

Inland ENC Development and Standardization

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Abstract: Following 1999 recommendation by the National Transportation Safety Board, the U.S. Army Corps of Engineers (USACE) initiated a program to produce Inland Electronic Navigational Charts (ENCs) on major river and inland waterway systems in the USA. Currently, over 45 Inland ENC cells covering 3,200 miles on the Mississippi, Ohio, Red, and Atchafalaya Rivers, and the Black Warrior/Tombigbee system have been produced and are available for public access via the Internet. Other production efforts are ongoing on five other waterways. While there are some differences between the North American and European inland waterways, there are far more similarities. In 2002 the Economic Commission for Europe of the United Nations (UN ECE) adopted an Inland ECDIS Standard as a recommendation for the European inland waterway system. To date, Inland ENC data conforming to the Inland ECDIS standard have been produced for the Rhine, Main and Danube Rivers in Germany, the Austrian portion of the Danube River, the Dutch connection between Rotterdam and the German border for the Scheldt River, the Garonne river in France, and sections of the Danube river in Slovakia, Hungary, Croatia, Serbia and Montenegro and Romania.

This paper discusses the current status of Inland ENC development, and reviews the ongoing initiative to harmonize Inland ENC Standards between North America and Europe. For the harmonization effort, it was agreed that an international Inland ENC Content/Product Specification include all IHO features that are relevant for Inland ENCs, as well as any additional real-world features that are needed for Inland ENCs (i.e., not contained in the “maritime” ENC Product Specification). It is intended that the Inland ENC Base Product Specification be suitable for all regions of the world. This is being accomplished via the development of a harmonized Inland ENC Encoding Guide that will become the framework for an Inland ENC Content/Product Specification. In conjunction with what IHO decides for IHO S-57 Edition 4 and its alignment with the ISO TC211 standards, there will be a separate register for specific Inland ENC features. Once IHO S-57 Edition 4 is released (potentially, in late 2006), it is expected that the Inland ENC Base Product Specification will become a separate application “profile” consisting of a feature catalogue, an application schema, and encoding.

Background

Based on the findings of the European transport R&D project *INDRIS* (Inland Navigation Demonstrator for River Information Services) and the German project *ARGO* in 2001, both the Danube and the Rhine Commissions adopted an Inland ECDIS Standard for ENC data and system requirements for the Rhine and the Danube Rivers. In 2002 the Economic Commission for Europe of the United Nations (UN ECE) adopted the Inland ECDIS Standard as a recommendation for the European inland waterway system (CCNR 2002). To date, Inland ENC data conforming to the Inland ECDIS standard have been produced for the Rhine, Main and Danube Rivers in Germany, the Austrian portion of the Danube River, the Dutch connection between Rotterdam and the German border for the Scheldt River, the Garonne river in France, and sections of the Danube river in Slovakia, Hungary, Croatia, Serbia and Montenegro and Romania. Private companies are co-operating in producing complete Inland ENC coverage for remaining European navigable waterways. In addition, ECDIS and ECS equipment manufacturers that are active on the European inland waterways have upgraded their software to use Inland ENC data.

In the USA following 1999 recommendation by the National Transportation Safety Board, the U.S. Army Corps of Engineers (USACE) initiated a program to facilitate the production and implementation of Inland ENCs on Major River and inland waterway systems in the USA (Niles 2003, Niles and Scheid 2003). To date, 45 Inland ENC cells covering 3,200 miles on the Mississippi, Ohio, Red, and Atchafalaya Rivers, and the Black Warrior/Tombigbee system have been produced and are available for public access via the Internet (www.tec.army.mil/echarts/). In 2004, work began on five additional waterways. Similar to Europe, several North American ECDIS and ECS equipment manufacturers now offer systems capable of using Inland ENC data.

