CHAPTER 5

COMPASS CONVERSIONS

INTRODUCTION

500. Magnetic Compass Error

Directions relative to the northerly direction along a geographic meridian are **true**. In this case, true north is the **reference direction**. If a compass card is horizontal and oriented so that a straight line from its center to 000° points to true north, any direction measured by the card is a true direction and has no error (assuming there is no calibration or observational error). If the card remains horizontal but is rotated so that it points in any other direction, the amount of the rotation is the **compass error**. Stated differently, compass error is the angular difference between true north and **compass north** (the direction north as indicated by a magnetic compass). It is named east or west to indicate the side of true north on which compass north lies.

If a magnetic compass is influenced by no other magnetic field than that of the earth, and there is no instrumental error, its magnets are aligned with the magnetic meridian at the compass, and 000° of the compass card coincides with **magnetic north**. All directions indicated by the card are **magnetic**. As stated in volume I, the angle between geographic and magnetic meridians is called **variation** (**V** or **Var.**). Therefore, if a compass is aligned with the magnetic meridian, compass error and variation are the same.

When a compass is mounted in a vessel, it is generally subjected to various magnetic influences other than that of the earth. These arise largely from induced magnetism in metal decks, bulkheads, masts, stacks, boat davits, guns, etc., and from electromagnetic fields associated with direct current in electrical circuits. Some metal in the vicinity of the compass may have acquired permanent magnetism. The actual magnetic field at the compass is the vector sum, or resultant of all individual fields at that point. Since the direction of this resultant field is generally not the same as that of the earth's field alone, the compass magnets do not lie in the magnetic meridian, but in a direction that makes an angle with it. This angle is called **deviation** (**D** or **Dev.**). Thus, deviation is the angular difference between magnetic north and compass north. It is expressed in angular units and named east or west to indicate the side of magnetic north on which compass north lies. Thus, deviation is the error of the compass in pointing to magnetic north, and all directions measured with compass north as the reference direction are **compass directions**. Since variation and deviation may each be either east or west, the effect of deviation may be to either increase or decrease the error due to variation alone. The algebraic sum of variation and deviation is the total compass error.

For computational purposes, deviation and compass error, like variation, may be designated positive· (+) if east and negative (-) if west.

Variation changes with location. Deviation depends upon the magnetic latitude and also upon the individual vessel, its trim and loading, whether it is pitching or rolling, the heading (orientation of the vessel with respect to the earth's magnetic field), and the location of the compass within the vessel. Therefore, deviation is not published on charts. The effects of variation and deviation on the compass card is depicted in Figure 500.

501. Deviation Table

In practice aboard ship, the deviation is reduced to a minimum through adjustment of the compass. The remaining value, called **residual deviation**, is determined on various headings and recorded in some form of **deviation table**. Figure 502 shows the form used by the United States Navy. This table is entered with the magnetic heading, and the deviation on that heading is determined from the tabulation, separate columns being given for degaussing (DG) equipment off and on. If the deviation is not more than about 2° on any heading, satisfactory results may be obtained by entering the values at intervals of 45° only.

If the deviation is small, no appreciable error is introduced by entering the table with either magnetic or compass heading. If the deviation on some headings is large, the desirable action is to reduce it, but if this is not practicable, a separate deviation table for compass heading entry may be useful. This may be made by applying the tabulated deviation to each entry value of magnetic heading, to find the corresponding compass heading, and then interpolating between these to find the value of deviation at each 15° compass heading.

502. Applying Variation and Deviation

As indicated in Section 500, a single direction may have any of several numerical values depending upon the reference direction used. One should keep clearly in mind the relationship between the various expressions of a direction. Thus, true and magnetic directions differ by the

