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REVISED MARITIME POLICY AND REQUIREMENTS FOR A FUTURE GLOBAL NAVIGATION SATELLITE SYSTEM (GNSS)

THE ASSEMBLY,

RECALLING Article 15(j) of the Convention on the International Maritime Organization concerning the functions of the Assembly in relation to regulations and guidelines concerning maritime safety,

RECOGNIZING the need for a future civil and internationally-controlled global navigation satellite system (GNSS) to contribute to the provision of navigational position-fixing for maritime purposes throughout the world for general navigation, including navigation in harbour entrances and approaches and other waters in which navigation is restricted,

RECOGNIZING ALSO that the maritime needs for a future GNSS are not restricted to general navigation only; that requirements for other maritime applications should also be considered, as a strict separation between general navigation and other navigation and positioning applications cannot always be made; and that intermodal use of GNSS is expected to increase in the future,

RECOGNIZING FURTHER the need to identify at an early stage the maritime user requirements for a future GNSS, to ensure that such requirements are taken into account in the development of such a system,

BEING AWARE of the current work of the International Civil Aviation Organization on the aviation requirements for a future GNSS,

HAVING CONSIDERED the recommendation made by the Maritime Safety Committee at its seventy-third session,

1. ADOPTS the Revised maritime policy and requirements for a future global navigation satellite system (GNSS) set out in the Annex to the present resolution;

2. INVITES Governments and international organizations providing or intending to provide services for the future GNSS to take account of the annexed Maritime Policy and Requirements in the development of their plans, and to inform the Organization accordingly;

3. REQUESTS the Maritime Safety Committee to keep this policy and requirements under review and to adopt amendments thereto, as necessary;

4. REVOKES resolution A.860(20).

ANNEX

REVISED MARITIME POLICY AND REQUIREMENTS FOR A FUTURE GLOBAL NAVIGATION SATELLITE SYSTEM (GNSS)

1 INTRODUCTION

1.1 A Global Navigation Satellite System (GNSS) is a satellite system that provides worldwide position, velocity and time determination for multimodal use. It includes user receivers, one or more satellite constellations, ground segments and a control organization with facilities to monitor and control the worldwide conformity of the signals processed by the user receivers to predetermined operational performance standards. A set of relevant definitions and a glossary are included in Appendix 1 to this annex.

1.2 For maritime users, IMO is the international organization that will recognise a GNSS as a system which meets the carriage requirements for position-fixing equipment for a World Wide Radionavigation System (WWRNS). The formal procedures and responsibilities for the recognition of a GNSS should be in accordance with the IMO policy on WWRNS, as far as applicable.

1.3 The current satellite navigation systems (see paragraph 2) are expected to be fully operational until at least the year 2010. Future GNSS(s) will improve, replace or supplement the current systems, which have shortcomings in regard to integrity, availability, control and system life expectancy (see paragraph 2).

1.4 Maritime users are expected to be only a small part of the very large group of users of a future GNSS. Land mobile users are potentially the largest group. Maritime users may not have the most demanding requirements.

1.5 Early identification of maritime user requirements is intended to ensure that these requirements are considered in the development of future GNSS(s).

1.6 There are rapid developments in the field of radionavigation, radiocommunication and information technology. Developments in these technologies for maritime use have to be taken into consideration.

1.7 The long period required to develop and implement a GNSS has led the Organization to determine the maritime requirements for future GNSS(s) at an early stage.

1.8 However, as the development of future GNSS(s) is presently only at the design stage, these requirements have been limited to basic user requirements, without specifying the organizational structure and system architecture. The maritime requirements, as well as the Organization's recognition procedures, may need to be revised as a result of subsequent developments.

1.9 When proposals for a specific future GNSS are presented to IMO for recognition, these proposals will be assessed on the basis of any revised requirements.

1.10 Early co-operation with air and land users and providers of services is essential to ensure that a multimodal system is provided in the time expected.

2 PRESENT SITUATION

2.1 Currently two State-owned military-controlled satellite navigation systems are available for civilian use. These systems are mainly used in shipping, in aviation, and in land mobile transport; they are also used for hydrography, survey, timing, agricultural, construction and scientific purposes. For maritime use the following aspects of each system are the most relevant:

.1 GPS*

.1.1 The Global Positioning System (GPS) is a space-based three-dimensional positioning, three-dimensional velocity and time system which is operated for the Government of the United States by the United States Air Force. GPS achieved full operational capability (FOC) in 1995. The system will undergo a modernization programme between 2002 and 2010, when its performance will be improved.

