

ADDING VALUE BY QCING S57 PRODUCTS

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Abstract

Traditional CHS products are renowned for their quality, especially in terms of accuracy and reliability. So it was natural for CHS Central and Arctic Region to want to maintain this level of quality as they moved into full-scale production of S57 ENC products.

In traditional CHS products, quality control is done by visually checking the final graphic product. This approach does not work for S57 products for two reasons. One, the amount of data in an S57 product makes it virtually impossible to check visually. Two, much of the data is not displayed on the graphic, it is held in an associated data file.

This paper describes a series of semi-automated processes and procedures (working name QC Suite), developed to help hydrographers check the values of attributes in an S57 ENC product. QC Suite provides interfaces and tools to review attributes and attribute values in S57 ENCs. Using these tools the checkers ensure that the quality of our product is maintained and the time for production is kept to a minimum.

Introduction

In 1993 the Canadian Hydrographic Service ("CHS") started a three-year pilot project to test and evaluate new electronic charting technology. Offshore Systems International ("OSI") and the CHS collaborated in this development.

The collaboration effort was a result of the 1990 Brander-Smith *Public Review on Tanker Safety and Marine Spill Response Capability* and was a pilot project funded under the Federal Government's Green Plan program.

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In 1993 Canada Steamship Lines ("CSL") purchased eleven Electronic Chart Displays ("ECDIS") for their self-unloading fleet from OSI. Central and Arctic Region ("C&AR") became actively involved in production of Electronic Navigation Charts ("ENC") shortly after the then director Earl Brown committed the region to supplying ENCs of the Great Lakes and the St. Lawrence Seaway to CSL.

Central and Arctic Region faced two major problems. The first, nobody in the region had ever produced an electronic chart in a production environment. The second, there were no standards for the production of ENCs. The first problem was over come by assigning about 25% of the regions resources to the project. The second problem was resolved by developing a temporary regional standard called "level one" and storing the files in NTX format. Level one ENCs contained only enough data for safe navigation in well defined shipping lanes. As time progressed C&AR added data to these level one ENCs until they became "full content" or complete.

In the summer of 1995 CHS committed itself to produce ENCs based on the International Hydrographic Organization ("IHO") S57 Transfer Standard for Digital Hydrography. S57's primary function is to provide a standard means of describing real world entities. The model categorizes real world entities (e.g. lights, land features soundings) into a finite number of types called objects. The objects are precisely described by attributes (e.g. colour, shape, size) associated with the object. In January 1996 C&AR started producing S57 ENCs using our existing NTX data sets and converting them to S57 with Universal Systems Limited ("USL") object manager program, OBMAN.

The traditional CHS checking procedure is based on a "what you see is what you get" approach. If it's not on the graphic it's not in the file. This approach does not work for S57 products for three reasons. One, the amount of data in an S57 product makes the product virtually impossible to check visually. Two, much of the data is not displayed on the graphic, it is held in an associated data file. Three, there is no efficient method to check for changes that were made inadvertently.

The graphic NTX files of the level one and full content ENC could be checked visually in much the same way that our conventional paper products are checked. But checking S57 products proved to be another problem completely. Some verification was possible because CHS headquarters anticipated the adoption of S57 and developed several programs and scripts to check many aspects of these S57 ENC data sets. However, these programs are designed to ensure data in our ENCs is S57 compliant, that is to say the ENC will run on any S57 compliant ECDIS. These automatic processes do not check if the value of the data is correct.

How then could S57 files be checked so that they would meet the rigorous standards of accuracy traditionally upheld by the CHS? The solution arrived at in C&AR was to develop tools to assist hydrographers in checking the data. These tools consist of a suite of PL/SQL and SQL scripts used in conjunction with graphic user interface ("GUI") that provides assorted views of the data. Using the GUI the checkers can quickly look at the attributes of each S57 object and check the value of that attribute. The views from the GUI can be used alone or in conjunction with OBMAN. This combination of scripts and the GUI have a working name of QC Suite.

THE PROBLEM

Hydrographers charged with checking S57 ENC's face an enormous task. S57 products or data sets have in the order of 10,000 objects in them and each of these objects can have upwards of 15 attributes. Many of these attributes and their values are stored in associated database tables and are not displayed on the graphic part of the data set. The amount of data to be reviewed and the structure of the ENC data model result in three significant problems in checking the data.

The first problem is the volume of data in an S57 ENC. The volume of data to be checked is further complicated by the fact that much of the attribution is not displayed, making the traditional CHS method of checking a proof copy is inadequate. Automated processes can and have been developed to check the validity of S57 data. But programs cannot check absolute accuracy. Checking for correct data values requires a skilled hydrographer to look at, and check the value. A computer can flag invalid data in terms of data type and allowable range. A computer cannot determine if the value of the data is a correct representation of the real world.

The second problem in checking S57 data stems from the OBMAN model itself. Each time an object is edited within the OBMAN program a new object is created, and this new object supercedes the object being edited. In simple terms, this could mean that if ten changes were made to the description of one object in a data set 10 new objects would be created and stored. The result is that the size of the S57 data set (i.e. number of objects in data set) increases dramatically but the number of correct objects or "current objects" remains very close to number of object in the file before it was edited. These "old" objects have no relevance to the final S57 product although; they must be sorted through to get to the final version of the data set.

The final problem in checking S57 data is to verify that the no changes were made to the data set inadvertently during editing.

THE MODEL

The OBMAN data model separates S57 data into two types of data vector and attribute. The vector data for each data set is stored as 10 CARIS files. The attribute data for all the data sets is pooled and stored in 6 relational data base tables. The vector files and the relational tables are linked in OBMAN through a combination of unique identifying numbers based on the data set name and a randomly generated key. The OBMAN model is a traditional GIS type solution that handles vector and attribute data. At the time of writing C&AR had 320 Megabytes of data stored in the relational tables associated with 32 ENC files. The OBMAN data model works comparatively well for the creation and editing of S57 data sets because editing is only done to a small subset of all the data in the relational tables. The model does not allow for rapid checking of attribute values because it requires a search of the entire relational database for each attribute to be checked.