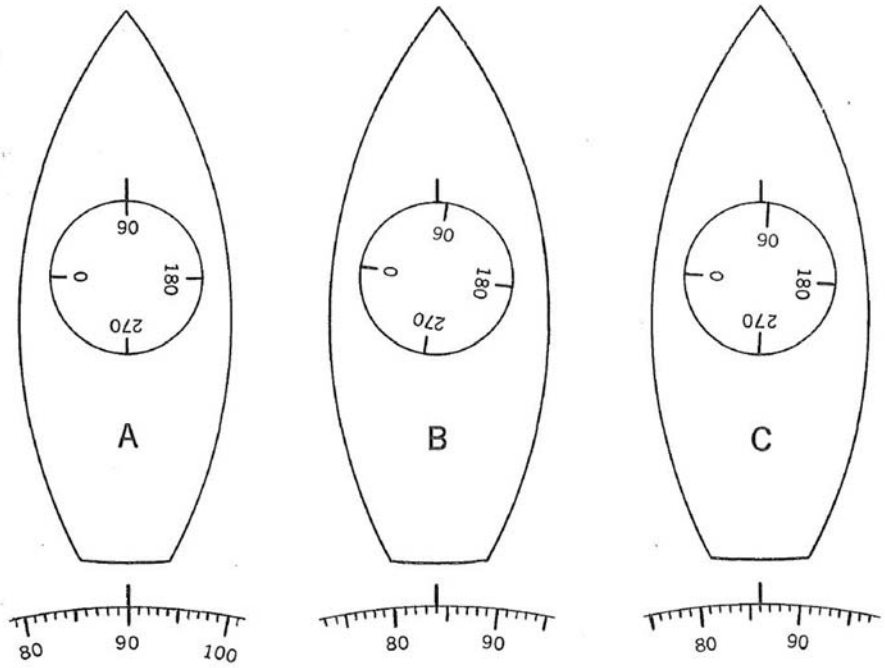

Figure 500. Effects of variation and deviation on the compass card.

variation, magnetic and compass directions differ by the deviation, and true and compass directions differ by the compass error.

If variation or deviation is easterly, the compass card is rotated in a clockwise direction. This brings smaller numbers opposite the lubber's line. Conversely, if either error is westerly, the rotation is counterclockwise and larger numbers are brought opposite the lubber's line. Thus, if the heading is 090° true (Figure 500, A) and variation is 6°E, the magnetic heading is 090°- 6°= 084° (Figure 500, B). If the deviation on this heading is 2°W, the compass heading is 084°+ 2°= 086° (Figure 500, C). Also, compass error is 6°E-2°W= 4°E, and compass heading is 090°- 4°= 086°. If compass error is easterly, the compass reads too low (in comparison with true directions), and if it is westerly, the reading is too high. Many rules-of-thumb have been devised as an aid to the memory, and any which assist in applying compass errors in the right direction are of value. However, one may forget the rule or its method of application, or may wish to have an independent check. If they understand the explanation given above, they can determine the correct sign without further information. The same rules apply to the use of gyro error. Since variation and deviation are compass errors, the process of removing either from an indication of a direction (converting compass to magnetic or magnetic to true) is often called **correcting**. Conversion in the opposite direction (inserting errors) is then called **uncorrecting**.

Example. - A vessel is on course 215° true in an area where the variation is 7°W. The deviation is as shown in Figure 502. Degaussing is off. The gyro error (GE) is 1° E. A lighthouse bears 306.5° by magnetic compass.

Required.- (1) Magnetic heading (MH).
(2) Deviation.
(3) Compass heading (CH).
(4) Compass error.
(5) Gyro heading.
(6) Magnetic bearing of the lighthouse.
(7) True bearing of the lighthouse.
(8) Relative bearing of the lighthouse.

Solution. -

	TH	215°
	V	7°W
(1)	MH	222°
(2)	D	1.5°W
(3)	CH	223.5°

The deviation is taken from the deviation table (Figure 502) to the nearest half degree.

(4) Compass error is 7° W + 1.5° W = 8.5° W.

	TH	215°
	GE	1°E
(5)	Hpgc	214°
	CB	306.5°

	D	1.5°W
(6)	MB	305°
	V	7°W
(7)	TB	298°

(8) RB='I'B-TH=298°-215°= 083°.

Answers.- (1) MH 222°, (2) D 1.5W°, (3) CH 223.5°, (4) CE 8.5°W, (5) Hpgc 214°, (6) MB 305°, (7) TB 298°, (8) RB 083°.

