

Accuracy of Aids to Navigation on NOAA's ENC[®]s

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Abstract

The future of the National Oceanic and Atmospheric Administration's (NOAA) nautical charting program is vested in the production of NOAA's Electronic Navigational Charts (NOAA ENC[®]). NOAA's objective is to produce highly accurate ENCs in support of marine navigation and coastal management by supplying the marine community with highly accurate data portrayal. The initial collection of the NOAA ENC was accomplished using the raster chart base as the primary source. Although this strategy provided an early ramp up to production, it introduced the inherent positional error of the legacy charts into the ENC. Furthermore, NOAA's customers are using positioning technologies that have eclipsed the traditional cartographic methods. As a solution, to correct the positional error of charted features and to provide the pinpoint accuracy the customers require, NOAA developed a program whereby the positions of all the Federally maintained Aids to Navigation (ATONs) within the ENCs are updated to match the US Coast Guards Aids to Navigation Information System (ATONIS) database.

The Navigation Center, U.S. Coast Guard, and the Marine Chart Division (MCD), Office of Coast Survey (OCS), National Oceanic & Atmospheric Administration (NOAA), have worked cooperatively toward the goals of using the Coast Guard's, Aids to Navigation Information System (ATONIS) database as a master database, a communication conduit for critical safety information, a publication tool, and a data source to update NOAA nautical charts. Since inception of ATONIS, NOAA has augmented its chart suite by more than 400 Electronic Nautical Charts and Coast Guard will soon supersede ATONIS with its next generation database, the Integrated-ATONIS. This paper will discuss the goal elements, their present status, and the relationship between the US Coast Guard's master database, NOAA's nautical charts, and the safety benefits to the mariner.

Introduction

The future of the National Oceanic and Atmospheric Administration's (NOAA) nautical charting program is vested in the production of NOAA's Electronic Navigational Charts (NOAA ENC[®]). NOAA's objective is to produce highly accurate ENCs in support of marine navigation and coastal management by supplying the marine community with highly accurate data portrayal. The ability to accomplish this has been supported by converging technologies and interagency cooperative programs. Most notable are the creation of NOAA's second generation ENC[®]s, NOAA's ability to distribute incremental updates to ENCs, the creation of the Coast Guard's Aids to Navigation Information System (ATONIS) master database, the setting of Global Positioning System (GPS) Selective Availability to zero, and the widespread availability of GPS hand-held devices. I will discuss the evolution of each and its contribution to NOAA's objective to produce

highly accurate ENC's, and end with the resulting benefits to the mariner and other members of the maritime community.

The NOAA Electronic Nautical Chart

Creation

NOAA began producing its first ENC's almost four years ago in June of 2001. In order to expedite construction and speed availability of any ENC to the marketplace, they were compiled from the traditional NOAA paper chart. That is, the ENC was constructed from the information and geographical position of features as displayed on the traditional paper chart. The purpose of these first ENC's was not navigation, but to be available on the Internet to electronic chart system vendors so that they could become familiar with this future NOAA chart product. Thirty-six of these "Version One" ENC's were made.

While construction of ENC's using the traditional paper chart as source material did quickly get ENC's into the hands of electronic chart system vendors, it would not provide the mariner with the accuracy and detail necessary for safe and efficient navigation nor the coastal manager with the necessary base for geographical information system presentations.

User Community

NOAA turned its attention to these two communities, mariners and coastal managers.

For the mariner, NOAA made the commitment to construct a full suite of ENC's covering U.S. harbors, approaches, and coastal waters and to do so from original source documents. This is tremendously time consuming. The cartographer must research the original source document, must fully attribute the feature in the ENC, and do this using software that is far more complicated than that used to create the traditional chart. Now, three and a half years later, almost half of the entire suite is complete. Within NOAA such ENC's are known as "Version Two."

In June 2002, NOAA published in the Federal Register the definition of what NOAA, the Coast Guard, and the mariner shall recognize as an "official chart meeting chart carriage requirements." The Version Two ENC is an "official chart" by this definition.

For the coastal manager and geographical information system community, NOAA created what it calls NOAA ENC[®] Direct to GIS¹. This Web portal provides comprehensive access to display, query, and download all available large-scale NOAA ENC[®] data in a variety of GIS/CAD formats for non-navigational purposes using Internet mapping service technology. Nautical chart features contained within a NOAA ENC[®] provide a detailed representation of the U.S. coastal and marine environment. These data include coastal topography, bathymetry, landmarks, geographic place names and marine boundaries.

While construction of an ENC is complicated and time consuming, maintenance is also, and each ENC cell created must be maintained.

Maintenance

NOAA breaks maintenance into two categories, long term and short term. Long-term maintenance involves application of new hydrography, topology, and new shoreline. Short-term maintenance involves application of any critical safety item known to NOAA. Typically, application of any long item will result in issuing a new edition of the ENC cell. Critical safe items cannot await a new edition and are posted to the Web more frequently as incremental updates.

Critical Safety Updates

In order for NOAA to quickly recognize and apply critical safety items to its ENCs, NOAA relies upon both internal and external resources. In-house, NOAA has a process to identify a critical sounding embedded in, for example, the gigabytes of data associated with a typical modern-day hydrographic survey. NOAA field parties submit reports on wrecks found or cleared. Externally, NOAA relies upon the Corps of Engineers for changes to Federal Channels. For Aids to Navigation, NOAA relies upon the Coast Guard, and the new vehicle for exchange of navigational aid characteristics is the Coast Guard's ATONIS database.

In addition to identifying such critical safety items and applying them to the ENC, NOAA began this past summer to post to the Web incremental updates rather than full cell reissues. Cells posted as incremental updates are smaller because they only reflect changes since the last posting. This smaller file size can speed the download process for the user of the ENC².

