Direction

- What is the direction from R“90” to G C”1”?
- 276M
- What is the direction from G “WR87” to 1AH?
- 286M



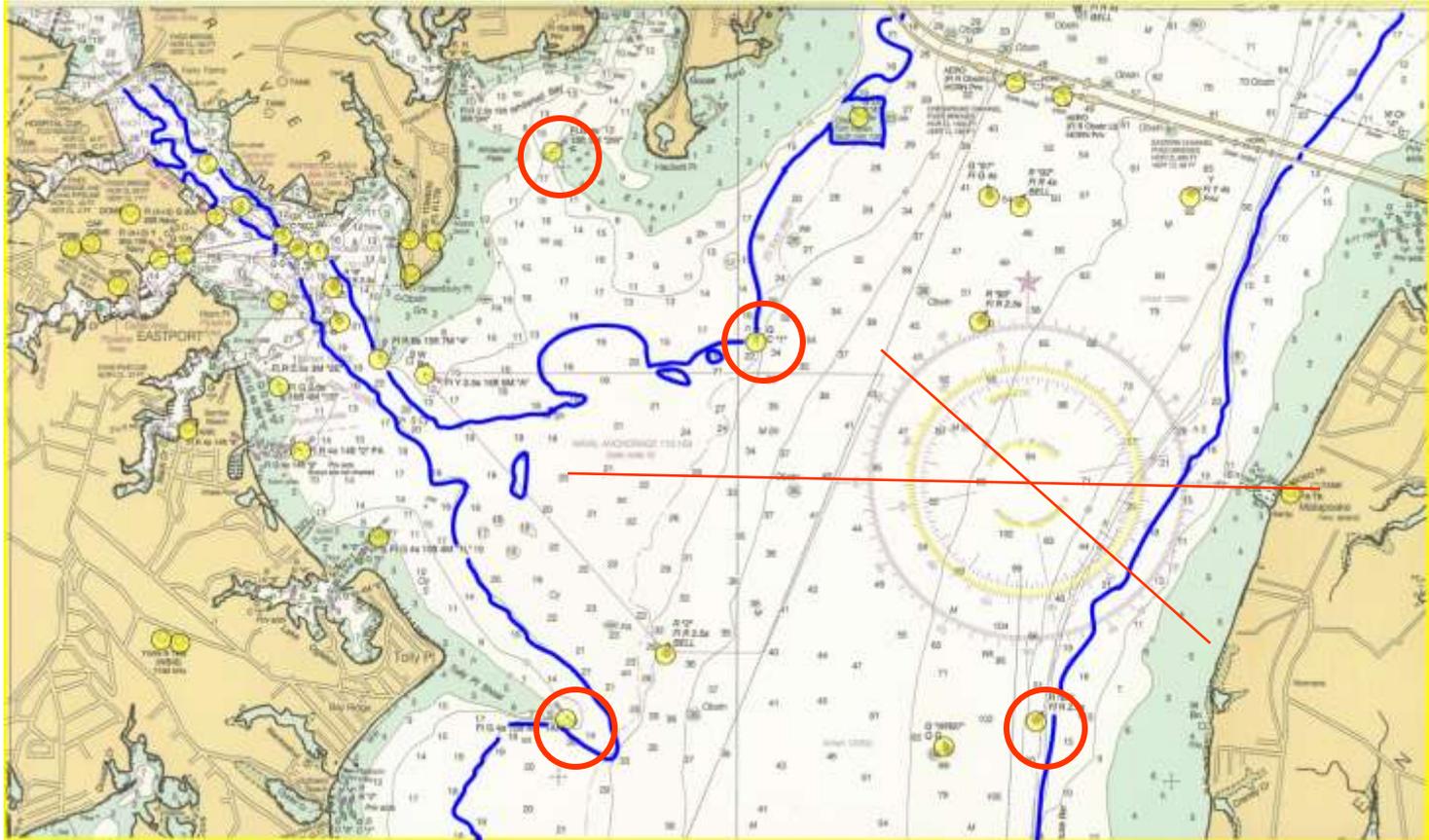
# Draw a LOP given an origin and a bearing

- On the nearest compass rose to the origin, place the parallel or rolling rule edge to touch the center of the rose and the given bearing on the **magnetic (inner)** ring.
- Move the rule parallel to the given origin and draw in the LOP.
- Label the LOP with the time of the bearing.



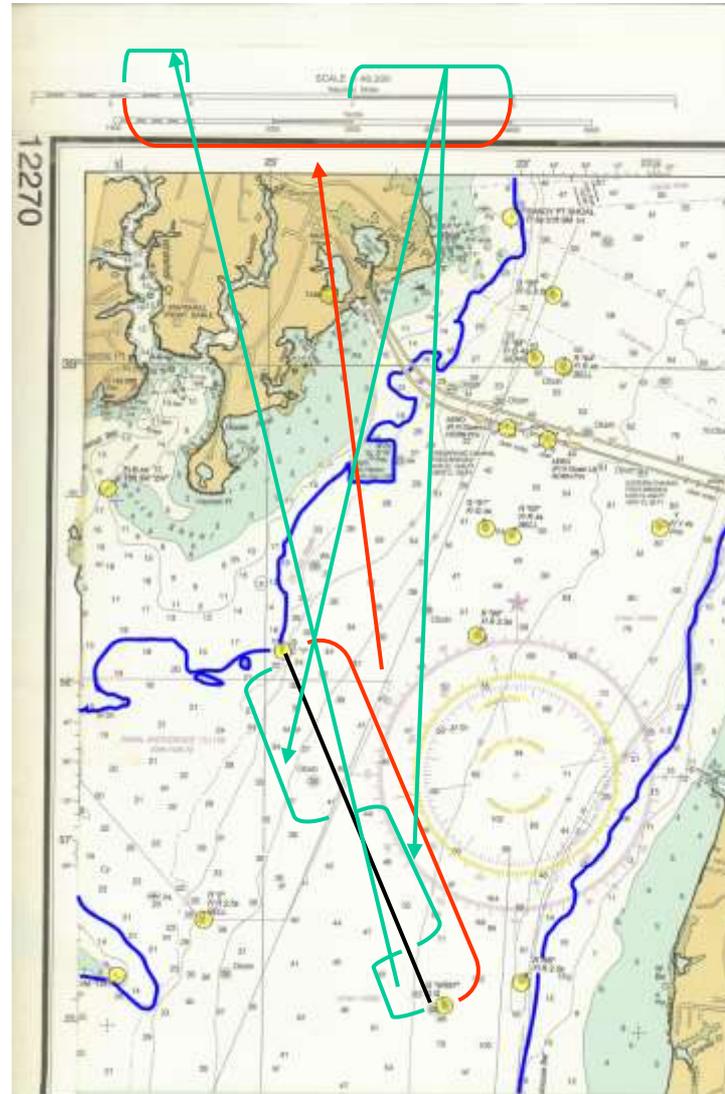
# Draw a LOP given an origin and a bearing

- From the Fl R 4s “2W” at 144M.
- What navaid do you intersect?  
  
