

RIVER ELECTRONIC NAVIGATIONAL CHARTS

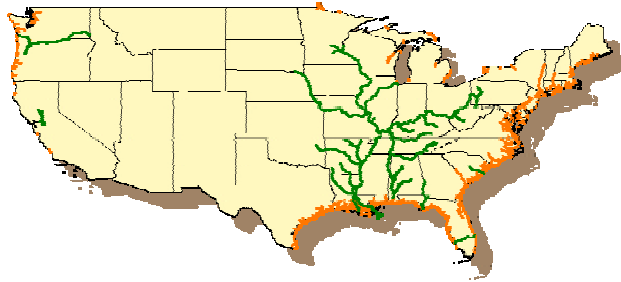
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The navigation program of the U.S. Army Corps of Engineers includes all of the nation's deep draft harbors, which are a vital link to maritime commerce as well as hundreds of smaller harbors that serve a variety of recreational and commercial purposes. The Corps has also built and maintains an Intracoastal and inland network of commercial channels, including many locks and dams, which support low cost transportation between the nation's heartland and the coastal harbors. This program is critical to our national economy in which 98 per cent of our international trade (by bulk) is transported by sea, with 1.3 billion short tons of foreign commerce handled by the nation's top 20 ports in 1999. On the inland system and Intracoastal waterways, 48 billion ton-miles of cargo were moved between U.S. ports.



Coastal and Inland Waterways Maintained by the Corps

For a number of years, as part of this navigation program, the Corps has provided nautical charts for more than 9,100 miles of inland waterways in 23 different river/waterway systems. Now, a major objective of the Corps is to improve the safety of navigation on these waterways by providing highly accurate electronic chart data and positioning systems. In support of this objective, the Corps has installed 11 Differential GPS radio beacons and established DGPS service for all but the upper Ohio River. The Corps has also started a program to develop and produce a uniform electronic chart data product for these inland waterways - a River Electronic Navigational Chart or RIVER ENC.

Background

In 1989, a Russian freighter grounded in Southwest Pass, closing the channel and causing serious shoaling conditions. During the ensuing period of disrupted ship traffic, the Corps initiated a mechanism for publishing same day survey and channel condition reports for the port pilots. This service continues, but the use of traditional paper media compromises both efficiency and effectiveness.

In an effort to improve the delivery of this near real-time service, the Corps looked to electronic chart technology that was already being investigated at a Research and Development level. As part of their continuing evaluation of this evolving technology, in 1992, the Corps joined the U.S. ECDIS Testbed Project along with U.S. Coast Guard, National Oceanic and Atmospheric Administration (NOAA), Defense Mapping Agency (DMA), Maritime Administration, Radio Technical Commission for Maritime Service (RTCM), Woods Hole Oceanographic Institution and various commercial interests. This project contributed significantly to the development of international standards for Electronic Chart Display and Information Systems (ECDIS) which were eventually adopted (in 1995) by the International Maritime Organization (IMO). As part of this project, the Corps developed a prototype electronic chart data set for the Lower Mississippi River and demonstrated it aboard a Corps vessel in the spring of 1993.

On September 22, 1993, a towboat operator with a barge under tow became disoriented on a waterway near Mobile, Alabama during a period of poor visibility and navigated up the wrong waterway. A break-away barge struck a railroad bridge before the vessel could be corralled, which produced minor damage to the barge and caused tracks to be slightly offset. Unfortunately, an Amtrak passenger train crossing the bridge a short time later derailed and plunged into the waterway, resulting in the death of more than 30 people.

The ensuing National Transportation Safety Board investigation concluded that electronic chart technology used with satellite positioning information could have prevented this tragedy. As a result, the Corps committed to promoting the use of electronic charts on inland waterways to improve the safety of navigation. This led to a Corps Headquarters Directive in 1995 to all Districts and divisions to begin making hydrographic data available to outside users for chart applications. The longer-term intent is to develop a standard format and structure for this data, which comes mostly from computer-aided design and drafting (CADD) systems.

Internationally, electronic chart technology has continued to develop, and a number of countries have begun to produce Electronic Navigational Charts (ENCs) for coastal waterways and harbors using the International Hydrographic Organization (IHO) Transfer Standard for Digital Hydrographic Data (S-57) and ENC Product specification that is recognized by IMO. NOAA has started to produce ENCs for selected US harbors, and as part of this effort has produced a prototype ENC for the Lower Mississippi River. In an effort to improve the accuracy of these ENCs, specifically for large-scale harbor and channel features, NOAA is using source data wherever possible and has asked the Corps to provide such Corps data in an efficient, consistent digital format.

A recent Marine Transportation Study recommended that ENC coverage be extended into the inland waterways. This recommendation was vigorously endorsed by the American Waterway Operators.

Corps Master Plan for Inland Waterways

It is a top priority for the Corps to develop and produce an electronic chart data product using one single data format and product specification for all inland waterways. It is imperative that this product be compatible with the standard electronic chart systems being manufactured and sold in the existing marketplace. This product is to be suitable for direct dissemination to the public on the Internet, and it must be kept continuously up-to-date, providing the most recent data available with the least processing delay. In order to avoid inefficiencies and the confusion that can come from similar but different representations of the same data, the present paper chart books will be discontinued and replaced by paper charts of one uniform format for all Districts that are printed from the electronic product.



