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Magnetic compasses and accessories — Rules for testing and certification

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FOREWORD

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Draft International Standards adopted by the Technical Committees are circulated to the Member Bodies for approval before their acceptance as International Standards by the ISO Council.

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Magnetic compasses and accessories — Rules for testing and certification

ERRATUM

Page 9

Scope, third line : Amend "developped" to read "developed".

Page 10

Sub-clause 2.1.3.1, second line : Amend "when test" to read "when tested".

Page 21

Sub-clause 2.3.1, first line : Amend "verge or" to read "verge ring or".

Sub-clause 2.5.1, last line : Amend "2.5.2 or 2.5.4" to read "2.5.2 to 2.5.4".

Page 22

Sub-clause 2.6.2.2, eleventh line : Amend "diametrally" to read "diametrically".

Page 24

Sub-clause 3.2, first line : Amend "azimuth devices" to read "azimuth reading devices".

Page 27

Sub-clause 2.3.1, first line : Amend "verge or" to read "verge ring or".

Page 31

Sub-clause 3.6A.2, third line : Amend "the plane sight" to read "the plane of sight".

Page 35

Sub-clause 1.3b), third line : Amend "fitting" to read "fittings".

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Magnetic compasses and accessories — Rules for testing and certification

PART I

TYPE TESTING AND CERTIFICATION

SECTION I — MAGNETIC COMPASSES AND ACCESSORIES — CLASS A

INTRODUCTION

The following test procedures are based on the performance specifications as laid down in ISO/R 449, *Magnetic compasses and binnacles, Class A, for use in sea navigation.*

Acceptance of Test Certificates between countries will be a matter for mutual agreement.

SCOPE

This part of this International Standard sets out the test procedures and acceptable limits of performance necessary in order to establish conformity of newly developed devices with the requirements laid down in ISO/R 449.

1 GENERAL

1.1 *Conditions for testing*

The type-testing shall be carried out before the compasses come into regular service.

For type-testing, new devices only are to be accepted. All compasses other than those hemispherical compasses which are used as steering compasses only, are to be tested with their gimbal ring(s).

Unless otherwise stated, all tests are to be carried out at a temperature of 20 ± 3 °C.

1.2 Types of compasses

Testing shall be carried out on :

a) standard compasses;

b) steering compasses;

c) standby steering and emergency compasses;

these include projector, reflector or transmitting compasses, and compasses which allow course readings and control navigational aids;

d) azimuth reading devices.

1.3 Manufacturer's statement

The manufacturer shall produce a written statement covering those requirements which cannot be ascertained during the type test. The statement shall contain the following points :

a) that the coercivity of the magnets of the directional system is at least 11 200 A/m;

b) that the paint used inside the compass is of good quality and that over a period of 2 years it is not likely to deteriorate to such an extent as to make the compass unusable, either as a result of a change of temperature over the range of − 30 °C to + 60 °C, or any other cause (for example the legibility of graduations shall not be impaired by discolouration or blistering);

c) under the circumstances described in b), that the compass liquid is not likely to show any appreciable discolouration such as to render the compass unusable;

d) whether non-toughened or toughened glass is used for the top and bottom glass covers;

alternatively, when material other than glass is used, that its strength is equivalent to that of non-toughened glass of the thickness prescribed;

e) that the material of the compass card will not distort;

f) that the moment of inertia of the directional system is appreciably the same about all horizontal axes passing through the bearing surface of the pivot jewel;

g) the vertical distance between the mid-plane of the magnets of the directional system and the inner gimbal axis of the compass supplied.

1.4 Marking

1.4.1 Compasses shall be marked in a conspicuous place on the compass card and the verge ring with the name of the manufacturer, or other means of identification.

Compass card, verge ring and gimbal ring shall be marked with an identification number.

Azimuth reading devices shall be marked on the top of the base with the name of the manufacturer or other means of identification, and an identification number.

1.4.2 The above mentioned markings shall be noted on the certificate.

1.4.3 If the jewel retaining screw is not visible, a small mark (about 1 mm across) may be placed at the top of the float to assist in testing.

