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The WEND Concept for a Worldwide ENC Database - Past or Future?

A Review of Progress and a Look to the Future

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Introduction

Over 13 years ago, the IHO developed a concept, called "Worldwide Electronic Navigational Chart Database" (WEND), to:

"ensure a world-wide consistent level of high-quality, updated official ENC's through integrated services that support chart carriage requirements of SOLAS Chapter V, and the requirements of the IMO Performance Standards for ECDIS" (see Annex)

To help implement the concept, a WEND Committee was established to:

"promote the establishment of a Worldwide Electronic Navigational Chart Database (WEND) suitable for the needs of international shipping". (see WEND Committee Terms of Reference)

While significant progress in ENC data production has been accomplished, market take-up of ENC's remains below expectations, and substantial additional efforts are still necessary to ensure worldwide coverage. Some are now questioning the value of the WEND concept. The purpose of this paper is to review the development of the WEND concept, discuss some of the more important factors that have impeded a

more rapid progress by WEND, and to provide some recommendations on the best way forward.

Background and Objective of WEND

It was in 1985 that IMO and IHO first initiated discussion on the development of the Electronic Chart - or more precisely, on what eventually became the "Electronic Chart Display and Information System" (ECDIS). In 1988, IMO requested that IHO study how distribution of the data needed for ECDIS should occur, and how the "Electronic Navigational Chart" (ENCs) and its updating could be organised. The result was a blueprint of an organisational scheme that was first published by IHO as *"Updating the Electronic Chart"* (IHO S52Appl, 1996). However, at that time the standardisation of ECDIS was far from complete. Thus, in 1993 (four years before completion of ECDIS standardisation) IHO began considering how it as an organisation could cope with the challenges of the electronic age. At that time, no IHO Member State had any idea of the complexity of the task, particularly the amount of effort required to produce ENC's, and to develop concrete technical and organisational arrangements.

One of the first steps that IHO undertook was to define the overall objective and the necessary principles required to produce and make ENC's available worldwide. The goal of this effort was implied in its title: "Worldwide Electronic Navigational Chart Database" (WEND). This name reflects two mutually-dependent conditions:

- In principle, every national HO is responsible for producing the ENC's of its national waters. It is holder of copyright and also liable for the data. This requirement was an outcome of the XIVth IHO Conference where the ownership of all data collected by an HO in its national waters has been defined, irrespective of its uses (for example, the data in charts, in nautical publications, in other publications and data bases).
- In order to provide an authoritative and unambiguous product, the totality of ENC's contributed from national HOs must be considered as a distributed, "virtual" data base (i.e., WEND), from which a physical data base can be assembled. This task was intended to be performed by Regional Centres (called RENCs) along with the necessary centralised quality assurance.

The expectation was that WEND would become *the cooperative measure of all IHO members to ensure worldwide availability of ENC's*. This need for cooperation is not only a logical consequence of the nature of worldwide ENC coverage as a distributed database; it is also one of the purposes of the IHO itself. This is clearly stated in the IHO Convention in Article IIb: *"to bring about . . . the greatest possible uniformity in nautical charts and documents"*. It is covered even more specifically in Sections 3 and 4 of Regulation 9 of the new Chapter V of the SOLAS Convention:

"3 Contracting Governments undertake to ensure the greatest possible uniformity in chart and nautical publications and to take in account, whenever possible, relevant international resolutions and recommendations.

4 Contracting governments undertake to co-ordinate their activities to the greatest possible degree in order to ensure that hydrographic and nautical information is made available on a world-wide scale as timely, reliably, and unambiguously as possible." (IMO SOLASV, 2000)

As pointed out by Ehlers (Ehlers, 2002), unlike the IHO Convention, SOLAS V is *"binding under international law."* Under the new Regulation 9, the govern-

ments which are parties to SOLAS are now required to maintain hydrographic services. In addition to providing all nautical information necessary for safe navigation, they are required to cooperate and to carry out nautical and hydrographic services including data management services. Since almost all international voyages transit through the coastal waters of different nations, this has become a fundamental reason for IHO members to cooperate in terms providing worldwide ENC coverage and distribution.

