NAVIGATIONAL AIDS AND RELATED MATTERS

Report of the Technical Working Group

(continued)

6 AIS MATTERS

6.1 The Group considered documents NAV 51/4/2 (IEC) and NAV 51/4/3 (Sweden) concerning AIS Class B equipment for non-SOLAS craft. In particular, it was noted that the IEC was preparing a draft standard IEC 62287 which used a different technology, CSTDMA, from the SOTDMA used by Class A (SOLAS) AIS and pointed out some potential concerns:

.1 Class A is designed to have a graceful degradation in case of overloading, whereas the proposed Class B will stop its transmissions in a similar situation;

.2 the proposed Class B cannot utilize the identification message that is prepared for Class B in ITU-R Recommendation M.1371;

.3 the proposed Class B will use an inferior, indirect method for synchronization of the timeslots;

.4 the proposed Class B will transmit in the first time-slot that is detected as not used, which will result in an increased number of collisions of transmitted messages resulting in a reduced total throughput; and

.5 certain VTS systems may poll vessels with Class B equipment for static information and never get an answer because that message is not possible to transmit from the proposed Class B device.

6.2 The observer from the IEC described work that had taken place together with IALA and responded to these concerns as follows:

.1 simulations had shown that CSTDMA performed better than SOTDMA in terms of received messages from Class A devices;

.2 ship-to-ship navigational messages are utilized and these provide the primary safety function of AIS;
.3 Class B is superior in respect of not using occupied or garbled slots;

.4 simulation has demonstrated that Class B CSTDMA performs better than SOTDMA in terms of total received messages; and

.5 Class B CSTDMA will in fact respond to a VTS interrogation as this is part of the test standards.

6.3 In conclusion, therefore, it appeared that CSTDMA would work as well as SOTDMA but it was understood that some Administrations, from applications point of view, would prefer a SOTDMA Class B. The delegation of Sweden offered to prepare this as an alternative standard for IEC.

6.4 Meanwhile, it was pointed out that the CSTDMA Class B was compatible with the SOLAS Class A and would not degrade the VHF data link as required by resolution MSC.140(76). The main difference between the technologies was the way in which they handled very heavy overload conditions which were not expected to be frequently encountered. The delegation of the United Kingdom stated that even in the Dover Straits the VHF channel loading did not exceed 10%.

6.5 The delegation of France pointed out that the CSTDMA technology proposed by the IEC did not conform with the current ITU-R Recommendation M.1371 and might alternatively be referred to as "Class C". It was noted, however, that the ITU-R Study Group 8 had instructed its Working Party 8B to review the recommendation with a view towards revising the Class B protocol maintaining interoperability with Class A.

6.6 The observer from IALA stated that IALA was preparing a suitable paper for the next meeting of Working Party 8B on the issue.

6.7 The Group also noted that the SOTDMA technology was subject to a patent belonging to a Swedish company and it was further noted that the ITU was attempting to seek clarifications from the patent holder concerning difficulties which had not been supplied.

6.8 The observer from CIRM pointed out that the patent holder had originally indicated that the patent would be royalty free for applications for SOLAS ships but had subsequently indicated that thus would not be the case. CIRM had had extended negotiations with the patent holder which had not been resolved. This was leading to uncertainty in the future application of Class A AIS and concerns about the application of Class B AIS where cost to users will be crucial.

6.9 Taking into account the above considerations, the Group was of the opinion that a low-cost AIS devices, Class B or Class C, affordable for non-SOLAS vessels and pleasure craft and harmoniously operating with Class A devices, with a view to improve safety of navigation in general and safety of life at sea, in particular, should be developed as a matter of urgency.

6.10 Therefore, Member Governments should be invited to actively participate in the work of IALA, ITU, IEC and other organizations dealing with the issue.
7 WORLD-WIDE RADIONAVIGATION SYSTEM

7.1 Having considered document NAV 51/12 (France) and reviewed the amended draft performance standards for Galileo Open and Safety of Life service receivers, the Group was of the opinion that both service receivers could be described in single performance standards. The Group also noted that there was an urgency to complete the performance standards by 2006 in order to give time for industry to produce equipment for the Galileo system becoming operational in 2008.

