

INTERNATIONAL STANDARD

NORME INTERNATIONALE



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

Matériels et systèmes de navigation et de radiocommunication maritimes – Systèmes de contrôle de route – Exigences opérationnelles et de fonctionnement, méthodes d'essai et résultats exigibles



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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

Matériels et systèmes de navigation et de radiocommunication maritimes – Systèmes de contrôle de route – Exigences opérationnelles et de fonctionnement, méthodes d'essai et résultats exigibles

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**MARITIME NAVIGATION AND
RADIOCOMMUNICATION EQUIPMENT AND SYSTEMS –
TRACK CONTROL SYSTEMS –****Operational and performance requirements,
methods of testing and required test results**

FOREWORD

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International Standard IEC 62065 has been prepared by IEC technical committee 80: Maritime navigation and radiocommunication equipment and systems.

This second edition cancels and replaces the first edition published in 2002 and constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- alarms and warnings have been brought into line with the requirements for Bridge Alert Management;
- requirements for the category B system have been revised;

- the parameters of the ship models of Annex I have been adjusted to resemble more Newtonian-like behaviour and the tidal current has been modelled;
- a new Annex K has been added with interface requirements.

This bilingual version (2017-09) corresponds to the monolingual English version, published in 2014-02.

The text of this standard is based on the following documents:

FDIS	Report on voting
80/716/FDIS	80/729/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

The French version of this standard has not been voted upon.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

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).

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

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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

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 Recommendation on Performance Standards for Track Control Systems. In addition, it takes into account IMO resolution A.694(17) to which IEC 60945 is associated.

When a requirement of this standard is different from IEC 60945, the requirement in this standard takes precedence. Also it takes into account IMO resolution MSC.302(87) on bridge alert management (BAM).

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. 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 61162 (all parts), *Maritime navigation and radiocommunication equipment and systems – Digital interfaces*

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

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

IEC 61924-2, *Maritime navigation and radiocommunication equipment and systems – Integrated navigation systems – Part 2: Modular structure for INS – Operational and performance requirements, methods of testing and required test results*

IEC 62288, *Maritime navigation and radiocommunication equipment and systems – Presentation of navigation-related information on shipborne navigational displays – General requirements, methods of testing and required test results*

IEC 62616, *Maritime navigation and radiocommunication equipment and systems – Bridge navigational watch alarm system (BNWAS)*

IMO MSC.74(69) Annex 2, *Recommendation on Performance Standards for Track Control Systems*

IMO resolution A.694(17), *General requirements for shipborne radio equipment forming part of the Global Maritime Distress and Safety System (GMDSS) and for electronic navigational aids*

IMO MSC.302(87), *Performance standards for bridge alert management (BAM)*

3 Terms, definitions and abbreviations

3.1 Terms and definitions

For the purposes of this standard, the following terms and definitions apply

3.1.1

active track

track activated for track control

3.1.2

alarm

high-priority alert

Note 1 to entry: Condition requiring immediate attention and action by the bridge team, to maintain the safe navigation of the ship.

3.1.3

alert

announcement of abnormal situations and conditions requiring attention

Note 1 to entry: Alerts are divided in four priorities: emergency alarms, alarms, warnings and cautions.

Note 2 to entry: Alerts are additionally classified in two different categories for navigational purposes: category A and category B as described in IMO resolution MSC.302(87).

Note 3 to entry: An alert provides information about a defined state change in connection with information about how to announce this event in a defined way to the system and the operator.

3.1.4

along-track speed control

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

3.1.5

assisted turn

manoeuvre of a ship automatically controlled by a pre-set radius or rate of turn but not based on the ship's position to perform an approximation of a curved track

3.1.6

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

3.1.7

back-up navigator alarm

signal automatically sent from the TCS to call assistance to the bridge when the officer of the watch fails to acknowledge certain alarms within a defined time period

Note 1 to entry: Note that the back-up navigator alarm does not represent an alarm as defined in 3.1.2.

3.1.8

consistent common reference system

sub-system or function of a TCS for acquisition, processing, storage, surveillance and distribution of data and information providing identical and obligatory reference to all

systems and subsequent functions within a TCS and to other connected equipment, if available

3.1.9

course

for marine navigation, 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°

Note 1 to entry: 360° is indicated as 000°.

3.1.10

course difference limit

maximum difference between track course and heading before a warning is activated

3.1.11

cross-track distance

cross-track error

perpendicular distance of a predefined point on the ship from the track including direction (negative if the ship is left of the intended track)

3.1.12

cross-track limit

maximum cross-track distance before an alarm is activated

3.1.13

curved track

non-straight track between two legs

3.1.14

fall-back arrangements

automatic reaction of the TCS by using data, function or hardware of degraded quality in relation to the failed one

EXAMPLE Dead reckoning for position information, heading control in case of a failure of track control.

3.1.15

FROM-waypoint

last passed waypoint

3.1.16

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

3.1.17

heading

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°

Note 1 to entry: 360° is indicated as 000°.

3.1.18

heading control

control of the ship's heading

3.1.19

heading monitor function

monitoring of the actual heading sensor by an independent second source

3.1.20

leg

straight line between two waypoints and/or curved track(s)

3.1.21

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

3.1.22

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

Note 1 to entry: The value depends on the ship's design and loading and on the present environmental conditions.

3.1.23

NEXT-waypoint

waypoint following the TO-waypoint

3.1.24

override facility

control to perform the override function

3.1.25

override function

intentional fast change-over from automatic to temporary manual control

3.1.26

position monitor function

monitoring of the actual position sensor by an independent second source

3.1.27

primary position-fixing system

electronic position-fixing system (EPFS) used for track control and approved by the International Maritime Organization (see 5.1.1.3)

3.1.28

radius of turn

radius of a curved track

3.1.29

rate of turn

change of heading per time unit

3.1.30

rhumb line sailing

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

3.1.31

ship manoeuvring characteristics

range-of-manoeuvre possible for the ship

Note 1 to entry: Examples of the range-of-manoeuvres are: maximum rate of turn, minimum radius of turn, maximum turn acceleration and deceleration.

3.1.32**single operator action**

procedure achieved by no more than one hard-key or soft-key action, excluding any necessary cursor movements, or voice actuation using programmed codes

3.1.33**speed**

absolute value of velocity

Note 1 to entry: May either be the ship's speed through the water, or the speed made good over the ground.

3.1.34**steering mode selector**

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

3.1.35**surge**

forward component of ship motion

3.1.36**sway**

athwartships component of ship motion (positive to starboard)

3.1.37**temporary track**

track that originates at the current position of the ship and joins the pre-planned track

Note 1 to entry: The temporary track may include temporary waypoints which can be identified as different from the waypoints of the pre-planned track.

3.1.38**TO-waypoint**

waypoint which the ship is approaching

3.1.39**track**

path to be followed over ground

3.1.40**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)

3.1.41**track course**

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

3.1.42**warning**

alert for condition requiring immediate attention, but no immediate action by the bridge team

Note 1 to entry: Warnings are presented for precautionary reasons to make the bridge team aware of changed conditions which are not immediately hazardous, but may become so if no action is taken.

3.1.43

waypoint

geographic position together with its associated data

3.1.44

wheel-over-line

WOL

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 rate of turn

3.1.45

wheel-over-time

WOT

point in time when the track control system initiates the planned course change

3.1.46

yaw

rate of turn (positive to starboard)

3.2 Abbreviations

~A	Not applicable for category A systems
ACCA	Actual course change alarm
ACCW	Actual course change warning
BAM	Bridge alert management
CCRP	Consistent common reference point
CCRS	Consistent common reference system
COG	Course over ground
DGPS	Differential GPS
DR	Dead reckoning
ECCA	Early course change alarm
ECCW	Early course change warning
ENC	Electronic navigational chart
EPFS	Electronic position fixing system
EUT	Equipment under test
GC	Great circle
GPS	Global positioning system
INS	Integrated navigation system
NA	(Back up) Navigator alarm
RL	Rhumb line
ROT	Rate-of-turn
SDME	Speed and distance measuring equipment
SWH	Significant wave height
TCS	Track control system
WOL	Wheel-over-line
WOT	Wheel-over-time

4 Application of this standard

The application of this standard is as follows.

