

# *Chapter 5*

## *Dead Reckoning*

Dead Reckoning (DR) is the fundamental basis of navigation at sea and is essential in the use and analysis of all other navigational data, weather forecasts, and evaluation of route progress. DR position should be faithfully logged and plotted whether you are navigating with electronics or with paper and pencil methods.

DR is definitely not guessing where you are based on an "eyeball view" of the world around you as many people may think. It is a specific procedure involving the following two elements and plotting these on your chart on a regular and timely basis:

- Course Steered, based on the ship's steering compass, during a recent time interval, and
- Distance Traveled through the water, based on your speed or distance log, during that same time interval.

This information is entered into your logbook and plotted on your chart at regular time intervals. It represents where you think you are based on these two pieces of information. But, we know that there are factors that will make this position incorrect, such as current, wind leeway, steering errors, instrument errors, data recording errors and carelessness. In fact, I would not expect to be where the DR says I am. I would expect to be elsewhere, but I can use the DR as a basis for evaluating and using other data and thus making a reasonable conclusion as to where I'm likely to be.

We'll talk about these other factors in later chapters; for now we'll concentrate on getting the DR right, and here are the main elements.

### *Deck Logbook*

Chapter 3 outlines the basic elements of a proper Deck Logbook with its Narrative and Tabular data sections and shows a tabular page from a logbook recorded during an ocean passage. The time interval for recording data will vary depending on the waters you are sailing, and I recommend the following:

- Open ocean: 1 hour intervals.
- Near coastal: 1/2 hour intervals.
- Inland: 1/4 hour intervals.

For DR purposes, we're interested in five elements of the tabular section of that logbook including date, time, average course steered per ship's compass during the preceding time

interval, distance traveled based on the distance log at the beginning and end of the time interval, and the DR calculations workspace. Course and Distance are through the water values, as defined in Chapter 4, and not over ground values.

**Example:** The following data were recorded during a recent coastal cruise; at 0800 you were at Latitude 26°19.0N, Longitude 70°52.1W:

<i>Logbook</i>					
<u>Date</u>	<u>Time</u>	<u>Course (C)</u> <u>° PSC</u>	<u>Distance (D)</u> <u>NM</u>	<u>DR</u> <u>Calculations</u>	
11/12/19	0800		144.6		
	0830	041	146.5	T	V
				029	9W
				038	3W
				041	
				Distance = 146.5 - 144.6 = 1.9	
	0900	333	148.5	T	V
				323	9W
				332	1W
				333	
				Distance = 148.5 - 146.5 = 2.0	
	0930	058	150.5	T	V
				045	9W
				054	4W
				058	
				Distance = 150.5 - 148.5 = 2.0	
	1000	113	152.6	T	V
				101	9W
				110	3W
				113	
				Distance = 152.6 - 150.5 = 2.1	
	1030	031	154.7	T	V
				019	9W
				028	3W
				031	
				Distance = 154.7 - 152.6 = 2.1	
	1100	063	156.6	T	V
				050	9W
				059	4W
				063	
				Distance = 156.6 - 154.7 = 1.9	
	1130	040	157.6	T	V
				028	9W
				037	3W
				040	
				Distance = 157.6 - 156.6 = 1.0	

The first four columns are entered by the Helmsman at completion of each half-hour watch trick; the last column is used for the DR calculations as follows:

- Distances are calculated for each 1/2-hour period by subtracting one log reading from the next. For example, for the interval from 0800 to 0830,  $D = 146.5 - 144.6 = 1.9$  NM.
- Courses will be plotted in True degrees, so it is necessary to convert the compass courses (PSC) to Magnetic and then to True degrees. Partial degrees are rounded to the nearest whole degree.

- Lookup the Compass Deviations for each course in the Deviation Table shown below, entering that table from the righthand °PSC column. For example, notice that the first course (041°PSC) falls between 030 and 060 in the Deviation Table, and we must choose between the whole degrees of 3W or 4W in the Deviation column. This can be done by either eyeball inspection or by numerical interpolation, and, either way, the resultant Deviation is 3W for a course of 041°PSC, which is entered in the logbook table as above.
- Calculate the Magnetic course for the first row:  $041^{\circ}\text{psc} - 3\text{W} = 038^{\circ}\text{M}$
- The Magnetic Variation of 9W is looked up on a recent local chart and is entered in the V-column.
- Then, calculate the True course for the first row:  $038^{\circ}\text{M} - 9\text{W} = 029^{\circ}\text{T}$
- Convert all of the PSC courses shown to degrees True in the same manner.