.1.2 GPS is expected to be available for the foreseeable future, on a continuous worldwide basis and free of direct user fees. The United States expects to be able to provide at least six years notice prior to termination or elimination of GPS. This service, which is available on a non-discriminatory basis to all users, has since FOC met accuracy requirements for general navigation with a horizontal position accuracy of 100 m (95%).

.1.3 Accordingly, GPS has been recognized as a component of the World Wide Radionavigation System (WWRNS) for navigational use in waters other than harbour entrances and approaches and restricted waters.

.1.4 Without augmentation, GPS accuracy does not meet the requirements for navigation in harbour entrances and approaches or restricted waters. GPS does not provide instantaneous warning of system malfunction. However, differential corrections can enhance accuracy (in limited geographic areas) to 10 m or less (95%) and also offer external integrity monitoring. Internal integrity provision is possible by autonomous integrity monitoring using redundant observations from either GNSS or other (radio) navigation systems, or both.

.2 GLONASS*

.2.1 GLONASS (Global Navigation Satellite System) is a space-based three-dimensional positioning, three-dimensional velocity and time system, which is managed for the Government of the Russian Federation by the Russian Space Agency.

.2.2 GLONASS has been recognized as a component of the WWRNS. GLONASS was declared fully operational in 1996, and was declared to be operational at least until 2010 for unlimited civilian use on a long-term basis and to be free of direct-user fees. Early in 2000, the intended space segment was not fully available.

* **Note**. When GPS and GLONASS are mentioned in this annex the Standard Position Services (SPS) provided by these systems are being referred to.

.2.3 GLONASS is meant to provide long-term service for national and foreign civil users in accordance with existing commitments. When fully operational, the service will meet the requirements for general navigation with a horizontal position accuracy of 45 m (95%). Without augmentation, GLONASS accuracy is not suitable for navigation in harbour entrances and approaches.

.2.4 GLONASS does not provide instantaneous warning of system malfunction. However, augmentation can greatly enhance both accuracy and integrity. Differential corrections can enhance accuracy to 10 m or less (95%) and offer external integrity monitoring. Internal integrity provision may be possible by using redundant observations from either GNSS or other (radio) navigation systems, or both.

2.2 There are several techniques that can improve the accuracy and/or integrity of GPS and GLONASS by augmentation. The widespread use of differential correction signals from stations using the appropriate maritime radionavigation frequency band between 283.5 and 325 kHz for local augmentation and craft or receiver autonomous integrity monitoring may be mentioned as examples. In addition, integrated receivers are already developed and in development, combining signals from GPS, GLONASS, LORAN-C and/or Chayka. Wide area augmentation systems are also being developed using differential correction signals from geostationary satellites such as EGNOS for Europe, WAAS for the United States and MSAS for Japan. Receivers for these augmentation systems are being developed.

2.3 Within the overall context of radionavigation, developments concerning terrestrial systems must also be taken into consideration. DECCA is phased out in many countries, and OMEGA was phased out in 1997. The future of the United States-controlled LORAN-C networks is under consideration. However, the Russian Federation-controlled CHAYKA networks will not be considered for phasing out until at least the year 2010. Civil-controlled LORAN-C and LORAN-C/Chayka networks are in operation in the Far East, north-west Europe and other parts of the world, with plans for extension in some areas. A number of Loran-C and Chayka stations are transmitting on an experimental basis differential GPS correction.

3 MARITIME REQUIREMENTS FOR A FUTURE GNSS

3.1 The maritime requirements for a future GNSS can be subdivided into the following general, operational, institutional and transitional requirements:

General requirements

.1 A future GNSS should primarily serve the operational user requirements for general navigation. This includes navigation in harbour entrances and approaches, and other waters in which navigation is restricted.

.2 A future GNSS should also serve other operational navigation and positioning purposes where applicable.