G C”1”
- From R”88” at 282M what navaid do you intersect?
- 1AH



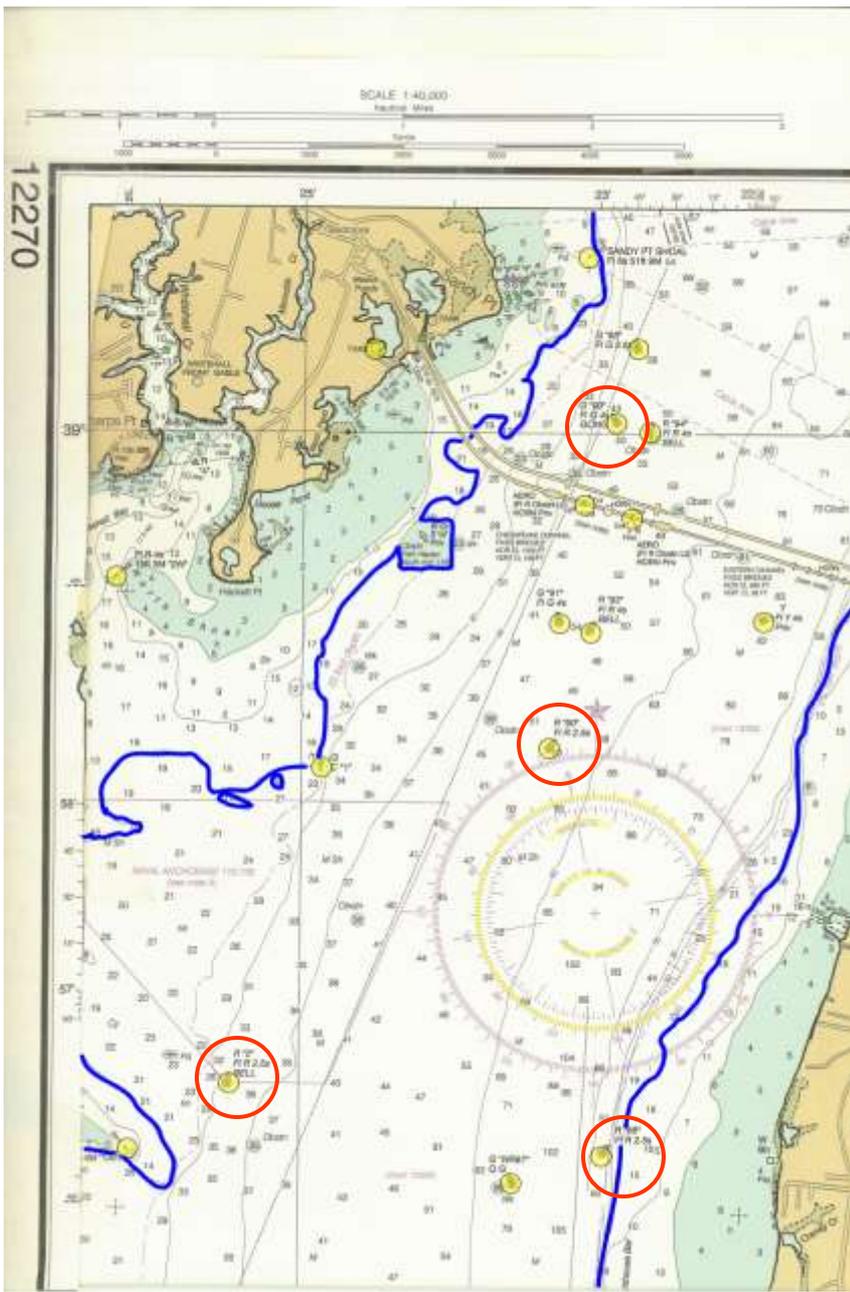
# Measure a distance

- If the distance is short enough to permit the dividers to cover the full distance, open the dividers to the distance, then transfer the dividers to the distance scale and read the distance.
- If the distance is too long, set the dividers to one nautical mile on the scale, mark off all the full miles, set the dividers to the remaining distance and measure the rest at the scale.



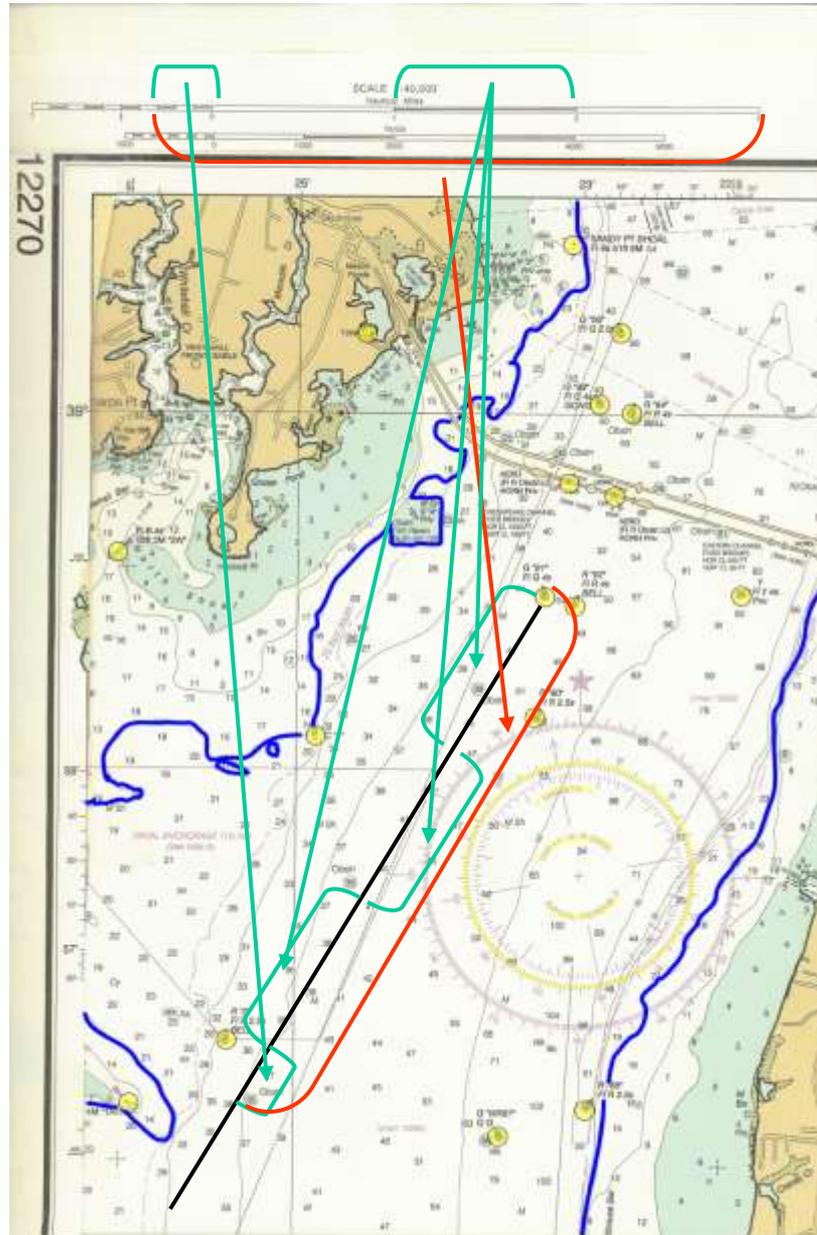
# Measure a distance

- What is the distance between R"90" and R"88"?  
2.2 nm
- What is the distance between G"93" and R"2"?  
4.1 nm