1.4.4 If other than alcohol, the type of liquid used shall be marked on the bowl in the vicinity of the filling plug.

1.5 Type test certificates

1.5.1 Devices which have passed the type test and comply with the requirements shall be so certified in two languages – in the language of the test authority and in English.

Separate certificates shall be issued for magnetic compasses and azimuth reading devices.

1.5.2 Each certificate is valid exclusively for the model tested. In case of alterations or technical improvements which affect its compliance with ISO/R 449, the model shall be given a new identification number (or mark) and the type test repeated. All alterations shall be submitted to the original test authority who will decide whether a new type test is necessary.

1.5.3 Copies of the certificates shall be issued on demand. They must explicitly be marked "Copy".

1.6 Sample checks

In order to check that the manufacturer's statement in 1.3 has been fulfilled, sample checks may be carried out.

2 COMPASS AND GIMBAL RING

2.1 Construction and material

2.1.1 *Non-magnetic properties*

Compass bowls and gimbals shall undergo an examination to test their non-magnetic properties. See 2.7.4.

2.1.2 *Condition of compass bowl*

The compass shall be inspected to see that it is in an undamaged and mechanically perfect condition. The liquid shall be colourless and free from turbidity and formation of flocks. There shall be no leaks. The paint, including that on the compass card, shall be free from cracks and blisters.

2.1.3 *Condition at high temperature*

The compass shall be warmed up slowly from room temperature to between + 55 °C and + 60 °C and kept at least 8 h at this temperature. After this period the compass shall not show any mechanical damage, leakage or bubbles. The compass liquid and the paint shall not show any deterioration, and the directional system shall not be deformed.

2.1.3.1 The error due to friction, when tested in accordance with the procedure described in 2.7.3, shall not exceed the value of 0,5°.

2.1.4 *Condition at low temperature*

The compass shall be slowly cooled down to between – 25 °C and – 30 °C and kept at least 8 h at this temperature. After this period the compass shall not show any mechanical damage or deformation, leakage or bubbles. The liquid in the bowl shall not be frozen, discoloured or separated into its ingredients. A formation of flocks or ice shall not have occurred within the liquid, and the directional system shall not be deformed.

2.1.4.1 The error due to friction, when tested in accordance with the procedure described in 2.7.3, but with an initial deflection of ± 10°, shall not exceed the value of 1°.

2.1.5 *Thickness of the top and bottom glass cover*

When made of non-toughened glass, the glass covers of compasses (including the hemispherical type) shall have a thickness of at least 4,5 mm.

When toughened glass is used, the thickness shall be at least 3,0 mm.

The type of glass used shall be stated in the manufacturer's statement.

NOTE – When material other than glass is used, its properties shall be stated in accordance with 1.3 d).

The thickness of the glass may be measured by means of a micrometer. As this requires the opening of the compass, it shall be done when the other examinations have been carried out.

2.2 Compass gimballing

2.2.1 *Plane of the gimbal axes*

The gimbal axes shall lie in one plane, within a tolerance of 1 mm.

This test may be carried out from a fixed horizontal plane of reference by means of a suitable scale.

2.2.2 *Angle of the gimbal axes and the intersection of the vertical planes passing through them*

The angle formed by the outer and inner gimbal axes shall be 90 ± 1°. The vertical planes through the gimbal axes

shall intersect to within 1 mm of the pivot point. The outer gimbal axis shall be in the fore and aft direction.

Measurement of the angle of the axes may be made by means of the graduation of the testing stand, when first one and then the other gimbal axis is brought into the vertical plane of view passing through the centre of the graduation, by turning the compass support.

Determination of the line of intersection may be carried out on a testing stand by measuring the displacement of the compass support in a direction perpendicular to either of the gimbal axes.

2.2.3 *Freedom of movement within the gimbal ring*

When the gimbal ring is in the horizontal plane, the compass bowl shall freely revolve about the inner axis up to ± 40°.

