

# Maritime navigation and radiocommunication equipment and systems — Track control systems — Operational and performance requirements, methods of testing and required test results

The European Standard EN 62065:2002 has the status of a  
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National foreword

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The UK participation in its preparation was entrusted to Technical Committee EPL/80, Maritime navigation and radiocommunication equipment and systems, which has the responsibility to:

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**Maritime navigation and radiocommunication equipment and systems -  
Track control systems -  
Operational and performance requirements,  
methods of testing and required test results  
(IEC 62065:2002)**

Matériels et systèmes de navigation  
et de radiocommunication -  
Systèmes de contrôle de route -  
Exigences opérationnelles  
et de fonctionnement,  
méthodes d'essais et résultats exigés  
(CEI 62065:2002)

Navigations- und Funkkommunikationsgeräte  
und -systeme für die Seeschifffahrt -  
Bahnregelungssysteme -  
Betriebs- und Leistungsanforderungen,  
Prüfverfahren und geforderte Prüfergebnisse  
(IEC 62065:2002)

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European Committee for Electrotechnical Standardization  
Comité Européen de Normalisation Electrotechnique  
Europäisches Komitee für Elektrotechnische Normung

**Central Secretariat: rue de Stassart 35, B - 1050 Brussels**

### Foreword

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Annexes designated "normative" are part of the body of the standard.

Annexes designated "informative" are given for information only.

In this standard, annexes A, G, I and ZA are normative and annexes B, C, D, E, F, H and J are informative.

Annex ZA has been added by CENELEC.

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### Endorsement notice

The text of the International Standard IEC 62065:2002 was approved by CENELEC as a European Standard without any modification.

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## CONTENTS

|       |                                                         |    |
|-------|---------------------------------------------------------|----|
| 1     | Scope .....                                             | 7  |
| 2     | Normative references .....                              | 7  |
| 3     | Definitions and abbreviations .....                     | 8  |
| 3.1   | Definitions .....                                       | 8  |
| 3.2   | Abbreviations .....                                     | 11 |
| 4     | Requirements and application of this standard .....     | 12 |
| 4.1   | Operational requirements .....                          | 13 |
| 4.1.1 | Functionality .....                                     | 13 |
| 4.1.2 | Accuracy and performance constraint documentation ..... | 16 |
| 4.1.3 | Alarms and indications .....                            | 16 |
| 4.2   | Ergonomic criteria .....                                | 17 |
| 4.2.1 | Operational controls .....                              | 17 |
| 4.2.2 | Presentation of information .....                       | 18 |
| 4.3   | Design and installation .....                           | 19 |
| 4.4   | Interfacing .....                                       | 19 |
| 4.4.1 | Sensors .....                                           | 19 |
| 4.4.2 | Status information .....                                | 19 |
| 4.4.3 | Standards .....                                         | 19 |
| 4.5   | Fall-back arrangements .....                            | 19 |
| 4.5.1 | Failure of track control .....                          | 19 |
| 4.5.2 | Failure of position sensor .....                        | 20 |
| 4.5.3 | Failure of the heading measuring system .....           | 20 |
| 4.5.4 | Failure of the speed sensor .....                       | 20 |
| 5     | Test requirements and results .....                     | 21 |
| 5.1   | General requirements .....                              | 21 |
| 5.1.1 | Environmental tests .....                               | 21 |
| 5.1.2 | Documentation .....                                     | 22 |
| 5.1.3 | Declarations .....                                      | 23 |
| 5.2   | Environment setup .....                                 | 23 |
| 5.2.1 | Ship motion simulator .....                             | 25 |
| 5.2.2 | Test scenarios .....                                    | 26 |
| 5.2.3 | Planning .....                                          | 26 |
| 5.3   | Test execution .....                                    | 27 |
| 5.3.1 | Check the track .....                                   | 27 |
| 5.3.2 | Execution of the scenarios .....                        | 28 |
| 5.3.3 | Execution of additional tests .....                     | 34 |
| 5.3.4 | Monitoring and alarms .....                             | 36 |
| 5.3.5 | Fallback and manual change over .....                   | 39 |
| 5.3.6 | Display of information .....                            | 41 |
| 5.3.7 | Operational controls (4.2.1.1, 4.2.1.2) .....           | 42 |

|                                                                                 |    |
|---------------------------------------------------------------------------------|----|
| Annex A (normative) .....                                                       | 43 |
| Annex B (informative) Speed control .....                                       | 44 |
| B.1 General .....                                                               | 44 |
| B.2 Planning .....                                                              | 44 |
| B.3 Execution – commanded speed generation .....                                | 44 |
| B.3.1 Required speed-of-advance .....                                           | 44 |
| B.3.2 Leg speed .....                                                           | 44 |
| B.3.3 Operator-specified speed .....                                            | 45 |
| B.4 Execution – propulsion control .....                                        | 45 |
| B.4.1 Open-loop propulsion control .....                                        | 45 |
| B.4.2 Closed-loop propulsion control .....                                      | 45 |
| B.5 Execution – speed monitor .....                                             | 45 |
| B.6 Displays .....                                                              | 45 |
| B.7 Failure and alarms .....                                                    | 45 |
| B.8 Changeover controls and termination of automatic speed control .....        | 45 |
| Annex C (informative) Track control systems with dual heading controllers ..... | 46 |
| C.1 Change over from active to back-up heading controller .....                 | 46 |
| C.2 Failure of track control .....                                              | 46 |
| Annex D (informative) Management of static and dynamic data .....               | 47 |
| D.1 Management of geographic (chart) data .....                                 | 47 |
| D.2 Management of ships data and reference parameters .....                     | 47 |
| D.3 Management of track-related data (planning and control) .....               | 47 |
| D.4 Management of sensor data .....                                             | 48 |
| Annex E (informative) Limits .....                                              | 49 |
| Annex F (informative) Data flow diagram .....                                   | 50 |
| Annex G (normative) Scenario definitions and plots .....                        | 51 |
| Annex H (informative) Sensor errors and noise models .....                      | 56 |
| H.1 Simulation of position sensor errors .....                                  | 56 |
| H.2 Simulation of heading and speed information .....                           | 57 |
| H.3 Simulation of sea state .....                                               | 58 |
| Annex I (normative) Ship model specification .....                              | 63 |
| I.1 General .....                                                               | 63 |
| I.2 Definitions .....                                                           | 63 |
| I.3 Related documents .....                                                     | 64 |
| I.4 Introduction – background and requirements .....                            | 65 |
| I.5 The model – derivation .....                                                | 65 |
| I.6 Summary and block diagram .....                                             | 74 |
| I.7 Ship parameter sets .....                                                   | 81 |
| Annex J (informative) Explanation of adaptation tests (5.3.3.1) .....           | 82 |
| J.1 Adaptation to speed change .....                                            | 82 |