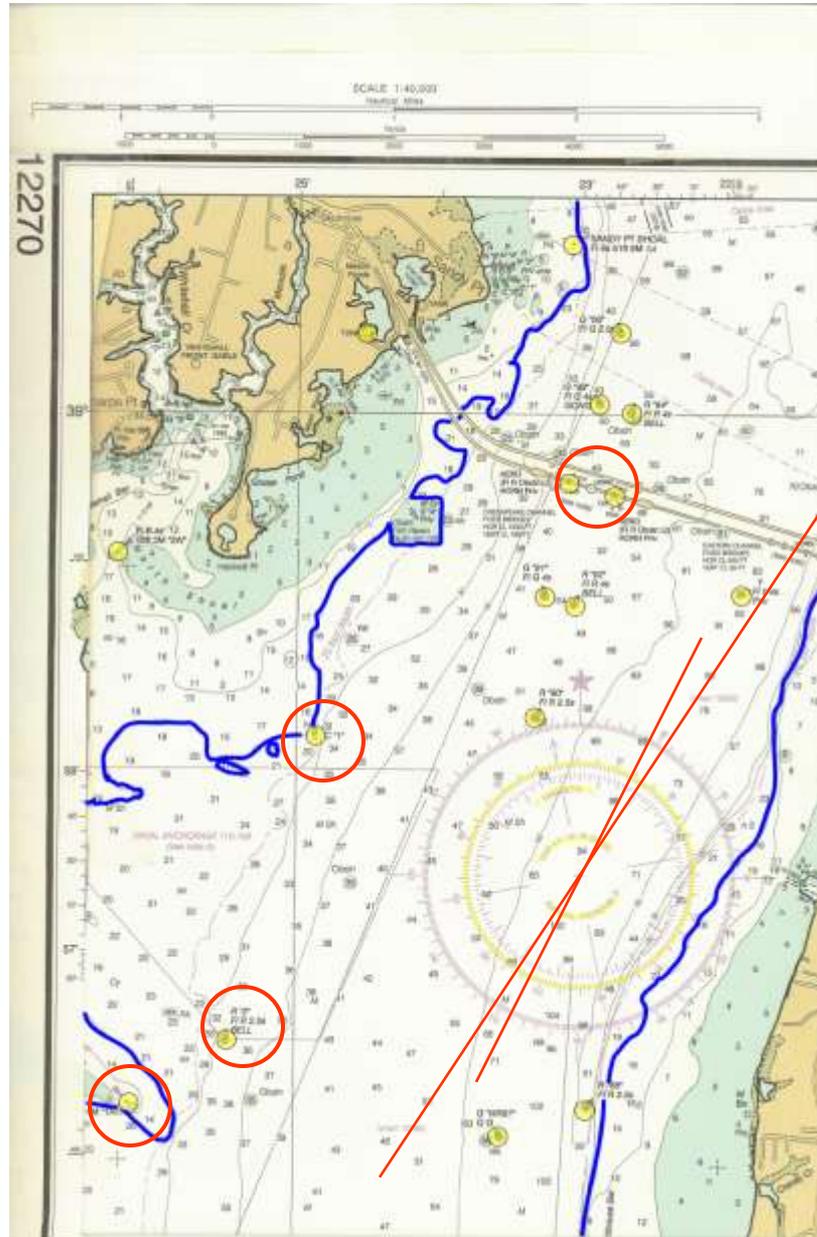
# Draw a distance

- Draw the line from the proper origin in the proper direction; extend it further than you believe the distance will be.
- If the distance is short enough, set your dividers to the full length on the scale and transfer the length to the drawn line.
- If the distance is too long, set the dividers to one mile on the scale, mark off the full miles, then reset the dividers to the remainder and add it to the end of the full miles.



# Draw a distance

- Draw a line from “1AH” at 038M for 2.3nm. What navaid is there?
- G C”1”
- Draw the line from the Horn on the Bay Bridge 3.7 nm at 224M. What is at the end of the line?
- R”2”



## Calculate Distance given Speed and Time

- $D = ST$  where
  - D is distance in nautical miles (nm)  
(x.x)
  - S is speed in knots  
(x.x)
  - T is time in hours  
(x.xx)
- For a speed of 4.5 knots (kts), distance traveled in 24 minutes is :
- $4.5 \times (24/60) =$
- $4.5 \times .4 = 1.8\text{nm}$

## Calculate Distance given Speed and Time

- How far do you travel in 20 minutes at 7.5 knots?
- 2.5 nm
- You pass G"91" abeam at 1315 at 5.6 knots. How far from G"91" are you at 1400?
- 4.2 nm
- For a speed of 4.5 knots (kts), distance traveled in 24 minutes is :
- $4.5 \times (24/60) =$
- $4.5 \times .4 = 1.8\text{nm}$

## Calculate Distance given Speed and Time

- At 8.6 kts, how far would you travel in 1 hr 27 min?
- 12.5 nm
- In 56 min, how far would you travel at 4.5 kts?
- 4.2 nm
- For a speed of 4.5 knots (kts), distance traveled in 24 minutes is :
- $4.5 \times (24/60) =$
- $4.5 \times .4 = 1.8\text{nm}$

## Calculate Speed given Distance and Time

- $S = D/T$  where
  - D is distance in nm (x.x)
  - S is speed in knots (x.x)
  - T is time in hours (x.xx)
- If you have gone 3.2 nm in 48 minutes, your speed is
- $3.2 / (48/60) =$
- $3.2 / 0.8 =$
- 4.0 kts

## Calculate Speed given Distance and Time

- You leave the dock at 1210. At 1240 you have traveled 2.8 nm. What was your average speed?
- 5.6 kt
- You take R"90" close abeam at 0817. At 0841 you pass close to R"88." What was your average speed?
- 5.5 kt
- If you have gone 3.2 nm in 48 minutes, your speed is
- $3.2 / (48/60) =$
- $3.2 / 0.8 =$
- 4.0 kts

## Calculate Speed given Distance and Time

- How fast would you have to travel to cover 27.3 nm in 4 hrs 24 min?
- 6.2 kt
- It's 1530 as you pass TPL abeam. How fast must you go to pass under the eastbound span of the CBB by 1615?
- 8.2 kt
- If you have gone 3.2 nm in 48 minutes, your speed is
- $3.2 / (48/60) =$
- $3.2 / 0.8 =$
- 4.0 kts

## Calculate Time given Speed and Distance

- $T = D/S$  where
  - D is distance in nm  
(x.x)
  - S is speed in knots  
(x.x)
  - T is time in hours  
(x.xx)
- To travel 6.7 nm at 5.6 kts it will take you
- $6.7/5.6 = 1.2$  hours, or
- one hour and twelve minutes ( $.2 \times 60 = 12$ )

## Calculate Time given Speed and Distance

- How long will it take to go 4.8 nm at 3.2 kt?
- 1.5 hr
- You leave G"93" at 1210. Your boat speed is 5.6 kt. At what time will you reach R"2"?
- 44 min
- 1254
- To travel 6.7 nm at 5.6 kts it will take you
- $6.7/5.6 = 1.2$  hours, or
- one hour and twelve minutes ( $.2 \times 60 = 12$ )

## Calculate Time given Speed and Distance

- How long will it take to go 13.4 nm at 3.4 kt?
- 3.94 hrs
- 3 hrs 56 min
- You leave Annapolis at 1730 for your home 52 nm away. If you average 45 kts, when will you reach home?
- 1 hr 10 min
- 1840
- To travel 6.7 nm at 5.6 kts it will take you
- $6.7/5.6 = 1.2$  hours, or
- one hour and twelve minutes ( $.2 \times 60 = 12$ )

# The Bearing Book

- General location
- Blank, or “All bearings magnetic”
- Date (when changed) and time of bearings
- Name of bearing target (each possible target highlighted with yellow circle and labeled per Chart Preparation Checklist)
- Bearing to target
- Depth from vessel depthsounder at time of bearings (to be checked against depth of plotted position)

STANDARD BEARING BOOK  
FORM NO. 1000 (7-74)