Current Chart Products on River Systems Have a Variety of Features, Scales, Accuracies, and Update Frequency

It has already been determined that the most desirable data format to use is the IHO S-57 format along with the IHO ENC Product Specification because they have been extensively developed at the international level and are the industry standards. However, the S-57 format and the ENC Product Specification have been developed for coastal and harbor charts and may not be completely compatible with the features and attributes used by the Corps on their river charts. If inconsistencies are found, as is likely, deviation from, or changes to the standards may or may not be needed. In some cases, the electronic chart system (ECS) or ECDIS might be able to convert incompatibilities into needed or preferred format. An example from NOAA's experience is the standard requirement of depth contours in meters, although the ECS can simply convert those values to feet, as required by users. Extensive testing will be necessary to determine if these standards need any modifications for the inland waterways.

Also, for production efficiencies, it will be necessary to determine how to translate existing Corps digital data files into the S-57 in accordance with the ENC Product Specification in order to produce a RIVER ENC without intensive manual intervention. A detailed mapping of data from the Corp's Spatial Data Standard (SDS) to S-57 will be completed to facilitate a standardized translation. It is expected that the requirements of S-57 will also guide future SDS developments and revisions, producing a better Corps enterprise standard for electronic charts.

In the long term, it is believed that the adoption of S-57 by the Corps will provide for a platform independent transfer between CADD and GIS for both survey and chart data. It will provide a better structure for watershed and regional data analysis, and it will provide for more accurate and more detailed data for the Navigation Data Center.

A study will be undertaken to identify the basic navigational chart features for inland waterways by using the IHO ENC Product Specification, existing NOAA charts, existing Corps chart books, inland waterway user requirements and existing USCG Standards for Navigation Aids. After this has been accomplished, the accuracy of existing Corps chart data will be assessed relative to the 1-2 meter accuracy level of the DGPS service that has been installed and implemented by the Corps and USCG. Based on this assessment, areas will be identified where new surveys will be required to achieve this desired accuracy level.

An area of particular interest, and challenge, is features below the waterline; primarily bottom contours. Although most areas in a river system are fairly stable over a year, some areas can be quite dynamic, with hazardous shoals forming in a matter of weeks or even days. Such areas are usually promptly surveyed and dredged by the Corps, although compilation of the survey data, conversion to S-57 format, upload to an internet server, download by a user or ECS vendor and use onboard vessels in a short time could be daunting. As demonstrated in Southwest Pass, same-day processing and availability on the internet is possible. The challenge to the Corps is to

develop and integrate an S-57 production structure in this rapid publication process. Only then would this detailed bottom information be accurate and useful to the mariner.

It is expected that more accurate or new shoreline data may be required along with data for piers, hazards to navigation (both above and below the waterline) and other features not in the current Corps Chart Books. A possible priority for these new surveys will be those sections which carry the highest volume of traffic, which in general includes the Mississippi River from its mouth to St. Louis, MO and the Ohio River from Cairo, IL to Pittsburgh, PA. Another implementation scheme could be based on hazard, favoring areas particularly difficult to navigate, or reaches with a high volume hazardous cargo.

The Corps will use a series of Pilot Projects to conduct these tests and develop the necessary national data production guidelines and procedures. These Pilot Projects will also be useful in facilitating the necessary coordination between the Corps and other federal agencies and industry. Following the completion of these Pilot Projects, it will be possible to develop the implementation options for the various Corps Districts.

New Orleans District Pilot Project

In reviewing the areas of Corps responsibility, the Lower Mississippi River stands out as a unique example. It represents the largest port area in the United States in terms of tonnage. It also represents an area of overlap and transition between the inland waterway barge traffic and the deep-draft ocean/coastal shipping traffic. The river itself has areas with extremely dynamic channels such as Southwest Pass, and it is in this long, narrow waterway where hazardous cargo is most closely associated with densely populated urban areas. It is critical for the Lower Mississippi River to have accurate, up-to-date, large scale charts.

At this time, the New Orleans District is the only Corps District Office publishing near real-time channel condition surveys, and their paper chart book is in good condition and well organized. This District is best poised to immediately begin S-57 data conversions and electronic chart data production. Therefore, the New Orleans District, in coordination with the Topographic Engineering Center (TEC), has initiated the first Pilot Project for production and dissemination to the public of S-57 RIVER ENCs.