.3 A future GNSS should have the operational and institutional capability to meet additional area-specific requirements through local augmentation, if this capability is not otherwise provided. Augmentation provisions should be harmonised worldwide to avoid the necessity of carrying more than one shipborne receiver or other devices.

.4 A future GNSS should have the operational and institutional capability to be used by an unlimited number of multimodal users at sea, in the air and on land.

.5 A future GNSS should be reliable and of low user cost. With regard to the allocation and recovery of costs, a distinction should be made between maritime users that rely on the system for reasons of safety and those that additionally benefit from the system in commercial or economic terms. The interests of both shipping and coastal States should also be taken into consideration when dealing with allocation and recovery of costs.

.6 Some possible cost-recovery options are identified as follows:

- through funding by concerned international organizations (IMO, ICAO, etc.);

- through cost-sharing between Governments or commercial entities (e.g. satellite communication providers); or

- through private investments and direct user charges or licensing fees.

Operational requirements

.7 Future GNSS(s) should meet the maritime user's operational requirements for general navigation, including navigation in harbour entrances and approaches and other waters where navigation is restricted. The minimum maritime user requirements for general navigation are given in Appendix 2 to this annex.

.8 Future GNSS(s) should meet the maritime operational requirements for positioning applications. The minimum maritime user requirements for positioning are given in Appendix 3 to this annex.

.9 Future GNSS(s) should operate with the geodetic and time reference systems compatible with present satellite navigation systems.

.10 Service providers are not responsible for the performance of the shipborne equipment. This equipment should meet performance standards adopted by IMO.

.11 The development and use of integrated receivers using future GNSS(s) and terrestrial systems is recommended.

.12 Future GNSS(s) should enable shipborne equipment to provide the user with information on position, time, course and speed over the ground.

.13 Shipborne equipment for GNSS(s), including the integrated receivers mentioned in 3.11, should have a data interface capability with other shipborne equipment to provide and/or use information for navigation and positioning such as: ECDIS, AIS, the GMDSS, track control, VDR, ship heading and attitude indication and ship motion monitoring.

.14 All users should be informed in good time of degradations in performance of individual satellite signals and/or of the total service by the provision of integrity messages.

Institutional requirements

.15 Future GNSS(s) should have institutional structures and arrangements for control by an international civil organization representing, in particular, contributing Governments and users.

.16 International civil organizations should have institutional structures and arrangements to permit (supervision of) the provision, operation, monitoring and control of the system(s) and/or service(s) to the predetermined requirements at minimum cost.

.17 These requirements can be achieved either by the use of existing organization(s) or by the establishment of new organization(s). An organization can either provide and operate the system by itself or monitor and control the service provider.

.18 IMO itself is not in a position to provide and operate a GNSS. However, IMO has to be in a position to assess and recognize the following aspects of a GNSS:

- provision of the service to maritime users on a non-discriminatory basis;
- operation of the GNSS in respect of its ability to meet maritime user requirements;
- application of internationally established cost-sharing and cost-recovery principles; and
- application of internationally established principles on liability issues.

Transitional requirements

.19 Future GNSS(s) should be developed in parallel to present satellite navigation systems, or could evolve in part or wholly from such systems.

.20 A regional satellite navigation system that is fully operational may be recognized as a component of the WWRNS.

.21 Shipborne receivers or other devices required for a future GNSS should, where practicable, be compatible with the shipborne receiver or other devices required for current satellite navigation systems.

4 REQUIRED ACTIONS AND TIME-SCALE

4.1 The continuing involvement of IMO will be necessary. The maritime requirements given in this annex should be continually reassessed and updated on the basis of new developments and specific proposals.

4.2 The involvement of IMO should be positive and interactive, and the Organization should consider establishing a forum at which meaningful discussions can take place with air and land users in order to resolve institutional difficulties and consider a joint way forward.

4.3 Since ICAO is studying the aviation requirements for a GNSS and there are prospects of a Joint IMO/ICAO Planning Group for the development of the GNSS, close contacts between IMO and ICAO are necessary.

4.4 International, regional and national organizations as well as individual companies involved in the development of future GNSSs should be informed of the requirements set by IMO for acceptance of a future GNSS. These IMO requirements should be incorporated in GNSS plans to be accepted for maritime use.