While there are some differences between the North American and European inland waterways, there are far more similarities. A North American – European Inland ENC Workshop was held in Nijmegen, The Netherlands on 30 June – 1 July 2003 in conjunction with a *COMPRIS* (Consortium Operational Management Platform River Information Services) Conference on River Information Systems (RIS). In addition to informing participants on the status of standards development and projects being conducted, a key objective was to discuss the benefits of harmonizing Inland ENC data standards between Europe and North America. As an outcome of the Workshop, an Inland ENC harmonization group was formed (Alexander and Klutenaar 2003).

Harmonization Group

The North American – European Inland ENC Harmonization Group (IEHG) is comprised of representatives from government, industry and academia. The IEHG meets once per year, the most recent being 22-24 September 2004 in St. Louis, Missouri, USA. However, most of the work is accomplished via e-mail correspondence and the *Open ECDIS Forum*.

Key persons involved in the IEHG include:

Co-Chairman

Anthony R. Niles, U.S. Army Corps of Engineers (Anthony.R.Niles@erdc.usace.army.mil)

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In addition, Ralph A. Scheid (USACE – New Orleans District) is facilitating the effort to develop a harmonized Inland ENC Base Content Specification

Framework for International Inland ENC Specifications

The overall framework for the development of international Inland ENC standards is comprised of several components.

- IHO S-57 Edition 3.0/3.1 where applicable.
- A central register for non-IHO S-57 object classes, attributes and attribute values.
- A Base Content/Product Specification that includes all known Inland ENC requirements.
- Regional product specifications containing items from local waterway networks not contained in the Base Inland Product Specification.
- Use of the Open ECDIS Forum (www.openecdis.org) as a means for communication and publication.
- Align with the future edition of IHO S-57 (Edition 4).

IHO S-57

IHO S-57 Edition 3.1, Appendix B.1 is the Product Specification for the production of “maritime” Electronic Navigational Charts (ENCs) to be used in conjunction with an IMO-compliant ECDIS. However, for Inland ECDIS it became evident that additional object classes, attributes and attribute values were required to meet real-world inland navigation requirements. The European Inland ECDIS Expert Group developed a regional product specification based on IHO S-57, Edition 3.1. The Central Commission adopted it in 2002 for Navigation on The Rhine (CCNR), Danube Commission (DC), the Economic Commission for Europe Of the United Nations (UN-ECE), and the Permanent International Association of Navigation Congresses (PIANC). In parallel, U.S. Army Corps of Engineers (USACE) also adopted in 2002 an Inland ENC Content Specification based closely on the IHO S-57 Edition 3.1 ENC Product Specification. The USACE Inland ENC (IENC) Content Specification has recently evolved to become an *IENC Chart No. 1 and Encoding Guide*.

Central Register

In conjunction with the next edition of IHO S-57 (Edition 4), a central register is planned that will include both IHO and non-IHO extensions. The register will be based on ISO TC211 standards, and is planned to be operational when S-57 Edition 4.0 is published (planned for 2006). In the interim, the *Open ECDIS Forum* (<http://www.openecdis.org/>) currently serves as a central register for S-57 Edition 3.1 extensions.

“Core → Base” Product Specification

Initially, there were two different approaches that Europe and North America took towards developing Inland ENC standards. The European Inland ECDIS standard contains additional and/or modified objects/attributes (i.e., extensions), while the North America approach was to refrain from extending IHO features, but to produce a regional (i.e., USACE) content specification and encoding guide.

For harmonization, it was initially agreed that a “Core” Product Specification for Inland ENC be developed that would be suitable for basic inland navigation requirements in Europe and North America. However, the term “Core” was confusing. In the USA, the word “Core” is pronounced the same as the term “Corps.” Therefore, it was agreed that the term “Core” be changed to “Base”. It was decided that the somewhat limited “core” (now base) product specification should be expanded to accommodate all known requirements of both Europe and North America. It was also agreed that the International Inland ENC Specification should include those IHO features that are relevant for Inland ENCs, as well as the real-world features that are needed for Inland ENCs (i.e., not contained in the “maritime” ENC Product Specification). It is intended that the Base Product Specification will be suitable for all regions of the world¹.