|                                                            |    |
|------------------------------------------------------------|----|
| J.2 Adaptation to current changes along straight leg ..... | 82 |
| J.3 Adaptation to current changes during turn .....        | 83 |
| J.4 Adaptation to sea state during turn .....              | 83 |
| J.5 Adaptation to sea state change on straight leg .....   | 84 |

|                                                                                                                                 |    |
|---------------------------------------------------------------------------------------------------------------------------------|----|
| Annex ZA (normative) Normative references to international publications with their<br>corresponding European publications ..... | 86 |
| Bibliography.....                                                                                                               | 85 |

|                                                                                                    |    |
|----------------------------------------------------------------------------------------------------|----|
| Figure 1 – Functional model of track control as part of an integrated navigation system.....       | 22 |
| Figure 2 – Block diagram .....                                                                     | 24 |
| Figure 3 – High level block diagram .....                                                          | 25 |
| Figure A.1 – Sequence of course change indications and alarms (~A) .....                           | 43 |
| Figure G.1 – Scenario plot 1 .....                                                                 | 52 |
| Figure G.2 – Scenario plot 2 .....                                                                 | 52 |
| Figure G.3 – Scenario 3 plot .....                                                                 | 53 |
| Figure G.4 – Scenario 4 plot .....                                                                 | 55 |
| Figure H.1 – Spectral distribution of modelled GPS errors .....                                    | 57 |
| Figure H.2 – Wave sequence – sea state 5.....                                                      | 59 |
| Figure H.3 – Wave spectrum – sea state 5.....                                                      | 60 |
| Figure H.4 – Supertanker – sea state 5.....                                                        | 60 |
| Figure H.5 – Container ship – sea state 5 .....                                                    | 61 |
| Figure H.6 – Fast ferry – sea state 5.....                                                         | 61 |
| Figure H.7 – Container ship – sea state 2 .....                                                    | 62 |
| Figure I.1 – High level model block diagram.....                                                   | 65 |
| Figure I.2 – Model block diagram .....                                                             | 78 |
| Figure I.3 – Application with simple follow-up.....                                                | 79 |
| Figure I.4 – Control system using actuator outputs and feedback.....                               | 80 |
| Figure I.5 – System with actuator mechanism, bypassing the rudder response model .....             | 80 |
| Figure I.6 – System with actuator mechanism using a fast rudder response time<br>in the model..... | 81 |
| Figure J.1 – Adaptation to speed change .....                                                      | 82 |
| Figure J.2 – Adaptation to changes along straight leg .....                                        | 82 |
| Figure J.3 – Adaptation to current changes during turn .....                                       | 83 |
| Figure J.4 – Adaptation to sea state during turn .....                                             | 83 |
| Figure J.5 – Adaptation to sea state change on straight leg .....                                  | 84 |

|                                                                      |    |
|----------------------------------------------------------------------|----|
| Table 1 – Simulator input rate .....                                 | 25 |
| Table 2 – Simulator output rate .....                                | 26 |
| Table E.1 – Limits .....                                             | 49 |
| Table G.1 – Scenario 1 .....                                         | 51 |
| Table G.2 – Scenario 2 .....                                         | 52 |
| Table G.3 – Scenario 3 .....                                         | 53 |
| Table G.4 – Scenario 4 .....                                         | 54 |
| Table H.1 – Histogram limits .....                                   | 57 |
| Table H.2 – Heights and periods for half-waves .....                 | 59 |
| Table I.1 – Relationship between thrust lever and rudder models..... | 67 |
| Table I.2 – Constant parameters of the model.....                    | 75 |
| Table I.3 – Run-time inputs .....                                    | 76 |

|                                                  |    |
|--------------------------------------------------|----|
| Table I.4 – Model outputs .....                  | 77 |
| Table I.5 – Parameter sets for three ships ..... | 81 |

# MARITIME NAVIGATION AND RADIOCOMMUNICATION EQUIPMENT AND SYSTEMS – TRACK CONTROL SYSTEMS –

## Operational and performance requirements, methods of testing and required test results

### 1 Scope

This International Standard specifies the minimum operational and performance requirements, methods of testing and required test results conforming to performance standards adopted by the IMO in resolution MSC.74(69) Annex 2 Recommendations on Performance Standards for Track Control Systems. In addition it takes into account IMO resolution A.694 to which IEC 60945 is associated. When a requirement of this standard is different from IEC 60945, the requirement in this standard shall take precedence.

NOTE All text of this standard that is identical to that in IMO resolution MSC.74(69), Annex 2, is printed in *italics* and the resolution (abbreviated to – A2) and paragraph numbers are indicated in brackets i.e. (A2/3.3).

### 2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60945, *Maritime navigation and radiocommunication equipment and systems – General requirements – Methods of testing and required test results*

IEC 61108-1, *Global navigation satellite systems (GNSS) – Part 1: Global positioning system (GPS) – Receiver equipment – Performance standards, methods of testing and required test results*

IEC 61108-2, *Maritime navigation and radiocommunication equipment and systems – Global navigation satellite systems (GNSS) – Part 2: Global navigation satellite system (GLONASS) Receiver equipment – Performance standards, methods of testing and required test results*

IEC 61162-1, *Maritime navigation and radio communication equipment and systems – Digital interfaces – Part 1: Single talker and multiple listeners*

IEC 61162-2, *Maritime navigation and radio communication equipment and systems – Digital interfaces – Part 2: Single talker and multiple listeners, high speed transmission*

ISO 9000, *Quality management and quality assurance standards*

IMO Resolution A.694(17), *General requirements for shipborne radio equipment performing part of the GMDSS and for electronic navigational aids*

IMO Resolution A.830(19), *Code on alarms and indicators*

IMO MSC.74(69) Annex 2, *Recommendations on performance standards for Track control systems*

### 3 Definitions and abbreviations

For the purposes of this standard, the following definitions and abbreviations apply.