The measurement may be carried out by a clinometer placed on the top glass cover or verge ring.

2.2.4 *Horizontal position*

The compass bowl shall be balanced so that its verge ring or top glass cover settles in the horizontal plane to within 1° when the gimbal ring is fixed in a horizontal position; this shall be so whether the azimuth reading device or magnifying glass is in place or not.

Measurement shall be carried out using a spirit level of suitable sensitivity placed on the top glass cover or its verge ring.

2.2.5 *Friction of the inner gimbal axis*

When the gimbal ring is kept in the horizontal position and the compass bowl is inclined by ± 5°, it shall return to within 1° of the horizontal plane.

The test may be carried out by means of a clinometer or a spirit level.

2.2.6 *Bearings of the gimbal axis*

The axial play of the compass bowl in the direction of the inner gimbal axis shall not exceed 0,2 mm.

Measurement may be carried out by means of a feeler gauge.

NOTE – The bearings of the inner and outer gimbal axes shall be of the same type.

2.3 Compass bowl

2.3.1 *Verge ring or relative bearing ring graduation (if any)*

The verge ring shall be graduated in 360 single degrees in a clockwise direction; each 10th degree shall be marked with three figures so that, as seen through the azimuth reading device, 000° is the direction of the ship's head.

This shall be checked by inspection.

2.3.2 *Centring of azimuth reading devices*

The distance between the rotating axis of the azimuth reading device (bridge type or ring type) and the vertical axis of rotation of the compass card passing through the pivot point shall not exceed 0,3 mm.

Depending on the construction of the azimuth reading device, the axis of rotation may be defined either by an indentation or centre boss on the top glass cover of the compass, or by the centre of the inside or outside rim of the verge ring, or by the outside rim of the compass bowl.

The examination may be carried out by measuring, on a compass testing stand, the displacement which is necessary to bring the pivot point of the compass, when horizontal, and the axis of rotation of the azimuth reading device, one after the other, into coincidence with the axis of rotation of the testing stand.

2.3.3 *Directional error of the verge ring graduation*

The angle between the vertical plane passing through the rotating axis of the azimuth reading device and the main lubber mark, and the vertical plane passing through the rotating axis of the azimuth reading device and the zero point of the verge ring graduation, shall not exceed 0,5°.

2.4 Compass card bearing

2.4.1 *Centring of the pivot*

The pivot point shall not deviate by more than 0,2 mm from the vertical through the centre of the inner rim diameter of the bowl measured in the inner gimbal axis.

NOTE – The tolerance given above is only for use when the azimuth reading device to be used in conjunction with the compass is of the ring type.

The test may be carried out on a testing stand by measuring the movement which is necessary to bring first the centre of the inner side rim, when the bowl is horizontal, and then the pivot bearing into the centre of the testing stand.

2.4.2 *Height of the pivot bearing*

The pivot point shall not deviate from the horizontal plane through the inner gimbal axis by more than 1,0 mm. Should the pivot bearing be equipped with a vertical spring suspension, this condition shall be fulfilled when the directional system is completely immersed.

When the compass bowl is open, this examination may be carried out by using a depth-gauge, the rim of the compass bowl being the plane of reference.

2.4.3 *Retention of the directional system against displacement*

The bearing of the directional system shall be constructed in such a way that it returns to the original position on its pivot when the bowl is completely inverted and returned to normal.

This can be checked by visual inspection.

2.4.4 *Freedom of tilt of the directional system*

The bearing of the directional system and the compass bowl shall be constructed in such a way that the directional system can rotate freely when the compass bowl is tilted in any direction at an angle of :

a) 10° when the compass has a flat top cover;

b) 30° when the compass is of the hemispherical type.

The examination may be carried out by means of a revolving platform with adjustable inclination.

2.5 Lubber marks

2.5.1 *Number of lubber marks*

Each compass shall be fitted with a lubber mark indicating the direction of the ship's head (main lubber mark). Other lubber marks are allowed showing the direction of the ship's stern or athwartships respectively. These additional lubber marks shall fulfil the conditions laid down in 2.5.2 to 2.5.4. The main lubber mark shall be clearly identifiable.

