

## **STATUS REPORT ON ACTIVITIES OF IMO AND IHO CONCERNING THE ELECTRONIC CHART**

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### **Background**

In a paper presented to the International Association of Institutes of Navigation, at Sydney, Australia, in February, 1988, Captain James E. Ayres and the author provided the early administrative history of the evolution of electronic chart standards (Ref. 1). To summarize this history, the IHO's North Sea Hydrographic Commission (NSHC), at its 15th Conference in 1984, recognizing the rapid development of electronic chart systems, established a Working Group to study the matter. This group presented its report in 1986. (Ref. 2). The NSHC also recommended that the IHO give greater priority to studies of ECDIS (Electronic Chart Display and Information Systems). It further recommended to the NSHC that a joint IHO/IMO Working Group be formed. This was considered not appropriate by the International Hydrographic Bureau (IHB), in part because of the committee structure within IMO and restraints on the formation of joint committees. Instead IMO was requested, in January 1985, to consider the questions of user requirements and legal aspects. After discussion by the relevant IMO Committees, in September 1986, the Maritime Safety Committee (MSC) approved the formation of an IMO Study Group, which the following year, became designated as the IMO/IHO Harmonization Group on ECDIS (IMO/IHO-HGE). Dr. Gerhard Zickwolf, President of the Deutsches Hydrographisches Institut was asked to chair the group. It may be noted that the request concerning the legal question of ECDIS has not yet been addressed in detail by IMO.

While events were taking place at IMO, the IHO has decided to form its own Committee on ECDIS (COE). This was formed under the chairmanship of Captain James E. AYRES, in 1986. It is the work of this Committee and its

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interaction with the IMO/IHO-HGE which is the main topic of this paper. On the change of the Directing Committee of the International Hydrographic Bureau in September 1987, the author assumed the chairmanship of COE. In 1989, on the retirement of Dr. Gerhard Zickwolf, the Norwegian Hydrographer, Mr. Oyvind Stene, became the Chairman of the IMO/IHO-HGE.

### COMMITTEE ON ECDIS (COE)

The COE provides an administrative umbrella under which there are at present Six Working Groups. These are as follows:

1. Group of Experts on Specifications for ECDIS
2. Working Group on Updating ECDIS
3. Working Group on Regional Data Bases
4. Working Group on ECDIS Glossary
5. Working Group on Colours and Symbols
6. Working Group on Data Quality.

The Working Groups meet whenever appropriate and the results of their work are published in various papers and reports. In particular, the International Hydrographic Bureau (IHB) has published SP-52 'Draft Specifications for Electronic Chart Display and Information Systems' (Ref. 3) and Appendix to SP-52 'Updating the Electronic Chart' (Ref. 4). Documents in an unpublished or draft stage include the Report of the Colours and Symbols Working Group Meeting (Ref. 5) and the Draft ECDIS Glossary (Ref. 6).

### SPECIFICATIONS

The Group of Experts dealing with the specifications for ECDIS was the first group to be formed and its resulting report covered all aspects of ECDIS Standards. The group was cognizant of the need of users and refined its report according to user's comments. It was realized that, at the time, there was very little real experience with ECDIS and that the Specifications must remain in a draft form. In its original recommendations the Group identified certain areas in need of further development. These included the format and routes for corrections to the data base; the data exchange formats; ergonomic studies of colours and symbols and above all, the need for further practical experience. The Groups' Report led to the publication of SP-52. This publication has been presented as an information document to IMO. The Group of Experts has remained in force and carries out continual updating as experience is gained and comments are received from users of ECDIS and other individuals.

## UPDATING

The need to update charts is recognized in the IMO Safety of Life at Sea (SOLAS) Convention, in which regulation 20 of Chapter V states the need for all ships to carry up-to-date charts. If the electronic chart is to be equivalent to the paper chart it also must be maintained up-to-date. The matter to be considered is how to update the data base which is used to produce the electronic chart. It was felt by the Working Group that the data base should be capable of being updated both at sea and in port and that the INMARSAT Enhanced Group Call (EGC) SafetyNet would be able to do the task. Recent recommendations of the IMO Sub-Committee on Radio Communications propose that ECDIS updates should be considered as part of the MSI (Maritime Safety Information) and, consequently, subject to the preferential charges of INMARSAT.