#### 3.1 Definitions

##### 3.1.1

**active track**

*track activated for track control*

##### 3.1.2

**alarm**

audio and visual signal announcing a condition requiring attention. The audio continues until acknowledged. The acoustic noise pressure of the alarm is at least 75 dBA but not greater than 85 dBA at a distance of 1 m (IEC 60945). The visual indication continues until the alarm condition is removed

##### 3.1.3

**along track speed control**

automatic control of the ship's speed during track control based on a pre-planned track

##### 3.1.4

**assisted turn**

manoeuvre of a ship from one straight leg to the next automatically controlled by a pre-set radius or rate of turn but not based on the ship's position

##### 3.1.5

**back-up navigator**

*any individual, generally an officer, who has been designated by the ships master to be on call if assistance is needed on the bridge*

##### 3.1.6

**consistent common reference system**

sensor input data, providing identical and obligatory reference pertaining to position, course, heading, bearing, speed, velocity, etc. and horizontal datum to different sub-systems within an integrated navigation system

##### 3.1.7

**course**

for marine navigation, course is the horizontal direction in which a vessel is steered or intended to be steered, expressed as angular distance from north, usually 000° at north, clockwise through 360°. <sup>1</sup>

##### 3.1.8

**course difference limit**

maximum difference between track course and heading before an alarm is activated

##### 3.1.9

**cross track distance (also known as cross track error)**

*perpendicular distance of the ship from the track including direction (negative if the ship is left of the intended track)*

##### 3.1.10

**cross-track limit**

*maximum cross track distance before an alarm is activated*

---

<sup>1</sup> 360° is indicated as 000°.

**3.1.11**

**curved track**

*non-straight track between two straight legs*

**3.1.12**

**fall-back arrangements**

automatic reaction of the system to a failure to provide the best possible functionality

**3.1.13**

**FROM-waypoint**

*the last passed waypoint*

**3.1.14**

**great circle sailing**

sailing on the intersection of the earth surface and a plane containing the points A, B and the centre of the sphere

**3.1.15**

**heading**

the horizontal direction in which a ship actually points or heads at any instant, expressed in angular units from a reference direction, usually from 000° at the reference direction clockwise through 360°<sup>2</sup>

**3.1.16**

**heading control**

*control of the ship's heading*

**3.1.17**

**heading monitor function**

*Monitoring the actual heading sensor by an independent second source*

**3.1.18**

**indication**

visual display of any message to the user which may be accompanied by a low intensity acoustic signal to gain attention

**3.1.19**

**leg**

*line between two waypoints defining the track*

**3.1.20**

**main conning position**

*place on the bridge with a commanding view providing the necessary information and equipment for the conning officer to carry out his functions*

**3.1.21**

**minimum manoeuvring speed for track control**

lowest fore/aft speed through the water at which the track control system is capable of maintaining its performance within the specified accuracy limits. The value depends on the ship's design and loading and on the present environmental conditions

**3.1.22**

**NEXT-waypoint**

*the waypoint following the TO-waypoint*

---

<sup>2</sup> 360° is indicated as 000°.

**3.1.23****override facility**

*a control to perform the override function*

**3.1.24****override function**

*an intentional fast change-over from automatic to temporary manual control*

**3.1.25****position monitor function**

*monitoring the actual position sensor by an independent second source*

**3.1.26****primary position-fixing system**

electronic position-fixing system (EPFS) used for track control and approved by the International Maritime Organization (see 4.1.1.3)

**3.1.27****radius of turn**

*radius of a curved track*

**3.1.28****rate of turn**

*change of heading per time unit*

**3.1.29****rhumb line sailing**

sailing on a line on the surface of the earth making the same angle with each meridian crossed

**3.1.30****ship manoeuvring characteristics**

these define the range-of-manoeuve possible for the ship (for example, maximum turn rate, minimum turn radius, maximum turn acceleration and deceleration)

**3.1.31****single operator action**

an action which is directly accessible and immediately effected, for example by:

- dedicated controls;
- primary access in an associated menu;
- alternative solutions which meet the functional requirements

**3.1.32****speed**

the absolute value of velocity. May either be the ship's speed through the water, or the speed made good over the ground

**3.1.33****steering mode selector**

a switch provided for the selection of manual steering modes and automatic steering devices

**3.1.34****temporary track**

a track that originates at the current position of the ship and joins the pre-planned track. The temporary track may include temporary waypoints which can be identified as different from the waypoints of the pre-planned track

### 3.1.35

#### **TO-waypoint**

*the waypoint which the ship is approaching*

### 3.1.36

#### **track**

*path to be followed over ground*

### 3.1.37

#### **track control**

*control of the ship's movement along a track, where corrections made by the controller to compensate for wind, drift and other influences, are based on the cross track error and not only on the bearing to the destination waypoint (TO-waypoint)*

### 3.1.38

#### **track course**

*the direction from one waypoint to the next, a constant course on a rhumb line track and a varying course on a Great Circle track*

### 3.1.39

#### **track planning**

*preplanning of a track including waypoint data and optionally speed data, commonly referred to as passage planning or voyage planning*

### 3.1.40

#### **waypoint**

*a geographic position together with its associated data*

### 3.1.41

#### **wheel-over-line**

*the line, for example, perpendicular to the course line, where the ship has to initiate a curved track to eliminate the effect of any offset with respect to the new course, taking into consideration the distance required for the ship to build up the necessary turn rate*

## 3.2 Abbreviations

|         |                                                                |
|---------|----------------------------------------------------------------|
| ~A      | Not applicable for category A systems                          |
| CCA     | Course change alarm                                            |
| CCI     | Course change indication                                       |
| DGPS    | Differential GPS                                               |
| DR      | Dead reckoning                                                 |
| ECCI    | Early course change indication                                 |
| ENC     | Electronic navigational chart                                  |
| EPFS    | Electronic position fixing system                              |
| EUT     | Equipment under test                                           |
| GC      | Great circle                                                   |
| GLONASS | Russian Ministry of Defence global navigation satellite system |
| GPS     | Global positioning system                                      |
| HSC     | High speed craft                                               |
| INS     | Integrated navigation system                                   |
| NA      | (Back up) Navigator alarm                                      |
| RL      | Rhumb line                                                     |
| SDME    | Speed and distance measuring equipment                         |
| WOT     | Wheel-over time                                                |