2.5.2 *Length of the lubber mark(s)*

The lubber mark(s) shall be of such a shape that the card may be read against the lubber mark when the compass bowl of a gimbal compass is tilted 10°, and that of a hemispherical compass is tilted 30°, from the horizontal plane.

The examination may be carried out by visual inspection in conjunction with the examination described in 2.4.4.

2.5.3 *Width of the lubber mark(s)*

The width of the lubber mark(s) shall be not greater than 0,5° of the graduation of the card.

The examination may be carried out by visual inspection.

2.5.4 *Distance between lubber mark and outer edge of the card*

The distance between the lubber mark and the outer edge of the card shall be between 1,5 and 3,0 mm.

The examination may be carried out by using a mirror gauge which is laid on top of the rim of the bowl, or by a travelling microscope, or by direct measurement when the compass has been dismantled.

2.6 Directional system

2.6.1 *Compass card*

2.6.1.1 Graduation

Compass cards shall be graduated in single degrees, starting from North = 000° or 360° in a clockwise direction as viewed from above.

Every 10th degree shall be indicated by corresponding three figures. The cardinal points shall be indicated by the capital letters N, S, E and W. The intermediate points may also be marked. Alternatively, the North point may be indicated by a suitable emblem.

2.6.1.2 Readability

In steering compasses, the thickness of lines and the height of figures and letters shall allow a person with normal vision to read the card, both in daylight and artificial light, at a distance of 1,4 m.

The use of a magnifying device is permitted.

If only part of the card is visible, it shall be possible to read at least 15° on each side of the lubber mark.

The examinations required by 2.6.1.1 and 2.6.1.2 shall be carried out visually.

2.6.1.3 Relationship of edge of compass card and pivot bearing

The pivot point shall be within 1 mm of the plane of the graduated edge of the card.

This measurement may be carried out by means of a depth gauge from a fixed plane of reference.

2.6.2 *Magnets of the directional system*

2.6.2.1 Magnetic moment

The magnetic moment of the directional system shall, depending on the card diameter, be not less than the values given in Figure 1.

The testing may be carried out by means of a magnetometer (deflection method). The length of bar magnets in the directional system shall be not greater than 85 mm.

2.6.2.2 Arrangement of the magnets

The poles of the magnets shall be arranged in such a way that no excessive sextantal or octantal deviation will be produced by the influence of the correcting devices. A criterion for this is the ratio H/D, which means the proportion of the octantal and quadrantal deviation coefficients.

The ratio H/D shall not exceed 0,08.

The test shall be carried out by means of the four-corrector-method of Meldau.

In this test the compass shall be mounted on a stand and two soft iron correctors placed diametrally opposite and symmetrical to the centre of rotation. The device with the two soft iron correctors shall then be rotated around the fixed compass and coefficient D calculated.

To cancel out the quandrantal deviation, two additional exactly similar correctors shall be placed at the same distance from the centre with their line of connection at

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right angles to that of the original pair. The arrangement of the four soft iron correctors shall then be rotated around the compass and coefficient *H* calculated.

From these values the ratio of coefficient *H* to coefficient *D* is obtained.

2.6.2.3 Coercivity

The coercivity of the material of the magnets shall be at least 11 200 A/m. As a manufacturer's statement is required for this, the examination is restricted to sample checks, for which a suitable coercimeter shall be used.

2.6.3 *Tilt of the directional system with regard to the vertical field*

2.6.3.1 Inclination from the horizontal plane in a vertical zero field

The directional system shall be constructed or balanced in such a way that it does not incline more than 0,5° from the horizontal plane when the vertical flux density is zero.

The test shall be carried out with liquid filled compasses of the conventional type when the bowl is dismantled, or by means of a suitable optical device, when closed. In the case of hemispherical compasses, the test may be carried out when the bowl is dismantled.