RECORD GYRO BEARINGS

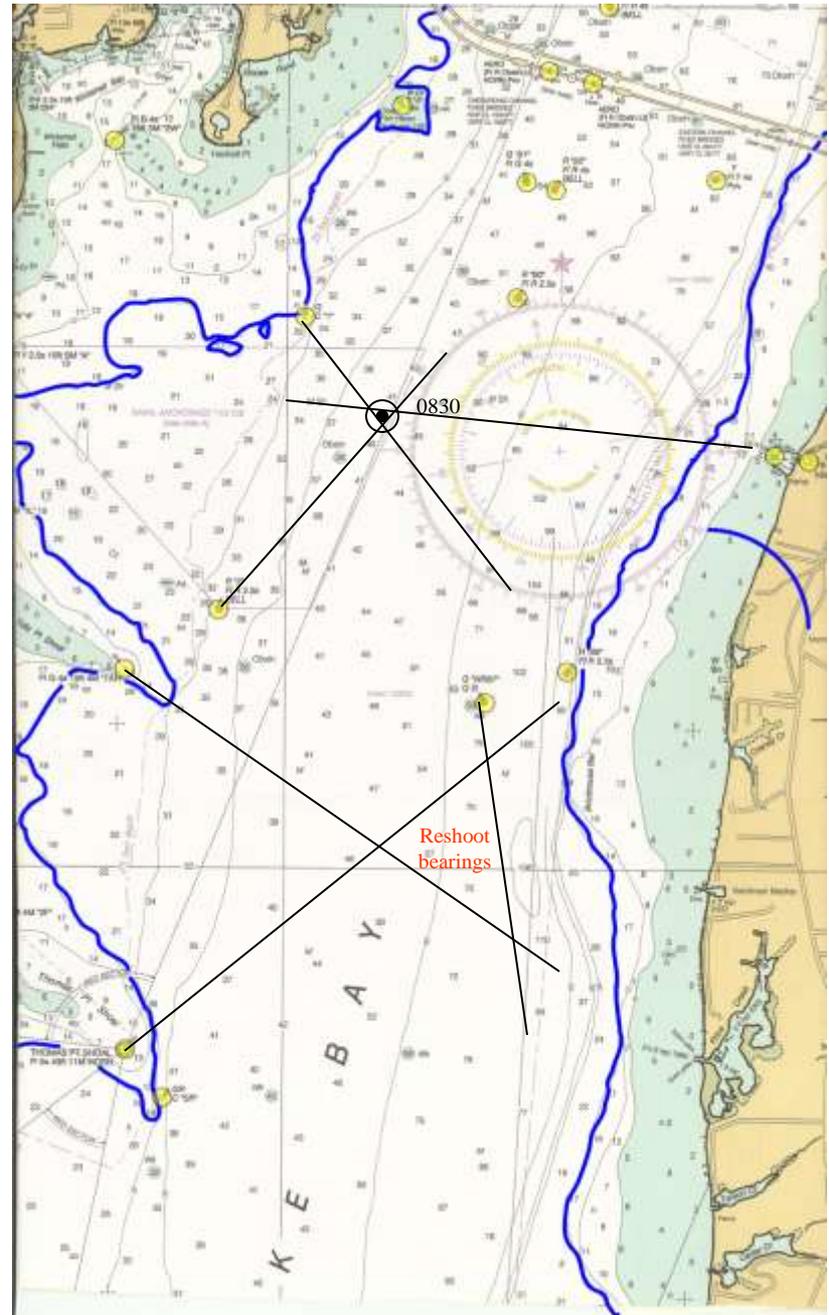
CHESAPEAKE BAY, VIC. Annapolis

DATE: 10/20/06

TIME	BEARING	TARGET	DEPTH
1610	58°	170	22
1620	170	170	19
1640	170	170	40
1653	170	170	55
1710	---	---	---
1723	282°	282	45
1753	015	150	40

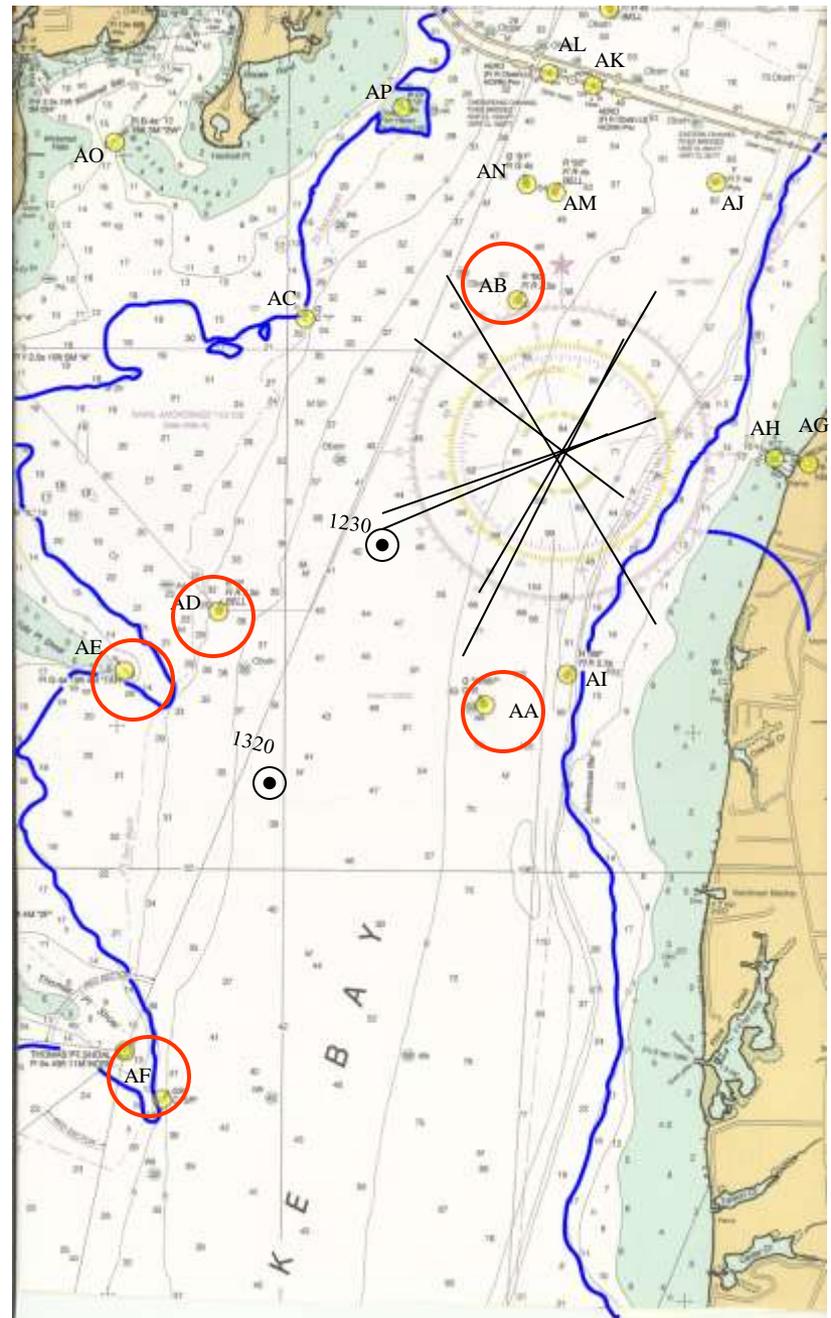
# Create a Visual Fix from LOPs and Soundings

- Take the bearings (at least two, preferably three, sometimes more) and mark down the bearings and times in the bearing book.
- Take the bearings fore and aft before the bearings on the beam.
- In the bearing book, record the time and the depth at the time of the last bearing.
- Plot all bearings to intersect one another.
- If they all converge into a point, congratulations.
- If they make a small triangle, choose the center of the triangle as the fix position.
- If the triangle is large, try again, being sure you know which landmarks or navaids you are using.
- Check that the charted depth at the fix position is within 10 feet of the depth recorded when taking bearings. If not, try again.
- Label the fix with a dot in a circle and the time.



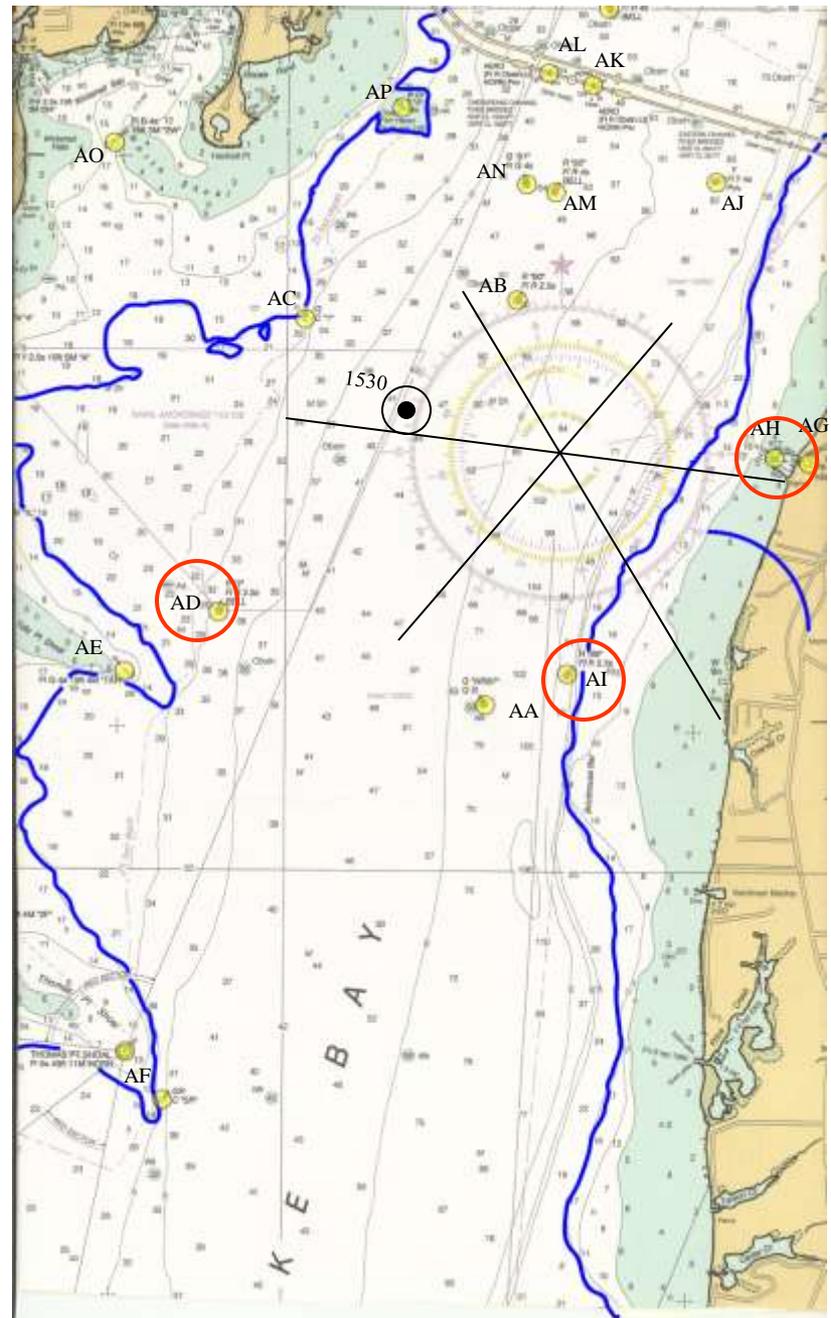
# Create a Visual Fix from LOPs and Soundings

- At 1230, the Bearing Book gives you the following data: AD: 258M, AB: 042M, AA: 162M, Depth: 46'. Plot the fix. Is it good?
- At 1320, The Bearing Book gives you the following data: AF: 214M, AA: 082M, AE: 318M, Depth: 40'. Is it good?



