**ANNEX 1**

**DRAFT PERFORMANCE STANDARD FOR SHIP-BORNE RECEIVING EQUIPMENT USING MULTIPLE [RADIONAVIGATION] SYSTEMS**

**1 INTRODUCTION**

* 1. Global Navigation Satellite Systems such as Galileo, GLONASS, GPS and Compass are space-based positioning, velocity and time systems. Each GNSS space segment will normally be composed of up to 30 satellites, which may be deployed in several orbital planes. The spacing of satellites in orbit will normally be arranged so that a minimum of four satellites will be in view to users world-wide, with a position dilution of precision (PDOP) <6.
  2. Terrestrial Electronic Position Fixing Systems (EPFS) use ground-based transmitting stations. The signals can be processed in a similar way to those from GNSS, using times of arrival from at least three stations to establish a two-dimensional position.
  3. Augmentation systems use ground-based or satellite based transmitters to provide augmentation to improve accuracy and integrity for specific service areas (such as coastal and port).
  4. An integrated receiver, using a combination of signals from one or more GNSS and/or terrestrial EPFS, offers improved availability, integrity, accuracy and resistance to intentional and unintentional interference.
  5. Receiving equipment capable of combining individual measurements from a number of GNSS and/or terrestrial EPFS to form a single solution can be used for navigational purposes on ships of speeds not exceeding 70 knots. Such equipment should, in addition to the general requirements contained in resolution A.694(17)[[1]](#footnote-1), comply with the following minimum performance requirements.
  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.

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

1. antennas capable of receiving GNSS and/or terrestrial EPFS signals;
2. GNSS and/or EPFS receiver and processor;
3. means of accessing the computed PVT data (latitude/longitude position, COG, SOG, timing, PVT source and navigational phase(s) that is currently supported[[2]](#footnote-2)) based on all available input data;
4. data control interface;
5. additional interface to enable the raw data from all available inputs to be interfaced to applications (such as Integrated Navigation Systems (INS)) for an enhanced assessment of provided PVT data; and
6. Alert management together with Bridge Alert Management (BAM) and INS.

2. **SENSOR REQUIREMENTS**

1. Antennas should be capable of receiving GNSS and/or terrestrial EPFS signals.
2. The antenna design should be suitable for fitting at a position on the ship which provides the best environment for the reception of GNSS and/or terrestrial EPFS signals.
3. The combined receiver should be designed to mitigate interference from out-of-band sources[[3]](#footnote-3).

### **3. OPERATIONAL REQUIREMENTS**

The combined EPFS receiver equipment should:

3.1 operate on at least one GNSS navigation signal provided in protected frequency band, carrying a range code (e.g. GPS: L1 and L5, GLONASS: L1, GALILEO: L1 and E5,…) with civil access.

3.2 be capable of receiving and processing GNSS in one or more protected frequency bands (e.g. L1, L5, E5…) and provide position information in latitude and longitude in a common worldwide geodetic reference system[[4]](#footnote-4) with co-ordinates in degrees and minutes to 4 decimal places.

3.3 have the facilities to process differential correction data fed to it, in accordance with the appropriate ITU-R Recommendations[[5]](#footnote-5);

3.4 be provided with means to transform the computed position into data compatible with the datum of the navigational chart in use. The display and/or any data output should indicate that the co‑ordinate conversion is being performed and should identify the co‑ordinate system in which the position is expressed;

3.5 given sufficient input sources, provide assessment of current achieved performance (e.g. accuracy and integrity) against each navigation phase simultaneously[[6]](#footnote-6). The unit should indicate when it is unable to provide such assessment.

3.6 be capable to provide COG in degrees to 2 decimal places, SOG in knots to 2 decimal places and timing information in UTC.

3.7 provide at least one output from which combined position information, COG, SOG, timing, PVT source and navigation phase for which performance requirements are met, to other equipment.

3.8 provide at least a second output from which raw data (e.g. code and carrier phase, navigation data, augmentation data) from the input sources can be supplied to other equipment.

3.9 Be capable of meeting the requirements for navigation under the various dynamic conditions that could be experienced onboard the vessel for the particular navigation phase in which the system is being used.

3.10 be capable of providing current PVT data within 15min of powering up;

3.11 be capable of providing current PVT data, within 2 min, when subjected to a power interruption or loss of signal of <60s.

3.12 meet the maritime user requirements for the appropriate navigation phase for the operation at hand, as detailed in A.915(22) and A.1046(27).

3.13 provide a means of autonomous integrity monitoring[[7]](#footnote-7).

3.14 The combined EPFS receiver equipment should provide as a minimum:

.1 a caution, should any of the following conditions exist for 3s for conventional vessel and 2s for high speed vessel:

.1.1 unable to estimate the supported navigation phase;

.1.2 new PVT data has not been calculated.

.2 If after 5s (high speed vessel) or 7s (conventional vessel) new PVT data has not been provided a warning shall be raised[[8]](#footnote-8).