Current Status of WEND

In accordance with the principles in the IHO and the SOLAS Conventions, WEND was conceived as the means of achieving the necessary cooperation to ensure worldwide uniformity and availability of ENC's. In order to define the terms of this cooperation, essential principles were drawn up. These so-called *WEND Principles* (see Annex) have been refined and clarified in recent years in the light of further experience. They are now part of the compendium of IHO Technical Resolutions; see Resolution K 2.19 (IHO M3, 2007).

But, have they proven successful? In many respects, it is the dilemma of whether the glass is either half-full or half-empty. One way to address this question is to examine where IHO stands now in terms of ENC availability and services. The following criteria are provided by the WEND Principles themselves.

- **Worldwide coverage and availability including updating** (WEND Principles 1.1 and 2.3); ENC Coverage has greatly improved in recent years, but there are still some significant gaps. Europe, USA and East Asia are well covered, at least as far as major shipping routes and ports are concerned. However, important areas in Southeast Asia are still missing. Coastal Africa and South America have very limited coverage. Nevertheless, a recent study undertaken by the Norwegian Classification Society Det Norske Veritas (DnV) reached the conclusion, based on an analysis of 11 important international shipping routes, that by 2010 there will be sufficient coverage to justify an ECDIS carriage requirement for all vessels of at least >10,000 gross tonnage (oil tankers >3,000GT), and for new vessels >3,000GT (oil tankers >500GT) [5]. While this analysis may be valid for the category of larger vessels with its limited number of destinations, there is still some

doubt whether sufficient ENC coverage will exist for the greater number of smaller ports and their approaches that are frequented by tankers of only 500 GT. In terms of ENC availability and updating services, there are also a number of regions where ENCs have been produced, but for a variety of reasons, they are not yet widely available or not updated. Most often, this is because the producer HO has not joined a RENC.

Integrated services (WEND Principles 1.2, 1.4 and 1.7); As defined by WEND, integrated ENC services are made possible through the Data Servers, as described in the IHO Data Protection Scheme S-63 (IHO S63, 2003), (IHO WEND, 2006): ENCs are supplied centrally to the Data Servers from RENCs who cooperate closely on joint S-63 implementation and consistent business terms. Currently, the two RENCs (IC-ENC and PRIMAR-Stavanger) have a combined membership of 35 HOs. Cooperation between these two RENCs means that most of the existing ENCs are available today through integrated services. Additional ENCs are also made available through bilateral arrangements between the Data Servers and some non-RENC HOs. Service integration requires, in practical terms, that each Data Server is given control over the definition of the cell permits that are created, and which effectively control the subscription licence that a customer has for each ENC. Where an HO implements S-63 itself for its own ENCs, particularly data signing and cell permit generation, the provision of full route coverage for an international voyage via an integrated service is therefore impossible to achieve. Unfortunately, there are a small number of HOs that are doing this, and distributing their ENCs independently of the Data Servers.

User-friendliness of services (WEND Principle 1.7); User-friendliness was included as a principle under WEND to help promote the use of ENCs. Apart from service integration (see above), one particularly relevant feature of user-friendliness is pricing. The pricing policies of IHO members vary from no-cost (such as USA) to high prices well above the equivalent cost of paper or raster charts. Whilst the headline cost of an ENC cell is often seen to be the same as that of a paper chart (i.e. about \$25-\$30), it has to be remembered that an ENC cell very often provides much less data coverage than the equivalent paper chart which has overlaps, and inset plans which are normally sold as separate ENC cells. The price of an ENC cell also typically covers only an annual licence, whilst the

price of a paper chart is for the life of that edition of the chart, and so tends to be re-purchased less frequently. The result is that the WEND database is projected to be more expensive for a customer than an equivalent coverage in paper. It is also considerably more expensive than the commercial ECS portfolios that already exist. This therefore makes the ENC/ECDIS option much less attractive either to resellers or to users. Strategies to overcome the unfavourable ENC pricing are under consideration, such as "Pay-Per-Use" (IHO WEND/ESF, 2006), but such schemes require a new and more flexible system of licensing and so are impossible as long as HO participation and RENC cooperation and policy is less than universal. In other words, a partial implementation of WEND principles will never be enough to resolve this important issue.