# Create a Visual Fix from LOPs and Soundings

- At 1530, the Bearing Book gives you the following data: AH: 108M, AD: 232M, AI: 160M, Depth: 36'. Plot the fix. Is it good?



## Dead Reckoning

Dead Reckoning (DR) is the estimation of boat location based solely on directed boat heading (Course), boat speed through the water measured by the speed log instrument (Speed), and elapsed time (Time).

## Dead Reckoning

A DR Plot is a series of straight lines each with direction (Course). The length of each line is determined by the Speed and Time duration for that line.

If Course or Speed change, the line must be segmented at the change and the new Course or Speed indicated.

# Dead Reckoning

The three DR symbols are:

CxxxM where xxx is the direction of the line  
(Placed above and parallel to the line),

Sxx.x where xx.x is the speed in knots (Placed  
below and parallel to the line), and

Half circle with a dot at the center and a four  
digit, 24-hour time label. (Placed on the line at  
the calculated position of the boat at the  
indicated time.)

## Dead Reckoning

DR positions are theoretical, not real. They are based only on Course, Speed, and Time. They do not consider poor helmsmanship, water currents, calculation errors, or leeway due to wind or waves on the vessel.

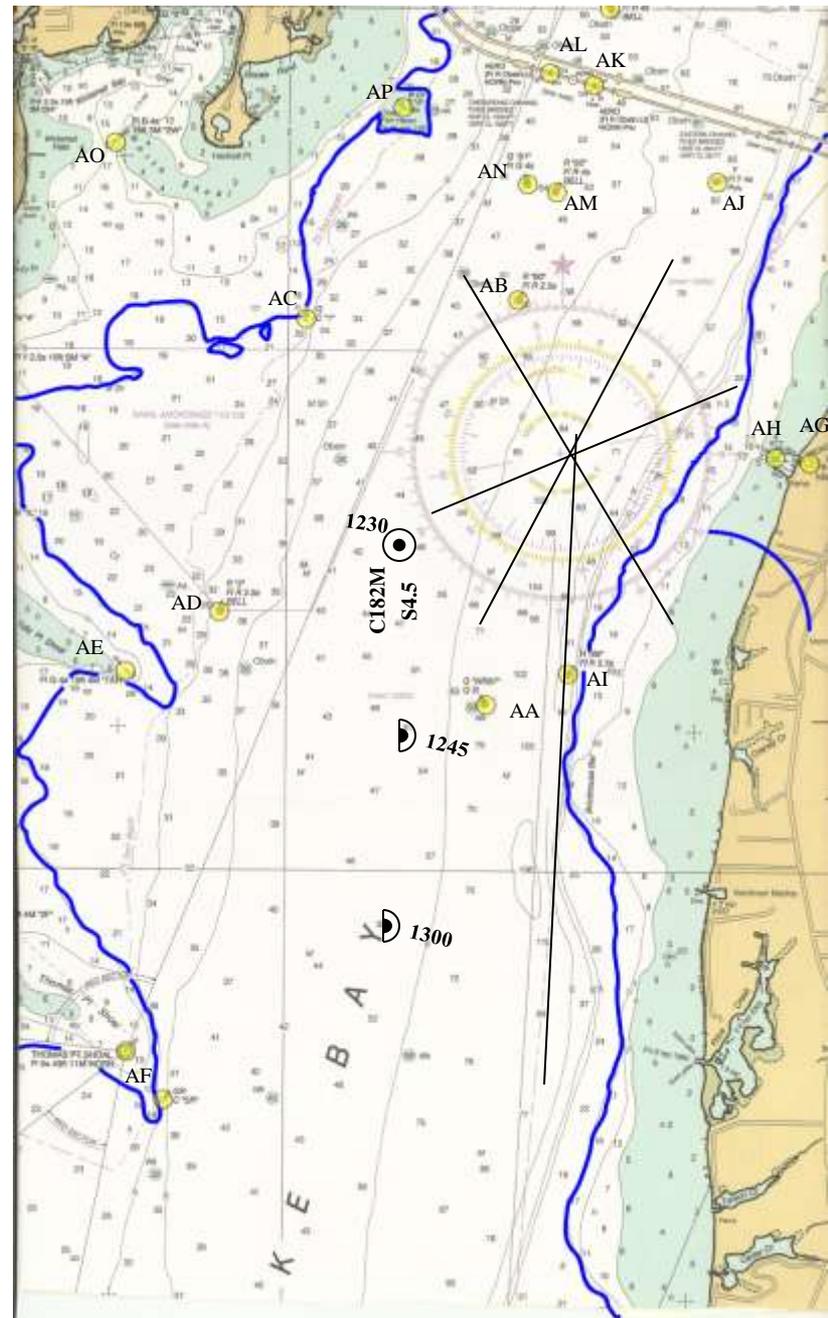
DR positions create a plan which must be periodically validated/ updated by depth soundings and fixes or running fixes.

## Dead Reckoning

Fixes and Running Fixes are not DR symbols  
– even though they may appear at the head  
of a line – because they are not determined  
using the DR technique.

# Create a Dead Reckoning Plot

- Create and label a visual fix.
- Extend a line from the fix in the direction given the helm as steering orders. (Check that the wind will allow you to sail that direction.)
- Using the indicated boat speed and the fix time interval (see next slide), determine the distance along the extended line to plot a half circle for each of two fix intervals. Label the half circles with the expected time of arrival.



# Determine the latest time for the next fix

- The latest time for the next fix is determined by the lesser of the following:
  - The CO's fix interval
  - **The time it will take to get half the distance to shoal water in the direction you are traveling (CSNTS only), else to nearest shoal water.**
- Note that the requirement to plot position on the hour does not require a fix on the hour.



# Determine the latest time for the next fix

- Plot the DR from the fix with your given course, C, and speed, S (knots).
- From the fix, determine the closest distance, D (nm), to shoal water. **0.8 nm**.
- Divide by two for the half interval. **0.4 nm**
- With the formula  $T = D/S$ , calculate T (hours). Convert to minutes and divide by two for the time interval to the next fix. **5 min**
- **If the calculated time interval is less than the CO's fix interval, use the calculated time interval and distance.**
- Add the time interval to the fix time. This is the latest time for the next fix. 1235