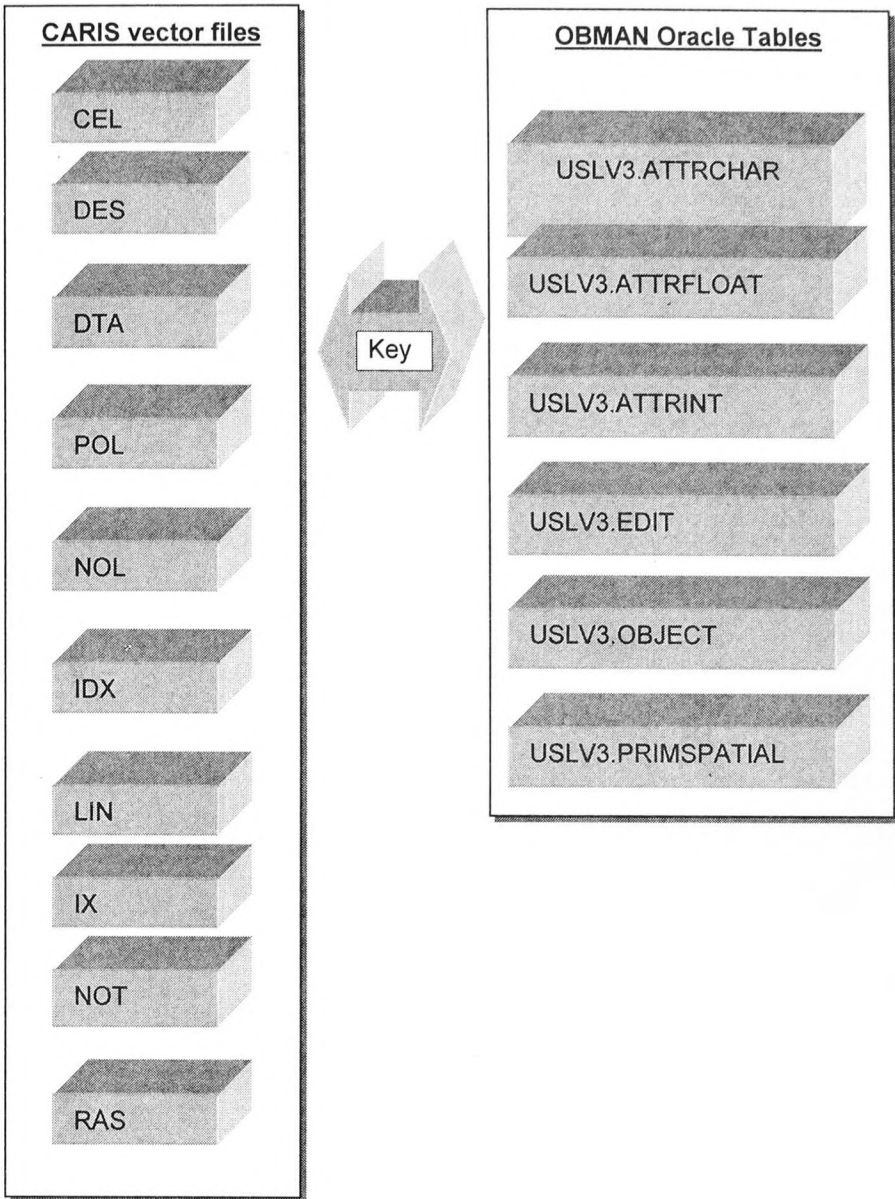


FIG. 1.- OBMAN DATA.

THE SOLUTION (BRIEF)

To check S57 data sets C&AR developed automated tools that presented the S57 attribute data in ways that can be quickly verified by hydrographers. QC Suite is the working name of this solution. QC Suite is a set of procedures, scripts and user interfaces designed in C&AR as a set of desk-top tools to assist the hydrographer in checking S57 ENC's. QC Suite sorts through the data base side of the object model and provides organized views of single S57 data set. These views allow efficient checking of the S57 objects. The important feature of QC Suite is that it does not check data, checking is done by skilled hydrographers.

The first step in the solution is to extract a given data set from the attribute data of the USL OBMAN data pool. QC Suite searches through the four USL attribute tables (USL_V3.attrchar, USL_V3.attrint, USL_V3.attrfloat and USL_V3.object) using a process called *new_object*. In this process the current objects in a given data set are selected. The result of running this process is an Oracle table called *new_objects_temp* that contains all the current objects, object attribute and attribute values for a ENC data set.

The second step in the solution is to separate the objects and to load them into an Oracle table for each object in the data set. These tables are held in a directory common to all ENC checkers and are named *object_temp* (e.g. ACHARE_TEMP, LIGHT_TEMP). Each *object_temp* Oracle table contains one type of object from several different data sets.

The third step in the solution is to use the GUI to check the objects of the given data set. The *object_temp* object tables are viewed interactively by the checker using an assortment of pre-programmed and ad hoc queries. When the checker has finished reviewing an object in a given data set a report of the review is generated. The GUI used in QC Suite is Andyne Computing Limited GQL Version 4.1 it is one of a number of products on the market that provide graphic user interface for data base applications.

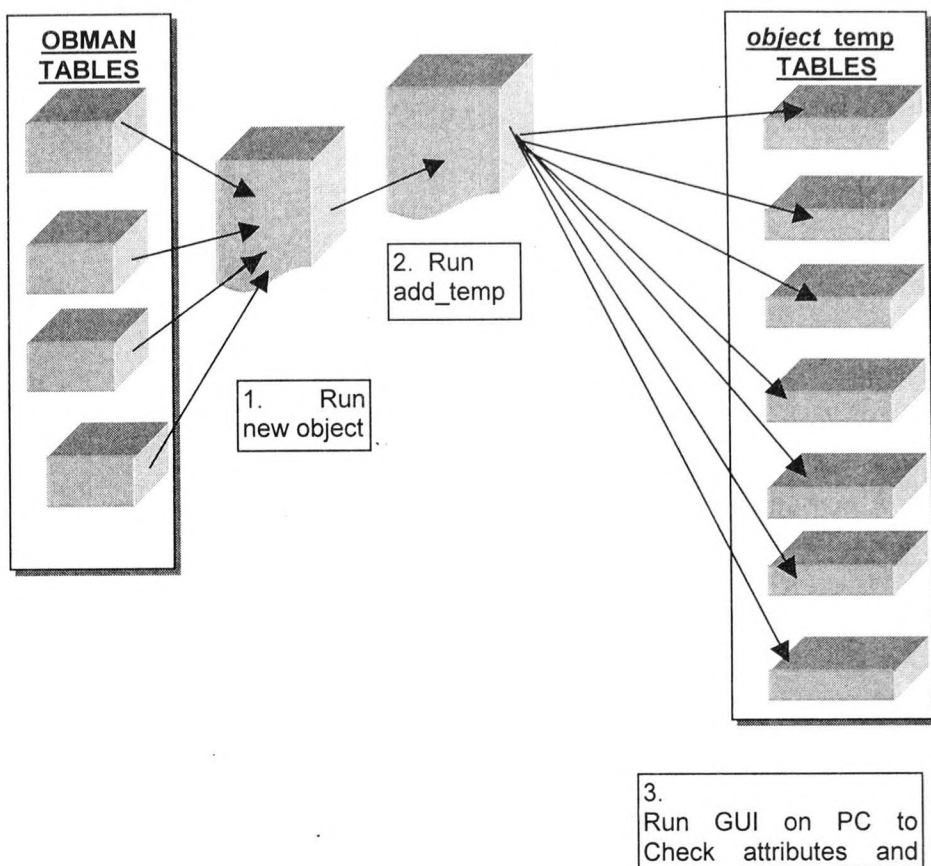


FIG. 2.- OVERVIEW of QC Suite Processes.

THE SOLUTION (LONG)

QC Suite is a set of UNIX scripts, SQL scripts, PL/SQL procedures and GQL models that look at the attribute data stored in the USL OBMAN tables. The purpose QC Suite is to give hydrographers doing quality control on S57 ENC's a set of tools for reviewing the values of object attributes. The hydrographers view the data with GQL, running on their desk-top computer. There are four steps in the process and they are run by the hydrographer.

