

SBAS Guidelines for Shipborne Receiver based on IMO Res. A.1046 (27): EGNOS performance assessment in Norwegian coast

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The European Geostationary Navigation Overlay Service (EGNOS) augments the open public service offered by the GPS in Europe. EGNOS makes GPS suitable for safety critical applications. EGNOS is conceived as an integral part of a multi-modal inter-regional Satellite-Based Augmentation System (SBAS) service that integrates systems designed according to the same standard (RTCA MOPS 229) such as US WAAS, Japanese MSAS, GAGAN in India, SDCM in Russia and KAAS in South Korea. EGNOS provides over Europe both corrections and integrity information about the GPS system, delivering opportunities for accurate positioning improving existing applications or developing a wide range of new ones. As the European SBAS, EGNOS offers three services: Open Service, Safety-of-life Service and EDAS. In general, the EGNOS Safety-of-life (SoL) Service is intended for transport applications in different domains (and currently in use by Aviation) where lives could be endangered if the performance of the navigation system is degraded below specific accuracy limits without giving notice in the specified time to alert. This requires that the relevant authority of the particular transport domain determines specific requirements for the navigation service based on the needs of that domain. A new EGNOS service for maritime is currently under development with the objective to complement the existing maritime radionavigation systems (e.g. DGNSS) in the European region for enhanced accuracy and integrity information where there is no back-up infrastructure or in poorly covered environments.

One of the steps needed for the development of this new EGNOS maritime service is the definition of a minimum set of recommendations for receiver manufacturers to provide them with a clear view on how to design their SBAS receivers to be compliant with the requirements defined for such a service. EC, GSA, ESA and ESSP SAS have been working together since 2016 to develop guidelines for manufacturers for the implementation of SBAS in shipborne receiver. These guidelines, together with a set of test specifications, were developed in the frame of the SBAS Working Group created in the Special Committee (SC) 104 on Differential Global Navigation Satellite Systems (DGNSS) of Radio Technical Commission for Maritime Services (RTCM). The aim of these guidelines is to define the minimum SBAS messages needed to be processed by a SBAS receiver for the maritime sector to be compliant with the International Maritime Organization (IMO) Resolution A.1046.

This paper firstly presents the set of SBAS message type recommended by these SBAS guidelines as well as the preliminary list of tests that must be fulfilled to be compliant.

Secondly, GSA and ESSP, with the collaboration of The Norwegian Coastal Administration and Hurtigruten Cruises, have carried out a GNSS data collection campaign of 10 days along the Norwegian coast with a trajectory through Trondheim to Kirkenes and Kirkenes to Bergen. The aim of this data campaign is to assess EGNOS performance at user level in the maritime domain at high latitudes in Europe. The data campaign includes the navigation outside the

MT27 region defined in EGNOS (70°N). A performance assessment of EGNOS using some commercial receivers and a software receiver in line with the SBAS guidelines will be presented, showing the observed accuracy and availability results of the EGNOS solution.

Finally, the performances obtained with the receiver will be compared with the requirements of the IMO Res. A.1046 (27) to assess the feasibility of EGNOS for some maritime applications. The IMO Resolution required to the system to provide:

- positional information with an error not greater than 10 m,
- an update rate of the computed position data not less than once every 2 s
- an integrity warning of system malfunction, non-availability or discontinuity to users within 10 s
- a signal availability above 99.8%
- a service continuity above 99.97% over a period of 15 minutes, when the system is available.

Preliminary results show that the vessel is receiving EGNOS differential messages from at least one of the GEO satellites used by EGNOS to broadcast the SBAS messages, which indicates that EGNOS is compliant with signal availability requirement. Besides, the number of satellites that the receiver used to compute the PVT using SBAS is above 8 most of the time. The preliminary assessment of the accuracy performance, that is, the difference between the PVT solution and the true path computed using PPP algorithms, shows that horizontal navigation solution error (HSNE) is around 1 meter during the 95 % of the time. That result indicates that SBAS accuracy performance is widely compliant with the accuracy requirement defined in the IMO Res. A.1046 (27).