## REGIONAL DATA BASES

Both the NSHC and the COE realized the importance of developing data bases for ECDIS. The North Sea Project, an experimental project to evaluate ECDIS (Ref. 7), showed the need to design methods to develop a data base which would be available to ECDIS users. The work of the Group is both technical and administrative. There remains today some difference of opinion between Hydrographic Offices on the future of ECDIS. Will they complement or replace the paper chart? Consequently what level of investment should be given to the development of the data bases? There is no doubt that the technical difficulties will be resolved soon but the financial and administrative arrangements will take longer to resolve.

## GLOSSARY

Terminology is a matter to consider in any technological development. A large number of acronyms quickly develops and there often develops ambiguity or uncertainty of their meaning. ECDIS itself stands for Electronic Chart Display and Information System, but some people refer to the hardware part of the System as ECDIE — Electronic Chart Display and Information Equipment. The terminology associated with the data bases present particular difficulties. For instance ENC stands for Electronic Navigational Chart, which is the data base issued with ECDIS. On the other hand, ENCD is Electronic Navigational Chart Data base, which is the master data base for production and maintenance of ENC. All this can be very confusing and therefore the COE has agreed to develop a Glossary of ECDIS terms for IMO.

## COLOURS AND SYMBOLS

The need to standardize the colours and symbols used on the electronic display was realized at the start by the Group of Experts on ECDIS Specifications, but in the North Sea Project (see below) it was clearly demonstrated. Of the six systems aboard every one provided a different presentation. It was also realized from the start that specialists in perception psychology and ergonomics were needed to help select the most effective palette of colours and array of symbols. As the ECDIS provides an integration of navigation and chart information, it is necessary to develop colours and symbols for both the charted information and the navigator's electronic annotations. One must not obscure the other and priorities have to be established. The 'Comité International Radio Maritime' (CIRM) was asked to coordinate their views of non-chart symbols with those of the COE Working Group, which was designing the colours and symbols for the chart information. The relationship with other bridge displays such as ARPA have to be considered.

## DATA QUALITY

Some criteria for identifying the quality of the data is needed both in the chart compilation process and in the eventual display of the chart information to the navigator. Hydrographers have realized for some years that the navigator must be told explicitly about the quality of the data on his chart (Ref. 8). This resulted in the Source or Reliability diagrams which are now included in the IHO Chart Specifications (Ref. 9). The introduction of digital data processing in the compilation of both paper and electronic charts has given rise to the need to assign quality information to the raw data as well, in order that it may be statistically treated. A recently added complexity to assigning data quality is the increasing use of survey systems which collect vast amounts of data. The immediate solution for ECDIS may be quite straightforward, as current plans for ECDIS data bases are to simply digitize the paper charts and accordingly to make use of the Source/Reliability diagram shown on them.

## THE NORTH SEA PROJECT

During the period 1987 and 1988, a significant project was carried out in the North Sea (Ref. 10). This was initiated by the Hydrographic Offices of Norway and Denmark and eventually led by the former. The Norwegian Hydrographic Service offered its survey vessel LANCE to be used as a test platform. The Hydrographic Offices around the North Sea digitized portions of their chart coverage on a route that connected the ports of Stavanger, Esjberg, Cuxhaven,

Rotterdam, Dieppe and Harwich. The data was consolidated into a data base by the Norwegian Hydrographic Service. Commercial organizations producing electronic chart systems were invited to demonstrate their systems aboard LANCE, making use of the integrated data base. A large number of companies were invited, but eventually six systems were placed aboard. Interested persons from the maritime world were invited to either visit the ships and attend demonstrations in the ports or to observe the equipment on passage between the ports. As a result, over five hundred people had an opportunity to observe the systems in operation. These were invited to comment by the use of a questionnaire (Ref. 11) and the results of this have been used in further developments of ECDIS Standards.