The four steps are:

1. Run: new_objects. This script runs a process that retrieves all the objects and attributes from the four USL OBMAN tables and loads them into the user's directory. The input required for this is the ENC chart number (DATASETID). Each time this process is run it overwrites the previous data in the user's temporary table

2. Run: add_temp. This script takes the data in the user's temporary table and loads it into *object_temp* tables. There is a *object_temp* table for about sixty S57 objects and new ones are added as needed. The data stays in the *object_temp* tables until it is deleted.
3. Run: QCOBJ.gql / checking. This is GQL model on the user's desktop computer. The hydrographer uses the GQL gui to check the data set object by object.
4. Run: delete_dataset. This script deletes a given data set from the *object_temp* tables.

The four scripts are written in PL/SQL, to build and maintain tables for the QCing of S57 products are described in detail below.

1. new_objects

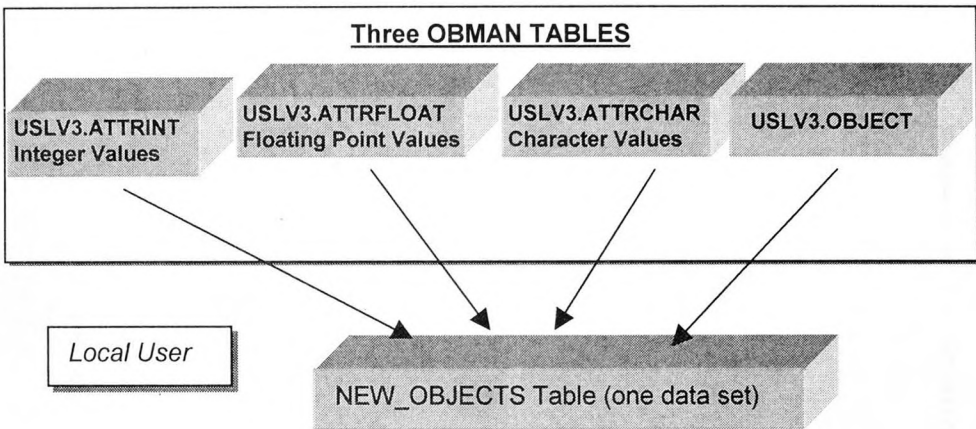


FIG. 3.- NEW_OBJECTS Process Flow

The `new_objects` procedure generated a unique set of objects for a given data set. The main input for this process are the four OBMAN attribute tables `ATTRINT`, `ATTRFLOAT`, `ATTRCHAR` and `OBJECT`. Only the current objects are selected. The output from `new_objects` is the `NEW_OBJECTS` table owned by the local user. The `NEW_OBJECTS` table is recreated each time this process is executed and exists for only one data set at a time.

2. add_temp

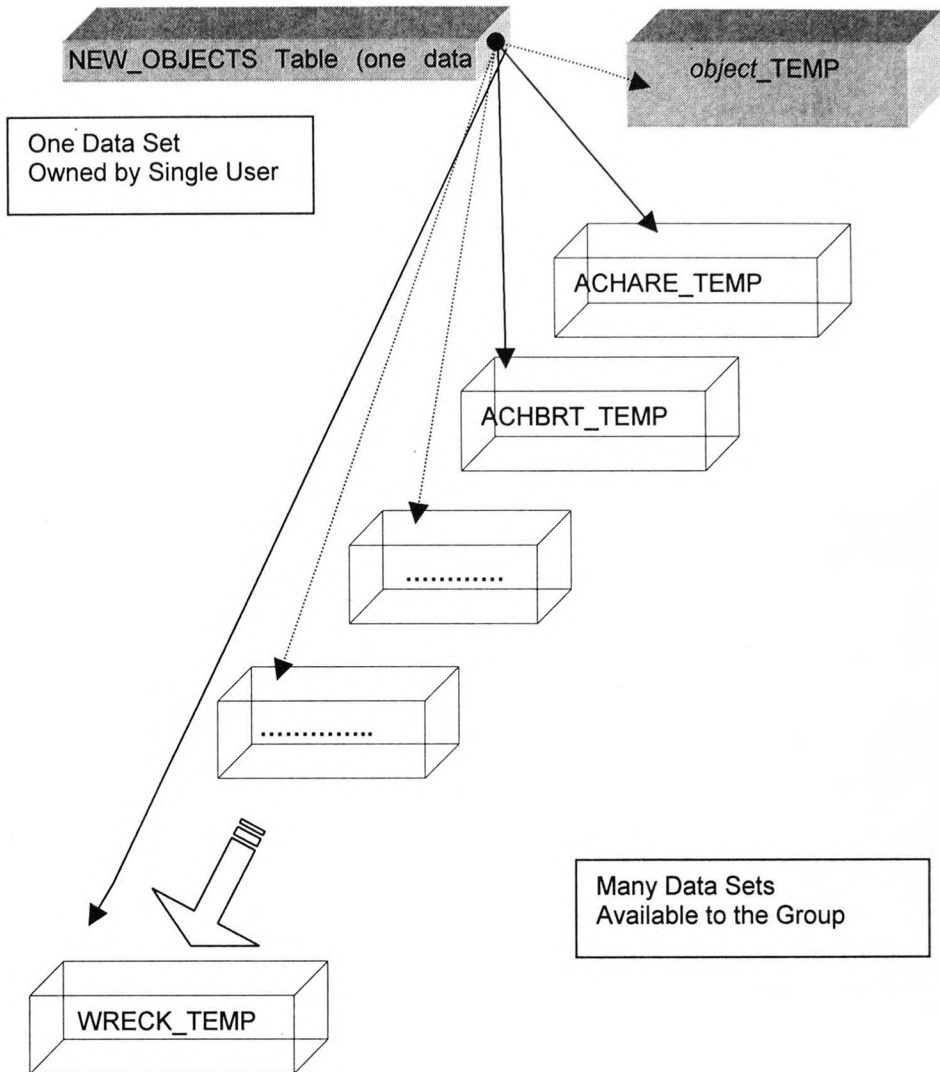


FIG. 4.- ADD_TEMP Process Flow.

The **add_temp** procedure loads data from the new_objects table into each object's data base table. There is one table for each S57 object and each table describes several ENC. The input for this process is the new_objects table. The output from add_temp is updates to the object_temp tables. The object_temp are open to all hydrographer/checkers and describe a number of data sets.

3. QCOBJ.gql / checking

Query Results 3

Query completed:

50	DATASETID	OBJECTID	OBJCODE	BOYSHP	QCBOYSHP	CAT	COLOUR
1	ca473034	AAkc4wAZADI	BOYLAT Buoy,lateral	4 BOYSHP pillar		1 CATLAM port-hand late4	COLOUR green
2	ca473034	AAkc5AAZADI	BOYLAT Buoy,lateral	2 BOYSHP can (cylindric		3 CATLAM preferred cha4	COLOUR green
3	ca473034	AAeifgAZADI	BOYCAR Buoy,cardinal	5 BOYSHP spar (spindle		CAT(m) 6	COLOUR yellow
4	ca473034	AAkc3gAZADI	BOYLAT Buoy,lateral	1 BOYSHP conical (nun,		2 CATLAM starboard-har3	COLOUR red
5	ca473034	AAedSAAZADI	BOYLAT Buoy,lateral	4 BOYSHP pillar		2 CATLAM starboard-har3	COLOUR red
6	ca473034	AAedTAAZADI	BOYLAT Buoy,lateral	5 BOYSHP spar (spindle		2 CATLAM starboard-har4	COLOUR green
7	ca473034	AAedRQAZADI	BOYLAT Buoy,lateral	5 BOYSHP spar (spindle		2 CATLAM starboard-har3	COLOUR red
8	ca473034	AAedRwAZADI	BOYLAT Buoy,lateral	5 BOYSHP spar (spindle		1 CATLAM port-hand late4	COLOUR green
9	ca473034	AAedRAAZADI	BOYLAT Buoy,lateral	5 BOYSHP spar (spindle		1 CATLAM port-hand late4	COLOUR green
10	ca473034	AAedLwAZADI	BOYLAT Buoy,lateral	5 BOYSHP spar (spindle		1 CATLAM port-hand late4	COLOUR green
11	ca473034	AAedMwAZADI	BOYLAT Buoy,lateral	5 BOYSHP spar (spindle		2 CATLAM starboard-har3	COLOUR red
12	ca473034	AAedJgAZADI	BOYLAT Buoy,lateral	4 BOYSHP pillar		2 CATLAM starboard-har3	COLOUR red
13	ca473034	AAedKpAZADI	BOYLAT Buoy,lateral	4 BOYSHP pillar		1 CATLAM port-hand late4	COLOUR green
14	ca473034	AAedHQAZADI	BOYLAT Buoy,lateral	4 BOYSHP pillar		2 CATLAM starboard-har3	COLOUR red
15	ca473034	AAedIQAZADI	BOYLAT Buoy,lateral	4 BOYSHP pillar		1 CATLAM port-hand late4	COLOUR green
16	ca473034	AAedQOAZADI	BOYLAT Buoy,lateral	5 BOYSHP spar (spindle		2 CATLAM starboard-har3	COLOUR red
17	ca473034	AAedOwAZADI	BOYLAT Buoy,lateral	5 BOYSHP spar (spindle		1 CATLAM port-hand late4	COLOUR green
18	ca473034	AAedPwAZADI	BOYLAT Buoy,lateral	5 BOYSHP spar (spindle		1 CATLAM port-hand late4	COLOUR green
19	ca473034	AAedOAAZADI	BOYLAT Buoy,lateral	5 BOYSHP spar (spindle		1 CATLAM port-hand late4	COLOUR green
20	ca473034	AAedOwAZADI	BOYLAT Buoy,lateral	4 BOYSHP pillar		2 CATLAM starboard-har3	COLOUR red
21	ca473034	AAedPgAZADI	BOYLAT Buoy,lateral	5 BOYSHP spar (spindle		1 CATLAM port-hand late4	COLOUR green
22	ca473034	AAedOQAZADI	BOYLAT Buoy,lateral	5 BOYSHP spar (spindle		1 CATLAM port-hand late4	COLOUR green
23	ca473034	AAedOgAZADI	BOYLAT Buoy,lateral	5 BOYSHP spar (spindle		2 CATLAM starboard-har3	COLOUR red
24	ca473034	AAedNgAZADI	BOYLAT Buoy,lateral	5 BOYSHP spar (spindle		2 CATLAM starboard-har3	COLOUR red
25	ca473034	AAedNwAZADI	BOYLAT Buoy,lateral	5 BOYSHP spar (spindle		1 CATLAM port-hand late4	COLOUR green
26	ca473034	AAedNAAZADI	BOYLAT Buoy,lateral	5 BOYSHP spar (spindle		1 CATLAM port-hand late4	COLOUR green
27	ca473034	AAedNQAZADI	BOYLAT Buoy,lateral	5 BOYSHP spar (spindle		1 CATLAM port-hand late4	COLOUR green
28	ca473034	AAedMQAZADI	BOYLAT Buoy,lateral	5 BOYSHP spar (spindle		1 CATLAM port-hand late4	COLOUR green

Checker Ad
Hoc Query

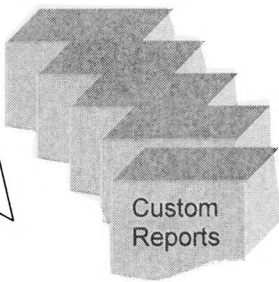
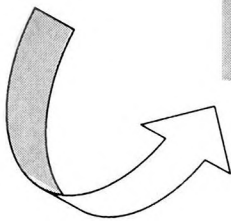


FIG. 5.- QCOBJ.gql Process Flow.

The **QCOBJ.gql** procedure is run on a PC using Andyne's GQL GUI. The process views each of S57 object_temp tables generated in the add_temp procedure. The input to this procedure is the data set id of the ENC data set that is to be reviewed. The output from QCOBJ.gql are spreadsheet like reports customized by the checker. The range and variety of the reports is only limited by the checker imagination.

4. delete_dataset

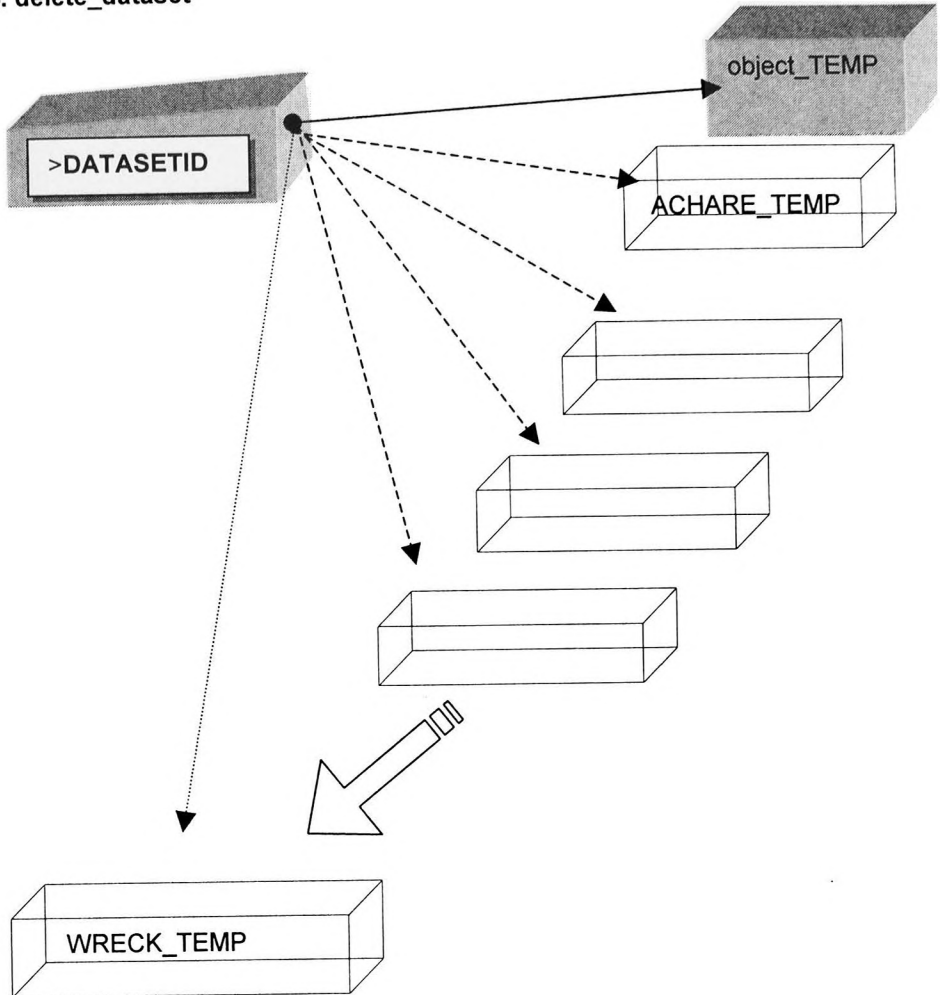


FIG. 6.- DELETE_DATASET Process Flow.