#### 4 Requirements and application of this standard

- a) (A2/1) *Track control systems in conjunction with their sources of position, heading and speed information are intended to keep a ship automatically on a pre-planned track over ground under various conditions and within the limits related to the ship's manoeuvrability. A track control system may additionally include or be combined with*
- heading control;
  - along-track speed control (see annex B).
- b) Planning the track by waypoints may be performed
- as part of the track control system, or
  - by importing waypoint or track data.
- c) This standard applies for track control systems which can exchange data with a heading sensor, speed sensor, EPFS and/or heading controller but excludes waypoint data exchange.
- d) If a track control system automatically receives additional data, including waypoints, from other navigational aids, the requirements of IEC 61924 for this data exchange shall also apply.
- e) If a track control system is integrated into an INS, the corresponding requirements of INS (as defined in IEC 61924), for example concerning
- track planning by waypoints,
  - data transfer of safety-checked waypoints and
  - monitoring of navigational safety for example by charts
- shall apply.
- f) Track control does not necessarily require that ENC or other geographic data such as shallow area information be taken into consideration by the track control system.
- g) (A2/2.1) *These IMO Performance Standards are applicable for track control systems working*
- at ship's speed from minimum manoeuvring speed up to 30 knots; and
  - at ship's maximum rate of turn not greater than 10°/s.
- h) These performance standards do not apply to HSC as defined by SOLAS chapter 10.
- i) (A2/2.2) *Track control systems fitted on ships shall meet all requirements of the IMO Performance Standards (MSC.74(69) Annex 2 Recommendations on Performance Standards for Track Control Systems) relating to straight tracks. Systems fitted on ships requiring curved track control shall additionally meet all the requirements relating to curved tracks.*
- j) This standard applies to three categories of track control systems:
- Category A: Single straight leg track control or multiple straight leg track control without assisted turns between legs;
- Category B: Multiple straight leg track control with assisted turns between legs;
- Category C: Full track control on straight legs and turns.
- k) Some requirements contained in this clause cannot be verified by objective measurements. The manufacturer shall declare that compliance to these requirements is achieved and shall provide relevant documentation. The declaration(s), documentation and, where necessary, the equipment shall be checked. The manufacturer shall also declare the general hardware and functional composition of the equipment and the relevant category of IEC 60945 for each unit.

## 4.1 Operational requirements

### 4.1.1 Functionality

#### 4.1.1.1 Track control steering modes

(A2/5.1.1) *A track control system shall be able to steer the ship from its position*

- .1 *to a single waypoint; or*
- .2 *along a track containing a sequence of waypoints*

using rhumb line or great circle sailing.

#### 4.1.1.2 Starting requirements

(A2/5.1.2) *The system shall allow the officer of the watch (user) to start or restart track control only if*

- the pre-planned track has been checked for plausibility and correctness of geometric and ship dependent limits before becoming the active track

and if

- *the ship's position* relative to the selected track,
- *the difference between track course and actual heading,*
- *the ship's manoeuvrability,*

*will result in a safe approach manoeuvre to the track.* A safe approach manoeuvre is a planned manoeuvre which is within the manoeuvring characteristics of the vessel and which does not result in an unexpected turning direction.

For this purpose, the system shall allow the user at least one of the following options:

- a) to select the TO-waypoint or a leg on a pre-planned track and to select the maximum allowable difference between the bearing to the TO-waypoint and the actual heading; or
- b) to define a temporary track to go to the pre-planned track. The temporary track shall meet all ship manoeuvring characteristics which apply to a pre-planned track (~A) .

#### 4.1.1.3 Primary position-fixing system

(A2/5.1.3) *The primary position-fixing system used for track control shall be an electronic position-fixing system (EPFS) approved by the International Maritime Organization.*

#### 4.1.1.4 Position monitoring

(A2/5.1.4) *The ship's position shall be continuously monitored by a second or additional independent position source.* <sup>3</sup> If the ship is fitted with a second EPFS and position is available from this EPFS its position shall be used for position monitoring. Otherwise, estimated position by dead reckoning (DR) as a minimum shall be used as the second position source for position monitoring. The DR position shall be derived from a shipborne heading sensor and a speed and distance measuring equipment (SDME). Means shall be provided to adapt the acceptable deviation to the required steering accuracy. *This monitoring need not be an integral part of the track control system.*

#### 4.1.1.5 Early course change indication (~A)

A graphical description of the sequences described here is given in annex A.

<sup>3</sup> For example, a secondary GPS may be used to monitor a primary GPS.

(A2/5.1.5) *In the case of track control by a sequence of waypoints, a confirmable 'early course change indication' shall be given up to 5 min, and no later than 1 min, before the wheel-over line.*

*The system shall provide means for the officer of the watch (user) to confirm the 'early course change indication' before wheel-over.*

#### **4.1.1.6 Actual course change and confirmation (~A)**

A graphical description of the sequences described here is given in annex A.

- a) (A2/5.1.6.1) *In the case of track control by a sequence of waypoints and if the 'early course change indication' was confirmed a confirmable course change indication shall be given at between 30 s to 1 min <sup>4</sup>, at the earliest, before the wheel-over line.*

*If the 'early course change indication' has not been confirmed, a confirmable course change alarm shall be given between 1 min <sup>5</sup> and no later than 30 s before the wheel-over line.*

- b) (A2/5.1.6.2) *The system shall provide means for the officer of the watch (user) to confirm or acknowledge the course change indication or course change alarm at or before wheel-over.*
- c) (A2/5.1.6.3) *With or without the confirmation, the ship shall follow automatically the track.*
- d) (A2/5.1.6.1) *If the course change indication has not been confirmed by or at wheel-over line then a course change alarm shall be given instead.*
- e) (A2/5.1.6.4) *If the actual course change indication or the actual course change alarm is not confirmed by the officer of the watch (user) within 30 s before or after the wheel-over line, a back-up navigator alarm shall be given.*

#### **4.1.1.7 Change of waypoints**

(A2/5.1.7) *In the case of track control by a pre-planned sequence of waypoints, it shall not be possible to modify the TO-waypoint, the FROM-waypoint and (~A) the NEXT-waypoint of the active track and their relevant associated waypoint data while in the track control mode without creating a new track and until:*

- a) *the pre-planning of the new track is completed; and*
- b) *the starting requirements (4.1.1.2) are fulfilled.*

#### **4.1.1.8 Turn performance (~A)**

(A2/5.1.8) *The track control shall enable the ship to sail from one leg to another by turns based:*

- a) *on a preset turn radius; or*
- b) *on a radius calculated on the base of a preset rate of turn and the planned speed; and within the turning capability of the ship.*

#### **4.1.1.9 Adaptation to steering characteristics**

(A2/5.1.9) *The track control shall be capable of manual or automatic adjustment to different steering characteristics of the ship under various weather, speed and loading conditions.*

<sup>4</sup> The preceding indication shall last at least 15 s before this indication is triggered.