.3 if at the next scheduled update, it is not possible to provide a new position update, the last known position, SOG, COG and the time of the last valid fix, with indication of this state so that no ambiguity can exist, should be output until normal operation is resumed.

.4 augmentation status indication of:

.1 the receipt of augmentation signals; and

.2 the validity of augmentation signals; and

.3 whether augmentations are being applied to the indicated ship’s position;

.4 provide the identification of the augmentation signals.

.5 provide position, COG, SOG, timing, PVT source, estimated navigation phase for which performance requirements are supported and augmentation text display either to a local display or interfaced to a separate display.

4. **INTERFACING AND TECHNICAL REQUIREMENTS**

The combined EPFS receiver equipment should:

4.1 generate a new position, COG and SOG at least once every 1s for conventional vessel and at least once every 0.5s for high-speed vessel. The update rate should be configurable.

4.2 provide a minimum resolution of position, i.e. latitude and longitude, in degrees and minutes to 4 decimal places.

4.3 provide COG in degrees to 2 decimal places, SOG in knots to 2 decimal places and timing information in UTC.

4.4 provide at least one output from which position information, COG, SOG, timing, PVT source and estimated navigation phase for which performance requirements are met can be supplied to other equipment.

4.5 output position, COG, SOG, timing, PVT source and estimated navigation phase for which performance requirements are supported in accordance with the relevant international standards[[9]](#footnote-9). For the VDR services, additional data on the multiple PVT sources applied should be provided.

4.6 provide at least a second output from which raw data (e.g. code and carrier phase, navigation data, augmentation data) from the applied radio navigation systems can be supplied to other equipment[[10]](#footnote-10).

4.7 have the facilities to take an input from at least one augmentation source[[11]](#footnote-11)

4.8 be capable of operating satisfactorily in typical L-band interference conditions.

4.9 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 combined receiver equipment inputs or outputs for a duration of 5 min.

4.10 Provide an interface with the BAM or INS for alert management[[12]](#footnote-12).

4.11 provide at least one normally closed contact, which should indicate failure of the combined EPFS receiving equipment;

### **5 SYSTEM AND EQUIPMENT DOCUMENTATION**

5.1 Operating manuals that should contain:

1. An overall function description of the combined EPFS receiving equipment;
2. The redundancy concept and the availability of functions given the loss of one input;
3. A description of possible failures and their effects on the system (e.g. by using part of the failure analysis);
4. A statement on which navigation phases are supported;
5. A statement on which radio navigation systems and augmentations are supported;
6. Guidance for the adjustments of the navigation phase requirements;
7. An explanation of the method used for the applied indicators and thresholds;
8. An explanation of the fusion process and input selection within the receiver when multiple systems are available.

5.2 Installation manuals that should contain:

1. Details of the sources, components and the interconnections between them;
2. Details of the interfaces and connections for data import and export and the interconnection diagrams;
3. Configuration options and commissioning instructions;
4. Power supply and earthing arrangement;
5. Recommendations on the physical layout of equipment, including antenna mounting requirements and necessary space for installation and maintenance;

5.3 The onboard familiarization material should explain all configuration, functions, limitations, controls, displays, alerts and indications of the combined EPFS receiving equipment.

5.4 A failure analysis, at the combined EPFS receiving equipment functional level, should be performed and documented for the receiver. The failure analysis should verify that the receiver is designed on a “fail-to-safe” principle. The failure analysis should consider the impact of all failure modes “e.g. those caused by electrical, component, signal jamming…etc).

5.5 Information to support maintenance of the EPFS receiving equipment.

1. Refer to Publication IEC 60945 [↑](#footnote-ref-1)
2. The requirements for different navigation phases are set out in IMO Resolution A.915(22) & A.1046(27) where it is noted some conflicts exist and further work is needed to resolve these conflicts. [↑](#footnote-ref-2)
3. Ref ITU-R M.823-4 [↑](#footnote-ref-3)
4. International Terrestrial Reference Frame, or some implementation of it, such as World Geodetic System (WGS) 84 in the case of GPS, or PZ-90 in the case of GLONASS. [↑](#footnote-ref-4)
5. ITU-R M.823-4 or other relevant standards [↑](#footnote-ref-5)
6. Refer to IMO A.1046(27) & A.915 (22) [↑](#footnote-ref-6)
7. This can include a combination of RAIM and CAIM as described in A.915(22). [↑](#footnote-ref-7)
8. Time durations include that expressed in 3.16.1 for each craft type. [↑](#footnote-ref-8)
9. Refer to IEC 61162 [↑](#footnote-ref-9)
10. Raw data should be provided in an open, interoperable format (refer to IEC 61162-450) [↑](#footnote-ref-10)
11. ITU-R M823-4 [↑](#footnote-ref-11)
12. Refer to IEC 61162 and IEC 61924-2 [↑](#footnote-ref-12)