The procedure **delete_dataset** is an PL/SQL script that remove a data set from each of the *object_temp* tables. A data set is deleted when the QC process is completed or when there is a requirement to start process over again. It is run from the Unix terminal and the required input is the datasetid that is to be deleted.

QC.sql

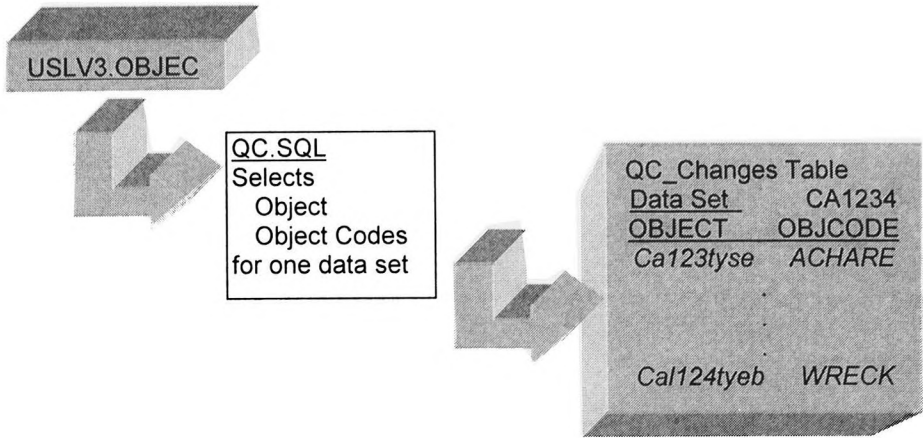


FIG. 8.- QC.SQL Process Flow.

The procedure QC.sql is a PL/SQL that takes a snapshot of the data set before any edit changes have been made. The script is run right after the ENC is converted from the OBMAN format to the S57 format. This process can only be done by the lead ENC QC officer.

QC_V_QC_diff

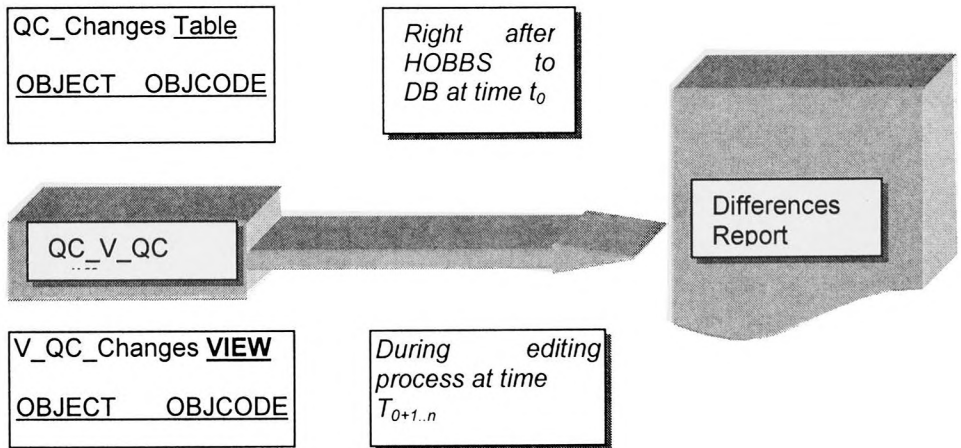


FIG. 9.- QC_V_QC_diff Process Flow.

QC_V_QC_diff is a Unix/SQL process that compares the present data set with the original snapshot created by QC.sql (at T₀). The process notes all differences between the original snapshot and the edited ENC at any time after T₀ (T_{0+1...n}).

bulk object

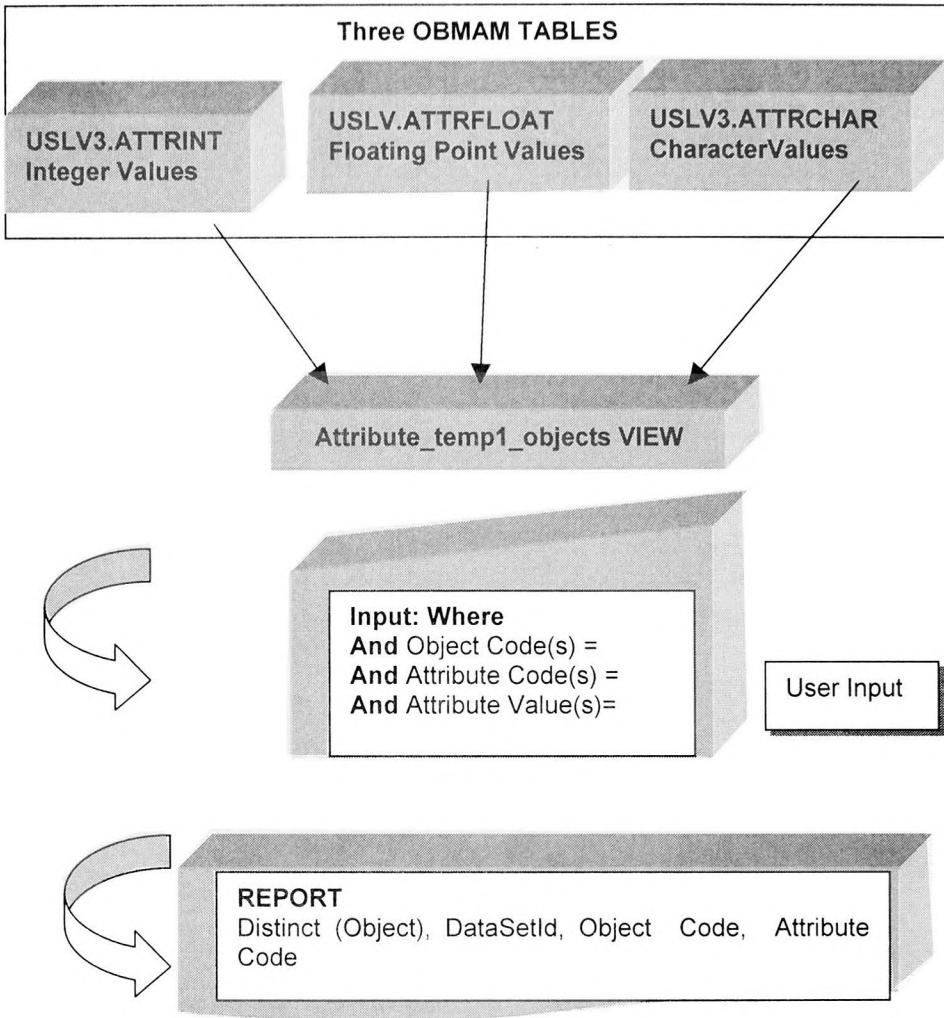


FIG. 10.- BULK_OBJECT Process Flow.

