



**Australian Government**

# **Assessment Requirements for MARB050**

## **Adjust a magnetic compass**

**Release: 1**

# Assessment Requirements for MARB050 Adjust a magnetic compass

## Modification History

Release 1. This is the first release of this unit of competency in the MAR Maritime Training Package.

## Performance Evidence

Evidence required to demonstrate competence in this unit must be relevant to and satisfy all of the requirements of the elements and performance criteria on at least one of occasion and include:

- adjusting a magnetic compass onboard a variety of International Convention for the Safety of Life at Sea (SOLAS) compliant commercial vessels on at least six (6) separate occasions and must include:
  - three (3) swings onboard SOLAS compliant commercial vessels between 500 Gross Tonnage (GT) and 3,000 GT, and
  - three (3) swings onboard SOLAS compliant commercial vessels greater than 3,000 GT
- Or:
  - three (3) swings onboard a SOLAS compliant commercial vessels between 500 GT and 3,000 GT, and
  - three (3) swings onboard a SOLAS compliant commercial vessels greater than 500 GT trading between hemispheres.
- adjusting deviations from coefficients taking into consideration limitations and practicalities and accuracy of results when adjusting a magnetic compass
- analysing the ships compass deviation book and records to determine causes of irregular deviations and determining measures for their removal
- ascertaining the magnetic bearing of a distant object and/or magnetic heading to determine compass deviation
- assessing the safe distances of electronic equipment in the vicinity of the compass
- checking accuracy of instruments used during the adjustment compasses, including pelorus, azimuth mirror/circle and alignment of gyro repeaters (as required)
- constructing a table and curve of deviations to determine coefficients
- swinging a ship using a fixed distant object, calculate the magnetic bearing to use for the observations and state how the correctors should be placed to correct the deviations and minimise the coefficients
- taking a celestial and terrestrial bearing using an azimuth mirror
- using a pelorus to determine a magnetic bearing and magnetic heading
- using methods of swinging a ship to obtain a table of deviations
- using the analysis method of adjustment and the tentative method of adjustment to adjust a

magnetic compass

- using the appropriate equipment, methods, theories and calculations for finding and compensating compass deviations
- using vertical force instrument (VFI) correctly and accurately.

## Knowledge Evidence

Evidence required to demonstrate competence in this unit must be relevant to and satisfy all of the requirements of the elements and performance criteria and include knowledge of:

- analysis method of adjustment and the tentative method of adjustment
- calculate maximum and minimum deviation due to permanent B and C and the heading on which these occur, including:
  - the effect on these values when the ship locates to another position on the earth's surface and horizontal component of the earth's magnetic field (H) and dip change
- calculations and solving problems, including:
  - how to solve problems involving an independent variable, including:
    - equations with direct, partial and inverse dependency
  - how to solve simultaneous equations with two unknowns
  - graphs and rectangular coordinates, including:
    - graphs which are developed using rectangular coordinates
    - information which can be extracted from a graph which uses rectangular coordinates
    - interpretation of graphs with rectangular coordinates
  - plane triangles, with or without right angles, including:
    - cosine formula
    - sine formula
    - trigonometry
  - spherical triangles, including:
    - definition of spherical triangles
    - the use of spherical triangles to solve azimuth
  - use of algebraic formulae, including:
    - how to use equations to assist in determining a solution
  - vector quantities, including:
    - vector additions completed graphically and mathematically
- calculations and heeling error constant, including:
  - calculations to derive the value of coefficient J
  - calculations to estimate deviation when variables H, Z and i (angle of heel) are changed along with a change in heel from port or starboard and vice versa
  - calculations to find deviation on any heading with the vessel heeled
  - condition for no deviation due to heeling error

- calculations and mathematical theories, including:
  - Fourier's Theorem and derivation of equation of condition
  - mathematical theory of the deviation at the compass (vessel upright)
  - Poisson's equations and calculations
  - slewing soft iron correctors to correct coefficient D and E together
  - slewing soft iron correctors to correct coefficient induced B and induced C together
- calculations involving approximate and exact coefficients, including:
  - how to derive the exact coefficients
  - threshold for deciding when to use exact instead of approximate in the equation of condition, and vice versa
- calculations involving quadrantal correctors, including:
  - calculations to describe the effects of the soft iron correctors
  - how coefficient D is minimised by the increase and decrease of soft iron rods a and e
  - positioning of quadrantal correctors to correct for coefficients +D and -D
- calculations involving the approximate coefficients by the method of least squares, including:
  - approximate method of analysis to show that A, D and E have the same value as if derived by least squares
  - use of two formula derived from the least squares method to calculate the correct coefficients B and C and thereby, also derive sextantal coefficients F and G, if existing
- causes of sextantal and octantal deviations including coefficients F, G, H and K
- construction of curve of deviations and its practical use in coefficient analysis
- directive force and calculations to find:
  - mean directive force on board, its effect on deflection and relationship with Lambda ( $\lambda$ )
  - methods to determine directive force, including modern instruments and magnetometers
- effect of heel on forces and rods
- forces P, Q and R
- general magnetism, magneto statistics and magnetometry, including:
  - calculations involving:
    - comparison of magnetic fields of magnets
    - first and second laws of magnetism
    - force exerted by a bar magnet on a point pole, including:
      - at right angles to the bar magnet
      - in line with bar magnet
      - when the point pole is any other direction
    - force exerted by a short and long bar magnet
    - how to calculate the direction of freely suspended needle onboard a ship given values for P, Q, R and soft iron rods
    - how to calculate the position of the neutral point between two bar magnets
    - how to calculate when the length of the magnet is not small when compared to the distance
    - how to calculate the magnetic length of a magnet