4.5 The anticipated time-scale for introduction of future GNSSs is given in Appendix 4 to this annex. The time-scales for the expected introduction and phasing out of radionavigation systems, such as the present satellite navigation systems, augmentation facilities and terrestrial systems, are also included in Appendix 4. These time-scales will determine the time-scale for the decision-making process within IMO.

4.6 To permit early and orderly participation by IMO in the introduction of future GNSS(s), the process of decision-making should include means to:

- review this resolution periodically;

- consider proposals urgently when submitted; and,

- recognize new systems when submitted.

Appendix 1

Terms used in the GNSS

Accuracy. The degree of conformance between the estimated or measured parameter of a craft at a given time and its true parameter at that time. (Parameters in this context may be position co-ordinates, velocity, time, angle, etc.)

- *Absolute accuracy (Geodetic or Geographic accuracy).* The accuracy of a position estimate with respect to the geographic or geodetic co-ordinates of the Earth.

- *Geodetic or Geographic accuracy*. See Absolute accuracy.

- *Predictable accuracy*. The accuracy of the estimated position solution with respect to the charted solution.

- *Relative accuracy*. The accuracy with which a user can determine position relative to that of another user of the same navigation system at the same time.

- *Repeatable accuracy*. The accuracy with which a user can return to a position whose co-ordinates have been measured at a previous time using uncorrelated measurements from the same navigation system.

Alert limit (or threshold value). The maximum allowable error in the measured position - during integrity monitoring - before an alarm is triggered.

Along-track error. The component of the Vessel Technical Error in the direction of the intended track.

Ambiguity. The condition obtained when one set of measurements derived from a navigation system defines more than one point, direction, line of position or surface of position.

Augmentation. Any technique of providing enhancement to the GNSS in order to provide improved navigation performance to the user.

- *Satellite-based augmentation system (SBAS).* A system providing additional satellite signals in order to enhance the performance of the GNSS service.

- *Ground-based augmentation system (GBAS).* A system providing additional signals from a ground-based station in order to enhance the performance of the GNSS service.

Availability. The percentage of time that an aid, or system of aids, is performing a required function under stated conditions. Non-availability can be caused by scheduled and/or unscheduled interruptions.

- *Signal availability.* The availability of a radio signal in a specified coverage area.

- *System availability.* The availability of a system to a user, including signal availability and the performance of the user's receiver.

Chart error. Position errors in the chart caused by inaccuracies in surveying and by errors in the reference geodetic system.

Circular error probable (CEP). The radius of a circle, centred on the measured position, inside which the true position lies with 50% confidence.

Confidence interval. The numerical range within which an unknown is estimated to be with a given confidence.

Confidence level. The percentage of confidence that a given statement is correct, or the percentage of confidence that a stated interval (numerical range) includes an unknown.

Confidence limits. The extremes of a confidence interval.

Continuity. The probability that, assuming a fault-free receiver, a user will be able to determine position with specified accuracy and is able to monitor the integrity of the determined position over the (short) time interval applicable for a particular operation within a limited part of the coverage area.

Correction. The numerical value of a correction is the best estimate that can be made of the difference between the true and the measured value of a parameter. The sign is such that a correction that is to be added to an observed reading is taken as positive.

Coverage. The coverage provided by a radionavigation system is that surface area or space volume in which the signals are adequate to permit the user to determine position to a specified level of performance.

Cross-track error. The component of the Vessel Technical Error perpendicular to the intended track.

Craft autonomous integrity monitoring (CAIM). This is a technique whereby various navigation sensor information available on the craft is autonomously processed to monitor the integrity of the navigation signals. (See also Receiver autonomous integrity monitoring.)

Differential system. An augmentation system whereby radionavigation signals are monitored at a known position and the corrections so determined are transmitted to users in the coverage area.

Dilution of precision. The factor by which the accuracy of the GNSS position and time co-ordinates are degraded by geometrical considerations of the constellation of GNSS satellites used by the receiver.

- *Geometric dilution of precision (GDOP).* The factor for the combined 3D-position and time accuracy.

- *Position dilution of precision* (PDOP). The factor for the 3D-position accuracy.

- *Horizontal dilution of precision (HDOP).* The factor for the horizontal position accuracy.

- *Vertical dilution of precision (VDOP).* The factor for the vertical accuracy.