Greatest possible standardisation, consistency, reliability (WEND Principle 1.3); A significant source of inconsistencies between ENCs is the differing interpretation and use of the IHO Data Transfer Standard (IHO S-57) (IHO S57, 1996), and its lack of a prescriptive ENC product specification. Whilst ENC validation tools can detect formal errors in data structure and formatting, they cannot detect a missing object or an inappropriate attribute or portrayal instruction. This sort of inconsistency largely exists with ENCs from different producers, who interpret the standard, and in particular the Use of the Object Catalogue, differently. To help overcome this problem is another reason for an HO to participate within a RENC since it acts as an independent quality assurance body and thereby standardises all the ENCs under its control. The lack of a definitive product specification is also a major source of inconsistency, allowing different HOs to compile their ENC products in different ways (e.g. the setting of compilation scales) resulting in poor results when displayed on a typical ECDIS. This introduces the risk that only a series of datasets are produced rather than a database product suitable for primary navigation. This risk is increased due to the fact that most ENCs have been produced by digitizing paper charts which were themselves designed to be used individually rather than as part of a database. Paper chart schemes therefore generally contain overlaps, are of different ages (and so contain different information), and are produced to varying scales. Consequently, when put together, they fail to offer seamless coverage. Discrepancies between adjacent ENC cells that were undetected on paper charts become immediately

obvious on an ECDIS screen. The problem not only occurs within a single paper chart series, but is also particularly pronounced on national charts that border charts from neighbouring HOs. The need for ENC harmonization within each national ENC series and between adjacent producer HOs is well recognized, and is a key function that is performed by the RENCs. Unfortunately, current RENC membership makes up for less than 50% of IHO membership and several of the largest HOs do not participate in a RENC at all, despite WEND Principle 1.3. This means that the percentage of ENC coverage administered through RENCs is even less in terms of sea area.

Looking Ahead

Overall, a serious challenge related to WEND continues to be sub-optimal ENC coverage. This is confirmed by feedback from shipowners who indicate their continuing preference for official ECDIS data - provided there is sufficient route coverage. In view of proposals to make ECDIS and ENCs mandatory for SOLAS vessels, overcoming this problem must be given the highest priority. IHO, at its recent XVIIth Conference, referring to the DNV study (DNV, 2007), has expressed its support to IMO and has resolved to provide the required ENC coverage by 2010 (Decision 21 of IHC XVII) (IHO ConfDecisions, 2007). Although this is part of the IHO 2008 to 2012 Work Program, it may not be possible for some HOs to complete sufficient ENC coverage using their own resources. In this regard, it will be necessary for these HOs to consider entering into bilateral ENC production arrangements with other HOs who have sufficient ENC production capability to provide assistance.

The other challenges with ENCs can be best characterised as problems of *service quality*. It is very important to make a clear distinction between "service quality" and "data quality". In the wider sense, service quality relates to the relationship between the distributor and the end user. This includes data presentation (i.e. the quality of the data as a navigational product), pricing, packaging, and distribution options. Meanwhile, data quality relates to correctness, completeness, and being up-to-date. Data quality deficiencies could have a direct impact on safety-of-navigation. In principle, official ENC data will always be superior in terms of data quality

(both correct and complete), and more up-to-date compared to commercial data derived from official products.

The display of ENC data on ECDIS requires careful attention, as the suitability and consistency of encoding decisions for each dataset within the database will affect its fitness for purpose to support primary navigation. Unfortunately ENC data will suffer in comparison to commercial electronic chart data since the inconsistencies between adjacent ENC cells are readily apparent. For most commercial data, such data inconsistencies will have been superficially "cleaned up" by the commercial data producers, and they will have schemed their product database in a consistent manner and to a single product specification. Of course this does not improve the data quality, and the "cleaning" could have safety consequences as any adjustments will have been made without reference to the original source data or to the HOs publishing the source chart. On the other hand, an inconsistent chart image displayed on a screen may be confusing for the mariner, and result in unnecessary and frustrating manipulation of the ECDIS settings in order to retain a consistent presentation as he pans across, and zooms into, the database. It is important, therefore, that HOs work together to remove any inconsistencies from their data to achieve both high data quality and a clean display.

It is worth noting that almost all of the issues that fall into the class of "service quality" can be solved by better international cooperation. Indeed, if the WEND Principles were strictly followed, and if all HOs were to cooperate with a RENC, problems would be jointly addressed and resolved. In other words, it is not the WEND concept that has failed, as it is frequently claimed. Instead, too many IHO members have not complied with the WEND Principles that the Organization adopted more than 10 years ago. In our view, WEND is not the problem. To the contrary, it has the potential to be the solution.