<sup>5</sup> The preceding indication shall last at least 15 s before this indication is triggered.

#### 4.1.1.10 Permitted tolerance

The quality of the track control shall be so that overshoot, oscillation and constant track deviation are within tolerable limits both for straight and curved tracks.

(A2/5.1.10) *Means shall be incorporated to prevent unnecessary activation of the rudder due to normal yaw or sway motion, sensor data resolution and statistically scattered position errors.*

For systems which include great circle sailing, the calculated great circle approximation of the planned track shall not differ by more than 250 m from the mathematical calculation based on geodetic solutions.

NOTE Appropriate solutions may be found in – T. Vincenty, Direct and inverse solutions of geodesics on the ellipsoid, *Survey Review* No 176 April 1976 (pages 88-93) Published by: The Commonwealth Association of Surveying and Land Economy, c/o Faculty of the "Built" Environment, University of West England, Cold Harbour Lane, Bristol, BS16 1QY, UK.

#### 4.1.1.11 Override function

(A2/5.1.11) *A track control system shall be able to accept a signal from the override facilities to terminate track control mode and switch to these override facilities. After change-over to override, return to track control shall require user intervention (see 4.1.1.2).*

#### 4.1.1.12 Heading control mode

(A2/5.1.12) *A track control system may be operated in heading control mode. In this case, the performance standards of heading control systems are to be applied.*

#### 4.1.1.13 Manual change over from track control to manual steering

(A2/5.1.13.1) *Change over from track control to manual steering shall be possible at any rudder angle.*

(A2/5.1.13.2) *Change over from track control to manual steering shall be possible under any conditions, including any failure in the track control system.*

(A2/5.1.13.3) *After change over to manual control, return to automatic control shall require operator (user) intervention (see 5.3.5).*

#### 4.1.1.14 Manual change over from track control to heading control

This subclause only applies if the heading control is included in the track control system.

(A2/5.1.14.1) *Any change over from track control to heading control shall be possible under all conditions of normal operation.*

(A2/5.1.14.2) *To maintain the course, the heading control system shall*

- *if sailing on a straight leg, take over the actual heading as the preset heading,*
- *if sailing on a curved path, take over the actual heading as the preset heading.*

Optionally, if sailing on a curved path, based on an intended operator selection, the heading control system may take over the actual heading as the preset heading or complete the turn with the track course of the next straight leg as the preset heading (~A). This selection shall only be available after the turn has started and shall be clearly and unambiguously indicated.

(A2/5.1.14.3) *Any switching back to track control shall require operator (user) intervention (see 5.3.5).*

#### 4.1.1.15 Steering mode indication

(A2/5.1.15) *Adequate indication shall be provided to show which method of steering is in operation. The indication of the steering mode is not required to be an integral part of the track control system, but shall be displayed at any work station of the track control system where the steering mode can be affected.*

#### 4.1.1.16 Heading monitoring

(A2/5.1.16) *Heading monitoring shall be provided to monitor the actual heading information by independent heading sources. The heading monitor is not required to be an integral part of the track control system.*

#### 4.1.1.17 End of track

- a) At the end of the pre-planned track, an 'end of track alarm' shall be generated.
- b) Until the user takes over, the system shall follow the track course of the final leg. As a minimum, the system shall maintain the actual heading.

For category A systems, the 'end of track alarm' shall be given at the end of each leg.

#### 4.1.2 Accuracy and performance constraint documentation

(A2/5.2.1) *A short qualitative description of the effect of:*

- .1 *the accuracy of the sensors for position, heading and speed;*
- .2 *changes of course and speed;*
- .3 *actual speed through the water; and*
- .4 *environmental conditions*

*on the track control system shall be provided to the user in appropriate documentation.*

#### 4.1.3 Alarms and indications

All alarms and indications shall conform to the IMO code on alarms and indicators A.830(19). In addition, indications may be accompanied by a short low intensity acoustic signal.

##### 4.1.3.1 Failure or reduction in power supply

(A2/5.3.1) *In case of failure or reduction of power supply to the track control system which effects its safe operation, an alarm shall be given.*

##### 4.1.3.2 Position monitoring alarm

(A2/5.3.2) *An alarm shall be given when the position monitor detects a deviation between the primary and secondary position-fixing system beyond a preset limit.*

##### 4.1.3.3 Heading monitoring alarm

(A2/5.3.3) *An alarm shall be given when the heading monitor detects a deviation beyond a preset limit.*

##### 4.1.3.4 Failure and alarm status of sensor

(A2/5.3.4) *In the case of any failure or alarm status received from the position-fixing sensor, the heading sensor or the speed sensor in use:*

- .1 *an alarm shall be generated at the track control system;*
- .2 *the system shall automatically provide guidance to the user of a safe steering mode, and*

- .3 a back-up navigator alarm shall be given if a failure or alarm status is not acknowledged by the officer of the watch (user) within 30 s.

*Fall-back procedures consequential to the failure and alarm conditions are stated in 4.5.*

#### **4.1.3.5 Use of faulty signals**

(A2/5.3.5) *It shall not be possible to select any sensor signal tagged with a fault or alarm status.*

#### **4.1.3.6 Cross track alarm**

(A2/5.3.6) *A cross-track alarm <sup>6</sup>, shall be provided when the actual position deviates from the track beyond a preset cross-track limit.*

#### **4.1.3.7 Course difference alarm**

(A2/5.3.7) *An alarm shall be given if the actual heading of the ship deviates from the track course beyond a preset value.* The preset course difference limit shall be large enough to prevent unnecessary alarms.

#### **4.1.3.8 Low speed alarm**

(A2/5.3.8) *If speed through the water in the fore/aft direction is lower than a predefined limit necessary for steering the ship under track control (minimum manoeuvring speed for track control) an alarm shall be given.* This alarm is not required to be an integral part of the track control system.

#### **4.1.3.9 End of track alarm**

An alarm shall be given between 1 min and 5 min before the last waypoint of the active track is passed. A back-up navigator alarm shall be given if the alarm is not acknowledged within 30 s.

#### **4.1.3.10 Track control stopped alarm**

A track control stopped alarm shall be given if the system automatically switches over to heading control or is unable to continue operation. A back-up navigator alarm shall be given if the alarm is not acknowledged within 30 s (see 4.5.1).

### **4.2 Ergonomic criteria**

#### **4.2.1 Operational controls**

##### **4.2.1.1 Controls for track control**

(A2/6.1.1) *Means shall be provided to:*

- .1 *accept or calculate the course between subsequent waypoints; and*
- .2 *adjust radius or rate of turn, all user settable track control related limits, limits for alarm functions and other control parameters.*

Means may include but are not limited to a keyboard, knob or input at a screen.