- *Time dilution of precision (TDOP).* The factor for the time accuracy.

Distance root mean square (dRMS). The root mean square of the radial distances from the true position to the observed positions obtained from a number of trials.

Failure. The unintended termination of the ability of a system, or part of a system, to perform its required function.

Failure rate. The average number of failures of a system, or part of a system, per unit time. (See also mean time between failures.)

Fix. A position determined by processing information from a number of navigation observations.

Fix rate. The number of fixes per unit time.

Fix interval (seconds). The maximum time in seconds between fixes.

Global navigation satellite service. The signal in space provided to the user by GNSS space and ground segments.

GLONASS (Global Navigation Satellite System). This is a space-based, radio positioning, navigation and time-transfer system operated by the Government of the Russian Federation.

Global Navigation Satellite System (GNSS). A worldwide position, time and velocity radio determination system comprising space, ground and user segments.

GNSS service. The service relates to the properties of the signal in space provided by the space and ground segments of the GNSS.

GNSS system. The system relates to the properties of the GNSS service plus the receiver.

Global Positioning System (GPS). This is a space-based, radio positioning, navigation and time-transfer system operated by the United States Government.

Gross errors. Gross errors, or "outliers", are errors other than random errors or systematic errors. They are often large and, by definition, unpredictable. They are typically caused by sudden changes in the prevailing physical circumstances, by system faults or operator errors.

Integrated navigation system. A system in which the information from two or more navigation aids is combined in a symbiotic manner to provide an output that is superior to any one of the component aids.

Integrity. The ability to provide users with warnings within a specified time when the system should not be used for navigation.

Integrity monitoring. The process of determining whether the system performance (or individual observations) allow use for navigation purposes. Overall GNSS system integrity is described by three parameters: *the threshold value or alert limit, the time to alarm and the integrity risk.* The output of integrity monitoring is that individual (erroneous) observations or the overall GNSS system can not be used for navigation.

- *Internal integrity monitoring* is performed aboard a craft.

- *External integrity monitoring* is provided by external stations.

Integrity risk. The probability that a user will experience a position error larger than the threshold value without an alarm being raised within the specified time to alarm at any instant of time at any location in the coverage area.

Latency. The time lag between the navigation observations and the presented navigation solution.

Marginally detectable bias (MDB). The minimum size of gross error in an observation that may be detected with given probabilities of type 1 and type 2 errors. A type 1 error occurs when an observation without a gross error is wrongly rejected, and a type 2 error occurs when an observation with a gross error is wrongly accepted.

Marginally detectable error (MDE). The maximum position-offset caused by a MDB in one of the observations.

Mean time between failures (MTBF). The average time between two successive failures of a system or part of a system.

Navigation. The process of planning, recording and controlling the movement of a craft from one place to another.

Navigation system error (NSE). The combined error of the GNSS position estimate and the *chart error*. The maximum NSE can be described by:

NSEmax = Chart error + GNSS error + other navigation errors

Pseudolite (pseudo-satellite). A ground-based augmentation station transmitting a GNSS-like signal providing additional navigation ranging for the user.

Precision. The accuracy of a measurement or a position with respect to random errors.

PZ-90 geodetic system. A consistent set of parameters used in GLONASS describing the size and shape of the Earth, positions of a network of points with respect to the centre of mass of the Earth, transformations from major geodetic datums and the potential of the Earth, developed in 1990.

Radio determination. The determination of position, or the obtaining of information relating to position, by means of the propagation properties of radio waves.

Radiolocation. Radio determination used for purposes other than radionavigation.

Radionavigation. The use of radio signals to support navigation for the determination of position or direction, or for obstruction warning.

Random error. That error of which only the statistical properties can be predicted.

Receiver autonomous integrity monitoring (RAIM). A technique whereby the redundant information available at a GNSS receiver is autonomously processed to monitor the integrity of the navigation signals. (See also craft autonomous integrity monitoring.)

Redundancy. The existence of multiple equipment or means for accomplishing a given function in order to increase the reliability of the total system.

Reliability (of an observation). A measure of the effectiveness with which gross errors may be detected. This "internal" reliability is usually expressed in terms of marginally detectable bias (MDB).

Reliability (of a position fix). A measure of the propagation of a non-detected gross error in an observation to the position fix. This "external" reliability is usually expressed in terms of marginally detectable error (MDE).