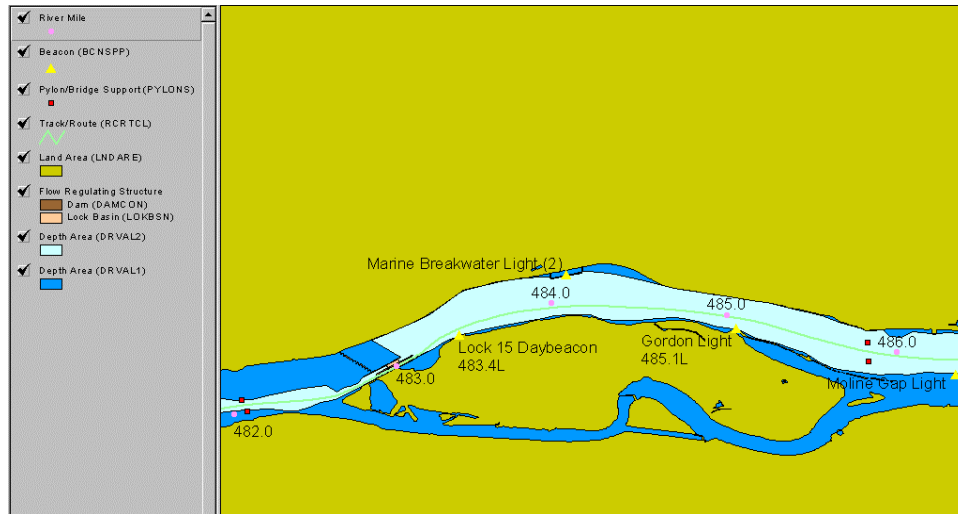
This Pilot Project will build on the results of a previous project that was completed last year to produce a digital data set of the Atchafalaya River in SDS format by converting from existing REEGIS files. Features in this data set are held in systematically named design files with specific layers, color and symbology. This represents the most accurate, most modern and most up-to-date compilation of inland waterway data that the Corps has available.

The New Orleans District has already awarded a contract to convert this data set to S-57 using the IHO ENC Product Specification. The conversion process is to be completed by the end of January, 2001, and field testing of the resulting prototype RIVER ENC will commence in March. In addition to the prototype RIVER ENC, the Corps expects this data conversion contract to provide an initial data mapping from SDS to S-57, along with process documentation, automation scripts and basic problem identification.

The second phase of the New Orleans District Pilot Project will involve new chart development on the Lower Mississippi River, Baton Rouge to the Gulf. The primary objective actually is to update the Mississippi River Navigation Map Book (conducted every four years), the Hydrographic Survey Book and the Mississippi River Levee Plan and Profile Book. The River ENC will be a by-product of the chart book and will serve as a model for the inland system. The Mississippi River product will also be used to solicit feedback from deep-draft navigation pilots, and help determine the optimum approach for Corps, NOAA and Coast Guard in a cooperative ENC.

Topographic Engineering Center Pilot Project

The Pilot Project initiated by TEC is collecting sample data from various Districts and producing electronic chart data from them for evaluation by outside users. This project will draw from five inland Districts (Vicksburg, Memphis, Kansas City, Rock Island and Pittsburgh) and five coastal Districts (to be determined), using a combination of CADD, GIS, text and hardcopy files. The District Offices will assist by compiling the data and editing according to ENC requirements.



Sample S-57 File at Rock Island, IL

TEC (or contractors) will use these data sets to develop production techniques and perform test production by using COTS software to structure and convert the data to S-57 format. The resulting S-57 electronic chart products will be field tested and demonstrated on Corps vessels and evaluated by electronic chart systems manufacturers and vendors, pilots, and other inland waterway users. The entire project will be closely coordinated with NOAA, USCG, the electronic chart systems manufacturer community and the waterway user community. The lessons learned from this project, along with user feedback, will help generate the policies, procedures and techniques that are disseminated to the Districts for production.

Electronic Chart Technology Center

Following the pilot projects necessary to develop the detailed mapping to convert from SDS to S-57, the new tools, techniques and procedures for production will have to be introduced and implemented in all Corps Districts. To accomplish this in an organized and consistent manner, an Electronic Chart Technology Center will be established. This will be a Central Corps Office located at the Engineering Research and Development Center, Topographic Engineering Center, in Alexandria, Virginia. This new Center, with guidance from Headquarters, will serve the entire Corps as the technology and policy coordination office for electronic chart products and navigation charts.

It is expected that the Electronic Chart Technology Center will be responsible for the development of electronic chart and navigation chart product standards to be used by all Corps Districts. It will be a technical support center for all related products and will provide technical assistance to all Districts. This Center will be the focal point for Corps coordination with other Federal agencies, industry and international interests. The Center will initiate and organize pilot production projects as necessary to achieve Corps-wide implementation. The Center will also develop quality control and assurance procedures for use by all Districts, and will monitor their use to ensure Corps-wide

consistency. Finally, the Center will develop and operate a web site for the publication and dissemination of all electronic data products.

Summary

The U.S. Army Corps of Engineers is committed to improving the safety of navigation in the inland waterways by providing highly accurate electronic chart products. These products will be produced in one uniform format that is suitable for use by industry with standard electronic chart systems that are now in the marketplace. These products will be made available to the public on the Internet and without charge, and will be kept up-to-date on a near real-time basis. The technologies and products developed for use on the inland waterways will be transitioned to the coastal waterways in cooperation with NOAA.