<sup>6</sup> Category B systems shall monitor assisted turns. The cross-track deviation shall be measured at a minimum from the straight legs and cross-track alarms shall be given during manoeuvres. If this monitoring is not done, the system shall be a category A system and track control must stop at the end of the leg.

(See restrictions under 4.1.1.7.)

#### 4.2.1.2 Change over controls

(A2/6.1.2.1) *Track control to manual control*

*Changing over from track control to manual steering shall be possible by a single operator action.*

(A2/6.1.2.2) *Track control to heading control*

*If the track control system can be operated with a heading control system, changing over from track to heading control shall be possible by a single operator action.*

(A2/6.1.2.3) *Location of change over controls*

*The steering mode selector switch or override facility, if installed, shall be located at or in the immediate vicinity of the main conning position.*

### 4.2.2 Presentation of information

#### 4.2.2.1 Continuously displayed information

(A2/6.2.1) *The following information shall be displayed clearly and continuously in the vicinity of the main conning position; but not necessarily on a single display:*

- .1 *mode of steering;*
- .2 *sources of actual selected position, heading and speed;*
- .3 *status and failure of selected heading, speed, and position sensors (if any) and their related monitoring functions;*
- .4 *track course and actual heading;*
- .5 *actual position, cross track distance including direction and speed over ground;*
- .6 *TO-waypoint and NEXT-waypoint;*
- .7 *time and distance to TO-waypoint;*
- .8 *next track course;*
- .9 *selected track identification; and*
- .10 *optionally actual course over ground*

For category B systems, an “assisted turn” indication shall be provided during course change manoeuvres.

*Items .4, .5, .7 and .8 shall be displayed numerically.*

#### 4.2.2.2 Information to be provided on demand

(A2/6.2.2) *The following information shall be provided on demand:*

- .1 *a list of pre-planned waypoints including*
  - *waypoint numbers,*
  - *co-ordinates,*
  - *courses and distances between waypoints,*
  - *turn radius or rates of turn (~A);*
- .2 *all user settable track control related limits and other preset control parameters;*

.3 geodetic datum in use.

The facility to provide the information in .1 is not required to be an integral part of the track control system.

#### 4.2.2.3 Presentation

(A2/6.2.3) *Logically related values such as preset and actual values shall be displayed as a pair of data.*

### 4.3 Design and installation

The track control system shall be designed, manufactured and installed to approved international quality standards, such as ISO 9000.

### 4.4 Interfacing

Track control mode shall not be available unless required position and heading sensor data are valid and selected.

#### 4.4.1 Sensors

(A2/7.1) *The track controller shall be connected to position, heading and speed sensors which meet the standards of the International Maritime Organisation. The heading measurement system shall be a gyro-compass or equivalent.*

#### 4.4.2 Status information

(A2/7.2) *All connected sensors shall be able to provide status, including failure information. The track control system shall check for received status and failure information. If a sensor used for track control does not provide status or failure information, the track control system shall perform corresponding plausibility checks.*

#### 4.4.3 Standards

(A2/7.3) *The track control system shall be capable of digital, serial communication with the ships navigation system and comply with the relevant international standards.<sup>7</sup>*

### 4.5 Fall-back arrangements

The associated alarms are stated in 4.1.3.

#### 4.5.1 Failure of track control

If track control fails, a 'track control stopped' alarm shall be given.

(A2/8.1.1) *If the heading control is installed and is still available then the system shall automatically switch over to heading control and*

- *if sailing on a straight leg, take the actual heading as the preset heading for the heading control,*
- *if sailing on a curved path, the turn shall be completed and the track course of the next straight leg shall be taken over as the preset heading (~A).*

(A2/8.1.2) *If the heading control is not available the rudder angle shall be maintained, i.e. stay in position. The rudder angle shall be set to a fixed angle in such a way that:*

<sup>7</sup> IEC 61162-1 and IEC 61162-2.

- if sailing on a straight leg, the actual heading shall be approximately maintained;
- if sailing on a curved path, the actual rate of turn shall be approximately maintained (~A).

For advice on failure of track control mode when dual heading controllers are installed, see annex C.

#### 4.5.2 Failure of position sensor

If the primary position sensor has failed or is unavailable, then:

- the position sensor alarm shall be activated;
- the track control system shall automatically switch to heading control within 10 min of the failure having been detected and a “track control stopped” alarm shall be given. The system shall
  - if sailing on a straight leg, take the actual heading as the preset heading;
  - if sailing on a curved path, complete the turn and take the track course of the next straight leg as the preset heading (~A).

When at position failure condition and not switched to heading control system, then

- the track control system shall provide the estimated position of the ship by dead reckoning as a minimum and use it for track control;
- after 1 min or less, another alarm shall be activated giving the advice to switch to a valid and available position sensor, heading control or manual steering;
- even if acknowledged, this alarm shall be repeated every 2 min until action is taken by the user or the automatic change over has taken place.

#### 4.5.3 Failure of the heading measuring system

If the heading sensor fails, then

- the ‘track control stopped’ alarm shall be activated, giving advice to the user to switch to manual control.
- (A2/8.2.1) *The actual rudder angle shall be maintained* (i.e. stay in position). The rudder angle shall be set to a fixed angle in such a way that
  - if sailing on a straight leg, the actual heading shall be approximately maintained;
  - if sailing on a curved path, the actual rate of turn shall be approximately maintained (~A).

#### 4.5.4 Failure of the speed sensor

If the speed sensor in use has failed or is unavailable then

- the speed sensor alarm shall be activated;
- the track control system shall automatically switch to heading control within 10 min after the failure has been detected and a “track control stopped” alarm shall be given. The system shall
  - if sailing on a straight leg, take the actual heading as the preset heading;
  - if sailing on a curved path, complete the turn and take the track course of the next straight leg as the preset heading (~A).

When at speed failure condition and not switched to heading control

- the track control system shall provide the last plausible speed of the ship and use it for track control;
- after 1 min, or less, another alarm shall be activated giving the advice to switch to a valid and available speed sensor, heading control or manual steering;

- even if acknowledged, this alarm shall be repeated every 2 min until action is taken by the user or the automatic change over has taken place.

## 5 Test requirements and results

All tests in this section are intended to be executed in a laboratory environment with a simulator. Additional onboard tests may or may not be required.