In what appears to be a promising sign, the IHO at the recent XVIIth Conference repeated its commitment to the WEND Principles, and has stressed that it is the responsibility of its Member States and Regional Commissions to improve coverage and consistency (IHC Decision 20) (IHO ConfDecisions, 2007). But for WEND to be successful, some changes in approach and organisational structure should

be considered.

In our view, it is debatable whether the current WEND structure of two RENCs is ideal. The first blueprint of the WEND structure dates back to a time when modern broadband communication allowing rapid data exchange of high data volumes was not readily available. Hence it was thought that a regional structure should be the basis for facilitating cooperation. The fact that the two RENCs have a worldwide scope, but they are both situated in the same region (northern Europe), may illustrate best the problem with the current WEND structure. However, a regional sub-structure may still be sensible for organisational reasons. In this regard, one RENC (*IC-ENC*) has already developed such a sub-structure for its 25 members from five continents.

Despite good cooperation between the two RENCs, they have a different organisational set-up and different distribution concepts. Whereas *IC-ENC* is a pure RENC concentrating on quality assurance and leaving service delivery to Data Servers, *Primar-Stavanger* is both a RENC and a Data Server. These two different distribution concepts create confusion, and are probably not the best way to convince a hesitant or confused HO to join a RENC.

IHO must acknowledge that in taking responsibility for producing ENC's the organization and its members have also taken on a role that requires coordinated professional management and an operational service orientation. In order to meet its short and medium term commitments regarding ENC coverage and service quality, the IHO must ensure that it has mechanisms that ensure that decisions on matters that have worldwide impact (like operating a "WEND") are acted upon in accordance with the time schedules and rules that were jointly agreed. After all, SOLAS V as binding international law ultimately forces IHO to act decisively. As stated by Ehlers (Ehlers, 2002).

"... the crucial factor regarding implementation of these commitments is that SOLAS refers to the relevant decisions and recommendations of IHO, which are thus connected with the SOLAS Convention. In this way, the IHO decisions take on a new quality under international law, namely that of generally recognized rules and standards as referred to in Articles 211 and 219 of the Convention on the Law of the Sea. They must be taken into account whenever possible - that means as a matter of principle - and can

no longer be disregarded on the grounds that they are not binding. This clearly enhances the value of the IHO functions".

Recommendations

- It is imperative that IHO members complete ENC coverage without further delay. For sea areas where no active HOs exist, IHO should develop a detailed program that includes a time schedule. Where necessary, IHO should designate producer HOs to fill in any remaining gaps in ENC coverage.
- It is crucial that the service quality related to ENC's be improved. This cannot be achieved without *all* HOs cooperating very closely, and this can be best achieved by participating in a RENC. The WEND Principles should be followed by *all* HOs as the means of fulfilling their obligations under international law "to ensure the greatest possible uniformity in chart and nautical publications" and "to co-ordinate their activities to the greatest possible degree" (Chapter V SOLAS Convention, Regulation 9). IHO must work with Regional Commissions and the WEND Committee to develop a plan for full implementation of the WEND system.
- Bearing in mind that all RENCs need to cooperate anyway and that there is no real need for strictly "regional" RENCs, the organisational backbone of WEND should be further developed and simplified towards a "Worldwide ENC Coordinating Centre" (WENC). The purpose is to achieve full participation of all IHO Member States. Ideally, this will be the goal of IHO in terms of implementing WEND as the ENC distribution system of the future.

Concluding Note

Recently, IHB has invited participation in an Extraordinary WEND meeting to "examine the status of production of ENC's and the possible problems that are connected with this", and to discuss possible solutions. This will be an excellent chance to take decisions towards full WEND implementation and to overcome existing problems both in ENC production and service provision. The preliminary failure at the recent IMO Safety of Navigation Committee meeting to find acceptance for a proposal to make ECDIS mandatory by some later date, and the questions raised in this conjunction, illustrate the urgency for IHO to come to a solid and effective solution.

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Annex

Principles Of The Worldwide Electronic Navigational Chart Database (WEND) (extract from IHO Res. K2.19)

The purpose of WEND is to ensure a world-wide consistent level of high-quality, updated official ENCs through integrated services that support chart carriage requirements of SOLAS Chapter V, and the requirements of the IMO Performance Standards for ECDIS.