<i>Deviation Table</i>		
<u>Ship's Heading</u> °M	<u>Deviation</u> °	<u>Ship's Heading</u> °PSC
358	2W	0
027	3W	030
056	4W	060
086	4W	090
117	3W	120
148	2W	150
179	1W	180
210	0	210
241	1E	240
271	1E	270
300	0	300
329	1W	330
358	2W	360

041°psc

### *Plotting the DR*

The DR chart is then plotted as shown in *Figure 5-1* using the numbers from the DR Calculations column. The resulting DR is shown in *Figure 5-2*.

- The DR should be faithfully plotted immediately at the end of each watch or time interval to maintain the plot up to date and ready for navigational needs as they occur. You should not play catch up in this important duty.

- Mark each position with a half circle and a dot (to signify a DR point) and Ship's Time. It's important to plot in a clear and legible manner and to consistently mark your chart using the standard symbols shown in Chapter 4 so that the navigator and others onboard can interpret the chart without confusion.
- The DR is virtually never completely accurate, and you will rarely be exactly where the DR says you are. This is why we correct the DR based on other information, such as visual bearings and depths, as will be discussed in later chapters.

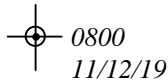


Figure 5-1a: Plot the starting point using Latitude & Longitude. Mark with a Circle and Dot and the Date & Time.

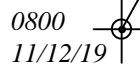


Figure 5-1b: Draw in the first course line at 029°T taken from the DR Calculations column in the Logbook.

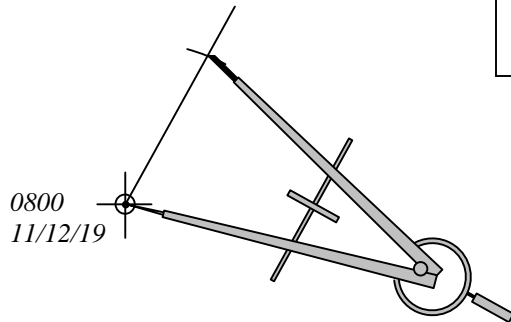


Figure 5-1c: Using the distance of 1.9 NM for the first course line from the DR Calculations column in the Logbook, spread the dividers to that distance using the Latitude scale to the left or right of your plot. Place the point of the compass at the 0800 position and mark the distance on the course line.

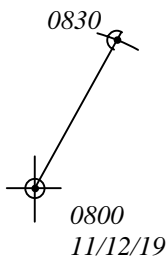


Figure 5-1d: Mark this second point with a Dot & Half Circle and the Time.

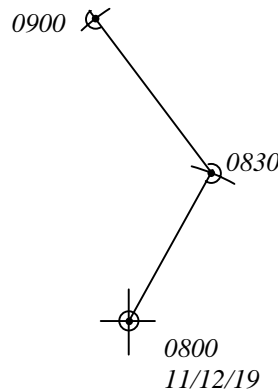


Figure 5-1e: Continue this process through all points in sequence. This is an on-going process and the DR should always be kept up to date.