2.6.3.2 Change of the tilt when the vertical flux density has changed 100 μT (microtesla)

The inclination of the directional system shall not change more than 3° when the vertical flux density changes 100 μT.

The vertical flux density may be changed by means of vertical magnets or coils placed sufficiently far away to produce a uniform field at the directional system. The measurement of tilt of the card shall be carried out in the manner indicated in 2.6.3.1 for conventional type and hemispherical compasses.

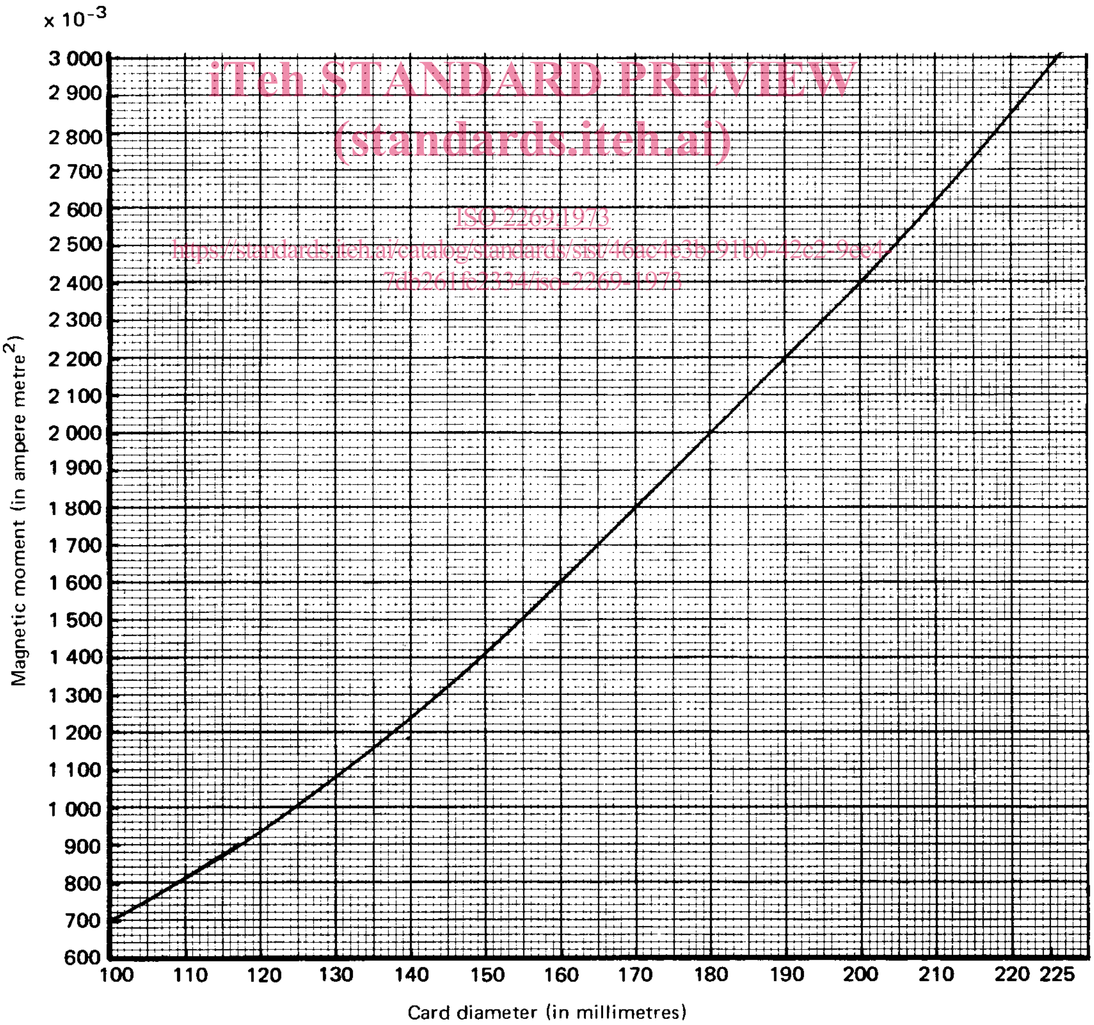

FIGURE 1 – **Magnetic moment of liquid compasses, Class A**
Minimum requirements

2.6.4 *Period*

2.6.4.1 Half period of periodic oscillating directional systems

The half period of the directional system shall be not less than 12 s following an initial deflection of the card of 40° from the magnetic meridian, when the horizontal component of the magnetic flux density is 18 μT.