1. Service Provision

- 1.1 Member States will strive to ensure that mariners, anywhere in the world, can obtain fully updated ENCs for all shipping routes and ports across the world.
- 1.2 Member States will strive to ensure that their ENC data are available to users through integrated services, each accessible to any ECDIS user (i.e., providing data in S-57 form), in addition to any national distribution or system-specific SENC delivery.
- 1.3 Member States are encouraged to distribute their ENCs through a RENC in order to share in common experience and reduce expenditure, and to ensure the greatest possible standardization, consistency, reliability and availability of ENCs.
- 1.4 Member States should strive for harmonization between RENCs in respect of data standards and service practices in order to ensure the provision of integrated ENC services to users.
- 1.5 Methods to be adopted should ensure that data bear a stamp or seal of approval of the issuing HO.
- 1.6 When an encryption mechanism is employed to protect data, a failure of contractual obligations by the user should not result in a complete termination of the service. This is to assure that the safety of the vessel is not compromised.
- 1.7 In order to promote the use of ENCs in ECDIS, Member States are to strive for the greatest possible user-friendliness of their services, and facilitate integrated services to the mariner.

2. Rights and Responsibilities

- 2.1 SOLAS Chapter V, Regulation 9, requires Contracting Governments to ensure that hydrographic data are available in a suitable manner in order to satisfy the needs of safe navigation. Once the carriage of ECDIS becomes mandatory, there will be a consequential requirement to ensure that such data, as agreed by IMO, are available in a form suitable for use in ECDIS.
- 2.2 It is expected that Member States, for waters of national jurisdiction, will have mature supply systems for ENC's and their subsequent updating in place by the earliest date for mandatory carriage of ECDIS.
- 2.3 By the dates established by IMO, Member States will strive to either:
- Provide the necessary ENC coverage, or
 - Agree with other States to produce the necessary ENC coverage on their behalf.
- IHO will address overall coverage on a regional basis through Regional Hydrographic Commissions.
- 2.4 The INT chart system is a useful basis for initial area selection for producing ENC's.
- 2.5 Member States are encouraged to work together on data capture and data management.
- 2.6 Responsibilities for providing digital data outside areas of national jurisdictions must be established (see guidance in Annex).
- 2.7 Technically and economically effective solutions for updating are to be established conforming to the relevant IHO standards. The updating of ENC's should be at least as frequent as that provided by the nation for correction of paper charting.
- 2.8 The Member State responsible for originating the data is also responsible for its validation in terms of content, conformance to standards and consistency across cell boundaries.
- 2.9 A Member State responsible for any subsequent integration of a country's data into a wider service is responsible for validating the results of that integration.
- 2.10 National HO's providing source data are responsible for advising the issuing HO of update information in a timely manner.
- 2.11 Member States should work together to ensure data integrity, and to safeguard national copyright in ENC data to protect the mariner from falsified products, and to ensure traceability.
- 2.12 In producing ENC's, Member States are to take due account of the rights of the owners of source data and if paper chart coverage has been published by another Member State, the rights of that State.
- 2.13 Member States should recognize their potential exposure to legal liability for ENC's.

3. Standards and Quality Management

- 3.1 A Quality Management System should be considered to assure high quality of ENC services. When implemented, this should be certified by a relevant body as conforming to a suitable recognised standard; typically this will be ISO 9001:2000.
- 3.2 There must be conformance with all relevant IHO and IMO standards.
- 3.3 Member States' HO's are strongly recommended to provide, upon request, training and advice to HO's that require it to develop their own national ENC provision.
- 1 Integrated services are a variety of end-user services where each service is selling all its ENC data, regardless of source, to the end user within a single service proposition embracing format, data protection scheme and updating mechanism, packaged in a single exchange set.
- 2 RENCs are organisational entities where IHO members have established co-operation amongst each other to guarantee a world-wide consistent level of high quality data, and for bringing about co-ordinated services with official ENC's and updates to them.
- 3 The IMO Sub-Committee on Safety of Navigation, at its 51th Session (NAV 51):
- agreed to recommend to the IMO Marine Safety Committee the mandatory carriage requirement of ECDIS for High Speed Craft (HSC) by 1 July 2008.
 - did not decide on a mandatory carriage requirement for other types of ship; this will be considered in conjunction with a Formal Safety Assessment (FSA) to be conducted into the use of ECDIS in ships other than HSC and large passenger ships.