In conjunction with what is decided for IHO S-57 Edition 4 and its alignment with the ISO TC211 standards, it is expected that the Inland ENC Product Specification will become a separate Application Schema. In the interim, future extensions to the Base and Regional product specifications will be registered with the Open ECDIS Forum.

Regional Product Specifications

Some S-57 Object Classes, attributes, attribute values and encoding rules are specific to a local waterway network to such an extent that inclusion within the Base Product Specification would be impractical. Such features would be described as part of a regional product specification. A complete product specification for International Inland ENC production is therefore comprised of both the Base and, likely, a Regional Product Specification (i.e., Base + Regional = International).

Guidelines for Inland ENC specifications

a) Existing and new S-57 objects:

- Wherever possible, use existing object classes, attributes and attribute values from the current IHO S-57 ENC Product Specification, Edition 2.0
- For additional object classes, attributes or attribute values that are not already described in the IHO S-57 Object Catalogue, first check the central registry for Inland ENC features.
- If the required object classes, attributes or attribute values are not described in the central registry, then new object classes, attributes or attribute values can be drafted and put forward to the IEHG for inclusion in the International Inland ENC set.

¹ Presently there are private initiatives to use ECDIS on major South American rivers. Also, China and Hong Kong have expressed interest in the developments of Inland ECDIS.

b) Creating new object classes, attributes or attribute values:

- An object class definition should be complete, covering all aspects of a real-world entity.
- An object class should represent an easily comprehensible concept. It is better to make two separate object classes if the definition of one object class is too lengthy and confusing.
- Each attribute should only exist once in an object class definition and should only contain one attribute value. The only exceptions to this rule are attributes of the type 'List'. These attributes should contain a composite string that can be broken down into a number of discrete values.
- The value of one attribute should not influence the value of other attributes, thus avoiding hierarchical dependencies within the attribute list of an object class.

c. Encoding rules

For all object classes, attributes, and attribute values, encoding rules should:

- Explain the basis for its creation.
- Describe its relationship to the real-world entity.
- Provide criteria for its proper use.
- Provide specific encoding examples for practical guidance.

Worked Planned

During 2005, a number of work actions are planned by the Inland ENC Harmonization Group.

1. Identify all real-world features, objects and attributes that need to be included into an “all inclusive” Inland ENC Base Content/Product Specification. The initial effort will start with the nine (9) primary features that were identified and agreed during the 2nd IEHG Meeting in St. Louis, MO in September 2004. The goal is to achieve a combined union of two standards (European and North America). In addition to the objects, attributes, and attribute values contained in the IHO ENC Product Specification (intended primarily for maritime navigation), it will contain necessary real-world inland ENC objects. The primary focus will be on data, rather than display aspects.

2. For the Content Specification, there is a need to agree on (real-world) feature to object class mapping. There also may be some additional features that need to be added. Identify those S-57 objects contained in the ENC Product Specification (maritime) that should be included. Given that the initial European and North American Inland ENC development was done separately, some duplication issues will need to be resolved (e.g., same thing, but different name).

3. In terms of producing a harmonized Encoding Guide, a two-step approach is planned:

Step #1 - Definition of what is a harmonized structure.

Initially, there is a need to agree on a template database structure that contains specific fields of information. The plan is to use the USACE Coding Guide as a “start”, and then add to it.

Step #2 - Produce Encoding Guide using the harmonized data base structure.

Part of this process will be to develop additional descriptions of new object classes, attributes, and values that are applicable to both North America and Europe. The Encoding Guide will also include examples of presentation of Inland ENC information for each object class.