The half period shall be measured between the first two consecutive passings of the original indication of the course.

The measurement shall be repeated by deflecting the card system in a contrary sense of rotation, and the mean value taken. Before measuring, the directional system shall be kept in the deflected state for 10 s.

Measuring the period may be done by means of a stop-watch or other suitable device.

2.6.4.2 Settling time of aperiodic directional systems

Aperiodic (or heavily damped) systems are those systems which, after an initial deflection, return to the magnetic meridian without carrying out a full oscillation. The time taken to approach finally to within 1° of the magnetic meridian, following an initial deflection of the directional system of 90°, shall be not more than 56 s, when the horizontal component of the magnetic flux density is 18 μT.

The measurement shall be repeated by deflecting the directional system in a contrary sense of rotation, and the mean value taken.

The settling time may be measured by means of a stop-watch or other suitable device.

2.6.5 *Supporting force*

The force exerted on the pivot bearing, in the liquid used, by the directional system shall be between 0,04 N and 0,10 N when the card diameter is 165 mm or less and shall be between 0,04 N and 0,14 N when the card diameter is larger than 165 mm.

The examination may be carried out by means of a suitable balance when the compass bowl is opened.

2.7 Accuracy

2.7.1 *Directional error*

The directional error is a constructional error of the directional system. It is composed of :

a) error of orientation of the magnets with regard to the graduation of the card (collimation error);

b) inaccuracies of graduation of the compass card;

c) eccentricity of the compass card graduation with regard to the centre of rotation of the card.

The directional error shall on no heading exceed 0,5°, and for transmitting compasses 0,6°, the transmitting system being energized or not.

The examination may be carried out on a compass testing stand. After having brought the centre of rotation of the compass card into the axis of rotation of the testing stand, the directional error can be read at the card graduation by means of a telescope, when the vertical plane of sight passing through the axis of rotation has been aligned with the magnetic meridian in advance. This measurement shall be carried out on at least four equidistant headings. When measuring, the top glass cover shall be tapped gently to eliminate the error due to friction (see 2.7.3).

NOTE – If the test is carried out in the compass bowl, it should be noted that the resulting value then includes the deviation due to magnetic material in the compass.

2.7.2 *Lubber error*

The lubber error is a constructional error of the compass bowl and gimbal which depends on the relative position of the main lubber mark (if it is fixed), the pivot bearing, and the direction of the outer gimbal axis.

In compasses with a movable lubber mark, but with an auxiliary graduation for coefficient *A* correction, also in transmitting compasses or compasses which operate auto-pilots with a rotatable compass bowl, the lubber mark shall be brought into the zero position before testing.

The lubber error shall not exceed 0,3°.

For compasses with a movable lubber mark, but without an auxiliary graduation or other means of securing a definite position of the lubber mark in relation to the direction of the outer gimbal axis, or for compasses without gimbals – as in hemispherical compasses for steering purposes only – the lubber error becomes undefined and cannot be determined.

The examination may be carried out on a compass testing stand by bringing the outer gimbal axis into the vertical plane of view passing through the centre of rotation of the testing stand and reading the vernier of the master graduation. After this the pivot point shall be brought into the centre of rotation of the testing stand and the compass support turned until the lubber mark lies in the vertical plane of view. The angle of rotation is the lubber error.

2.7.2.1 If there are additional lubber marks, the angular distances from the main lubber mark shall be 90°, 180° and 270° respectively with a tolerance of 0,3°.