Repeatability. The accuracy of a positioning system, taking into account only the random errors. Repeatability is normally expressed in a 95% probability circle.

Root mean square error (RMS). RMS error refers to the variability of a measurement in one dimension. In this one-dimensional case, the RMS error is also an estimate of the standard deviation of the errors.

Single point of failure. That part of a navigation system that lacks redundancy, so that a failure in that part would result in a failure of the whole system.

Systematic error. An error which is non-random in the sense that it conforms to some kind of pattern.

Service capacity. The number of users a service can accommodate simultaneously.

Threshold value (or alert limit) is the maximum allowable error in the measured position–during integrity monitoring - before an alarm is triggered.

Time to alarm. The time elapsed between the occurrence of a failure in the system and its presentation on the bridge.

Total System Error (TSE). The overall navigation performance can be described by the TSE. Assuming the contributions to TSE from NSE and VTE are random, the TSE can be described as:

$$TSE^2 = NSE^2 + VTE^2$$

True position (2D). The error-free latitude and longitude co-ordinates in a specified geodetic datum.

True position (3D). The error-free latitude, longitude and height co-ordinates in a specified geodetic datum.

Vessel Technical Error (VTE). This is the difference between the indicated craft position and the indicated command or desired position. It is a measure of the accuracy with which the craft is controlled.

World geodetic system (WGS). A consistent set of parameters describing the size and shape of the Earth, positions of a network of points with respect to the centre of mass of the Earth, transformations from major geodetic datums and the potential of the Earth.

GLOSSARY

AIS	Automatic Identification System
CAIM	Craft Autonomous Integrity Monitoring
Chayka	A radionavigation system, similar to Loran-C, operated by the Government of the Russian Federation
Decca Navigator	A low frequency hyperbolic radionavigation system based on phase comparison techniques
DGPS	Differential GPS
EGNOS	European Geostationary Navigation Overlay Service
EU	European Union
FOC	Full Operational Capability
DTOA	The Difference in Time Of Arrival of events in two signals
GLONASS	Global Navigation Satellite System, operated by the Government of the Russian Federation
GMDSS	Global Maritime Distress and Safety System
GNSS	Global Navigation Satellite System
GNSS-1	Global Navigation Satellite System, based on augmentation of GPS and GLONASS in development by the EU
GNSS-2	Future Global Navigation Satellite System in development by the EU
GPS	Global Positioning System operated by the Government of the United States
HSC	High Speed Craft
IALA	International Association of Marine Aids to Navigation and Lighthouse Authorities
ICAO	International Civil Aviation Organization
IHO	International Hydrographic Organization
IMO	International Maritime Organization
IOC	Initial Operational Capability
ITU	International Telecommunication Union
LAAS	Local Area Augmentation System
LADGNSS	Local Area Differential GNSS
LORAN-C	A low frequency hyperbolic radionavigation system based on measurements of TOA or DTOA of events in pulsed signals
MSAS	Multi-purpose Satellite Augmentation System developed by the Government of Japan
MSC	Maritime Safety Committee of IMO
NAV	Sub-Committee on Safety of Navigation of IMO

NSE	Navigation System Error
RAIM	Receiver Autonomous Integrity Monitoring
SAR	Search and Rescue
SIS	Signal in Space
TOA	Time Of Arrival of an event in a signal
TSE	Total System Error
VDR	Voyage Data Recorder
VTE	Vessel Technical Error
VTS	Vessel Traffic Services
WAAS	Wide Area Augmentation System developed by the Government of the United States
WRC	World Radio Conference of the ITU
WWRNS	World Wide Radio Navigation System

Appendix 2

Table of the minimum maritime user requirements for general navigation

	System level parameters				Service level parameters			
	Absolute Accuracy	Integrity			Availability % per 30 days	Continuity % over 3 hours	Coverage	Fix interval[2] (seconds)
	Horizontal (metres)	Alert limit (metres)	Time to alarm[2] (seconds)	Integrity risk (per 3 hours)				
Ocean	10	25	10	10^{-5}	99.8	N/A[1]	Global	1
Coastal	10	25	10	10^{-5}	99.8	N/A[1]	Global	1
Port approach and restricted waters	10	25	10	10^{-5}	99.8	99.97	Regional	1
Port	1	2.5	10	10^{-5}	99.8	99.97	Local	1
Inland waterways	10	25	10	10^{-5}	99.8	99.97	Regional	1

Notes: 1: Continuity is not relevant to ocean and coastal navigation.
2: More stringent requirements may be necessary for ships operating above 30 knots.