US Coast Guard Aids to Navigation Information System (ATONIS)

Creation

About the time ENCs were making their debut, the US Coast Guard, NOAA, and the former National Imagery and Mapping Agency, now the National Geospatial Intelligence Agency (NGA) began discussions about sharing aid to navigation information and standardizing exchange formats. This resulted in adoption of the Coast Guard database as the master source for information concerning aids to navigation. It is simply named the "Aids to Navigation Information System", also called ATONIS. ATONIS stores all necessary information about each navigational aid's history, construction, maintenance, features, and position. It is the master to which NOAA and NGA refer when aid information is needed. ATONIS is also a vehicle for exchange of Local Notice to Mariner information and publication of the Coast Guard Light List.

Baselining

To ensure the accuracy of ATONIS, in particular the features and position of each aid to navigation, NOAA and Coast Guard partnered in an activity called “Baselining.” Baselining involves NOAA comparing each and every record in ATONIS with the same aid as displayed on the NOAA Raster Nautical Chart. If no discrepancy is found between the data in ATONIS and the NOAA chart then NOAA and Coast Guard declare the ATONIS record for that aid to navigation to be “baselined”. If a discrepancy is found, either in position or features, the record is flagged for the Coast Guard to review. Review can involve researching Coast Guard office records or sending a Coast Guard field party to verify the aid’s features and position. When a Coast Guard verifies the aid’s features and position that new information is published in the Local Notice to Mariners and entered into ATONIS.

This mutual baselining effort began in April 2002. Just this winter NOAA completed its examination of the 32 thousand ATONIS records corresponding to the Federal aids to navigation. Fully 93 percent of the records are baselined. The remaining 7 percent are being checked by the Coast Guard as field party schedules permit. The availability of inexpensive, hand held Global Positioning System (GPS) units, the setting of GPS Selective Availability to a zero value in May 2000, and the availability of Differential GPS each make field verification activity more efficient and accurate. To supplement Coast Guard field units, NOAA has engaged its Navigational Response Teams in the verification of the position of fixed aids.

Implications for the NOAA ENC[®]

These baselined ATONIS records are now a valuable resource to the NOAA ENC[®]. Remember, baselining compared each ATONIS record with the corresponding feature on the NOAA Raster Nautical Chart, not the ENC. But now that both NOAA and Coast Guard have confidence in each baselined ATONIS record, NOAA can apply that information to the ENC without further delay. That is on going work at NOAA today.

Begun just five weeks ago, NOAA is systematically applying baselined information from ATONIS to its suite of 458 ENCs. This is accomplished in the following manner. Each night NOAA runs a software utility that compares the baselined geographical position of an aid in ATONIS with all nearby aids in an ENC and generates a digital report. While the NOAA cartographer reviews the report, they can select ENC aids that are up to two minutes latitude distant from the baselined ATONIS position. When the matching aid is found, the ENC aid’s position can be corrected to the baselined ATONIS position. To date, more than 380 ENC aids have been corrected to the ATONIS position on more than 60 ENC cells. It is estimated that by August, NOAA will have reviewed and corrected all ENC cells now posted. Once through the suite of ENCs, that is, in August, continuous maintenance of ENC cells against the ATONIS database will become a reality.

In this way, NOAA ENC[®]s will accurately reflect the true position of aids to navigation as maintained by the Coast Guard, entered into the ATONIS database, reflected in the

published Local Notice to Mariners, transferred to the NOAA ENC[®], and posted on the Web for use by mariners, electronic chart system manufacturers, and coastal managers.

Conclusion

It has been several years in the planning and the making, but NOAA and Coast Guard have achieved their goals and the maritime community is receiving the benefits.

ATONIS is now the common database for aids to navigation information. Coast Guard units, from the field, through the District Headquarters, to National Headquarters, rely upon this storehouse for their daily operations. The National Geospatial Intelligence Agency, US Army Corps of Engineers, and NOAA recognizes ATONIS. ATONIS provides formats by which Notice to Mariners items can be prepared for publication and quickly exchanged with NOAA. It provides for publication of the Coast Guard Light List.

The NOAA ENC[®] has evolved from a few cells constructed from items found on the traditional paper chart to the present coverage that includes all major ports, approaches, and associated coastal waters constructed from original source data. Coast Guard's ATONIS and NOAA's ENC[®] have been married so that the output of validated ATONIS records are easily imported into the electronic chart product.

The maritime community reaps the benefit. In the NOAA ENC[®] mariners have a chart that is accurate, with navigational aids positioned to hundredths of a second of latitude and longitude. Navigational aids are represented on the electronic chart with accuracies compatible with the mariner's GPS unit, now in such common usage. Waypoints referenced to navigational aids on the chart can be sailed to in the real world with accuracy and precision. Because NOAA and Coast Guard have put the effort into baselining ATONIS, all NOAA chart products benefit from the accurate positioning of aids to navigation. These products include the OceanGrafix print-on-demand paper chart and the Maptech raster chart, each recognized as an "official chart meeting chart carriage requirements."

NOAA and Coast Guard will continue their cooperation. Field units will verify the aid positions, the percentage of baselined records will approach 100 percent, and chart products will reflect those updates. As we speak, Coast Guard is implementing the next generation of ATONIS, the Integrated ATONIS, with refined capabilities that bring additional efficiencies to Coast Guard, NOAA and their sister agencies, and useful benefits to the mariner and coastal communities.

Footnotes

1. http://nauticalcharts.noaa.gov/csdl/ctp/encdirect_new.htm
2. <http://www.chartmaker.ncd.noaa.gov/mcd/enc/download.htm>