Bulk_object is a special procedure used to look at all the objects in a given data set. It was developed out of the need to check the values of object attributes that are common to all or most of the objects in a ENC data set (e.g. Source id, Source date or minimum scale). This Unix/SQL procedure creates a view of the three USLV3 attribute tables. Then the procedure queries the view selecting only the objects that satisfy the three “where” conditions in the select statement of the query. The output from this is a report listing all the objects that satisfy the where condition in the query.

QCOBJ.gql /usl_3:

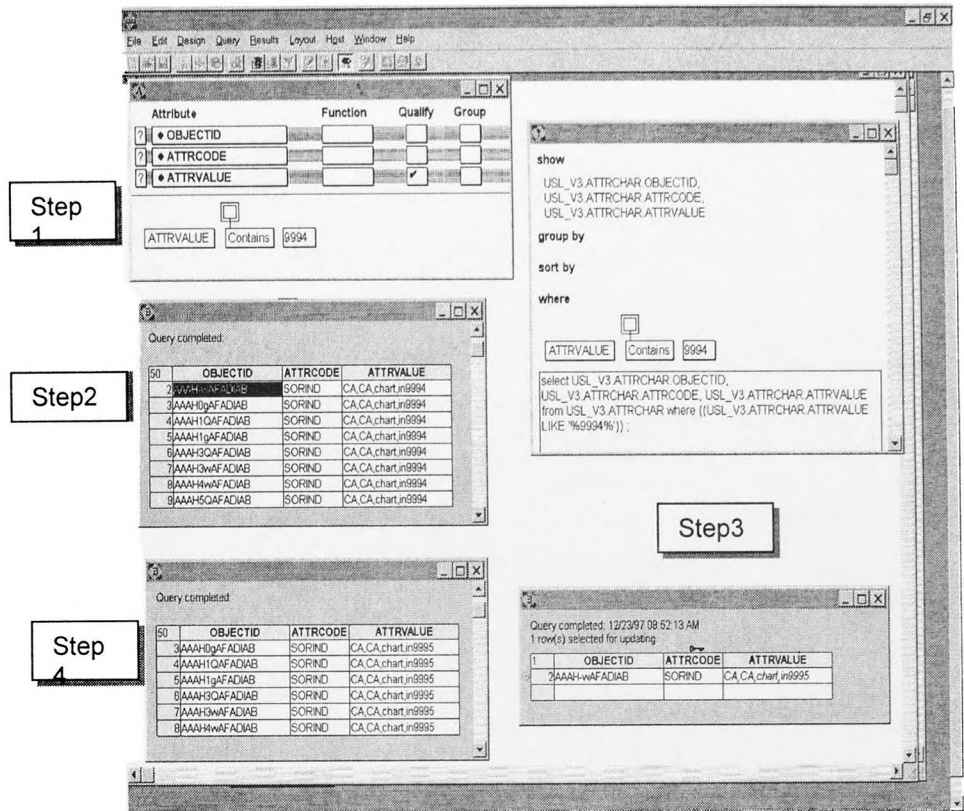


FIG. 11.- QCOBJ.gql Process Flow.

This GQL model/screen allows the bulk updating of object attributes by conditions defined by the user via the GQL GUI. The procedure is as follows:

1. The USLV3.table is queried to select the attribute values to be changed,
2. The ATTRVALUE column is selected and the GUI is told to go into UPDATE mode,
3. The value of the attribute to be changed and the GUI is told to update the table,
4. Change to the table is verified with a query similar to the query in Step 1.

Conclusion

Combined with the checking procedure developed by CHS Ottawa, QC Suite can provide a comprehensive method for checking the validity and accuracy of S57 ENC's. When used by a skilled and experienced hydrographer S57 data files can be checked so that the traditional quality of CHS products is maintained in these 21st century products.

TOWARDS "AUS ENC ONE" **(Australian Electronic Navigation Chart Number One)**

by Commodore Robert J. WILLIS ¹

This paper was first presented to the Congress of the Institution of Surveyors, Australia, held in Launceston, 9-12 November 1998, and is reproduced here with the permission of the Institution.

Abstract

This paper describes the Australian Hydrographic Office Electronic Navigation Chart (ENC) program covering the area from Weipa to Port Clinton, including Torres Strait, the Great Northeast Channel and the Inner Route of the Great Barrier Reef. It describes a novel approach whereby small scale charts are vectorised as low density data to present a backdrop, and the major shipping lanes are presented as an enhanced strip of high density vector data.

INTRODUCTION

Australia has a land area approximately the same size as the United States and a continental shelf of similar area to that of the continent itself. Australia, by international standards is remote, and has a population of only 18 million people. Consequently, Australia has had to seize the opportunities offered by emerging technologies and apply them in an innovative way in mapping and charting the continent and the offlying waters. This has especially been the case during the period of rapid development over the last fifty years. Perhaps one of the most visible expressions of such innovation has been the design, construction and successful operation of the Laser Airborne Depth Sounder for collecting bathymetric data. Australia's participation in international forums, such as the International Hydrographic Organisation, has assisted in keeping us at the forefront of developments in hydrographic surveying and nautical charting.

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It is pertinent to note that Australia has a particular focus in its offlying waters in the form of the Great Barrier Reef, which is the most navigationally complex region for coastal navigation in Australia. The principal navigation channel through the Great Barrier Reef is known as the Inner Route. Although the Reef is hazardous to shipping, shipping is also hazardous to the Reef. The Reef is beautiful, it is environmentally sensitive and it is a haven for researchers and tourists alike. Consequently, it attracts significant management attention. It has been declared a Particularly Sensitive Sea Area by the International Maritime Organisation, and it has always been an area of intense activity for the Australian Hydrographic Office (AHO).

The title of this paper bears some explanation. It is not meant to refer to the creation of the first Australian Electronic Navigation Chart (ENC), although such action is imminent. The title intends to convey a vision whereby the whole of Australian waters will be contained in one seamless electronic chart, the number of which will be ONE. This will clearly not happen under the current rules that limit the size of an ENC², but I believe that unless one has an expansive vision of ENC generation for a country the size of Australia, the ENC cells will be a long time coming. The AHO holds such a vision – imagine, one eighth of the earth's surface covered by a single electronic navigation chart!

ELECTRONIC CHARTING IN THE AHO TO DATE

The AHO has been experimenting with digital charts since the 1980s. Licences were granted to a couple of companies to produce raster versions of Australian charts in the early 1990s. At about the same time the AHO began to experiment with raster charting, primarily to improve the management and production of the paper chart series. The AHO contracted Hydrographic Sciences Australia, Pty Ltd, (HSA) to design and develop a raster database. This later became the Raster Data Centre which was capable of managing the maintenance and printing of the paper chart series, as well as providing raster charts in a variety of formats for different users.

In 1995, an initial sample of 45 raster charts in the HCRF³ format was released for trial. After a further two years of development and refinement, the Australian Raster Chart service, *Seafarer*, was launched in mid 1997. *Seafarer* has proven to be very popular in all sectors of the maritime community. A number of navigation packages now accommodate *Seafarer*, and we have developed a viewer for those customers who do not need to navigate, but who prefer to have a chart backdrop for other GIS like applications. Since its launch, *Seafarer* has received a number of awards, the most notable being the Gold Award for Cartographic Excellence from the Mapping Sciences Institute of Australia in May 1998.