7.2 The Group therefore prepared revised performance standards together with a draft justification to include a new agenda item on "Performance standards for shipborne Galileo receiver equipment" in the Sub-Committee's work programme and was of the opinion that the performance standards should be finalized at NAV 52.

7.3 Therefore, taking into account the Group's view on the matter, the Sub-Committee was invited to agree to the draft justification, set out in annex 3, and invite the Committee to include the proposed new agenda item in the Sub-Committee's work programme.

7.4 The Group considered the timescales for the recognition process for Galileo and concluded that this could be achieved in a timely manner once the system became operational. Therefore, the Galileo system operators should be invited to commence the process as soon as they were able.

8 REVIEW OF PERFORMANCE STANDARDS FOR INS AND IBS

8.1 In considering documents NAV 51/4 (Germany) and NAV 51/4/4 (Japan), the Group agreed with the conclusions of the correspondence group that work should begin with a revision of INS performance standards and with a revision of the IBS performance standards following. The Group also agreed with the correspondence group that performance standards for a bridge alarm management system were also required but was of the opinion that they could form a part of INS performance standards.

8.2 The Group, therefore, prepared a revised draft structure of performance standards for INS together with terms of reference for a correspondence group to prepare the work under the leadership of Germany.*

8.3 The Sub-Committee was invited to approve the formation of the correspondence group on INS and IBS with terms of reference, as given in annex 4.

8.4 The Group noted document NAV 51/4/1 (IEC) concerning the results of studies on task orientated displays.

9 ACTION REQUESTED OF THE SUB-COMMITTEE

9.1 The Sub-Committee is invited to:

1 agree with the Group's view expressed in paragraph 6.9 and invite Member Governments to actively participate in the work of IALA, ITU, IEC and other

* [will be inserted later]
organizations dealing with the development of Class B (C) AIS equipment for non-SOLAS vessels and pleasure craft (paragraphs 6.9 and 6.10);

.2 taking into account the Group's view on the issue:

a) agree to the draft justification for inclusion of a new agenda item; and

b) invite the Committee to include the proposed new agenda item on "Performance standards for shipborne Galileo receiver equipment" in the Sub-Committee's work programme (paragraphs 7.2 and 7.3 and annex 3);

.3 invite the Galileo system operators to commence the recognition process as soon as they would be able (paragraph 7.4);

.4 agree to establish the correspondence group on INS and IBS and its terms of reference (paragraphs 8.2 and 8.3 and annex 4); and

.5 approve the report in general.

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ANNEX 3

DRAFT JUSTIFICATION FOR PROPOSED NEW WORK PROGRAMME ITEM
(in accordance with MSC/Circ. 1099-MEPC/Circ.405)

PERFORMANCE STANDARDS FOR SHIPBORNE GALILEO
RECEIVER EQUIPMENT

1. Scope of the proposal

Develop performance standards for Galileo satellite navigation system receiver equipment as a future part of the World-Wide Radionavigation System.

2. Compelling Need

A new work item is necessary to enable the Sub-Committee to prepare performance standards for Galileo receiver equipment. The system is currently being developed by the European Commission and the European Space Agency. The first Galileo test satellite will be launched at the end of 2005. The system will be gradually deployed with the initial operational capability in 2008.

Similarly to GPS and GLONASS in the past, Galileo will be offered for the use of the international maritime community as an element of the World-Wide Radionavigation System (WWRNS).

The capacity to use the system is therefore dependent upon the availability of IMO performance standards.

3. Analysis of the issues involved, having regard to the costs to the maritime industry and global legislative and administrative burdens

The purpose of this effort is to establish performance standards for Galileo receiver equipment based on the existing IMO performance standards for GPS and GLONASS receiver equipment which are of a similar nature (global navigation satellite systems). This will provide an additional option for the maritime community. The administrative burdens to the Organization and to Member States are anticipated to be minimal.

4. Benefits

The Galileo satellite navigation system will provide a global radio-navigation service meeting all the requirements for oceanic, coastal, port approach and restricted waters operations, as established by resolutions A.915(22) and A.953(23). This includes, when using the Galileo Safety of Life service, the real-time provision of integrity information that will issue timely warnings in case of system failure or excessive positioning error.

The service is provided in several frequency bands allocated by ITU (RNSS allocations in ARNS bands) and offers a significantly improved robustness against on-board and ground interference.
The services offered can be further improved by jointly using a combination of Galileo and the other existing global navigation satellite systems GPS and GLONASS.