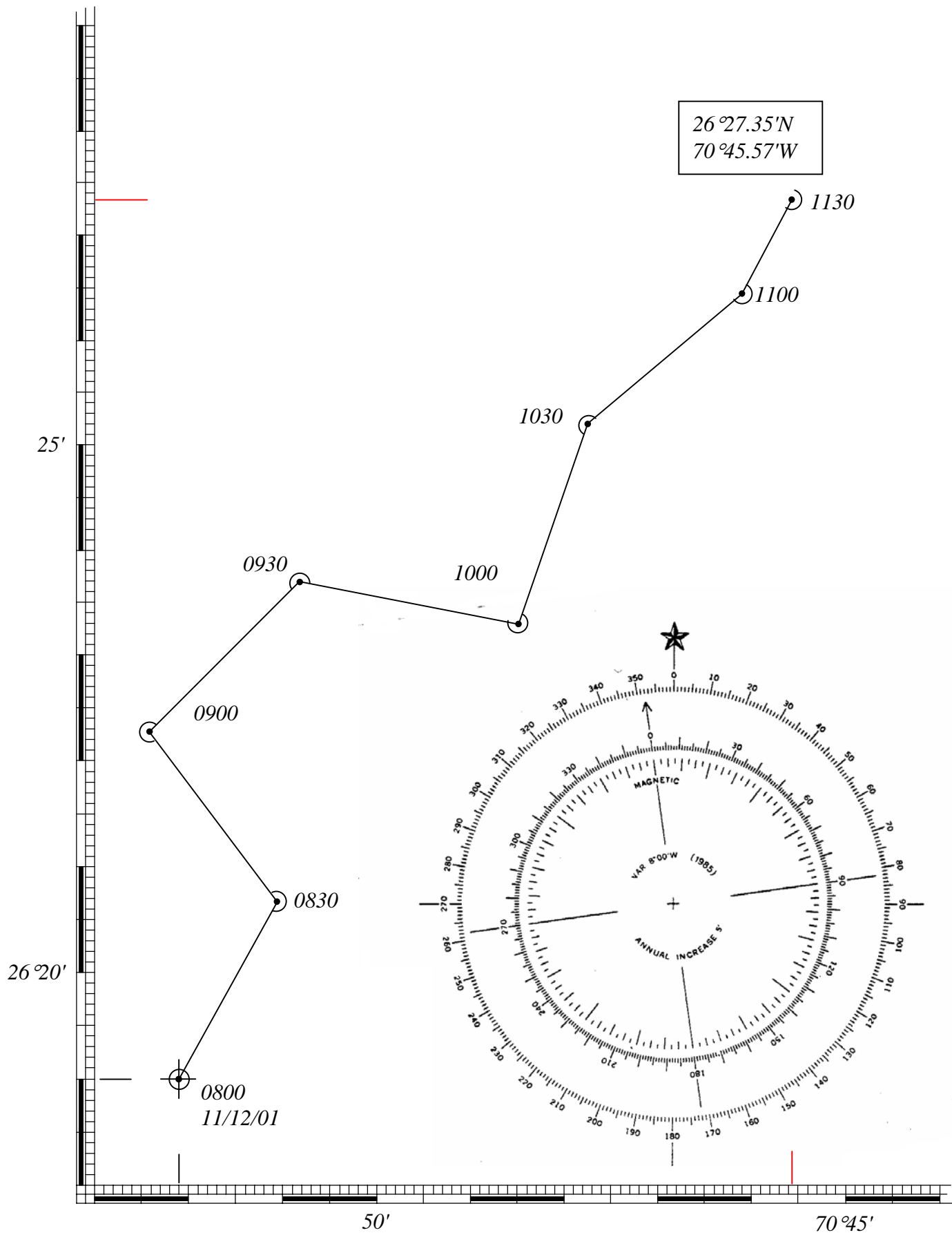


Figure 5-2: Dead Reckoning plot of Course & Distance.

## *Cruise Navigation*

Four separate and distinct elements are necessary for successful cruise navigation, as follows:

- **Rhumb Line (RL)** is the future course we intend to sail, and this should be plotted prior to the cruise to enable proper inspection and evaluation of the intended track and potential hazards and opportunities that may exist.
- **Dead Reckoning (DR)** is a historical record of courses actually steered and distances traveled, which tell us our approximate position and provide a basis for using and evaluating other navigational data.
- **Verification** is the process of improving our DR plot by adding other data and observations including LOPs from visual bearings, depths, radar, celestial, currents, leeway and other information.
- **Analysis** is the examination of your route progress as compared with your intended track and destination in order to evaluate progress actually being made and to consider the effects of changing weather conditions, time schedules, boat and equipment condition, crew condition and other pertinent factors.

Later chapters will further discuss these elements of navigation as well as the sequence of combining them into a comprehensive navigational procedure.

# Chapter 5 Homework

For this assignment, use the practice plotting sheet in *Appendix E*, or download and print a copy from our School Store, item #13b, at: <http://www.mdschool.com/SchoolStore/Store-Index.htm> Note that the compass rose on this practice plotting sheet shows a Variation of 8°00'W (1985) Annual Increase 5'. Correct this Variation to the year shown in the question below and round off to a whole degree before applying. Use the Deviation table in this Chapter 5.

At 0700 on 23 September 2002, you are located at point E. You record the following data in your deck log over the next few hours:

Date	Time	Course (C) ° PSC	Distance (D) NM	DR Calculations				
				T	V	M	D	C
9/23/02	0700		432.6					
	0730	001	435.6					
				Distance =				
	0800	076	438.8					
				Distance =				
	0830	319	442.2					
				Distance =				
	0900	076	445.4					
				Distance =				
	0930	319	448.4					
				Distance =				

Convert the Compass courses to °T. Plot the DR in °T for this period of time starting from point "E" and determine your DR position at 0930 hours.