- 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) The track control system shall ensure the integrity of the geodetic datum, the ship manoeuvring characteristics and the curved tracks of the imported data.
- d) 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.
- e) If a track control system automatically receives additional data, including waypoints, from other navigational aids, the requirements of IEC 61924-2 for this data exchange shall also apply.
- f) If a track control system is integrated into an INS, the corresponding requirements of INS (as defined in IEC 61924-2) shall apply, for example concerning
- *route planning by waypoints,*
 - *data transfer of safety-checked waypoints and*
 - *monitoring of navigational safety for example by charts.*
- g) 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.
- h) (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 kn; and*
 - *at ship's maximum rate of turn not greater than 10°/s.*
- i) These performance standards do not apply to High Speed Craft as defined by SOLAS chapter 10.
- j) (A2/2.2) *Track control systems fitted on ships shall meet all requirements of the IMO Performance Standards (MSC.74(69) Annex 2 Recommendation on Performance Standards for Track Control Systems) relating to straight tracks.*
- k) *Systems fitted on ships requiring curved track control shall additionally meet all the requirements relating to curved tracks (category C).*
- l) This standard applies to three categories of track control systems:
- Category A: *Single leg track control or multiple leg track control without assisted turns between legs;*
 - Category B: *Multiple leg track control with assisted turns between legs;*
 - Category C: *Full track control on legs and turns.*

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.

5 Requirements

5.1 Operational requirements

5.1.1 Functionality

5.1.1.1 Track control steering modes

(See 6.4.3.2)

(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.

5.1.1.2 Starting requirements

(See 6.4.2.1, 6.4.2.2, 6.4.2.3, 6.4.2.4, 6.4.3.1)

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

- the required position, heading and speed sensor data are valid and selected.
- the pre-planned track has been checked for plausibility and correctness of geometric and ship-dependent limits (see Annex E) 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).

5.1.1.3 Primary position-fixing system

(See 6.2.2.2)

(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.*

5.1.1.4 Position monitoring

(See 6.4.5.3)

(A2/5.1.4) *The ship's position shall be continuously monitored by a second or additional independent position source.* 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.*

5.1.1.5 Early course change warning (~A)

(See 6.4.5.12)

A graphical description of the sequences described here is given in Annex A Figure A.1.

(A2/5.1.5) *In the case of track control by a sequence of waypoints, an 'early course change warning' shall be given up to 6 min, and no later than 3 min, before the wheel-over time.*

If the early course change warning is not acknowledged within 30 s, at the latest 2 min 30 s before the wheel-over-time, the alert priority shall change from warning to alarm.

The early course change alarm is defined to be associated with NA activation (see 5.1.3.11).

5.1.1.6 Actual course change warning (~A)

(See 6.4.5.12)

A graphical description of the sequences described here is given in Annex A Figure A.1.

(A2/5.1.6.1) *In the case of track control by a sequence of waypoints an actual course change warning shall be given 30 s before the wheel-over time.*

If the actual course change warning is not confirmed/acknowledged by the officer of the watch (user) within 30 s the alert priority shall change from warning to alarm.

NOTE This warning is superfluous, if the NA from the unacknowledged early course change alarm is already active.

(A2/5.1.6.2) *The system shall provide means for the officer of the watch (user) to confirm/acknowledge the actual course change alerts.*

(A2/5.1.6.3) *With or without the confirmation/acknowledgement, the ship shall follow automatically the track.*

(A2/5.1.6.4) *If the actual course change alarm is not confirmed/acknowledged by the officer of the watch (user) within 30 s of wheel-over a back-up navigator alarm shall be given as fully described in 5.1.3.11.*

5.1.1.7 Change of waypoints

(See 6.4.2.2, 6.4.2.3, 6.4.2.4, 6.4.2.5, 6.4.3.1.6, 6.4.3.1.8, 6.4.3.1.9)

(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 (5.1.1.2) are fulfilled.*

5.1.1.8 Turn performance (~A)

(See 6.4.3.2)

(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 radius of turn;
- 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.

The planned track shall be checked for plausibility and correctness of geometry and of ship-dependent limits before becoming the active track.

5.1.1.9 Adaptation to steering characteristics

(See 6.4.4.1, 6.4.4.3)

(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.*

5.1.1.10 Permitted tolerance

(See 6.4.4.2)

(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.*

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.

Category B TCS shall comply with the requirements for curved track TCS, except that, after having passed the wheel-over, the actual cross-track distance is merely used for monitoring until completion of the automatic course change manoeuvre. Manual or automatic means shall be provided to adapt to variable drift and speed changes during a turn (e.g. facilitating manual adjustments of rate of turn or radius of turn).

5.1.1.11 Override function

(See 6.4.6.5, 6.4.8)

(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 5.1.1.2).*

5.1.1.12 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.*

NOTE The IMO performance standards for heading control are given in IMO resolution MSC.64(67) annex 3 and these are incorporated into ISO 11674.

5.1.1.13 Manual change over from track control to manual steering

(See 6.4.6.5)

(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.*

5.1.1.14 Manual change over from track control to heading control

(See 6.4.6.6)

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

Optionally, if sailing on a curved track, based on an intended operator selection, the heading control system may complete the turn with the track course of the next 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.*

5.1.1.15 Steering mode indication

(See 6.4.7.1)

(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.

5.1.1.16 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.*

NOTE This is an installation issue which is not covered by this standard.

5.1.1.17 End of track

(See 6.4.5.10)

At the end of the pre-planned track, an 'end of track warning' shall be generated.

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 warning' shall be given at the end of each leg.

5.1.2 Accuracy and performance constraint documentation

(See 6.2.2.1)

(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.

5.1.3 Alerts

5.1.3.1 Failure or reduction in power supply

(See 6.4.5.2)

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

5.1.3.2 Position monitoring alert

(See 6.4.5.3)

(A2/5.3.2) *A warning shall be given when the position monitor detects a deviation between the primary and secondary position-fixing system beyond a preset limit. See Annex E.*

5.1.3.3 Heading monitoring alert

(See 6.4.5.4)

(A2/5.3.3) *A warning shall be given when the heading monitor detects a deviation beyond a preset limit. See Annex E.*

5.1.3.4 Failure and alert status of sensor

(See 6.4.5.5)

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

- .1 *in case of a performance reduction of the track control process an alert of an appropriate priority 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 alert status of priority alarm is not acknowledged by the officer of the watch (user) within 30 s as fully described in 5.1.3.11.*

Fall-back procedures consequential to the failure and alert conditions are stated in 5.5.

5.1.3.5 Use of faulty signals

(See 6.4.5.6)

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

5.1.3.6 Cross-track alert

(See 6.4.5.7)

(A2/5.3.6) *A cross-track alarm, shall be provided when the actual position deviates from the track beyond a preset cross-track limit. See Annex E.*

Category B and C systems shall monitor the actual position against the curved tracks. If this monitoring and alerting is not done, the system shall be a category A system and track control shall stop at the end of each leg.

5.1.3.7 Course difference alert

(See 6.4.5.8)

(A2/5.3.7) A warning 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 alerts (see Annex E).

5.1.3.8 Low speed alert

(See 6.4.5.9)

(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) a warning shall be given. This alert is not required to be an integral part of the track control system.

5.1.3.9 End of track alert

(See 6.4.5.10)

A warning shall be given between 3 min and 6 min before the last waypoint of the active track is passed. If the end of track warning is not confirmed/acknowledged by the officer of the watch (user) within 30 s the alert priority shall change from warning to alarm. The end of track alarm is defined to be associated with NA activation (see 5.1.3.11).

5.1.3.10 Track control stopped alert

(See 6.4.5.11)

A track control stopped warning shall be given if the system automatically switches over to heading control or is unable to continue operation. If the track control stopped warning is not confirmed/acknowledged by the officer of the watch (user) within 30 s the alert priority shall change from warning to alarm. The track control stopped alarm is defined to be associated with NA activation (see 5.1.3.11).

5.1.3.11 Handling of the Back-up Navigator Alarm (NA)

(See 6.4.5.13)

A graphical description of the sequences described here is given in Figure A.2.

The back-up navigator alarm shall call assistance to the bridge by transfer of the unacknowledged alarm within the track control system to the BNWAS (see IEC 62616).

For all those unacknowledged alarms, required by this standard to have the NA activation function, the track control system shall generate the back-up navigator alarm output to the BNWAS, i.e. activate the NA signal output (either by contact closure or equivalent circuit, or an IEC 61162 interface using the ALR sentence).

Power failure of track control system shall not activate the NA signal output.

The NA shall be activated in accordance with the following.

- If within 30 s of the alarm's occurrence, the alarm has not been acknowledged, or has not been temporarily silenced, and the alarm condition has not been rectified, then the NA shall be activated.

- If within 30 s of the alarm's occurrence, the alarm has not been acknowledged, has not been rectified, but has been temporarily silenced by the operator, then the following will apply:

When the silencing expires, the NA activation shall function as if the alarm condition just arose, but any further silencing shall not result in further delay of the NA. Note that the silencing specified here is the temporary silence function which expires, reactivating the audible announcement, after 30 s.