5. **Priority and target completion date**

This issue should have a high priority since it would be desirable that Galileo receiving equipment can be available as soon as the service becomes operational in 2008.

Based on the work already performed by the NAV Sub-Committee on this issue (at annex), it is expected that, as a minimum, one session will be needed to address this matter.

Performance standards will be needed in 2006 in order to allow industry sufficient time to develop equipment.

6. **Specific indication of the action required**

In accordance with section 1 above.

7. **Remarks on the criteria for general acceptance**

   .1 Is the subject of the proposal within the scope of IMO’s objectives? Yes.

   .2 Do adequate industry standards exist? Not Yet. Development of IMO performance standards proposed is a pre-requisite for the development of such industry standards.

   .3 Do the benefits justify the proposed action? Yes.

8. **Identification of which subsidiary bodies are essential to complete the work**

The work should be able to be accomplished by the Sub-Committee on the Safety of Navigation exclusively.
1 INTRODUCTION

1.1 Galileo is the European satellite navigation system. Galileo is designed as a wholly civil system, operated under public control. Galileo comprises 30 medium earth orbit (MEO) satellites in 3 circular orbits. Each orbit has an inclination of 56° and contains 9 operational satellites plus one operational spare. This geometry ensures that a minimum of 6 satellites are in view to users world-wide with a position dilution of precision (PDOP) ≤ 3.5.

1.2 Galileo transmits 10 navigation signals and 1 search and rescue (SAR) signal. The SAR signal is broadcast in one of the frequency bands reserved for the emergency services (1544-1545 MHz) whereas the 10 navigation signals are provided in the radio-navigation satellite service (RNSS) allocated bands:
- 4 signals occupy the frequency range 1164-1215 MHz (E5a-E5b)
- 3 signals occupy the frequency range 1260-1300 MHz (E6)
- 3 signals occupy the frequency range 1559-1591 MHz (E2, L1, E1).

Each frequency carries two signals; the first is a tracking signal – the so-called pilot signal – that contains no data but increases the tracking robustness at the receiver whereas the other carries a navigation data message.

Galileo provides two different services of use for the maritime community.

1.3 The Galileo Open Service provides positioning, navigation and timing services, free of direct user charges. The Open Service can be used on one (L1), two (L1 and E5a or L1 and E5b) or three (L1, E5a and E5b) frequencies.

1.4 The Galileo Safety of Life Service can be used on one (L1 or E5b) or two (L1 and E5b) frequencies¹. Each of the L1 and E5b frequencies carries a navigation data message that includes integrity information. The E5a frequency does not include integrity data.

1.5 Galileo receiver equipment intended for navigation purposes on ships of speeds not exceeding 70 knots, in addition to the general requirements specified in resolution A.694(17)², should comply with the following minimum performance requirements.

1.6 These standards cover the basic requirements of position fixing, determination of course over ground (COG), speed over ground (SOG) and timing, either for navigation purposes or as input to other functions. The standards do not cover the other computational facilities which may be in the equipment nor cover the requirements for any other systems that may take input from the Galileo receiver.

¹ The integrity parameters broadcast by the Galileo Safety Of Life service will be unencrypted and therefore fully accessible. Service Guarantees and Authentication services can be made available, at a charge, through contractual means if desired.
² Refer to publication IEC 60945.
2 GALILEO RECEIVER EQUIPMENT

2.1 The words “Galileo receiver equipment” as used in these performance standards include all the components and units necessary for the system properly to perform its intended functions. The Galileo receiver equipment should include the following minimum facilities:

.1 antenna capable of receiving Galileo signals;
.2 Galileo receiver and processor;
.3 means of accessing the computed latitude/longitude position;
.4 data control and interface; and
.5 position display and, if required, other forms of output.

2.2 The antenna design should be suitable for fitting at a position on the ship which ensures a clear view of the satellite constellation, taking into consideration any obstructions that might exist on the ship.