Alignment with IHO S-57 Edition 4

IHO Special Publication 57 (IHO S-57) is the *IHO Transfer Standard for Digital Hydrographic Data*. It is the current standard to be used for the exchange of digital hydrographic data between hydrographic offices, and for the distribution of hydrographic-related data to manufacturers, mariners and other users. At present, IHO S-57 Edition 3.0/3.1 has only one product specification: Electronic Navigational Charts (ENCs) required for (maritime) ECDIS (IHO 2000). Since IHO S-57 was originally intended to support all types of hydrographic data, it needs to be expanded in order to accommodate new requirements, customers, and technology. This includes Inland ENC data and other future applications. Based on the outcome of the 6th Meeting of the TSMAD S-57 Ed. 4 Sub-WG (29 March – 2 April 2004, Silver Spring, MD, USA), Inland ENC is now included under Work Item 2.10 (Non-IHO Applications).

At the 7th Meeting 6th Meeting of the TSMAD S-57 Ed. 4 Sub-WG (7-9 November 2004, Monaco), agreement was reached about what was planned for IHO S-57 Edition 4 (IHO 2004). The primary goal is to support a greater variety of hydrographic-related digital data sources, products, and customers. This includes matrix and raster data, 3-D and time-varying data (x, y, z, and time), and new applications that go beyond the scope of traditional hydrography (e.g. high-density bathymetry, seafloor classification, marine GIS, and Inland Electronic Charting applications). It will also enable the use of web-based services for data discovery, browsing, query, analysis, and transfer. S-57 Edition 4.0 will not be an incremental revision of Edition 3.1. Edition 4 will be a new standard that includes both additional content and support of a new data exchange formats. Due to the worldwide prominence of ISO standards, IHO S-57 Edition 4 will conform to the “ISO way” of standards development. However, alignment with the ISO 19100 series of geographic standards will require significant re-structuring of S-57. IHO plans to release Edition 4.0 in late 2006.

It is the intention of the Inland ENC Harmonization Group to conform to what is being planned for IHO S-57 Edition 4. In doing so, there will be several benefits:

a) All real-world Inland ENC-related object classes, attributes, and attributes values can be included with S-57 Edition 4. However, the Object Catalogue will become a series of *Feature Data Dictionaries*.

b) In order to align with the ISO TC/21 standards, an overall IHO “*registry*” will be established that contains individual “*registers*.” In addition to a hydrographic register, there will be registers for Ice Information, Additional Military Objects (AMLs) and for Inland Charting applications. For each register, there will some entity or organization responsible for its content and management. For Inland ENC applications, this initially will be performed by the IEHG. In the future, this activity could be taken over by some other organization (e.g., PIANC).

c) An *application schema* will specify how:

- features, attributes and associations are used to specify a data model
- the various components are ‘glued’ together (i.e. a feature and its spatial component)
- to use a register as part of an overall registry

These rules can then be applied to develop a product-specific application schema (e.g., Inland ENC) that in turn forms the basis of the product specification.

d) The *Inland ENC Base Product Specification* will become a separate “profile” consisting of a feature catalogue, an application schema, and encoding.

Summary

The North American – European Inland ENC Harmonization Group (IEHG) is working to harmonize European and North American Inland ENC standards. For the harmonization effort, it was agreed that an international Inland ENC Content/Product Specification include all IHO features that are relevant for Inland ENCs, as well as any additional real-world features that are needed for Inland ENCs (i.e., not contained in the “maritime” ENC Product Specification). It is intended that the Inland ENC Base Product Specification be suitable for all regions of the world. This is being accomplished via the development of a harmonized Inland ENC Encoding Guide that will become the framework for an Inland ENC Content/Product Specification. In conjunction with what IHO decides for IHO S-57 Edition 4 and its alignment with the ISO TC211 standards, there will be a separate register for specific Inland ENC features. Once IHO S-57 Edition 4 is released (potentially, in late 2006), it is expected that the Inland ENC Base Product Specification will become a separate application “profile” consisting of a feature catalogue, an application schema, and encoding.

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