As soon as all of the alarms associated with NA activation are acknowledged or rectified, the NA shall be deactivated. Note that acknowledgement may occur locally, remotely, or as a result of turning off the alert generating function (e.g. disabling track control).

5.1.3.12 Remote acknowledgments of alerts

(See 6.4.5.14)

Remote temporary silencing and remote acknowledgement shall be possible via alert related communication described in IEC 61924-2 (see also Annex K).

Remote acknowledgement shall only be possible for category B alerts (alerts where no additional information for decision support is necessary as described in IEC 61924-2).

Remote silencing of the relevant audible alarms of the TCS shall be possible at any time.

5.2 Ergonomic criteria

5.2.1 Operational controls

5.2.1.1 Controls for track control

(See 6.4.8)

(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 alerts, functions and other control parameters.*

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

NOTE There are restrictions described in 5.1.1.7.

5.2.1.2 Change over controls

(See 6.4.6.5, 6.4.8)

(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.

5.2.2 Presentation of information

5.2.2.1 Continuously displayed information

(See 6.4.7.1)

(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; for category B systems, an additional “assisted turn” indication shall be provided during course change manoeuvres;*
- .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;*

NOTE In this subclause the TO-waypoint means the related wheel-over.

- .8 next track course;*
- .9 selected track identification.*

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

All displayed information shall conform to the general requirements for displays contained in IEC 62288.

5.2.2.2 Information to be provided on demand

(See 6.4.7.2)

(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 of the curved track(s) (~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.

5.2.2.3 Presentation

(See 6.4.7.1)

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

5.3 Design and installation

The track control system shall be designed, manufactured and installed in accordance with recognized international quality standards, such as ISO 9000.

5.4 Interfacing

5.4.1 Sensors

(See 6.2.2.2)

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

NOTE Information flowing within the EUT can contain proprietary data.

5.4.2 Status information

(See 6.4.5.5)

(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.*

If a sensor is capable of distributing both processed sensor data and unprocessed sensor data then the status of the processing shall be incorporated in the data communication protocol. For example, if the distributed heading is normally corrected for speed/latitude error then the protocol should inform if this being the case or not, see Annex K.

5.4.3 Standards

(See 6.2.2.2)

(A2/7.3) *The track control system shall be capable of digital, serial communication with the ships navigation system and comply with the IEC 61162 series.*

The track control system shall support the IEC 61162 series interfaces as given in Annex K as a minimum. In addition, suitable alternative input or output interfaces may be used for instance equivalent Parameter Group Numbers (PGNs) with a IEC 61162-3 interface.

The manufacturer shall specify which IEC 61162 part each physical interface supports.

5.5 Fall-back arrangements

5.5.1 Failure of track control

(See 6.4.6.1)

NOTE The associated alerts are stated in 5.1.3.

If track control fails, a 'track control stopped warning' 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 leg, *take the actual heading as the preset heading for the heading control, or a calculated heading in such a way that the actual COG shall be approximately maintained,*
- if sailing on a curved track, the turn shall be completed and the track course of the next 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. The rudder angle shall be set to a fixed angle in such a way that:*

- if sailing on a leg, the actual heading shall be approximately maintained,

- if sailing on a curved track, 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.

5.5.2 Failure of position sensor

(See 6.4.6.2)

Position can be based on single position sensor or optionally can be based on multiple position sensors.

If the Track Control System is connected to multiple sensors (not integrated into an INS) an automatic change of sensors shall generate a warning. In this case position information has failed, or is unavailable, when all connected position sensors fail or are unavailable at the same time.

If position is based on CCRS position available from the INS and if the INS has reported that the CCRS position has failed integrity check (state failed in NSR sentence from the INS) or has not been possible (state doubtful in NSR sentence from the INS), then this situation shall be treated as if the CCRS position has failed or is unavailable.

If position information 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 warning” shall be generated. The system shall
 - if sailing on a leg, take the actual heading as the preset heading;
 - if sailing on a curved track, complete the turn and take the track course of the next 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 warning shall be activated giving the advice to switch to a valid and available position sensor, heading control or manual steering;
- even if acknowledged, this warning shall be repeated every 2 min until steering mode has been changed manually or automatically.
- when a position sensor becomes available before steering mode has been changed manually or automatically, the system may switch automatically back to position sensor information and, in that case, shall generate a warning.

The manual or automatic switching of position information shall not generate excessive rudder activities.

5.5.3 Failure of the heading measuring system

(See 6.4.6.3)

Heading can be based on single heading sensor or optionally can be based on multiple heading sensors.

If the Track Control System is connected to multiple sensors (not integrated into an INS), an automatic change of sensors shall generate a warning. In this case heading information has failed or is unavailable, when all connected heading sensors fail or are unavailable at the same time.

If heading is based on CCRS heading available from the INS and if the INS has reported that the CCRS heading has failed integrity check (state failed in NSR sentence from the INS) or has not been possible (state doubtful in NSR sentence from the INS), then this situation shall be treated as if the CCRS heading has failed or is unavailable.

If heading information has failed or is unavailable, then:

- the heading sensor alarm shall be activated;
- the 'track control stopped' warning 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 leg, the actual heading shall be approximately maintained;
 - if sailing on a curved track, the actual rate of turn shall be approximately maintained (~A).

5.5.4 Failure of the speed sensor

(See 6.4.6.4)

Speed can be based on single speed sensor/source or optionally can be based on multiple speed sensors/sources.

If the Track Control System is connected to multiple sensors (not integrated into an INS) an automatic change of sensors shall generate a warning. In this case speed information has failed or is unavailable, when all connected speed sensors fail or are unavailable at the same time.

If speed is based on CCRS speed available from the INS and if the INS has reported that the CCRS speed has failed integrity check (state failed in NSR sentence from the INS) or has not been possible (state doubtful in NSR sentence from the INS), then this situation shall be treated as if the CCRS speed has failed or is unavailable.

If speed information has failed or is unavailable, then:

- the speed sensor alarm shall be activated;
- the track control mode shall continue and use the last plausible speed of the ship, or a system derived speed as fallback information.

NOTE Examples of system derived speed information are an estimate deduced from continuous observation of shift of positions, or deduced from propeller RPM, etc.

In case of a reduction of the track control performance, the track control system shall additionally provide the following user guidance and alerts:

- after 1 min, or less, a warning shall be activated giving the advice to switch to a valid, alternative speed information or to change the steering mode.
- even if acknowledged, this warning shall be repeated every 2 min until a valid, alternative speed information (e.g. system derived speed) has been intentionally selected or steering mode has been changed.

When a suited speed sensor becomes available before the steering mode has been changed, the system may automatically switch back to speed sensor information and, in this case, shall generate a warning.

The manual or automatic switching of speed information shall not generate excessive rudder activities.

6 Test requirements and results

6.1 General

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

6.2 General requirements

6.2.1 Environmental tests

6.2.1.1 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 tests and checks shall be used for environmental tests:

- performance check: 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 a function.
- performance test: 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: visual check of the equipment or documentation.

6.2.1.2 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.

6.2.1.3 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 (see Annex D);
- 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.

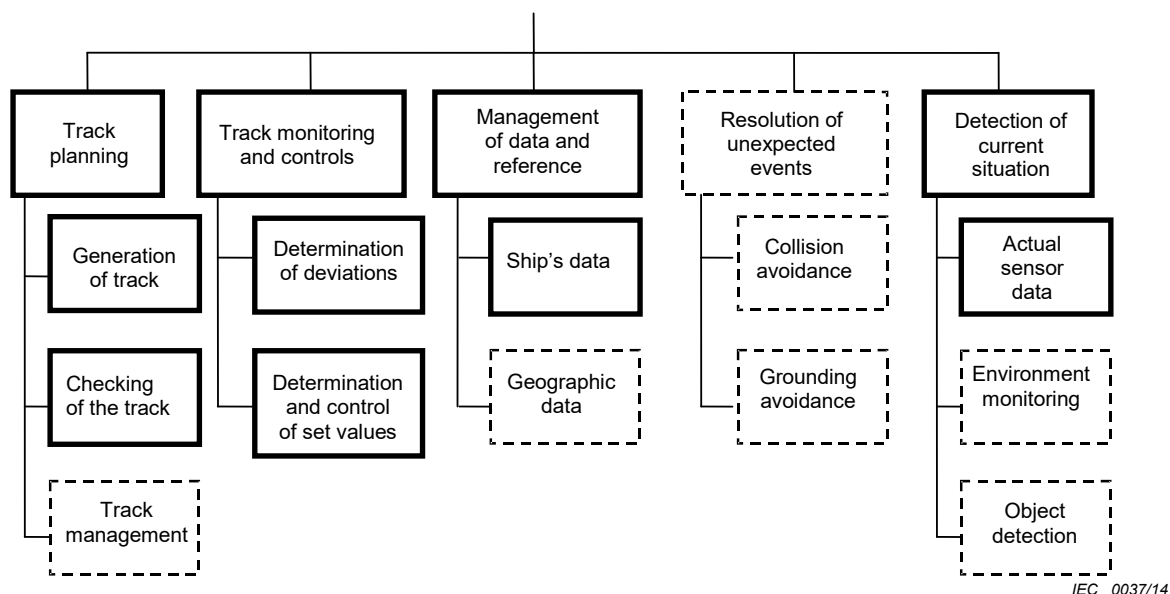


Figure 1 – Functional model of track control as part of an integrated navigation system

The information flow and the resulting dependencies between supported functions can be identified using the generic data flow diagram of the functional model (see 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.