This test may be made by comparison with the master graduation of the testing stand, when testing the lubber error according to the procedure in 2.7.2.

2.7.2.2 For projector compasses the course, as read from the projected image, shall agree with that read at the main lubber mark to within 0,5°.

2.7.3 *Error due to friction*

The directional system, when given an initial deflection of 2° and kept in this position for 10 s, shall, when released, return to within 0,5° of its original position. The original position shall be attained after gently tapping the top glass cover. The measurement shall take place in a horizontal flux density of 6 μT.

The test shall be repeated by deflecting the directional system in the contrary direction and the larger of the values obtained shall be taken as the error due to friction. The reading of the error due to friction may be carried out at the lubber mark, or more accurately, by means of the telescope of the compass testing stand.

2.7.4 *Swirl error*

When the compass bowl is rotated around its vertical axis, at a uniform speed of 360° in 4 min ± 10 s, the deflection of the directional system from the magnetic meridian shall on no heading be more than :

$(36/H)°$ for compasses with cards of less than 200 mm diameter;

$(54/H)°$ for compasses with cards of 200 mm diameter or more,

where H is the horizontal component of the flux density in microtesla at the place of examination.

The observation shall start after the compass has been rotated 180°. After having given the compass liquid a suitable time to settle, the measurement shall be repeated by rotating the compass in the opposite direction. The larger of the values obtained shall be taken to be the swirl error of the compass.

Any irregularity noted in the movement of the directional system during a full revolution shall not exceed $(9/H)°$.

NOTE – The cause of the irregularity may be :

a) friction of the pivot;

b) magnetic material contained in the compass.

In order to determine the cause, a friction test may be carried out on the heading(s) where the irregularity occurs. If the result of this test is satisfactory, a test for magnetic material may then be carried out by obtaining a deviation curve. This will indicate whether there is any magnetic material in the compass.

3 AZIMUTH READING DEVICES

There are two different groups of azimuth reading devices to be tested :

(A) Sights or telescope-sights which require an exact aiming at distant objects.

(B) Azimuth mirror or prism instruments – Thomson type – which do not require exact aiming and from which bearings may be obtained of diminished accuracy at small angles of yaw.

Where the requirements and testing procedure are different for these two groups, the following testing rules are also separated into 3.6A and 3.6B.

3.1 General

Azimuth reading devices shall only be accepted for type testing in connection with a suitable compass.

The data required in 1.4.1, as well as the type and card diameter of the compass to which the azimuth reading device belongs, shall be noted on a separate certificate for azimuth reading devices.

3.2 Material

All parts of azimuth reading devices shall be manufactured of non-magnetic material.

This test shall be carried out by exposing the azimuth reading device to a flux density of 2 mT along its longitudinal, transverse and perpendicular axes consecutively. After each exposure the azimuth reading device shall be placed on the compass to which it belongs. When the device is slowly turned on the compass, no discernible deviation of the directional system shall occur.

3.3 Mounting upon the compass

The azimuth reading device shall easily rotate upon the compass to which it belongs. No lateral movement which causes a difference in the reading of more than 0,2° shall be possible.

The examination may be carried out by means of the card or verge ring graduation of the compass.

3.4 Adjustment of the spirit level (if any)

A spirit level fitted to an azimuth reading device shall be adjusted in such a way that its zero position indicates the horizontal position of the compass top glass cover or verge ring, within a tolerance of 1,0°. The use of adjusting screws is allowed.

The examination may be carried out by comparing the spirit level of the azimuth reading device with a calibrated spirit level placed on the top glass cover or verge ring.

3.5 Field of view and range of altitude

3.5.1 The field of view of an azimuth reading device in the horizontal plane shall be at least 5° on each side of the line of sight.

The examination may be carried out by means of the compass card or verge ring graduation.

3.5.2 The range of altitude covered by an azimuth reading device shall lie between 5° below and at least 60° above the horizon.

The examination may be carried out by means of fixed angle marks on a plumb line or an illuminated vertical slit.