3 PERFORMANCE STANDARDS FOR GALILEO RECEIVER EQUIPMENT

The Galileo receiver equipment should:

.1 be capable of receiving and processing the Galileo positioning and velocity, and timing signals on:

i) for a single frequency receiver, the L1 frequency alone. The receiver should use the ionospheric model broadcast to the receiver by the constellation to generate ionospheric corrections;

ii) for a dual frequency receiver, either the L1 and E5b frequencies or the L1 and E5a frequencies. The receiver should use dual frequency processing to generate ionospheric corrections;

.2 provide position information in latitude and longitude in degrees, minutes and thousandths of minutes;

.3 provide time referenced to universal time coordinated UTC (BIPM);

.4 be provided with at least two outputs from which position information, UTC, course over ground (COG), speed over ground (SOG) and alarms can be supplied to other equipment. The output of position information should be based on the WGS84 datum and should be in accordance with international standards. The output of UTC, course over ground (COG), speed over ground (SOG) and alarms should be consistent with the requirements of 3.18 and 3.19;

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3 Galileo uses Galileo Terrestrial Frame System (GTRF) datum which is a realization of the International Terrestrial Frame Reference (ITRF) system and differs from WGS 84 by less than 5cm worldwide.

4 IEC Publication 61162
.5 have static accuracy such that the position of the antenna is determined to within:

i) 15 m horizontal (95%) and 35 m vertical (95%) for single frequency operations on the L1 frequency;

ii) 10 m horizontal (95%) and 10 m vertical (95%) for dual frequency operations on L1 and E5a or L1 and E5b frequencies;

.6 have dynamic accuracy equivalent to the static accuracy specified in .5 above under the sea states and motion experienced in ships;

.7 have position resolution equal or better than 0.001 minutes of latitude and longitude;

.8 have timing accuracy such that time is determined within 50ns of UTC;

.9 have velocity accuracy of better than 0.5 m.s⁻¹;

.10 be capable of selecting automatically the appropriate satellite-transmitted signals to determine the ship’s position and velocity, and time with the required accuracy and update rate;

.11 be capable of acquiring satellite signals with input signals having carrier levels in the range of –128dBm to –118dBm. Once the satellite signals have been acquired, the equipment should continue to operate satisfactorily with satellite signals having carrier levels down to –131dBm;

.12 be capable of operating satisfactorily under normal interference conditions consistent with the requirements of resolution A.694(17);

.13 be capable of acquiring position, velocity and time to the required accuracy within 5 minutes when there is no valid almanac data (cold start);

.14 be capable of acquiring position, velocity and time to the required accuracy within 1 minute when there is valid almanac data (warm start);

.15 be capable of re-acquiring position, velocity and time to the required accuracy within 1 minute when there has been a service interruption of 60 seconds or less;

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5 The minimum accuracy requirements specified for dual frequency processing are based on the performance requirements established by the Organization in resolution A.915(22) and resolution A.953(23) for navigation in harbour entrances, harbour approaches and coastal waters. The Galileo satellite navigation system will be able to provide better accuracy (4m horizontal 95% and 8 m vertical 95%).

6 Refer to resolution A.694(17), Publications IEC 6721-3-6 and IEC 60945.
generate and output to a display and digital interface\textsuperscript{7} a new position solution at least once every 1 s for conventional craft and at least once every 0.5 seconds for high speed craft;

the COG, SOG and UTC outputs should have a validity mark aligned with that on the position output. The accuracy requirements for COG and SOG should not be inferior to the relevant performance standards for heading\textsuperscript{8} and speed and distance measuring equipment (SDME)\textsuperscript{9} and the accuracy should be obtained under the various dynamic conditions that could be experienced onboard ships;

at least one normally closed contact should be provided for indicating failure of the Galileo receiver equipment; and

the Galileo receiver equipment should have a bidirectional interface to facilitate communication so that alarms can be transferred to external systems and so that audible alarms from the Galileo receiver can be muted from external systems; the interface should comply with the relevant international standards.\textsuperscript{10}