6.2.1.4 Test of optional track control related modes

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

6.2.2 Documentation

6.2.2.1 Equipment manuals

(See 5.1.2)

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

6.2.2.2 Technical documentation for type approval

(See 5.1.1.3, 5.4.1, 5.4.2)

Manufacturer's 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.

6.2.3 Declarations

Some requirements cannot be verified by objective measurements.

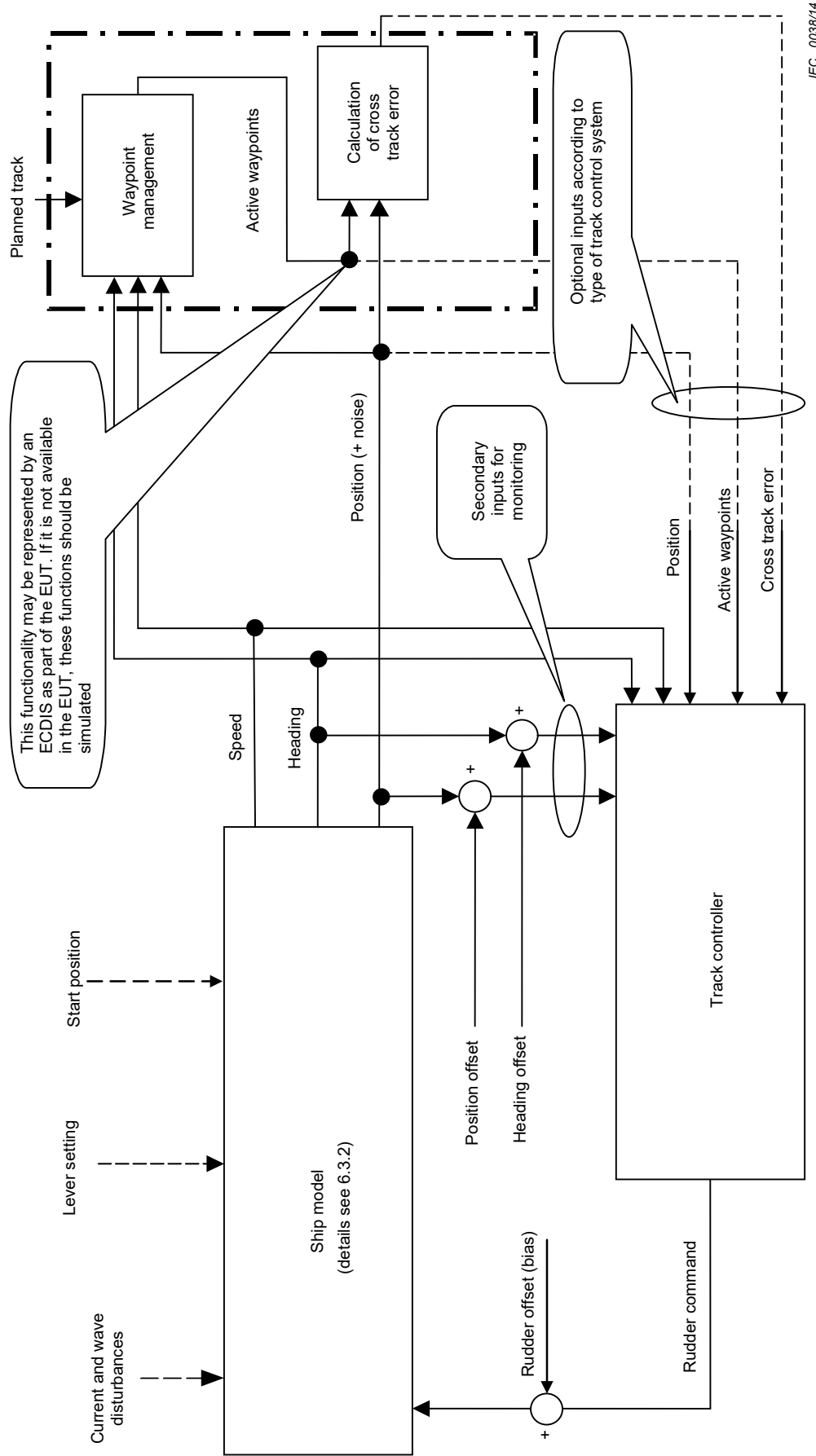
Verify that

- the declaration and relevant documentation comply with the requirements in Clause 5; and
- the general hardware and functional composition of the equipment and the relevant category of IEC 60945 for each unit is declared (see Clause 5).

6.3 Environment setup

6.3.1 General

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 (see 6.3.2) are available in the simulator. Prepare the scenarios by loading the test tracks into the planning system which is used by the EUT.



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Figure 2 – Block diagram

6.3.2 Ship motion simulator

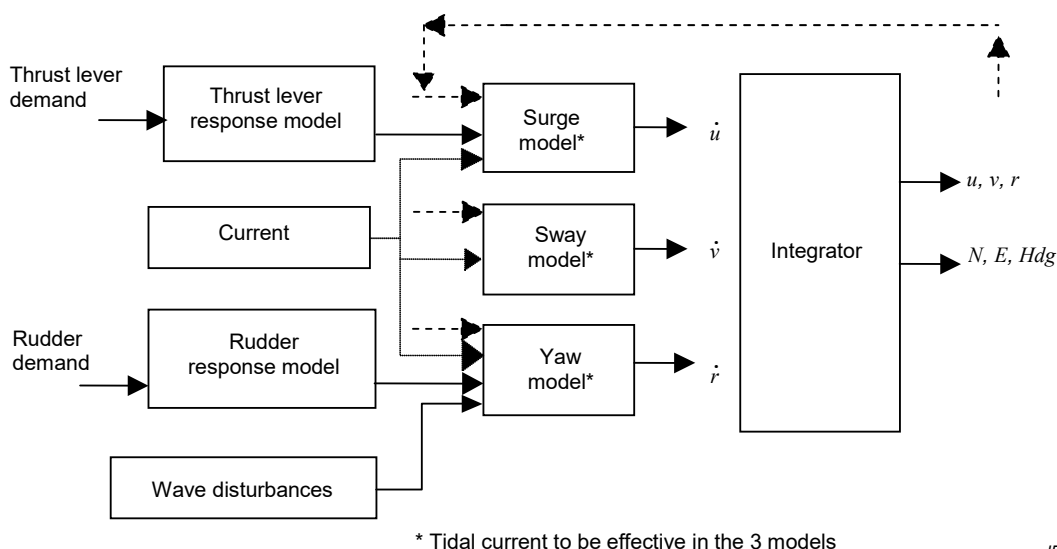
All functional tests of the track control system shall be performed using the ship motion simulator.

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

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

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.



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Figure 3 – High level block diagram

The mathematical model of the ship motion simulator is based on linear relationships between motions, propulsion and rudder control inputs, and the forces acting on the vessel (see Figure 3). 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

The model shall update data and produce messages at a rate not less than specified in Table 2:

Table 2 – Simulator output rate

Output of simulator			
Position	Speed	Heading	Rudder feedback
1 Hz	1 Hz	10 Hz	10 Hz

Additional simulation facilities for the following signals and functions shall be provided for:

- position (second position source for monitoring, random noise model, failures, integrity, alert communication),
- heading (second heading source for monitoring, integrity, alert communication),
- speed (second speed source for monitoring, integrity, alert communication),
- steering mode selection, override tiller, alert panel.

The noise model described in Annex H shall be used for the simulated position.

The resolution and accuracy of the simulated signals shall be in accordance with the applicable IMO, IEC and ISO requirements. The signal simulation shall use the interface standard as defined in relevant part of IEC 61162. Any other types of interfaces (for example, stepper or synchro, pulse log) shall also be tested.

6.3.3 Test scenarios

The following test scenarios shall be used for the performance test of the track control system.