Problem 1 - Fill in the blanks to this table						
	TC	V	MC	D	CC	CE
	°	°	°	°	°	°
(1)	105	15 E	-	5W	-	-
(2)	-	-	-	4 E	215	14 E
(3)	-	12 W	-	-	067	7 W
(4)	156	-	166	-	160	-
(5)	222	-	216	3 W	-	-
(6)	009	-	357	-	-	10 E
(7)	-	2 W	-	6 E	015	-
(8)	-	-	210	-	214	1 W

Answers to Problem 1.- (1) MC 090°, CC 095°, CE 10°E; (2) TC 229°, V 10°E, MC 219°; (3) TC 060°, MC 072°, D 5°E; (4) V 10°W, D 6°E, CE 4°W; (5) V 6°E, CC 219°, CE 3°E; (6) V 12°E, D 2°W, CC 359°; (7) TC 019°, MC 021°, CE 4°E; (8) TC 213°, V 3°E, D 4°W.

Problem 2: A vessel is on course 150° by compass in an area where the variation is 19°E. The deviation is as shown in Figure 502. Degaussing is on.

Required. - (1) Deviation.

(2) Compass error.

(3) Magnetic heading.

(4) True heading.

Answers to Problem 2. - (1) D 1° E, (2) XE 20° E, (3) MH 151°, (4) TH 170°.

Problem 3: A vessel on a course of 055° by gyro and 041° by magnetic compass. The gyro error is 1° W. The variation is 15° E.

Required. - The deviation on this heading.

Answer to Problem 3. - 2° W.

Problem 4: A vessel is on course 177° by gyro. The gyro error is 0.5° E. A beacon bears 088° by magnetic compass in an area where variation is 11° W. The deviation is as shown in Figure 502. degaussing off.

Required. - The true bearing of the beacon.

Answer to Problem 4. - TB 076°.

MAGNETIC COMPASS TABLE NAVSHIPS RPT. 3530-2
NAVSHIPS 3120/4 (REV. 8-67) (FRONT) *(Formerly NAVSHIPS 1104)*
S/N 0105-601-9520

U.S.S. Truckee NO. AO 147 *(BB, CL, DD, etc.)*

[X] PILOT HOUSE [ ] SECONDARY CONNING STATION [ ] OTHER

BINNACLE TYPE: [X] NAVY ST'D [ ] OTHER

COMPASS 7 1/2 MAKE Lionel SERIAL NO. 1592

TYPE CC COILS "K" DATE

READ INSTRUCTIONS ON BACK BEFORE STARTING ADJUSTMENT

SHIPS HEAD MAGNETIC	DEVIATIONS DG OFF	DEVIATIONS DG ON	SHIPS HEAD MAGNETIC	DEVIATIONS DG OFF	DEVIATIONS DG ON
0	0.5E	0.5E	180	0.5W	0.0
15	1.0E	1.0E	195	1.0W	0.5W
30	1.5E	1.5E	210	1.0W	1.0W
45	2.0E	1.5E	225	1.5W	1.5W
60	2.0E	2.0E	240	2.0W	2.0W
75	2.5E	2.5E	255	2.0W	2.5W
90	2.5E	3.0E	270	1.5W	2.0W
105	2.0E	2.5E	285	1.0W	1.5W
120	1.5E	2.0E	300	1.0W	1.0W
135	1.5E	1.5E	315	0.5W	0.5W
150	1.0E	1.0E	330	0.5W	0.5W
165	0.0	0.5E	345	0.0	0.0

DEVIATIONS DETERMINED BY: [ ] SUN'S AZIMUTH [X] GYRO [ ] SHORE BEARINGS

B 4 MAGNETS RED [ ] FORE [X] AFT AT 14" FROM COMPASS CARD

C 4 MAGNETS RED [ ] PORT [X] STBD AT 10" FROM COMPASS CARD

D 2-7" [X] SPHERES [ ] CYLS AT 12" [X] ATHHART-SHIP [ ] SLEWED ---° [ ] CLOCKWISE [ ] CTR. CLOCKWISE

HEELING MAGNET: [ ] RED UP [X] BLUE UP 10" FROM COMPASS CARD

FLINDERS BAR: [X] FORE 14" [ ] AFT

[X] LAT [ ] H 36°10' N [X] LONG [ ] Z 75° 20' W

SIGNED *(Adjuster or Navigator)* T. PARRISH

APPROVED *(Commanding)* R. MOSS

Figure 502. Deviation table.