### 5.1 General requirements

#### 5.1.1 Environmental tests

##### 5.1.1.1 General

The EUT shall meet the test requirements of IEC 60945. The equipment shall comply with the requirements of IEC 60945 that are appropriate to its category or alternatively, evidence of prior testing shall be supplied.

The manufacturer shall declare which equipment or units are 'protected' or 'exposed'. The manufacturer shall declare any 'preconditioning' required before environmental checks.

For the purposes of this standard, the following definitions shall apply for environmental tests:

##### **performance check**

a short functional check to show that the equipment under test is still operational without investigating all details of its functionality, for example power on equipment and activate any function

##### **performance test**

a detailed test of the equipment covering all functions provided. A performance test shall ensure that the full functionality is available under the present environmental conditions, power supply and input/output conditions, for example satisfactorily performing a subset of scenario 3

##### **inspection**

a visual check of the equipment or documentation

##### 5.1.1.2 Test site

Tests will normally be carried out at test sites, accredited by the type test authority. The manufacturer shall, unless otherwise agreed, set up the equipment and ensure that it is operating normally before type testing commences.

##### 5.1.1.3 Identification of the equipment under test (EUT)

The IMO performance standards for track control systems do not require distinct hardware components supporting distinct functions. It is up to the manufacturer to perform the different tasks for track control in possibly different physical and logical parts of its system. This may result in different layout solutions for the

- physical parts involved,
- logical parts involved,
- general data flow between physical and/or logical parts,
- sensor interfaces,
- locations of required functions,
- user access (human machine interface).

Therefore, the EUT's special layout and its information flow have to be identified before it can be decided which tests are applicable. Identification should follow a functional approach in steps:

- a) identify functions to perform different tasks of track control;
- b) identify information flow between functions;
- c) identify dependencies between functions;
- d) identify in which parts of the system the required functions are performed.

Identification of functions can be taken from the functional model of an integrated navigation system that incorporates track control (track control affected parts in boxes with solid lines), see figure 1.

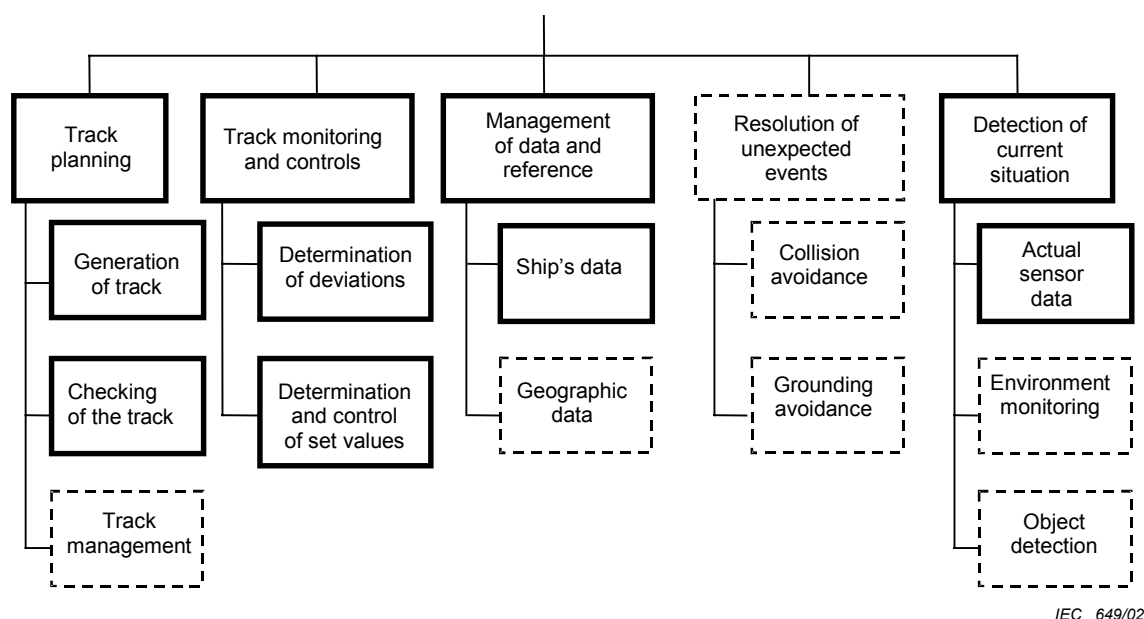


**Figure 1 – Functional model of track control as part of an integrated navigation system**

The information flow and the resulting dependencies between supported functions can be identified using the generic data flow diagram of the functional model (annex F). A general scheme of the EUT's components should be used to apply functions and their information flow to physical parts of the system.

#### 5.1.1.4 Test of optional track control related modes

All track control related modes offered by the manufacturer shall be exercised.

### 5.1.2 Documentation

#### 5.1.2.1 Equipment manuals

Verify that adequate information is provided to enable suitable qualified members of the ship's crew to operate and maintain the equipment properly.

#### 5.1.2.2 Technical documentation for type approval

Manufacturers documentation shall include:

- a test certificate according to IEC 60945;

- documentation of all system components and all relevant internal parts (parts lists, parts numbers, drawings, pictures, etc) according to IEC 60945 test certificates;
- wiring diagrams of system components;
- data flow diagrams of system components;
- documentation of external interfaces available;
- documentation of sensor data use, derived sensor data validity, ships parameters and reference parameters in physical and logical system components;
- layout of the minimum system configuration and all other system configurations possible relevant to track control;
- identification of relevant system components including names and numbers;
- identification of relevant software revision numbers;
- documentation specified by the IEC 61162 series for all relevant system components;
- documentation of manufacturer test results based on this standard where appropriate.

### 5.1.3 Declarations

Some requirements cannot be verified by objective measurements.

Verify that

- the declaration and relevant documentation comply with the requirements in clause 4; and
- the general hardware and functional composition of the equipment and the relevant category of IEC 60945 for each unit is declared (see clause 4).

## 5.2 Environment setup

Prepare the test environment (see figure 2) including necessary simulators and install the interfaces to the EUT. Verify that the 3 ship classes described below (5.2.1) are available in the simulator. Prepare the scenarios by loading the test tracks into the planning system which is used by the EUT.