- Scenario 1:

Complex track at 0°N/0°E with ship class A.

- Scenario 2:

Complex track at 0°N/180°E with ship class C.

- Scenario 3:

Zigzag track at 65°N/0°E with ship class B.

- Scenario 4:

Rhumb line/great circle Atlantic track (Boston to Rotterdam) with ship class B.

Details of the scenarios and graphs of the tracks are given in Annex G.

6.3.4 Planning

6.3.4.1 General

The defined test scenarios shall be created by the planning system used by the EUT and transferred to the EUT or stored.

6.3.4.2 Enter waypoints

Enter the waypoints of the test scenarios into the planning system. If necessary, they may be entered or transferred into other parts of the EUT.

6.3.4.3 Enter additional data

Enter additional data (limits, control data, ship's parameters, etc.) as defined in the operating manual of the EUT.

6.3.4.4 Store

Store the planned data so that they may be recalled and activated during execution of the test scenarios.

6.4 Test execution

6.4.1 General

Before any track becomes the active track, perform a check of the track data according to the operating manual of the EUT.

All tests concerning curved tracks

- shall be executed with systems able to perform full track control on these track segments (category C).
- shall be executed with systems able to perform an approximation by means of an assisted turn on these track segments (category B).
- shall not be executed with systems without curved track control (category A). In these cases course changes to follow the scenarios specified within this standard shall be performed using means according to the manufacturer's documentation.

6.4.2 Check the track

6.4.2.1 Check the radius (~A)

(See 5.1.1.2)

6.4.2.1.1 Purpose

The purpose of this test is to verify that the track control system recognizes radius data that does not match the waypoint data (geometric check).

6.4.2.1.2 Method of testing

Load the track data of scenario 1 and change or attempt to change the radius of waypoint 3 and 4 to 1,0 NM. Perform a check of the pre-planned track.

6.4.2.1.3 Required test results

Verify that indications are produced and that the changed track cannot be activated.

Restore the previous radius data and verify that no error messages are produced.

6.4.2.2 Check the waypoints

(See 5.1.1.2, 5.1.1.7)

6.4.2.2.1 Purpose

The purpose of this test is to verify that the track control system recognizes erroneous waypoint data (geometric check).

6.4.2.2.2 Method of testing

Load the track data of scenario 1 and move or attempt to move the position of waypoint 3 to the position of waypoint 1. Perform a check of the pre-planned track.

6.4.2.2.3 Required test results

Verify that indications are produced and that the changed track cannot be activated.

Restore the previous waypoint data and verify that no error messages are produced.

6.4.2.3 Check against the ship dynamics (~A)

(See 5.1.1.2, 5.1.1.7)

6.4.2.3.1 Purpose

The purpose of this test is to verify that the track control system detects a track that cannot be steered based on the ship's manoeuvrability (dynamic check).

6.4.2.3.2 Method of testing

Configure the track control system to use ship class C parameters. Load the data of scenario 1 into the system. Perform a check of the pre-planned track.

6.4.2.3.3 Required test results

Verify that track control cannot be activated and indications are produced that the track is not correct.

6.4.2.4 Invalidation of a modified track

(See 5.1.1.2, 5.1.1.7)

6.4.2.4.1 Application

If the planning system does not perform the check track function, this test applies.

6.4.2.4.2 Method of testing

Change the radius of waypoint 8 in scenario 2 to 0,25 NM (~A).

Repeat for any other methods of changing the track, including any facility to replace the active track.

6.4.2.4.3 Required test results

Verify that in all cases this modified track cannot become the active track.

6.4.2.5 Replace an active track without stopping track control

(See 5.1.1.7)

6.4.2.5.1 Application

If the track control system can replace the active track without stopping track control, this test applies.

6.4.2.5.2 Method of testing

Place the ship's position between waypoints 6 and 7 of scenario 2 and activate track control.

Change a copy of scenario 2 by modifying the course between waypoints 6 and 7 so that the starting requirements are not fulfilled by the current ship's position.

6.4.2.5.3 Required test results

Verify that the system prevents the track copy from becoming active.

6.4.3 Execution of the scenarios

6.4.3.1 Start track control on the pre-planned track

(See 5.1.1.2)

6.4.3.1.1 Application

This test only applies to systems that start track control directly, sailing on or near to the pre-planned track.

6.4.3.1.2 Purpose

The purpose of this test is to verify that the track control system is able to activate a pre-planned track, to display the track-related data, to reject or to accept the activated track and to activate track control, if accepted.

6.4.3.1.3 Display of data

6.4.3.1.3.1 Method of testing

Load the track of scenario 1 and set up the simulator accordingly. Set the simulated position on the leg between the first and second waypoint of the track. Set the ship's heading to 0° and the rudder to midships. Set the simulated speed according to the scenario.

Activate the pre-planned track.

6.4.3.1.3.2 Required test results

Verify that graphic displays, if available, show the ship sailing on the first leg heading towards waypoint 2. Verify that specified information to be displayed continuously or on demand is presented correctly.

6.4.3.1.4 “Start track control” not accepted

6.4.3.1.4.1 Method of testing

Set the heading to the track course and the simulated ship's position so that the cross-track difference to the track is beyond a preset limit.

Set the ship's position on the track and the simulated heading so that the course difference is beyond a preset limit.

6.4.3.1.4.2 Required test results

Verify with each of the methods that track control cannot be started and that the system gives an indication of the reason.

6.4.3.1.5 “Start track control” accepted

6.4.3.1.5.1 Method of testing

Set the simulated ship's position and heading in such a way that

- the cross-track difference to the track is below but close to the preset limit,
and
- the course difference is below but close to the preset limit.

6.4.3.1.5.2 Required test results

Verify that the system accepts track control.

Verify that the track control system steers to the second waypoint. The system shall steer smoothly towards and then join the track.

6.4.3.1.6 Track modification

(See 5.1.1.7)

6.4.3.1.6.1 Method of testing

Attempt to modify the relevant data of the FROM-, TO- and (~A) NEXT-waypoint of the activated track during track control.

6.4.3.1.6.2 Required test results

Verify that this is not possible without creating a new track and passing the starting requirements (see 6.4.1).

6.4.3.1.7 Start track control using a temporary track (~A)

(See 5.1.1.2)

6.4.3.1.7.1 Application

This test only applies to systems capable of generating a temporary track.

6.4.3.1.7.2 Purpose

The purpose of this test is to verify that the system or the user is able to generate a temporary track, to display the track-related data, to reject or to accept the temporary track and to start track control.

6.4.3.1.7.3 Method of testing

Perform the following tests.

- a) Load the track of scenario 1 and set up the simulator accordingly. Set the simulated position near but not on the track. Set the heading to 0° and the rudder to midships. Set the simulated speed according to the scenario.
- b) Activate the pre-planned track.
- c) Attempt to create a condition so that the temporary track does not fulfil the starting requirements and attempt to start track control.
- d) If track control has not been started, start track control with a temporary track which does fulfil the starting requirements.

6.4.3.1.7.4 Required test results

Verify that:

- a) the track control system or the user is able to generate a temporary track guiding to the pre-planned track. Verify that the system graphically displays the temporary track attaching to the pre-planned track. Verify that the temporary track can be accepted or rejected;

- b) the specified information to be displayed continuously or on demand is presented correctly;
- c) if this was successful, track control cannot be started and the system gives an indication of the reason;
- d) the following results are met:
 - track control can be started and the system accepts the temporary track;
 - the system turns the ship towards the track course of the temporary track and then follows it and joins the pre-planned track.

6.4.3.1.8 Temporary track modification

(See 5.1.1.7)

6.4.3.1.8.1 Method of testing

Attempt to modify the FROM, TO and NEXT waypoint of the temporary track during track control along the temporary track.

6.4.3.1.8.2 Required test results

Verify that this is not possible without creating a new temporary track and passing the starting requirements (see 6.4.1).

6.4.3.1.9 Pre-planned track modification

(See 5.1.1.7)

6.4.3.1.9.1 Method of testing

Proceed along the temporary track on to the pre-planned track. Attempt to modify the relevant data of the FROM, TO and NEXT waypoint of the activated pre-planned track during track control.

6.4.3.1.9.2 Required test results

Verify that this is not possible without creating a new track and passing the starting requirements (see 6.4.1).

6.4.3.2 Execute track control under undisturbed conditions

(See 5.1.1.1, 5.1.1.8)

6.4.3.2.1 Application

The following subclauses define the details of the tests to be executed with each scenario under operationally normal and undisturbed conditions.

6.4.3.2.2 Test using Scenario 1

6.4.3.2.2.1 Purpose

The purpose of this test is to verify that the EUT is able to perform track control according to scenario 1 with a class A ship and various turn rates/radii.

