around own ship for targets on relative bearings of 045°, 135°, 225° and 315° and will be zero at relative bearings of 0°, 90°, 180° and 270°. This error has a sinusoidal variation at twice the roll frequency.

For a 10° roll the mean error is
0.22° with a 0.22° peak sine wave superimposed.
Beam shape—assumed normal distribution giving bearing error with $\sigma = 0.05°$.
Pulse shape—assumed normal distribution giving range error with $\sigma = 20$ metres.
Antenna backlash—assumed rectangular distribution giving bearing error ± 0.5° maximum.

(iii) Quantification
Bearing—rectangular distribution ± 0.01° maximum.

Range—rectangular distribution ± 0.01°nautical miles maximum.

Bearing encoder assumed to be running from a remote synchro giving bearing errors with a normal distribution $\sigma = 0.03°$.

(b) Gyro-compass
Calibration error 0.5°.
Normal distribution about this with $\sigma = 0.12°$.

(c) Log
Calibration error 0.5 knots
Normal distribution about this, $3\sigma = 0.2$ knots.

80. Connections with other equipment—The ARPA shall not degrade the performance of any equipment providing sensor inputs. The connection of the ARPA to any other equipment shall not degrade the performance of that equipment.

81. Performance tests and warnings—The ARPA shall provide suitable warnings of ARPA malfunction to enable the observer to monitor the proper operation of the system. Additionally, test programmes shall be available so that the overall performance of ARPA can be assessed periodically against a known solution.

82. Equipment used with ARPA—Log and speed indicators providing inputs to ARPA equipment shall be capable of providing the ship's speed through the water.

Part VIII

Performance Standards for Devices to Indicate Speed and Distance

83. General—(1) Devices to indicate speed and distance are intended for general navigational use to provide information on the distance run and the forward speed of the ship, through the water or over the ground. The equipment shall function at forward speeds up to the maximum speed of the ship and in water of depth greater than 3 metres beneath the keel.

(2) In addition to the general requirements for electronic navigational aids the equipment shall conform to the following minimum performance standards.

84. Methods of presentation—(1) Speed information may be presented in either analogue or digital form. Where a digital display is used, its incremental steps shall not exceed 0.1 knots. Analogue displays shall be graduated at least every 0.5 knots and be marked with figures at least every 5 knots. If the display can present the speed of the ship in both forward and reverse directions, the direction of movement shall be indicated unambiguously.

(2) Distance run information shall be presented in digital form. The display shall cover the range from 0 to not less than 9999.9 nautical miles and the incremental steps shall not exceed 0.1 nautical miles. Where practicable, means shall be provided for resetting a readout to zero.

(3) The display shall be easily readable by day and by night.

(4) Means shall be provided for feeding distance run information to other equipment fitted on board. The information shall be in the form of one contact closure or the equivalent for every 0.005 nautical miles run.

(5) If equipment is capable of being operated in either the "speed through the water" or "speed over the ground" modes, mode selection and mode indication shall be provided.

85. Accuracy of Measurement—(1) Errors in the indicated speed, when the ship is operating free from shallow water effect, and from the effects of wind, current and tide shall not exceed 5 per cent of the speed of the ship, or 0.5 knots, whichever is the greater.

(2) Errors in the indicated distance run, when the ship is operating free from shallow water effect, and from the effects of wind, current and tide shall not exceed 5 per cent of the distance run by the ship in one hour or 0.5 nautical miles in each hour, whichever is the greater.

(3) If the accuracy of devices to indicate speed and distance run can be affected by certain conditions (e.g. sea state and its effects, water temperature, salinity, sound velocity in water, the depth of water under the keel, heel and trim of ship), details of possible effects shall be included in the equipment handbook.

86. Roll and Pitch—The performance of the equipment shall be such that it will meet the requirements of this Schedule when the ship is rolling up to plus or minus 10 degrees and pitching up to plus or minus 5 degrees.

87. Construction and Installation—(1) The system shall be so designed that neither the method of attachment of parts of the equipment to the ship nor damage occurring to any part of the equipment which penetrates the hull could result in the ingress of water to the ship.

(2) Where any part of the system is designed to extend from and retract into the hull of the ship, the design shall ensure that it can be extended, operated normally and retracted at all speeds up to the maximum speed of the ship. Its extended and retracted positions shall be clearly indicated at the display position.

Part IX

Performance Standards for Rate-of-turn Indicators

88. General Requirements—(1) The rate-of-turn indicator (ROTI) shall, in addition to the requirements of these standards, comply with the general requirements for electronic navigational aids.

(2) The ROTI shall be capable of indicating rates of turn to starboard and to port of the ship to which it is fitted.

(3) The ROTI may be self-contained; alternatively it may form part of, or derive information from, any other appropriate equipment.

89. Indication—(1) The indication required shall be provided by a centre-zero analogue type indicator (preferably circular). Where a circular scale indicator is used, the zero shall be uppermost.

(2) A turn of ship to port shall be indicated on the left of the zero point and a starboard turn to the right of the zero point. If the actual rate of turn exceeds full scale deflection, this shall be clearly indicated on the display.

(3) In addition, an alphanumeric display may be provided. Positive indication of port and starboard shall be provided on such displays.

(4) The length of scale in either direction from zero shall not be less than 120mm. The sensitivity of the system shall ensure that a change in the rate of turn of 1° per minute is represented by a distance of not less than 4mm on its scale.

90. Range Scales—(1) A linear range scale of not less than ± 30° per minute shall be provided. This scale shall be marked in intervals of 1° per minute on both sides of zero. The scale shall be marked with figures every 10° per minute. Every 10° mark shall be significantly longer than the 5° mark which