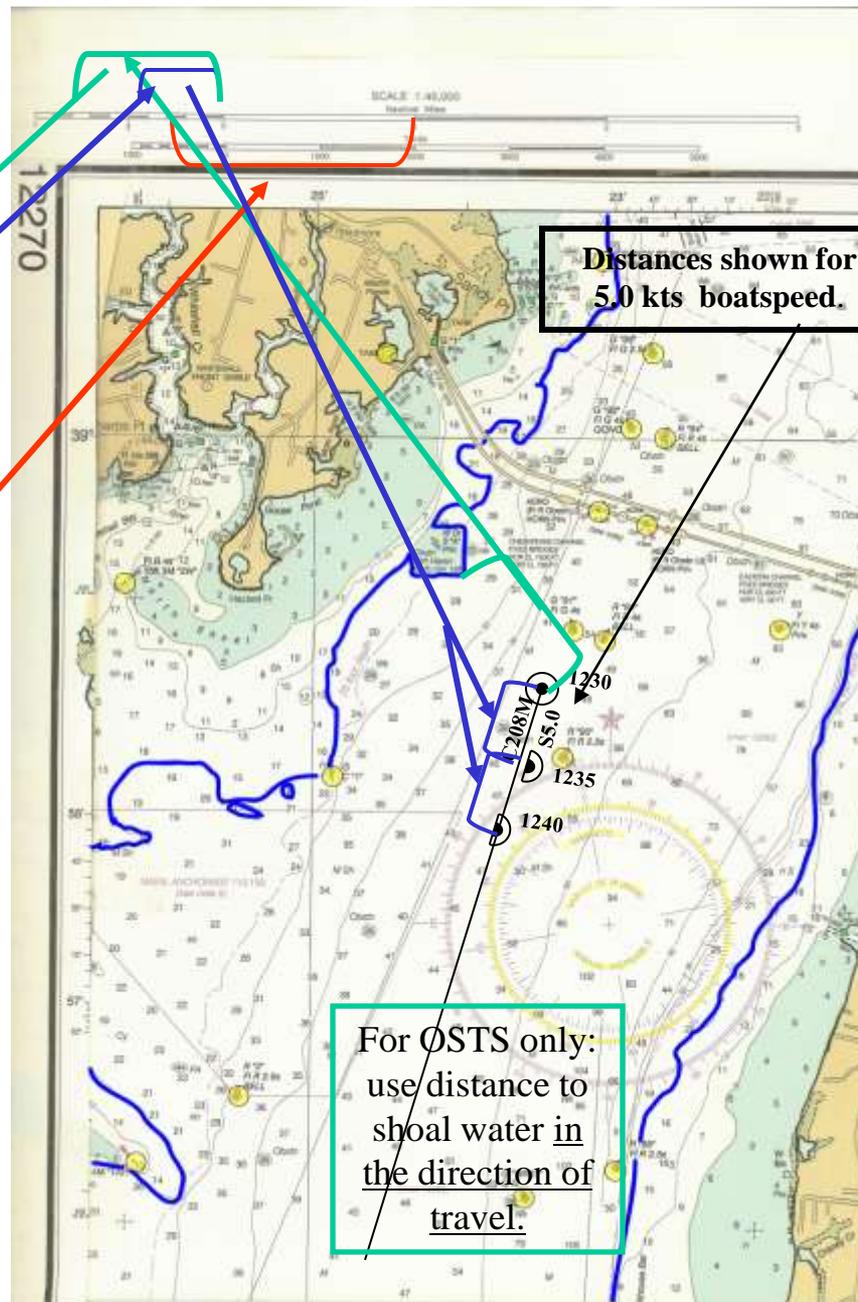
CO's fix interval is 15 min.

$$\begin{aligned} T &= 0.4/5.0 \\ &= .08 \text{ hr} \\ &= 4.8 \\ &\Rightarrow 5 \text{ min} \end{aligned}$$

$$\begin{aligned} 1230 + 5 \\ = 1235 \end{aligned}$$

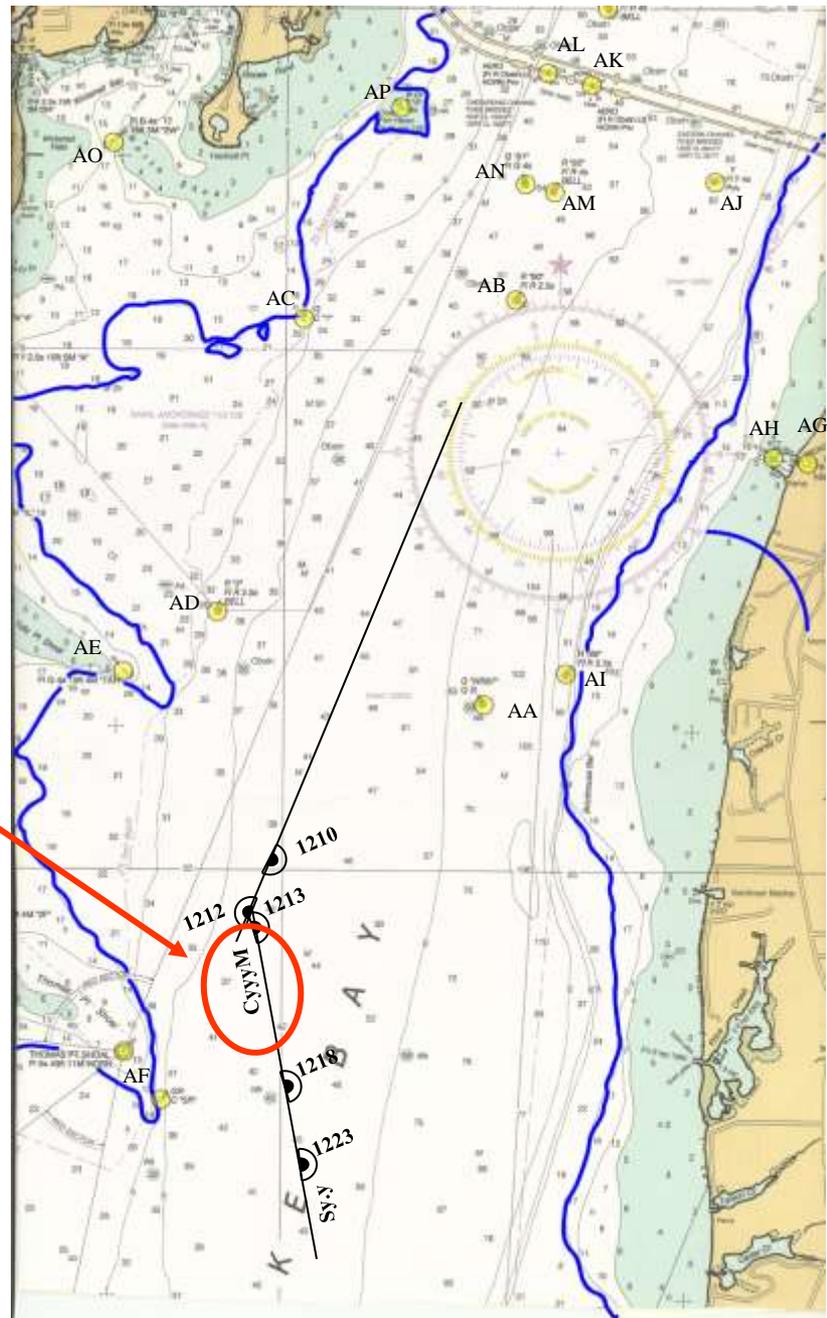
Distances shown for 5.0 kts boatspeed.

For OSTs only:  
use distance to shoal water in the direction of travel.