4 INTEGRITY CHECKING, FAILURE WARNINGS AND STATUS INDICATIONS

4.1 The Galileo receiver equipment should also indicate whether the performance of Galileo is outside the bounds of requirements for general navigation in the ocean, coastal, port approach and restricted waters, and inland waterway phases of the voyage as specified in either resolution A.953(23) or Appendix 2 to resolution A.915(22) and any subsequent amendments as appropriate. The Galileo receiver equipment should as a minimum:

provide a warning within 5 sec if a new position based on the information provided by the Galileo constellation has not been calculated for more than 1 second for conventional craft and 0.5 seconds for high speed craft;

provide a warning of loss of position;

use receiver autonomous integrity monitoring (RAIM) to provide integrity performance appropriate to the operation being undertaken;

for receivers having the capability to process the Galileo Safety of Life Service, integrity monitoring and alerting algorithms should be based on a suitable combination of the Galileo integrity message and receiver autonomous integrity monitoring (RAIM). The receiver should provide an alarm within 10 seconds (TTA) of the start of an event if an alert limit of 25 m (HAL) is exceeded for a period of at least 3 seconds. The probability of detection of the event should be better that 99.999\% over a 3-hour period (integrity risk $\leq 10^{-5}$/3 hours).

\textsuperscript{7} Conforming to the IEC 61162 series.
\textsuperscript{8} Resolution A.424 (XI) for conventional craft and resolution A.821(19) for high speed craft
\textsuperscript{9} Resolution A.824(19)
\textsuperscript{10} IEC Publication 61162
Under such conditions the last known position and the time of last valid fix, with the explicit indication of the state so that no ambiguity can exist, should be output until normal operation is resumed; and

5 provide a self-test function.

5 PROTECTION

Precautions should be taken to ensure that no permanent damage can result from an accidental short circuit or grounding of the antenna or any of its input or output connections or any of the Galileo receiver equipment inputs or outputs for a duration of 5 minutes or less.

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ANNEX 4

TERMS OF REFERENCE FOR THE CORRESPONDENCE GROUP ON INS AND IBS

The correspondence group should:

.1 develop draft revised performance standards for INS based on documents NAV 51/4, NAV 51/4/4 and the outcome of the discussion in the Technical Working Group (WG 2) regarding the draft structure, set out in the appendix. These performance standards should allow for the proper application of SOLAS regulation V/15 and overcome the limitations of the existing performance standards for INS;

.2 include an alarm management module;

.3 include considerations on how the human element and the interface with the bridge team and pilot should be addressed on items that are specific to the use of Integrated Navigation Systems;

.4 include guidance to equipment manufacturers for the provision of onboard familiarization material, designed to quickly instruct a user, who would have previously completed a generic course on the use of INS, to become familiar with the actual INS equipment and configuration onboard the ship;

.5 advise the way forward for the performance standards for IBS, bearing in mind the concerns raised with respect to the practicability of these standards;

.6 establish liaison with the Sub-Committee on Design and Equipment (DE) to ensure consistent treatment of alarm management; and

.7 submit its report to NAV 52 for consideration.
APPENDIX

Draft Structure of Performance Standards for INS

1 Purpose
2 Scope
3 Application
4 Definitions

Part A - Integration of navigational information

5 Requirements

5.1 General requirements
5.2 Interfacing and Data exchange
5.3 Accuracy
5.4 Validity, plausibility, latency
5.5 Consistent common reference system
5.6 Integrity monitoring
5.7 Marking of invalid information
5.8 Hierarchy, handling of multiple sources
5.9 Failure analysis (information / data failure)
5.10 Back-up and fallback arrangement (information / data)
5.11 Interfacing with alarm management system

Part B - Task related requirements for Integrated Navigational Systems

6 Operational requirements

6.1 General
6.2 Requirements for different levels of integration depending on task of INS
6.3 Situation awareness
6.4 Traffic situation awareness
6.5 Operational mode awareness
6.6 Abnormal conditions
6.7 Emergency conditions

7 Compliance with SOLAS

7.1 Compliance with SOLAS regulation V/15
8 Configuration of INS

9 Functional requirements for displays of INS

9.1 Collision avoidance
9.2 Route planning and route monitoring
9.3 Conning information
9.4 User selected presentation

10 Automatic control systems

10.1 General
10.2 Heading control system
10.3 Track control system

11 Back up and fallback arrangement

12 Technical requirements

12.1 General
12.2 Requirements for hardware and/or processors
12.3 Requirements for power supply
12.4 Power interruption and shut down
12.5 I/O and communication hardware
12.6 Communication protocols
12.7 Redundancies
12.8 Failure analysis (hardware and system functions)
12.9 Back up and fallback arrangement
12.10 Design and installation

Part C - Alarm management system

Part D - Documentation requirements