Appendix 3

Tables showing the minimum maritime user requirements for positioning

	System level parameters					Service level parameters			
	Accuracy		Integrity			Availability **% per 30** days	Continuity **% over 3** hours	Coverage	Fix interval[2] (seconds)
	Horizontal (metres)	Vertical[1] (metres)	**Alert limit (metres)**	Time to alarm[2] **(seconds)**	Integrity risk **(per 3 hours)**				
Operations	Relative accuracy								
• tugs and pushers	1		2.5	10	$\mathbf{10^{-5}}$	99.8	**99.97**	**Local**	**1**
• icebreakers	1		2.5	10	$\mathbf{10^{-5}}$	99.8	**99.97**	**Local**	**1**
• automatic collision avoidance	10		25	10	$\mathbf{10^{-5}}$	99.8	**99.97**	**Global**	**1**
	Absolute accuracy								
• track control	10	N/A	25	10	$\mathbf{10^{-5}}$	99.8	**99.97**	**Global**	**1**
• automatic docking	0.1		0.25	10	$\mathbf{10^{-5}}$	99.8	**99.97**	**Local**	**1**
Traffic management[3]	**Absolute accuracy**								
• ship-to-ship co-ordination	10		25	10	$\mathbf{10^{-5}}$	99.8	**99.97**	**Global**	**1**
• ship-to-shore co-ordination	10		25	10	$\mathbf{10^{-5}}$	99.8	**99.97**	**Regional**	**1**
• shore-to-ship traffic management	10		25	10	$\mathbf{10^{-5}}$	99.8	**99.97**	**Regional**	**1**

Notes: 1: There may be a requirement for accuracy in the vertical plane for some port and restricted water operations.
2: More stringent requirements may be necessary for ships operating above 30 knots.
3: Traffic management applications in some areas, e.g. the Baltic, may require higher accuracy.

Table 1: Manoeuvring and traffic management applications.

Appendix 3 (continued)

	System level parameters					Service level parameters			
	Accuracy		Integrity			Availability % per 30 days	Continuity % over 3 hours	Coverage	Fix interval (seconds)
	Horizontal (metres)	Vertical (metres)	Alert limit (metres)	Time to alarm (seconds)	Integrity risk (per 3 hours)				
Search and rescue	10	N/A	25	10	10^{-5}	99.8	N/A	Global	1
Hydrography	1 - 2	0.1	2.5 - 5	10	10^{-5}	99.8	N/A	Regional	1
Oceanography	10	10	25	10	10^{-5}	99.8	N/A	Global	1
Marine engineering, construction, maintenance and management									
• dredging	0.1	0.1	0.25	10	10^{-5}	99.8	N/A	Local	1
• cable and pipeline laying	1	N/A	2.5	10	10^{-5}	99.8	N/A	Regional	1
• construction works	0.1	0.1	0.25	10	10^{-5}	99.8	N/A	Local	1
Aids to navigation management	1	N/A	2.5	10	10^{-5}	99.8	N/A	Regional	1

Table 2: Search and rescue, hydrography, oceanography, marine engineering, construction, maintenance and management and aids to navigation management

Appendix 3 (continued)