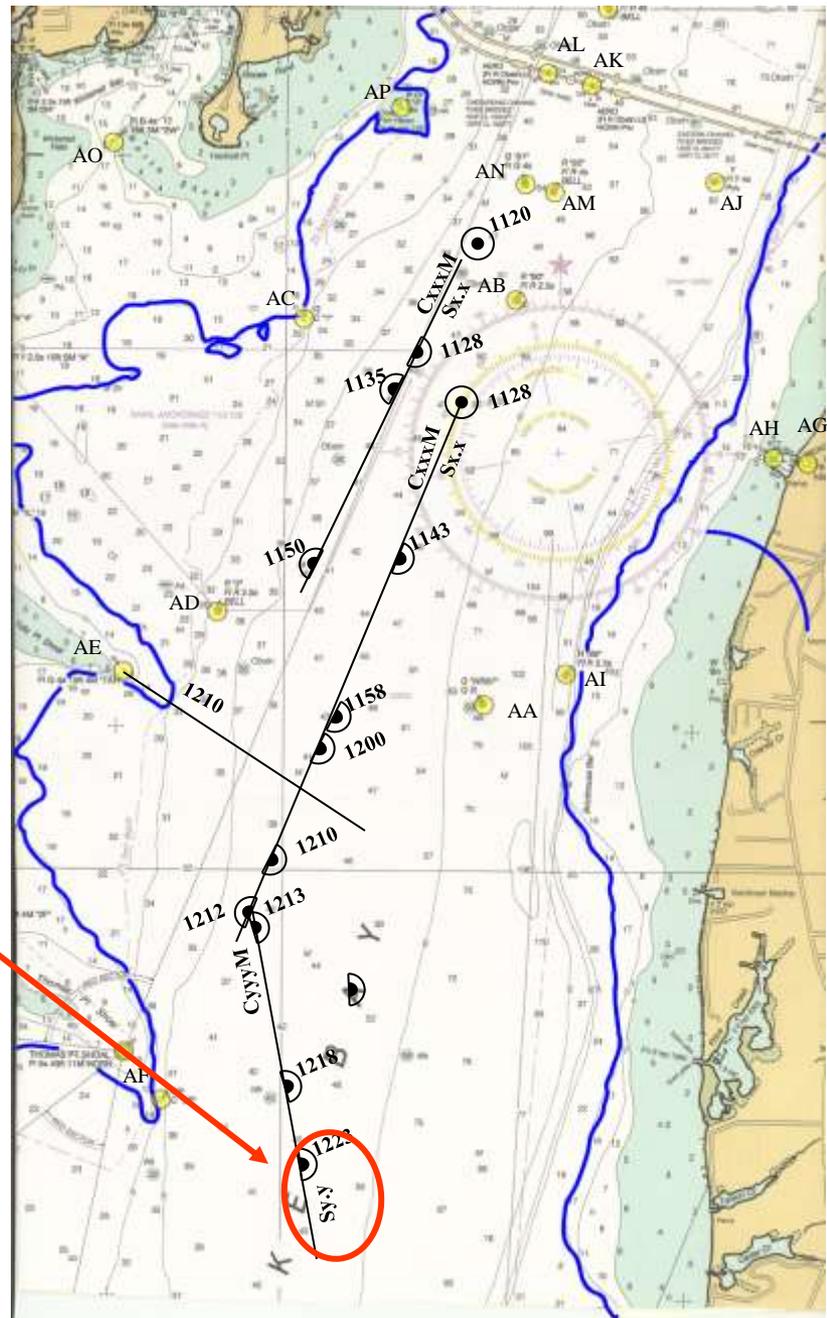
# Six Rules of Dead Reckoning

- Every change in Course



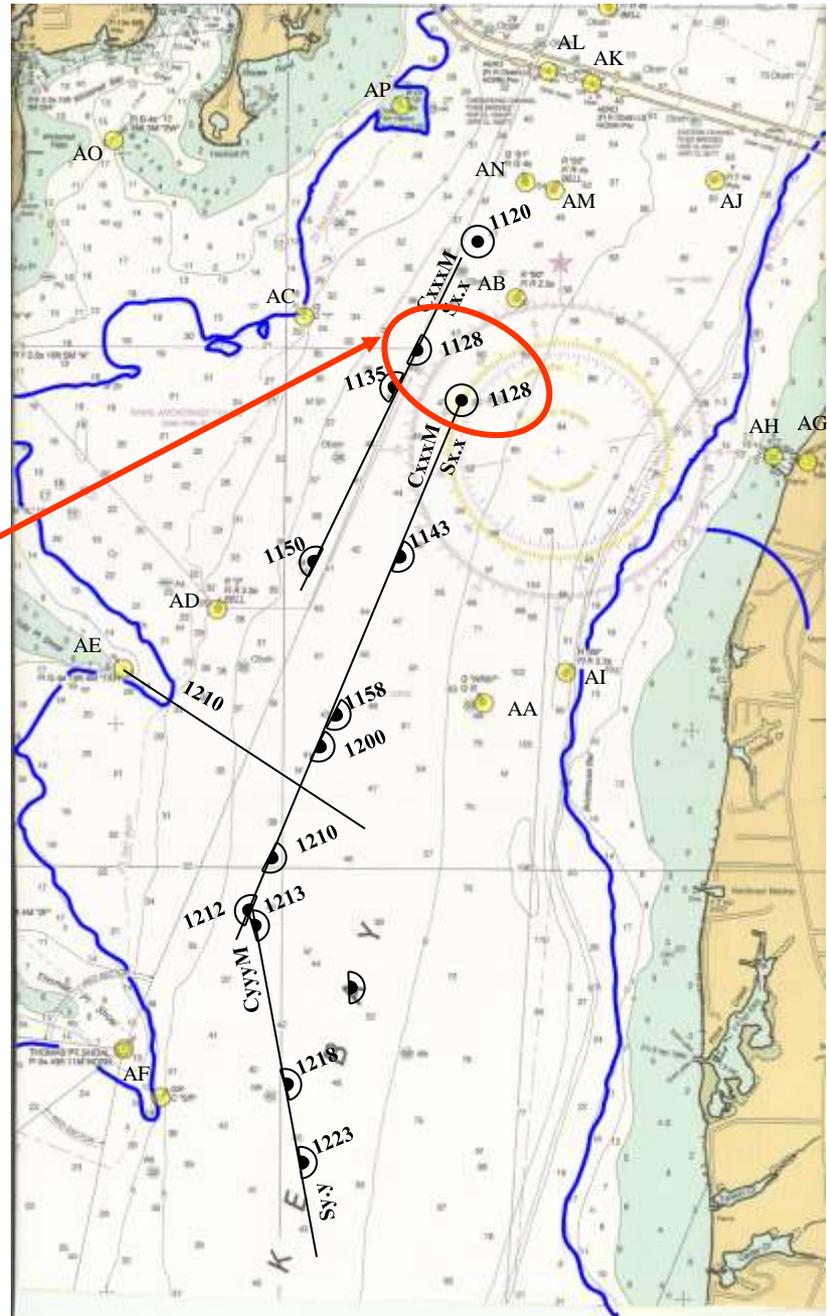
# Six Rules of Dead Reckoning

- Every change in Speed



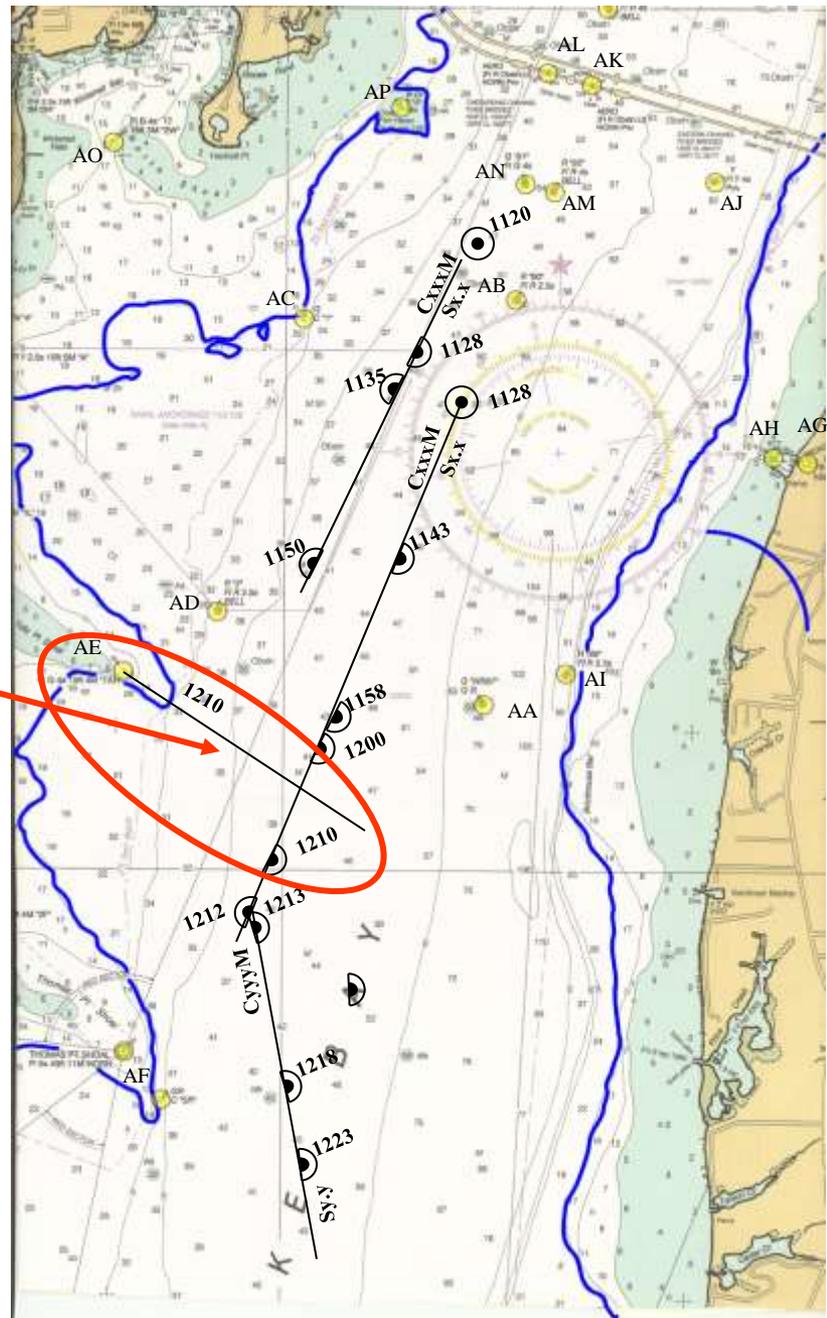
# Six Rules of Dead Reckoning

- Every  
Fix or  
Running  
Fix  
(Rfix)