Activities in relation to vector electronic charts became more focussed when the S-57 Standard of the International Hydrographic Organisation was released late in 1991. The S-57 Standard forms part of the standards underpinning

² The Product Specification for an ENC under S-57 Edition 3.0 limits the size of an ENC to 5 Mb.

³ The Hydrographic Chart Raster Format was developed by the UK Hydrographic Office as a suitable format to present raster data for electronic navigation purposes.

the Electronic Chart Display and Information System (ECDIS). Since then, several S-57 style data sets have been created by the AHO and by HSA under contract. The first of these was an S-57 Version 1 data set of Sydney Harbour which was used as a test bed for further development work. This data set continues to be used as a test bed and demonstration item.

In 1993, the AHO raised a requirement for capital investment that took into account the need to create electronic charts, but more fundamentally, recognised the need to make the organisational transition from the manuscript era into the digital era. In 1994, Project SEA 1430 was initiated and was placed under separate management in the Department of Defence Acquisition Program, while maintaining extensive consultation with the AHO. Project SEA 1430 has two phases: Phase 1 aims to install a Digital Hydrographic Data Base in the AHO; and Phase 2 will equip the ships of the Royal Australian Navy, and appropriate shore headquarters, with an electronic charting capability.

Tenders for Phase 1 closed last December. Tenders remain under evaluation although an announcement of a successful tenderer is expected before Christmas. Phase 1 of the Project will deliver many things, including the conversion of a number of paper charts into S-57 compliant data sets. However, of my 370 or so paper charts, one third are still in imperial units, two thirds are on datums other than WGS and LAT⁴ and about 50 are of such an age that redrawing from source is the only palatable option. Consequently, Project SEA 1430 Phase 1 will be more of a longer term solution to ENC generation.

THE IMMEDIATE PROBLEM

However, the market place has been sending a clear message that a shorter term solution to ENC generation was needed. In July 1997, the AHO embarked on a limited ENC production program with the aim of changing the emphasis from the paper chart as the primary navigational tool to the ENC as the primary tool. The paper chart production program will continue, but the paper chart will, in a mature state, become a product derived from an S-57 compliant database.

Before the release of S-57 Edition 3 in 1996, and the freezing of the standard at this edition level, the data sets that had been created varied in content and format.

Some of the reasons the data sets had been produced include:

- ◆ ECDIS testing and demonstration purposes;
- ◆ Development of standard operating procedures for digital data capture;
- ◆ Proof of concept for conversions from Autochart⁵ digital files;
- ◆ Proof of concept for conversions from S-57 to other formats such as the Digital Nautical Chart, raster and paper chart;

⁴ International charts, either in paper or ENC form, are based on the horizontal datum of WGS and the vertical datum for soundings of Lowest Astronomical Tide.

⁵ Autochart and ChartStation are applications used by the Australian Hydrographic Office under license from Hydrographic Sciences Australia Pty, Ltd.

- ◆ Support of requirements raised within the Department of Defence and by maritime and Port Authorities in Australia, and
- ◆ Training of cartographic staff on the new ChartStation application.

Almost invariably these data sets were based on direct vectorisation of a paper chart or a small group of paper charts based on a particular locality. For example, in July 1997, the AHO had S-57 data sets, in different versions, of Sydney Harbour, Jervis Bay, Port Philip, Westernport and the Port of Darwin. Training programs for cartographic staff were underway for some of the key waterways in the Torres Strait and the Whitsunday Islands. Each of these programs involved the compilation of four new charts using ChartStation, to be encoded from source as S-57 Edition 3.0 compliant data sets. We have plans to release these ports as ENC's, commencing with the first release in November this year.

In response to international calls for hydrographic offices to expedite the release of official ENC data sets compliant with S-57 Edition 3.0, and national calls to improve the state of electronic charting in the Inner Route of the Great Barrier Reef, the AHO undertook to produce ENC's of the Torres Strait and Inner Route by the end of 1998. This undertaking imposed a number of significant challenges and questions that needed robust responses:

- ◆ There was a need to develop a comprehensive data capture specification for the ENC.
- ◆ Was vectorisation of the existing paper chart the best way to present an ENC?
- ◆ Could we create an ENC of a long narrow strip of waterway, such as one might capture a river, without converting all the paper charts covering that strip?
- ◆ What compromise could be made in limiting the content outside the Inner Route?
- ◆ Should more information be included within the Inner Route from source data?

It was clear that an innovative approach was needed to undertake this task other than the traditional "chart by chart" approach, as there are 65 charts and 50 plans covering the Inner Route of the Great Barrier Reef. It was also acknowledged that some compromise would need to be made in the content and the means of compilation of these ENC's from what is generally understood to be desirable and expected of an ENC in the longer term. Nevertheless, in such a significant navigational channel, it was recognised as FUNDAMENTAL that the ENC product would need to be more authoritative than a straightforward vectorised version of the paper chart.

It was also recognised that this project would entail trials of the ENC, as well as developing the means of distribution, pricing, updating and security of the ENC. Fortunately, planning and managing these issues could proceed in parallel with ENC production.

THE SOLUTION

The solution, which I chose in February 1998, was to produce one or several ENC cells of low usage code (small scale) covering the entire Great Barrier Reef (GBR). Those sections comprising the GBR Inner Route would be included in those cells at larger scale, and selected depth critical areas would be included at survey source scale. Contours at one metre intervals will be provided within the critical areas, that is from 5 to 20 metres in the northern part of the Inner Route and 5 to 25 metres south of Hinchinbrook Island.

The small scale charts selected to provide the "backdrop" for this project are AUS 4620, Percy Islands to Booby Island including Gulf of Papua, and AUS 4621 (INT 621), Mackay to Port Moresby, both at a scale of 1:1,500,000. These charts were designed to cover the GBR Inner Route mandatory Ship Reporting System that has been in operation since 1 January 1997. The cells where the content level will be enhanced have been defined as one degree "squares".

In effect, there will be a strip of higher resolution vector data embedded within the lower resolution ENCs covering the most difficult and sensitive navigational region of the Australian coast.

OBJECTIVE

The overall objective of this project is to release an authorised ENC product of the GBR Inner Route by the end of 1999. I consider this an elegant solution as this particular ENC program is not restricted by, nor necessarily connected to, the paper chart program. The resulting ENC will be more comprehensive than a vector version of the existing paper charts within the area of the Inner Route, but may not include all of the area covered by the paper charts.

The project will provide the mariner with vector coverage of the major shipping lanes from the Port of Weipa in the Gulf of Carpentaria, through the Torres Strait and the GBR Inner Route to Port Clinton, including the Great Northeast Channel and Hydrographers Passage. This area generally coincides with the area covered by the compulsory pilotage requirements⁶. Outside of this area of interest, small-scale ENC coverage and the *Seafarer* raster service will support the detailed ENC⁷. Within the shipping lanes the mariner will be able to select and have the vessel's safety contour displayed on the ECDIS. The mariner will be able to zoom in (enlarge the scale) on the display within the shipping lane and have vector data at the scale of the largest scale paper chart.