6.4.3.2.2.2 Method of testing

Set the course difference limit to 15° and the cross-track limit to 35 m. Load the track of scenario 1 and set up the simulator and EUT accordingly. Start the simulation at the beginning of the first leg of the track.

Start track control and let the system follow the track until the last waypoint is passed.

At the end of each leg confirm/acknowledge the course change alerts within the assigned time windows (~A).

For category A, at the end of each leg confirm/acknowledge the 'end of track warning' within the assigned time windows.

6.4.3.2.2.3 Required test results

As the ship proceeds along the track, verify that:

- the ship's actual course and position do not deviate from the pre-planned track beyond the preset limits;
- the graphic screens, if available, display the ship sailing on the track;
- the displayed information is presented correctly, referencing the activated track and switch from leg to leg automatically;
- the course change alerts are given as specified in 5.1.1.5, 5.1.1.6 (~A);
- for category A, the 'end of track warning' is generated at the end of each leg as specified in 5.1.1.17.
- at the end of the track, the system proceeds as required under 5.1.1.17.

Furthermore, if the system supports track control along curved tracks, verify that:

- the track graphics include the curved tracks presenting the correct radii;
- the course changes are executed using the correct radii;
- once the ROT (+/- 10 %) has been achieved and until the steady part of the turn completes, the RMS of applied rudder is less than 20 % of maximum rudder as defined by the model.

6.4.3.2.3 Test using scenario 2

6.4.3.2.3.1 Purpose

The purpose of this test is to verify that the EUT is able to perform track control according to scenario 2 with a class C ship and various turn rates/radii.

6.4.3.2.3.2 Method of testing

Set the course difference limit to 15° and the cross-track limit to 100 m. Set up the simulator and the EUT according to scenario 2. Start the simulation at the beginning of the first leg. Start track control and let the system follow the track until the last waypoint is passed. At the end of each leg confirm/acknowledge the course change alerts within the assigned time windows (see also 6.4.5.10) (~A).

6.4.3.2.3.3 Required test results

As the ship proceeds along the track, verify that:

- the ship's actual course and position do not deviate from the pre-planned track beyond the preset limits;
- the graphic screens, if available, display the ship sailing on the track;
- the displayed information is presented correctly, referencing the activated track and switch from leg to leg automatically;
- the course change alerts are given as specified in 5.1.1.5, 5.1.1.6 (~A);
- at the end of the track the system proceeds as required under 5.1.1.17.

Furthermore, if the system supports track control along curved tracks, verify that:

- the track graphics include the curved tracks presenting the correct radii;
- the course changes are executed using the correct radii.
- once the ROT (+/- 10 %) has been achieved and until the steady part of the turn completes, the RMS of applied rudder is less than 20 % of maximum rudder as defined by the model.

6.4.3.2.4 Test using scenario 3

6.4.3.2.4.1 Purpose

The purpose of this test is to verify that the EUT is able to perform track control according to scenario 3 with a class B ship and various turn rates/radii.

6.4.3.2.4.2 Method of testing

Set the course difference limit to 15° and the cross-track limit to 60 m. Set up the simulator and the EUT according to scenario 3. Start the simulation at the beginning of the first leg. Start track control and let the system follow the track until the last waypoint is passed. At the end of each leg confirm/acknowledge the course change alerts within the assigned time windows.

6.4.3.2.4.3 Required test results

As the ship proceeds along the track, verify that:

- the ship's actual course and position do not deviate from the pre-planned track beyond the preset limits;
- the graphic screens, if available, display the ship sailing on the track;
- the displayed information is presented correctly, referencing the activated track and switch from leg to leg automatically;
- the course change indications/alarms are given as specified in 5.1.1.5, 5.1.1.6 (~A);
- at the end of the track the system proceeds as required under 5.1.1.17.

Furthermore, if the system supports track control along curved tracks, verify that:

- the track graphics include the curved tracks presenting the correct radii;
- the course changes are executed using the correct radii.
- once the ROT (+/- 10 %) has been achieved and until the steady part of the turn completes, the RMS of applied rudder is less than 20 % of maximum rudder as defined by the model.

6.4.3.2.5 Test using scenario 4 rhumb line (RL)

6.4.3.2.5.1 Purpose

The purpose of this test is to verify that the EUT is able to perform long term track control according to scenario 4 with a class B ship in rhumb line (RL) mode.

6.4.3.2.5.2 Method of testing

Set the course difference limit to 25° and the cross-track limit to 200 m. Set up the simulator and the EUT according to scenario 4.

- a) Start track control on the first leg in RL mode and let the system follow the track until waypoint 3 is passed. Confirm/acknowledge the course change alerts within the assigned time windows (~A).
- b) Let the system follow the leg from waypoint 3 to waypoint 4 (this can be done unattended). Stop track control before or at waypoint 4.

6.4.3.2.5.3 Required test results

The following results are required.

- a) Verify
 - the correctness of information on graphic displays, if available;
 - the correctness of specified track-related data during the test;
 - that the course change alerts are given as specified in 5.1.1.5, 5.1.1.6 (~A).
- b) Verify by recording or observation that the ship proceeds from waypoint 3 to waypoint 4 along a constant track course with a cross-track deviation not greater than 50 m.

6.4.3.2.6 Test using scenario 4 great circle (GC)

6.4.3.2.6.1 Application

This test is restricted to systems able to steer along a track in great circle (GC) mode.

6.4.3.2.6.2 Purpose

The purpose of this test is to verify that the EUT is able to perform long term track control according to scenario 4 with a class B ship in great circle mode and that the system is able to switch over from rhumb line to great circle mode and vice versa.

6.4.3.2.6.3 Method of testing

Set the course difference limit to the maximum specified by the manufacturer and the cross-track limit to 1 000 m. Set up the simulator and the EUT according to scenario 4. Set the leg from waypoint 07 to waypoint 08 to great circle mode.

- a) Start track control at the end of the leg from waypoint 06 to waypoint 07 in rhumb line mode and let the system follow the track until waypoint 07. If the system does not switch automatically to great circle mode, select great circle mode manually.
- b) Continue great circle track control for a minimum of 4 h.
- c) Restart track control on the four great circle positions between waypoint 07 and waypoint 08.
- d) Restart track control after setting the position before and the heading along the end of the great circle leg between waypoint 07 and waypoint 08 and let the system pass waypoint 08. If the system does not switch automatically to rhumb line mode, select rhumb line mode manually.

6.4.3.2.6.4 Required test results

The following results are required.

- a) Verify
 - that the switch over from rhumb line to great circle is performed;
 - the correctness of the graphic displays, if available;
 - the indicated track-related data during the test are correct.
- b) Verify that
 - the course changes while the ship is sailing on the great circle leg;
 - the tested part of the leg is sailed on a great circle according to the calculated courses of scenario 4 without track deviations greater than the test cross-track limit (by recording or observation).
- c) Verify that
 - the courses on the great circle approximation are correct.

d) Verify that

- the system is able to switch over from great circle to rhumb line mode automatically or manually after waypoint 08 has been passed;
- the tested part of the leg between waypoint 08 and waypoint 09 is sailed on a rhumb line according to the calculated course and with a cross-track deviation not greater than 50 m.

6.4.4 Execution of additional tests**6.4.4.1 Adaptation**

(See 5.1.1.9)

6.4.4.1.1 Purpose

The purpose of this test is to verify that the EUT is able to adapt by manual or automatic means to varying speed and weather conditions. Notice that the performance of the above tests covers the verification of system capabilities for different loading conditions. For systems requiring preconditioning, provide sufficient adaptation to the ship model in use before the test scenarios are performed.

The effects of speed variations and weather conditions to be tested are:

- influence of speed change during the turn;
- influence of current change on a leg;
- influence of current during the turn;
- influence of sea state during the turn;
- influence of sea state change on a leg.

See Annex J for an explanation of the tests.

6.4.4.1.2 Method of testing

Load the track of scenario 3 and set up the simulator accordingly, as follows.

a) Adaptation to intended speed change

- 1) Set the simulated ship on the first leg at a distance of 2 NM to 3 NM from WP2 sailing a course of 040° at 10 kn. Start track control. After the turn has been initiated, increase the commanded speed to 20 kn.
- 2) Restart track control on the second leg at a distance of 3 NM to 4 NM from WP3 sailing a course of 140° at 20 kn. After the turn has been initiated, decrease the commanded speed to 12 kn.

b) Adaptation to current change

- 1) Restart track control on the second leg sailing a course of 140° at 20 kn. When the simulated ship is 4 NM to 5 NM from WP3, induce a simulated current of 5 kn perpendicular to the track.
- 2) Restart track control on the first leg at a distance of 2 NM to 3 NM from WP2 sailing a course of 040° at 20 kn. In the middle of the turn, induce a simulated current of 5 kn northwards.
- 3) Restart track control on the second leg at a distance of 3 NM to 4 NM from WP3 sailing a course of 140° at 20 kn. In the middle of the turn, induce a simulated current of 5 kn northwards.

c) Adaptation to sea state

- 1) Restart track control on the first leg at a distance of 2 NM to 3 NM from WP2 sailing a course of 040° at 20 kn. Set the simulated sea state to 2 and complete the turn.