Latitude \_\_\_\_\_, Longitude \_\_\_\_\_

# Chapter 5 Solutions

Calculate Variation as follows:  
 2002 -1985 = 17 years x 5' = 85'

Variation in 1985 = 8°00'W  
                           + 85'  
                           9°25'W  
                           9°W

<b>Deviation Table</b>		
<u>Ship's Heading</u> °M	<u>Deviation</u> °	<u>Ship's Heading</u> °PSC
358	2W	0
027	3W	030
056	4W	060
086	4W	090
117	3W	120
148	2W	150
179	1W	180
210	0	210
241	1E	240
271	1E	270
300	0	300
329	1W	330
358	2W	360

Complete the DR Calculations column as follows:

<u>Date</u>	<u>Time</u>	<u>Course (C)</u> ° PSC	<u>Distance (D)</u> NM	<u>DR Calculations</u>				
9/23/02	0700		432.6					
	0730	001	435.6	T	V	M	D	C
				350	9W	359	2W	001
				Distance = 435.6 - 432.6 = 3.0				
	0800	076	438.8	T	V	M	D	C
				063	9W	072	4W	076
				Distance = 438.8 - 435.6 = 3.2				
	0830	319	442.2	T	V	M	D	C
				309	9W	318	1W	319
				Distance = 442.2 - 438.8 = 3.4				
	0900	076	445.4	T	V	M	D	C
				063	9W	072	4W	076
				Distance = 445.4 - 442.2 = 3.2				
	0930	319	448.4	T	V	M	D	C
				309	9W	318	1W	319
				Distance = 448.4 - 445.4 = 3.0				

Plot the DR from the starting point "E" using these directions and distances as shown below, then determine the Lat-Long at 0930.

Answer: Lat 26°09.34'N, Long 75°07.42'W



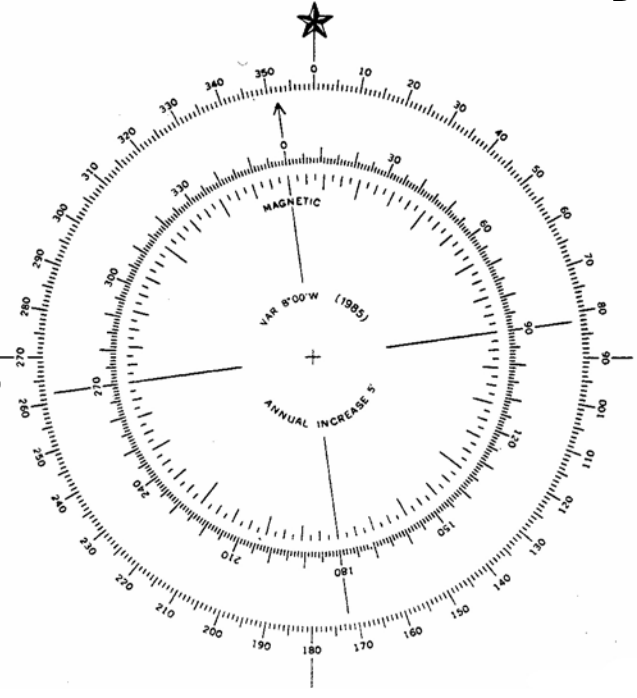
5-1

A •  
26°09.34'N  
75°07.42'W

• B

0930

0900

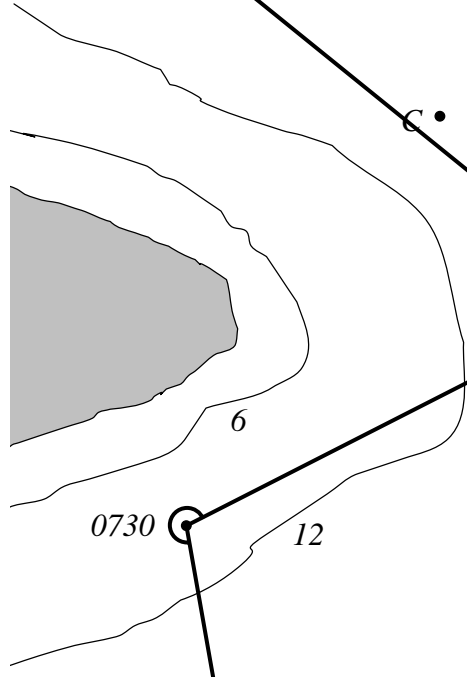


0830

C •

• D

0800



0730

12

• F

E •  
0700  
9/23/02

10

05

26°

10

05

75°

5-3