	System level parameters					Service level parameters			
	Accuracy		Integrity			Availability % per 30 days	Continuity % over 3 hours	Coverage	Fix interval[1] (seconds)
	Horizontal (metres)	Vertical (metres)	Alert limit (metres)	Time to alarm[1] (seconds)	Integrity risk (per 3 hours)				
Port operations	**Absolute accuracy**								
• local VTS	1	N/A	2.5	10	10^{-5}	99.8	N/A	Local	1
• container/cargo management	1	1	2.5	10	10^{-5}	99.8	N/A	Local	1
• law enforcement	1	1	2.5	10	10^{-5}	99.8	N/A	Local	1
• cargo handling	0.1	0.1	0.25	1	10^{-5}	99.8	N/A	Local	1
Casualty analysis	**Predictable accuracy**								
• ocean	10	N/A	25	10	10^{-5}	99.8	N/A	Global	1
• coastal	10	N/A	25	10	10^{-5}	99.8	N/A	Global	1
• port approach and restricted waters	1	N/A	2.5	10	10^{-5}	99.8	N/A	Regional	1
Offshore exploration and exploitation	**Absolute accuracy**								
• exploration	1	N/A	2.5	10	10^{-5}	99.8	N/A	Regional	1
• appraisal drilling	1	N/A	2.5	10	10^{-5}	99.8	N/A	Regional	1
• field development	1	N/A	2.5	10	10^{-5}	99.8	N/A	Regional	1
• support to production	1	N/A[2]	2.5	10	10^{-5}	99.8	N/A	Regional	1
• post-production	1	N/A[2]	2.5	10	10^{-5}	99.8	N/A	Regional	1

Notes: 1: More stringent requirements may be necessary for ships operating above 30 knots.
2: A vertical accuracy of a few cm (less than 10) is necessary to monitor platform subsidence.

Table 3: Port operations, casualty analysis, and offshore exploration and exploitation

Appendix 3 (continued)

	System level parameters					Service level parameters			
	Accuracy		Integrity			Availability % per 30 days	Continuity % over 3 hours	Coverage	Fix interval[1] (seconds)
	Horizontal (metres)	Vertical (metres)	Alert limit (metres)	Time to alarm[1] (seconds)	Integrity risk (per 3 hours)				
Fisheries	**Absolute accuracy**								
• location of fishing grounds	10	N/A	25	10	10^{-5}	99.8	N/A	Global	1
• positioning during fishing[2]	10	N/A	25	10	10^{-5}	99.8	N/A	Global	1
• yield analysis	10	N/A	25	10	10^{-5}	99.8	N/A	Global	1
• fisheries monitoring	10	N/A	25	10	10^{-5}	99.8	N/A	Global	1
Recreation and leisure	**Absolute Accuracy**								
• ocean	10	N/A	25	10	10^{-5}	99.8	N/A	Global	1
• coastal	10	N/A	25	10	10^{-5}	99.8	N/A	Global	1
• port approach and restricted waters	10	N/A	25	10	10^{-5}	99.8	99.97	Regional	1

Notes: 1: More stringent requirements may be necessary for ships operating above 30 knots.
2. Positioning during fishing in local areas may have more stringent requirements.

Table 4: Fisheries, recreation and leisure applications

Appendix 4

Development of future global navigation satellite systems/GNSSs (indicative)

Year

	Taskname	95	96	97	98	99	0	1	2	3	4	5	6	7	8	9	10	11	12
IMO	- intern	=========================																	
	- ISWG/1	+																	
	- NAV/41	+																	
	- ISWG/2		+																
	- NAV/42		+																
	- MSC/66		+																
	- NAV/43			+															
	- Assembly/20			+															
	- Assembly/21					+													
	- MSC/73						+												
	- Assembly/22							+											
ITU		=================================																	
	- Agenda WRC 2000					+													
	WRC 2000 and 2003 - allocate frequency						+			+									

```
Taskname                      95  96  97  98  99  0   1   2   3   4   5   6   7   8   9   10  11  12

OMEGA                         =========
DECCA                         =======================
LORAN-C (United States)       =======================-------------------------------------
LORAN (outside
        United States)        =================================================================----------
Chayka                        =================================================================----------

GPS                           =========================================================================
- IMO-recognition                    +
- WAAS                        --------------------------------==============================================
- WAAS/FOC                                               +
- EGNOS (EU)                  --------------------------------------------------=================---------
- EGNOS/AOC                                                          +
- EGNOS/FOC                                                              +
- MSAT                        ------------------------------------=========================================
- MSAT/FOC                                                   +
    - DGPS                                =============================================================
- Eurofix                     -----------------------------------------------------------------------------------

GLONASS                       =========================================================
- IMO-recognition                   +

GALILEO (EU)                                          -----------------------------------------============

GNSS-infrastructure                       =============================================================
- International agreements                --------------------
- Contract/design/development                                  -----------------------------
- Transition                                                                               ------------
```