⁶ Compulsory pilotage was introduced in October 1991 for ships transiting the GBR Inner Route and Hydrographers Passage, and applies to all vessels of 70 metres or more in length and all loaded oil tankers, chemical tankers and gas carriers of any length.

⁷ The notion of combining the presentation of one form of electronic chart data with another, either in the same display or separately, has become known as "dual fuelling". Many equipment manufacturers are producing dual or multi fuel displays for electronic navigation.

A secondary objective is to provide the basis for a small scale (low usage code) ENC coverage of Australian waters at a scale of 1:1,500,000 or smaller. Such coverage has applications including Search and Rescue operations, resource management, defence planning, route planning and even navigation in some circumstances.

The third objective is to use this program to guide future plans for the conversion of paper charts into S-57 data sets. We are clearly motivated by the view that chart by chart conversion will not be necessary in all cases, and that enhancement of navigationally significant waterways, through additional contours for example, is desirable and achievable with electronic chart technology.

ENC CONTENT

The primary guidance on the basic content of an ENC is provided in the Performance Standards for ECDIS that were approved by the International Maritime Organisation General Assembly in 1995⁸. Regulation V/20 of the International Convention for the Safety of Life at Sea (SOLAS), 1974, "requires all ships to carry adequate and up-to-date charts, sailing directions, lists of lights, notices to mariners, tide tables and all other nautical publications necessary for the intended voyage". The up-to-date charts required under the regulation can be provided and displayed electronically by ECDIS.

IMO prepared the Performance Standards to ensure the operational reliability of ECDIS equipment, and "to ensure that the information provided and displayed electronically is at least equivalent to that of the up-to-date charts and, when also provided and displayed, other nautical publications"⁹. This underlined clause is the guiding principle to ENC content.

The Performance Standards go on to state that "ECDIS should have at least the same reliability and availability of presentation as the paper chart published by government-authorised Hydrographic Offices"¹⁰.

The Performance Standards also state that "when a chart is first displayed on ECDIS, it should provide the standard display at the largest scale available in the SENC for the displayed area"¹¹. "It should be possible for the mariner to select a safety contour from the depth contours provided by the SENC"¹² and "for the mariner to select a safety depth. ECDIS should emphasise soundings equal to or less than the safety depth whenever spot soundings are selected for display"¹³.

The "Standard Display" is made up of two levels as given in Appendix 2 to the Performance Standards; namely the display base and the standard display. The display base, permanently retained on the ECDIS display, consists of:

⁸ IMO Resolution A.817 (19) adopted 23 November 1995, Performance Standards for Electronic Chart Display and Information Systems.

⁹ Performance Standards, preamble to Resolution.

¹⁰ Performance Standards Para 1.7.

¹¹ Performance Standards Para 3.4.

¹² Performance Standards Para 3.6.

¹³ Performance Standards Para 3.7.

- ◆ coastline (high water);
- ◆ own ship's safety contour, to be selected by the mariner;
- ◆ indication of isolated underwater dangers at depths of less than the safety contour which lie within the safe waters defined by the safety contour;
- ◆ indication of isolated dangers which lie within the safe water defined by the safety contour such as bridges, overhead wires, etc., including buoys and beacons, whether or not these are being used as aids to navigation;
- ◆ traffic routing systems;
- ◆ scale, range, orientation and display modes; and
- ◆ units of depth and height.

The standard display, to be displayed when the chart is first displayed by ECDIS, consists of:

- ◆ display base;
- ◆ drying line;
- ◆ indication of fixed and floating aids to navigation;
- ◆ boundaries of fairways, channels, etc.;
- ◆ visual and radar conspicuous features;
- ◆ prohibited and restricted areas;
- ◆ chart scale boundaries; and
- ◆ indication of cautionary notes.

Appendix 4 of the PS lists those areas for which special conditions exist and which ECDIS should detect and provide an alarm or indication. From interpretation of the PS, we consider that all the features shown in Appendices 2 and 4 of the PS are mandatory for ENCs produced by the AHO. Some comments on the particular aspects of content are detailed below.

Navigation Marks

Each ENC is required to hold the navigation marks applicable for the usage of that ENC. In the AHO, navigation marks are held in a separate Navigation Marks Database, maintained by Nautical Information Section. Navigation marks from the Navigation Marks Database are combined with the ChartStation data set at the time of generation of the ENC.

Although it may seem sufficient to include only those navigation marks within and immediately adjacent to the shipping lanes, this is not recommended. We do not know which aids the mariner uses. It is safer to include all marks and aids that would appear on the corresponding paper chart. In particular, the channel beacons leading from the shipping lanes into the major ports should be included wherever possible, even though the mariner may need to resort to the raster chart data to support the use of these navigation marks. This is relatively easy to do given the holding of navigation marks in a separate database.

Nomenclature

To be equivalent to the paper chart and to facilitate the use of the sailing directions and other publications, the corresponding ENC would be required to carry the same level of nomenclature. The reason for this is that very few place names can be assigned to a specific point feature. The vast majority of place names actually refer to areas and in many cases, the areas are not well defined. Each area needs to be defined and encoded incorporating the nomenclature as attributes. This task has proven to be a significant workload.

Contours and Soundings

The authoritative advantage that Hydrographic Offices have over commercial producers is access to the original survey source data. It is only when we add information such as additional depth contours in critical areas, or improved depth contours from the latest available information, which do not necessarily appear on the paper chart, that this authoritative advantage is realised. This forms the basis for inclusion of contours at one metre intervals between the 5 and 20 (25 south of Lucinda) contours in the designated shipping lanes in this project. Contours will be determined at survey source scale using, wherever possible, the most recent survey data.

There was some considerable debate as to whether soundings should be included, if contours at the one metre interval were to be used. The user community, the mariners, clearly indicated their desire for soundings, but the debate concerned how much value soundings would add. As a compromise, limited soundings will be included in the trial ENC, at critical points in the Inner Route. The balance of soundings in relation to densified contours will be reviewed following the trials program.

PROGRESS AND REVIEW

To date, the digitising of the small scale charts is completed, and the one degree cells are about 80 percent completed. We are aiming for a trial ENC by December 1998, with a view to conducting trials in early 1999. Following trials, we intend to adjust the Product Specification for user feedback, continue extending the coverage southward, and add new surveys with one metre contour intervals as they come to hand.

Future activity will be guided by what is delivered by Project SEA 1430. Charts that are converted into S-57 data sets will be integrated where possible. Pending the success of the trial, we will probably proceed with extending the small-scale coverage, in parallel with separating and populating the ENC layers. Decisions will need to be made for distribution and updating ENCs, although the IHO WEND arrangements are expected to inform the process.

CONCLUSION

I have attempted to describe a way forward to producing an authoritative and valuable ENC of Australia's most vulnerable seaway, the Inner Route of the Great Barrier Reef. The concept of providing high resolution vector data within and adjacent to the major shipping lanes embedded in a small scale (low usage code) ENC has been selected by the AHO to meet the international call for authorised ENC data. The method offers potential for rapid coverage of Australia's vast area of charting responsibility, but allows for the generation of higher usage code ENCs as data and resources becomes available. The concept is clearly designed to operate on a "dual fuel" approach in which raster coverage is available to supplement the high resolution ENC coverage.