- 2) Restart track control on the second leg at a distance of 2 NM to 3 NM after WP2 sailing a course of 140° at 20 kn at sea state 2. In the middle of the leg, induce a simulated sea state of 5.

d) Adaptation to loading conditions

Confirm by inspection of manufacturer's documentation that the EUT includes a method for adaptation to different loading conditions.

6.4.4.1.3 Required test results

6.4.4.1.3.1 Category A and category C

For category A cases b) 1) and c) 2) and for category C cases a) 1) to c) 2).

Verify that the track control system is able to adapt to the varying conditions by automatic or manual means and that it follows the track without exceeding the cross-track limit.

6.4.4.1.3.2 Category B

Cases a) 1), a) 2) and b) 2) to c) 1) verify that:

- the track control system is able to adapt to the varying conditions by automatic or manual means and that it follows the track approximately,
- in case the actual position deviates from the curved track beyond the pre-set limit, a cross-track alarm is given (see 5.1.3.6),
- the manoeuvre back to the pre-planned track is performed in a predictable and safe manner without excessive rudder activity.
- it is possible to adjust the rate(radius) of turn during the execution of the turn automatically and/or manually.

Confirm by inspection of manufacturer's documentation that:

- the manoeuvre back to track after exceeding the cross-track limit is exemplified including a graphical presentation,
- the conditions for reactivation of track control after the assisted turn is completed are described.

Cases b) 1) to c) 2):

Verify that the track control system is able to adapt to the varying conditions by automatic or manual means and that it follows the track without exceeding the cross-track limit.

6.4.4.2 Rudder activity

(See 5.1.1.10)

6.4.4.2.1 Purpose

The purpose of this test is to verify that the EUT is able to prevent unnecessary activation of the rudder due to normal yaw motion, sensor data resolution and statistically scattered position errors.

6.4.4.2.2 Method of testing

Load the track of scenario 3 and set up the simulator accordingly.

Set the simulated ship after waypoint 2 sailing a course of 140° at 20 kn.

Start track control and perform the following tests individually.

- Induce a periodical yaw motion using a sinus function with $f = 0,1$ Hz and an amplitude of $\pm 4^\circ$ into heading input of the track control.
- Induce the following reduced resolution sensor inputs, one at a time
 - heading $1/6^\circ$,
 - speed $1/2$ kn,
 - position data $1/100$ min (18 m).
- Induce statistically scattered position errors as per Annex H.

6.4.4.2.3 Required test results

Verify that the track control system is able to adapt to the disturbed environment by automatic or manual means and that it is following the track within the test track limit and without excessive activation of the rudder.

6.4.4.3 Ship steering bias

(See 5.1.1.9)

6.4.4.3.1 Purpose

The purpose of this test is to verify that the EUT is able to compensate for ship steering bias, such as asymmetries like hull flow and propeller effects.

6.4.4.3.2 Method of testing

Load the track of scenario 3 and set up the simulator accordingly. Set the rudder offset to $+2^\circ$ simulating a steering bias. Set the simulated ship just after WP1 sailing a course of 040° at 15 kn. Start track control. Stop track control after 20 min.

6.4.4.3.3 Required test results

Verify by observation that the track control system is able to compensate for the ship steering bias.

6.4.5 Monitoring and alerts

6.4.5.1 General

All tests of operational alerts shall verify that these alerts, if acknowledged, remain as an indication while the alert condition exists and complies with 5.1.3.

After each test in this clause, re-establish normal operation conditions for EUT.

6.4.5.2 Failure or reduction in power supply

(See 5.1.3.1)

6.4.5.2.1 Method of testing

Reduce the power supply of each component of the track control system successively below the limit specified by the manufacturer as the minimum for safe operation. In the absence of such data, limits according to IEC 60945 shall be used.

Switch off the power supply of each component of the track control system successively.

This test may be combined with environmental tests in 6.2.1.

6.4.5.2.2 Required test results

Verify that a warning is triggered (e.g. contact closure) by the track control system.

6.4.5.3 Position monitoring alert

(See 5.1.1.4, 5.1.3.2)

6.4.5.3.1 Method of testing

Supply a pair of position data to the position monitor function (see 5.1.1.4) to be used with the track control system. Modify the primary data or secondary data in such a way that the positions differ from each other by more than the preset alert limit.

If multiple position sensors are offered, then repeat the test method as needed to verify all sensor configurations.

6.4.5.3.2 Required test results

Verify that a corresponding warning is given.

6.4.5.4 Heading monitoring alert

(See 5.1.1.16, 5.1.3.3)

6.4.5.4.1 Application

This test applies only if the heading monitor function is an integral part of the track control system.

6.4.5.4.2 Method of testing

Supply a pair of heading data to the heading monitor function (see 5.1.1.16) to be used with the track control system. Modify the primary or secondary heading in such a way that the headings differ from each other by more than the preset alert limit.

If multiple heading sensors are offered, then repeat the test method as needed to verify all sensor configurations.

6.4.5.4.3 Required test results

Verify that a corresponding warning is given.

6.4.5.5 Failure and alert status of sensors

(See 5.1.1.16, 5.1.3.4, 5.4.2)

6.4.5.5.1 Method of testing

Successively modify input data from the position-fixing sensor, the heading sensor and speed sensor in use for track control to simulate a sensor failure or an alert status. If the EUT can accept position, heading or speed data from a sensor which does not provide status or failure information, modify the input data to a non-plausible value.

6.4.5.5.2 Required test results

Verify that an alert sequence and corresponding indications are generated as specified in 5.1.3.4.

(See also test of fall-back procedures defined in 6.4.5.)

6.4.5.6 Use of faulty signals

(See 5.1.3.5)

6.4.5.6.1 Method of testing

Successively provide input data from the position-fixing sensor, the heading sensor, the speed sensor and any other sensor provided for track control in the system so that it is tagged with a failure status. Attempt to select the faulty sensor.

6.4.5.6.2 Required test results

Verify that it is not possible to select the sensor for track control purposes and that a status indication is generated.

6.4.5.7 Cross-track alert

(See 5.1.3.6)

6.4.5.7.1 Method of testing

Perform the following tests.

- a) Modify the selected position so that a cross-track distance greater than the preset cross-track alert limit is generated.
- b) Acknowledge the alert and modify the selected position so that the preset cross-track alert limit is not exceeded.

6.4.5.7.2 Required test results

Verify that

- a) a corresponding alert of priority alarm is given.
- b) the alert status and its indication are cleared.

6.4.5.8 Course difference alert

(See 5.1.3.7)

6.4.5.8.1 Method of testing

Perform the following tests.

- a) Add a transversal current velocity so that the preset course difference alert limit is exceeded.
- b) Acknowledge the alert and modify the current velocity so that the preset course difference alert limit is not exceeded.

6.4.5.8.2 Required test results

Verify that

- a) a corresponding alert of priority warning is given,
- b) the alert status and its indication are cleared.

6.4.5.9 Low speed alert

(See 5.1.3.8)

6.4.5.9.1 Application

This test applies only to systems in which the low speed alert is an integral part of the FUT.

6.4.5.9.2 Method of testing

Perform the following tests.

- a) Reduce the selected speed input below the minimum speed for track control.
- b) Acknowledge the alert and set the selected speed input to a value higher than the minimum speed for track control.

6.4.5.9.3 Required test results

Verify that

- a) a corresponding alert of priority class warning is given,
- b) the alert status and its indication are cleared.

6.4.5.10 End of track alert

(See 5.1.1.17, 5.1.3.9)

6.4.5.10.1 Method of testing

Follow a pre-planned track until the last waypoint is passed with and without acknowledging the “end of track” alert.

This test may be carried out simultaneously with other tests (see 6.4.2.3).

6.4.5.10.2 Required test results

Verify that corresponding alerts of priority class warning are given as described in 5.1.3.9.

6.4.5.11 Track control stopped alert

(See 5.1.3.10)

6.4.5.11.1 Method of testing

Each of these tests is to be carried out in track control mode.