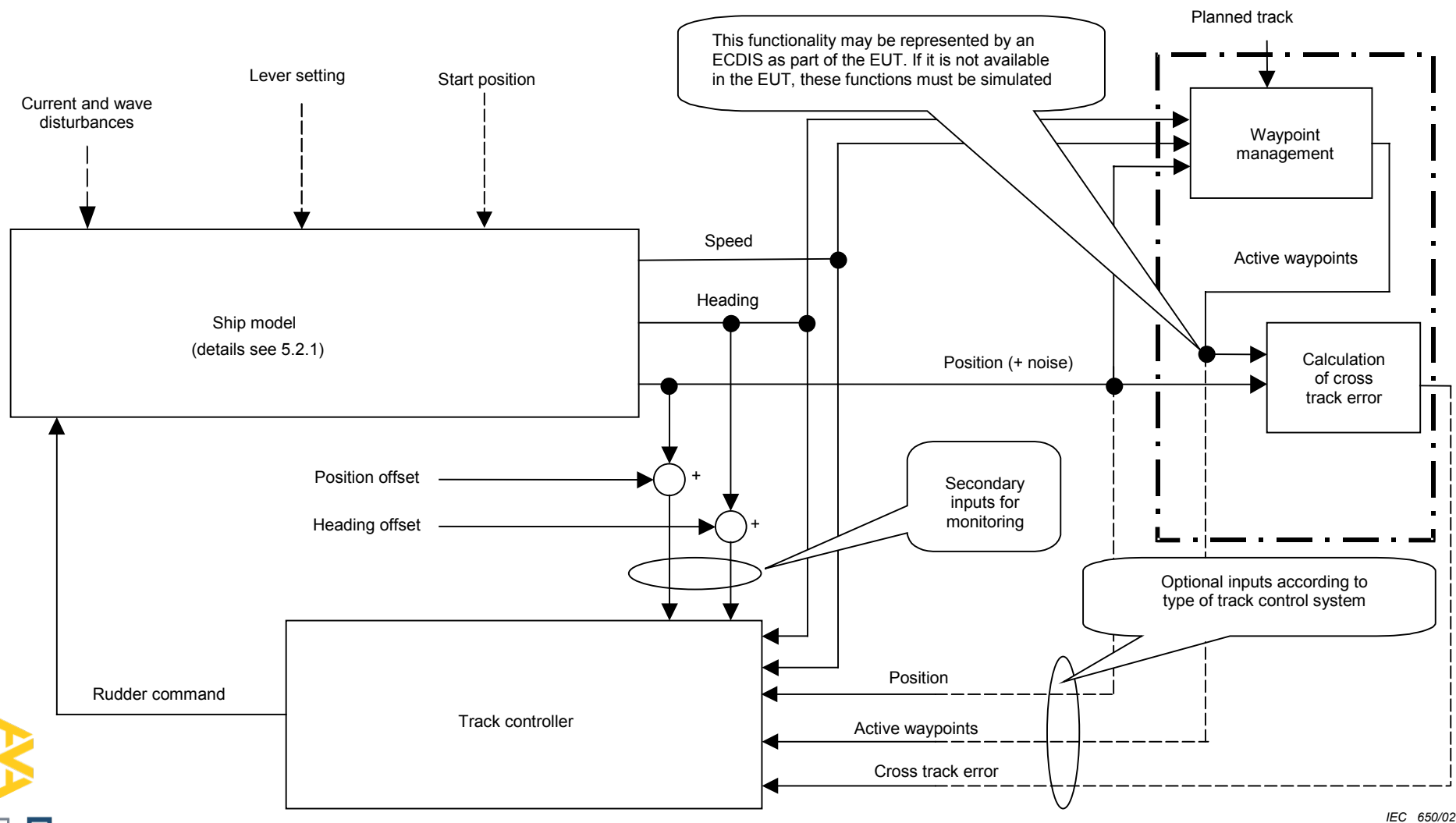


Figure 2 – Block diagram

### 5.2.1 Ship motion simulator

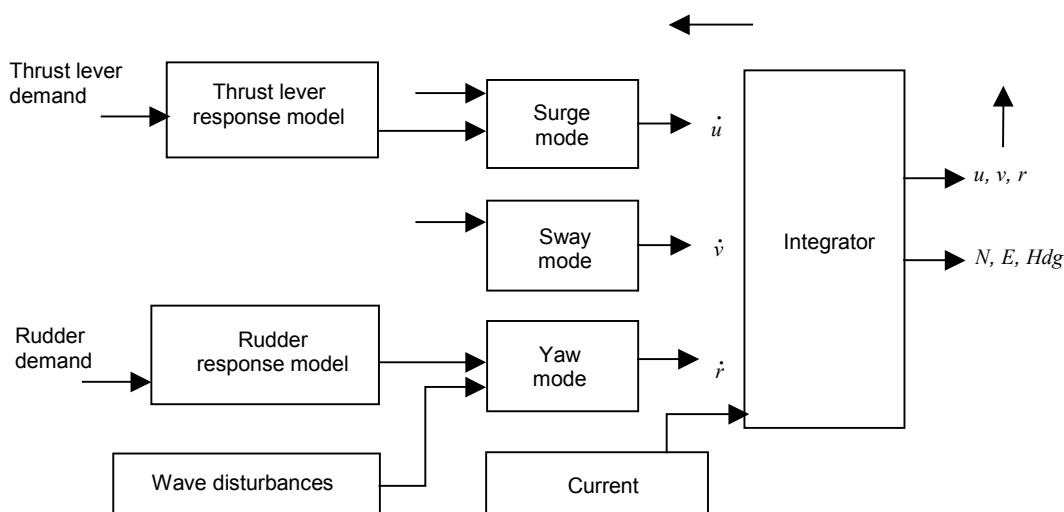
All functional tests of the track control system shall be performed using the ship motion simulator.

The ship's manoeuvrability shall be simulated in the range of

- ship class A: fast ferry, 30 knots,
- ship class B: container ship, 25 knots,
- ship class C: tanker, 10 knots.

The parameters of classes A, B and C are specified in annex I, table I.5.

These ship classes shall be used during the test of the track control system together with the scenarios defined in annex G.



IEC 651/02

**Figure 3 – High level block diagram**

The mathematical model of the ship motion simulator is based on linear relationships between motions, propulsor and rudder control inputs, and the forces acting on the vessel. The model may be set up using eight coefficients, all of which are related in a simple way to ship characteristics which are readily measured. One of the parameters is a stability coefficient which allows the model to be set up to exhibit straight-line instability. Parameter lists to generate three different types of ships and a detailed description of the simulator is given in annex I.

The model shall accept data at a rate not less than specified in table 1:

**Table 1 – Simulator input rate**

| Input to simulator |                 |
|--------------------|-----------------|
| Demand RPM         | Demanded rudder |
| 1 Hz               | 10 Hz           |