- magnetic moment and moment of inertia of a magnet bar
- magnetic potential and work done in moving a bar magnet
- sine and tangent rule and maximum deflection when disturbing force is at right angles to the deflected compass needle
- tangent rule and combining it with the expression for the force exerted by a bar magnet, including:
  - end-on and broadside-on
- heeling error, including:
  - correct use of the vertical force instrument (VFI)
  - effect of the g rod on error
  - effect on deviation of uncompensated c and e rods
  - identifying heeling error
  - measuring vertical force at the compass position
  - ship's multiplier ( $\lambda_2$ )
  - using vertical magnets to compensate heeling error
- how to test soft iron correctors for permanent magnetism and if permanent magnetism is found, how it is removed
- limitations of the accuracy of results from carrying out a compass adjustment, including:
  - apparent coefficient A
  - Gaussin error
  - gyro repeater not in the F&A line of the vessel
  - inherent errors when using gyro headings for a compass adjustment
  - instruments
  - magnetic bearing in error
  - method used to determine the deviation and coefficients, including:
    - effect on coefficients B and C, when coefficients F and G have sensible values
  - misalignment of lubberline and/or pelorus heading marker
  - observational errors, including:
    - constant errors
    - gross errors
    - random errors
  - observation of celestial body if altitude is high vs amplitude observation
  - recording errors
  - uncorrected or poorly compensated HE (heeling error) producing oscillations on N/S (north and/or south) headings which can deliver large errors when attempting to compare with the master gyro/repeater:
    - causes and identification of pitching errors on E/W headings
  - vessel movement
  - weather conditions and environment, including:
    - pitching

- rolling
- methods used for:
  - detecting mechanical errors in a liquid magnetic compass
  - taking a bearing, using and testing a pelorus and azimuth mirror
- process for reviewing ship's compass deviation book and ship's records to identify causes of irregular deviations and recording outcomes of compass adjustment
- rods a, b, c, d, e, f, g, h and k and their connection with coefficients A, D and E
- ships magnetism, including:
  - calculation of:
    - coefficients A - E derived from deviations on the eight principle compass headings and the deviation expected on a given compass heading
    - split B and C calculations with a compensated and uncompensated compass
  - how to determine:
    - the compass should be adjusted or re-adjusted given the position of the correctors and the coefficients derived from a set of deviations
    - the most probable values of B and C should higher order coefficients F and G exist
  - swinging a ship using a fixed distant object, calculate the magnetic bearing to use for the observations and state how the correctors should be placed to correct the deviations and minimise the coefficients
- standard for compass adjusting ISO 25862:2019 Ships and marine technology — Marine magnetic compasses, binnacles and azimuth reading devices
- terrestrial magnetism and calculations, including:
  - change of latitude and its effect on the coefficients A – E, including:
    - relationship between induced magnetism and dip
    - relationship between permanent magnetism and H
    - separation of permanent and induced magnetism P and cZ – split B
    - separation of permanent and induced magnetism Q and fZ – split C
  - directive force and calculations to find:
    - mean directive force on board and its effects on deflection and relationship with Lambda ( $\lambda$ )
    - methods to determine directive force, including modern instruments and magnetometers
  - the earth as a dipole and relationships are made between magnetic latitude, H, Z and T, including:
    - how to calculate the approximate values of H, Z and dip at a geographic position
- tools and equipment used to inspect and adjust a compass, including:
  - alignment of gyro repeater in the F and A line of the ship if it is used in the adjustment
  - azimuth circle and mirror
  - correctors
  - pelorus
  - VFI

- ‘wiping’ and degaussing a ship’s hull
- work health and safety (WHS)/occupational health and safety (OHS) work procedures including:
  - embarking and disembarking from a ship safely
  - manufacturers specifications
  - Marine Order and SOLAS, including requirements of a safely rigged pilot ladder
  - personal protective equipment (PPE) requirements.

## Assessment Conditions

Assessors must hold credentials specified within the Standards for Registered Training Organisations current at the time of assessment.

Assessment must satisfy the Principles of Assessment and Rules of Evidence and all regulatory requirements included within the Standards for Registered Training Organisations current at the time of assessment.

Assessment processes and techniques must be appropriate to the language, literacy and numeracy requirements of the work being performed and the needs of the candidate.

Practical assessment must include at least six practical swings onboard a variety of SOLAS compliant commercial vessels.

A qualified Compass Adjuster as defined in Marine Orders and/or qualified assessor must accompany and supervise a person undertaking practical assessments onboard a vessel.

All swings must be recorded in a training log, signed by a qualified Compass Adjuster and verified by a qualified assessor.

Resources for assessment must include access to:

- applicable documentation, such as legislation, regulations, codes of practice, workplace procedures, ship’s compass deviation book and operational manuals
- compass adjustor tools, equipment and materials currently used in industry.

## Links

Companion Volume Implementation Guides are found in VETNet -

<https://vetnet.gov.au/Pages/TrainingDocs.aspx?q=772efb7b-4cce-47fe-9bbd-ee3b1d1eb4c2>