- a) Use the manufacturer's documentation (e.g. Failure mode & effect analysis (FMEA)) to identify all failure conditions within the track control system which cause the system to switch automatically to heading control or which render track control unusable. Create one of these conditions that do not represent a sensor failure.
- b) Disconnect the selected position input from the track control system or define it as invalid.
- c) Disconnect the selected heading input from the track control system or define it as invalid.
- d) Disconnect the selected speed input from the track control system or define it as invalid.

6.4.5.11.2 Required test results

Verify that a track control stopped alert of priority class warning is given after application of each method by the track control system itself or that an external alarm device is triggered by the track control system as described in 5.1.3.10.

6.4.5.12 Course change alerts (~A)

(See 5.1.1.5, 5.1.1.6)

6.4.5.12.1 Purpose

The purpose of the following sequence of tests is to fully exercise the course change alert conditions (see 5.1.1.5, 5.1.1.6 and Annex A).

6.4.5.12.2 Method of testing

The tests may be carried out using any scenario of Annex G.

Start track control preceding any alerts becoming active and pass the wheel-over-time:

- a) without acknowledgment of early course change warning (ECCW) and without acknowledgment of actual course change warning (ACCW);
- b) with acknowledgment of ECCW and without acknowledgment of ACCW;
- c) without acknowledgment of ECCW and with acknowledgment of ACCW;
- d) with acknowledgment of both ECCW and ACCW.

After each test, normal operating conditions shall be re-established. Irrespective of any alert sequence, the pre-planned track shall be maintained.

6.4.5.12.3 Required test results

The following results are required.

- a) With no acknowledgment of alerts verify that:
 - ECCW occurs between WOT – 6 min and WOT – 3 min;
 - ECCW changes priority to alarm status (ECCA) within 30 s;
 - NA is triggered within another 30 s time lapse;
 - the track controller follows automatically the planned track.
- b) With acknowledgment of ECCW only verify that:
 - ECCW ceases and no ECCA occurs;
 - ACCW occurs at 30 s before the WOT;
 - ACCW changes priority to ACCA within 30 s;
 - NA is triggered within another 30 s time lapse;
 - the track controller follows automatically the planned track.
- c) With acknowledgment of ECCW and ACCW verify that:
 - no alarm is activated;
 - no NA is activated;
 - the track controller follows automatically the planned track.

6.4.5.13 Handling of the Back-up Navigator Alarm (NA)

(See 5.1.3.11)

6.4.5.13.1 Method of testing

Confirm by inspection of documented evidence that the EUT provides at least one of the required interfaces to BNWAS. Perform subsequently tests a) to c) below each with no alerts present as the start condition. Create an alarm associated with NA activation.

- a) After one minute acknowledge the alarm.
- b) Wait 10 s and silence the alarm. Wait until the audible announcement of the alarm is activated again. Wait 10 s and silence the alarm again.
- c) Rectify the cause of alarm after 40 s.

6.4.5.13.2 Required test results

Confirm by observation that:

a) 30 s after activation of the alarm

- If available ALR sentence defined at Annex K is generated,
- If available the contact is closed for NA transfer,
- If available other equivalent methods defined by the manufacturer are activated for NA transfer.

Confirm that after the acknowledgement of the alarm all BNWAS-interfaces reset the state to NA not activated.

b) 70 s after activation of the alarm

- If available ALR sentence defined at Annex K is generated,
- If available the contact is closed for NA transfer,
- If available other equivalent methods defined by the manufacturer are activated for NA transfer

Confirm that after the acknowledgement of the alarm all BNWAS interfaces reset the state to NA not activated.

c) 30 s after activation of the alarm

- If available ALR sentence defined at Annex K is generated,
- If available the contact is closed for NA transfer,
- If available other equivalent methods defined by the manufacturer are activated for NA transfer

Confirm that after the cause of the alarm is rectified (e.g. track control is switched off) all BNWAS interfaces reset the state to NA not activated.

6.4.5.14 Remote acknowledgments of alerts – Method of testing and required test result

(See 5.1.3.12)

Perform following test using a simulator for BAM:

a) Test of alert reporting and silencing

- Create 2 alerts, at least one of Cat B.
- Confirm by observation that ALF, ALC and HBT sentences are transmitted from the EUT to the BAM interface.
- Use simulator to send ACN sentence to the EUT to silence one of the alerts.
- Confirm by observation that ALF, ALC and HBT sentences report correctly the new state of the alerts.
- Use simulator to send ACN sentence to the EUT to acknowledge the Cat B alert.
- Confirm by observation that ALF, ALC and HBT sentences report correctly the new state of the alerts.

b) Test of attempt to acknowledge Cat A alert

- Create an alert of Cat A.
- Confirm by observation that ALF, ALC and HBT sentences are transmitted from the EUT to the BAM interface.
- Use simulator to send ACN sentence to the EUT to acknowledge the Cat A alert.
- Confirm by observation that the EUT refuses to acknowledge and that the ARC sentence reports correctly this refusal.

6.4.6 Fallback and manual change over

6.4.6.1 Failure of track control

(See 5.5.1)

6.4.6.1.1 Method of testing

If a physically separated heading controller is included, the following tests shall be repeated with and without failure of heading control.

Select scenario 3 and start track control. Wait until the ship is proceeding steadily on a leg and create a failure condition other than sensor failures that renders the track control system inoperative.

Select scenario 3 and start track control. Wait until the ship is performing a course change manoeuvre and then switch off the power supply of the track control system or render it inoperative by any other means.

6.4.6.1.2 Required test results

Verify that the system reacts as specified in 5.5.1.

6.4.6.2 Failure of position sensor

(See 5.5.2)

6.4.6.2.1 Method of testing

Select scenario 3 and start track control. Wait until the ship is proceeding steadily on a leg and perform the following tests a, c, e, f, i, j.

Restart track control using scenario 3 and perform the following tests b, d, g, h, k, l, during a course change manoeuvre (~A).

- a) Switch off the selected position.
- b) If applicable, switch off all available positions.
- c) Tag the selected position input as invalid.
- d) If applicable, tag all available position inputs as invalid.

If applicable

- e) tag the NSR-sentence for position input as integrity failed,
- f) tag the NSR-sentence for position input as integrity doubtful,
- g) switch off the selected speed sensor, wait 6 min and switch on the selected speed sensor,
- h) switch off all available speed sensors, wait 6 min and switch on all available speed sensors,
- i) tag the selected speed input as invalid, wait until 6 min and tag the selected speed input as valid,
- j) tag all available speed inputs as invalid, wait 6 min and tag all available speed inputs as valid,
- k) tag the NSR-sentence for speed input as integrity failed, wait 6 min and tag the selected speed input as passed,
- l) tag the NSR-sentence for speed input as integrity doubtful, wait 6 min and tag the selected speed input as passed.

6.4.6.2.2 Required test results

For a, b, c, d, e, f, g, h, i, j, k and l), verify that the system reacts as specified in 5.5.2.

6.4.6.3 Failure of the heading measurement system

(See 5.5.3)

6.4.6.3.1 Method of testing

Select scenario 3 and start track control. Wait until the ship is proceeding steadily on a leg and perform the following tests a, c, e.

Restart track control using scenario 3 and perform the following tests b, d, f, during a course change manoeuvre (~A).

- a) Switch off the selected heading sensor.
- b) If applicable switch off all available heading sensors.
- c) Tag the selected heading input as invalid.
- d) If applicable, tag all available heading inputs as invalid.
- e) If applicable, tag the NSR-sentence for heading input as integrity failed
- f) If applicable, tag the NSR-sentence for heading input as integrity doubtful,

6.4.6.3.2 Required test results

For a, b, c, d, e and f), verify that the system reacts as specified in 5.5.3.

6.4.6.4 Failure of the speed sensor

(See 5.5.4)

6.4.6.4.1 Method of testing

Select scenario 3 and start track control. Wait until the ship is proceeding steadily on a leg and perform the following tests a, c, e, f, i, j.

Restart track control using scenario 3 and perform the following tests b, d, g, h, k, l, during a course change manoeuvre (~A).

- a) Switch off the selected speed sensor.
- b) If applicable, switch off all available speed sensors.
- c) Tag the selected speed input as invalid.
- d) If applicable, tag all available speed inputs as invalid.

If applicable

- e) tag the NSR-sentence for speed input as integrity failed,
- f) tag the NSR-sentence for speed input as integrity doubtful,
- g) switch off the selected speed sensor, wait 6 min and switch on the selected speed sensor,
- h) switch off all available speed sensors, wait 6 min and switch on all available speed sensors,
- i) tag the selected speed input as invalid, wait until 6 min and tag the selected speed input as valid,
- j) tag all available speed inputs as invalid, wait 6 min and tag all available speed inputs as valid,