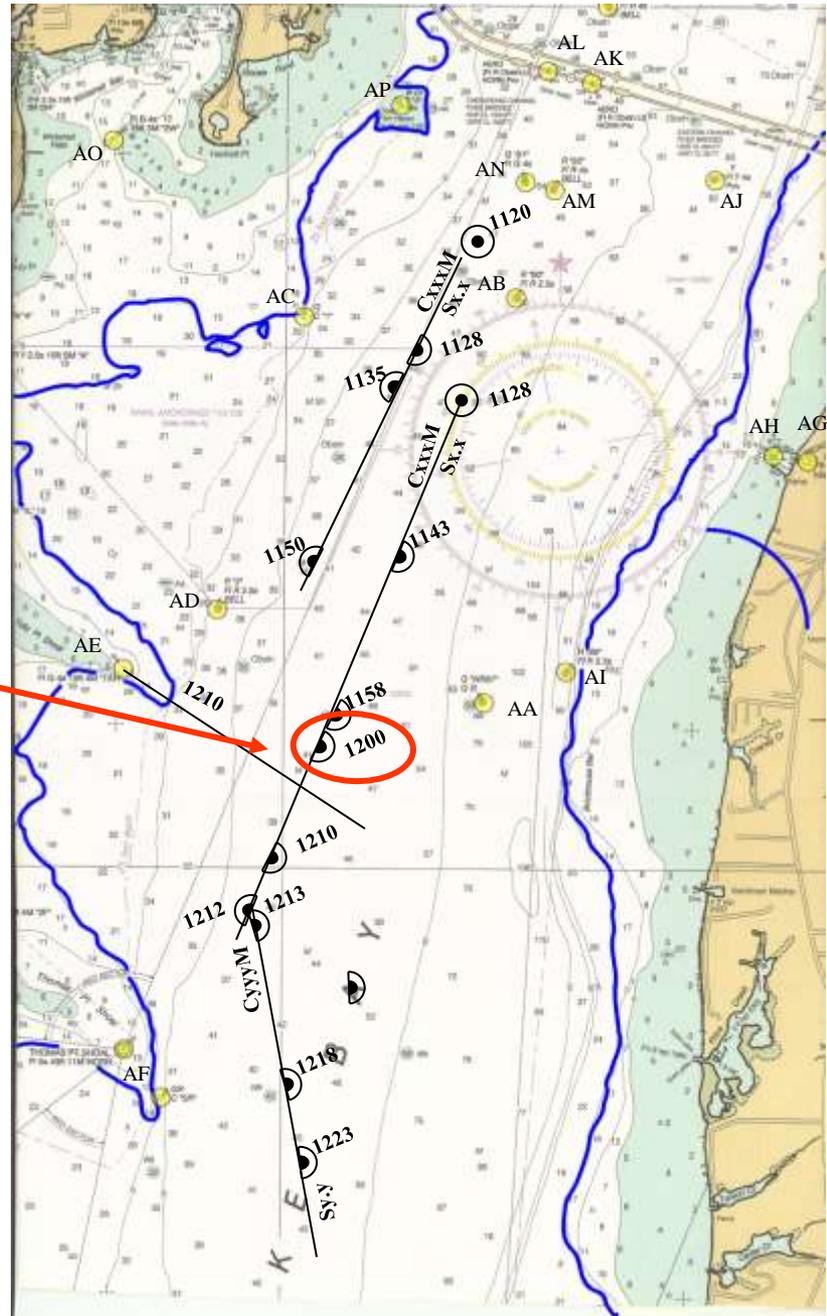
# Six Rules of Dead Reckoning

- Every  
LOP



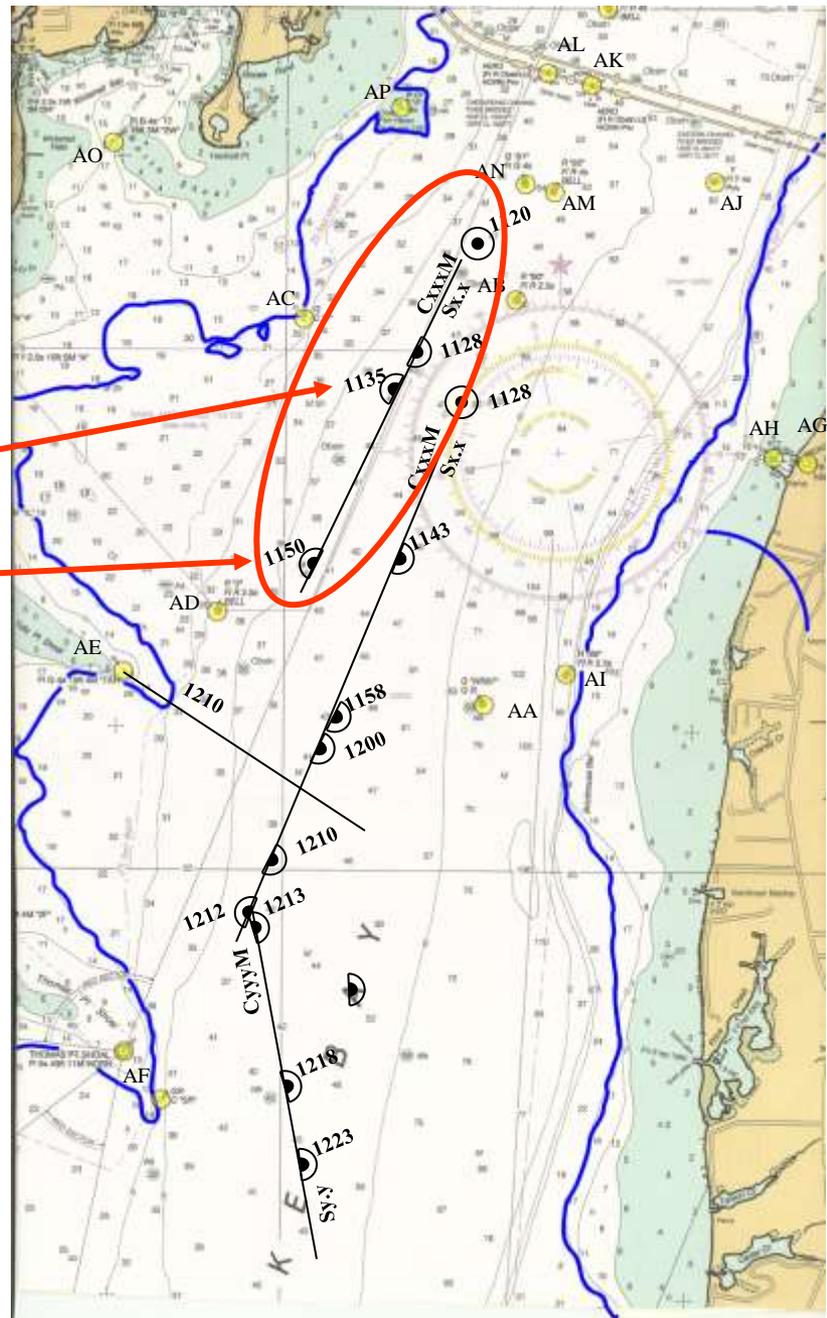
# Six Rules of Dead Reckoning

- Every hour on the hour



# Six Rules of Dead Reckoning

- From a fix or rfix, extend the DR plot two fix intervals



# Six Rules of Dead Reckoning

- Every change in Course
- Every change in Speed
- Every Fix or Running Fix (Rfix)
- Every LOP
- Every hour on the hour
- From a fix or rfix, extend the DR plot two fix intervals