As a demonstration project, the North Sea Project was a great success and in spite of the complexities of both the logistics and the equipment it ran smoothly. It showed Hydrographic Offices the difficulties of developing a data base. The subtleties of digitizing and the need for standard conventions were realized, as was the need for a digital data exchange format. As remarked previously, it showed the need for standards for the colours and symbols in the displays.

#### COMMITTEE ON THE EXCHANGE OF DIGITAL DATA (CEDD)

The need to develop a standard format for the exchange of digital data had become evident to the IHO before ECDIS became an issue. Digital data was being used in the production of paper charts and there was a need to be able to exchange this data between Hydrographic Offices. The idea for an IHO Committee to address digital data formats began in 1977 based on a proposal by the Australian Hydrographic Office. In 1983, the CEDD was created. In 1986, it presented to the IHO, a format for the exchange of digital hydrographic data (Ref. 12). This was originally known as the CEDD format but later became designated as the IHO DX 87 format.

In 1985, the IHO directed the CEDD to consider the needs of the electronic chart in any format development (Ref. 13). It was not until the development of the data base for the North Sea Project that the particular requirements for an exchange format for ECDIS data were realized. Considerable discussion took place on the use of sequential or chain node structure and of the need for topological integrity (i.e. polygons are surrounded by an unbroken boundary). It became evident that, within the tight time frame of the North Sea Project, national Hydrographic Offices did not have sufficient time to adopt their own digitizing methods to the existing CEDD format. In the end, the Norwegian Hydrographic Service treated each data set independently, but it was clear that further work was needed on the exchange format. Several other formats were discussed. These included a Canadian developed format, known as MACDIF and a NATO supported development known as the DGIWG.

At a joint meeting of COE and CEDD in Tokyo in October 1989, it was agreed to develop an entirely new format to be called IHO DX 90. This would incorporate the implementation standard ISO 8211 and would have a new code

for the coding of objects (features) and attributes. Urgency was placed on its development because of the schedule of the Regional Data Base Working Group which was planning to develop a model data base of part of the southern North Sea and wished to use IHO DX 90 in its construction, starting in mid 1990.

### HARMONIZING GROUP AND THE IMO

The committee structure used by IMO is complex and involves several steps in the approval of a technical matter. The end result of its work can be seen in international conventions and protocols, in circulars and in resolutions passed by its Assembly. It is necessary to understand that these agreements in themselves are not laws which actually control shipping but that from them national laws are developed. In dealing with ECDIS, the prime document to consider is the Safety of Life at Sea Convention (SOLAS) 1974 (Ref. 14). This document is supported by more recent Protocols and Amendments (Ref. 15). Of particular importance when dealing with ECDIS is the carriage requirement for Nautical Publications to be found in Regulation 20 of Chapter V which reads as follows:

‘All ships shall carry adequate and up-to-date charts, sailing directions, list of lights, notices to mariners, tide tables and all other nautical publications necessary for the intended voyage.’

Careful interpretation is necessary for this regulation. It is not stated that the charts are paper or that they are the official charts. This has so far been assumed. Although it clearly states that the regulation affects ‘All ships’, it is felt that it may not be so stringently applied to smaller vessels, particularly pleasure craft. It will be noticed that it includes a requirement not only for up-to-date charts but other hydrographic publications as well.

The other regulation to consider with respect to ECDIS in the SOLAS Convention is Regulation 5 of Chapter I ‘Equivalents’. This regulation authorizes an Administration to allow:

‘any other fitting, material, appliance or apparatus, or type thereof, to be fitted or carried, or any other provision to be made to that ship, if it is satisfied by trial thereof, or otherwise that such fitting, material, appliance or apparatus, or type thereof, or provision, is at least as effective as that required by the present regulations.’

The essence of this regulation with respect to ECDIS is that it is possible to approve an equivalent to some of the nautical documents required in Regulation 20 of Chapter V, subject to their being adequately tested.

The approach taken by the Harmonizing Group is based on that previously taken with other items of shipboard equipment. That is, to prepare Provisional Performance Standards (PPS). These standards are prepared to a particular format. Following detailed discussions in the IMO/IHO-HGE, they are then passed to the Sub-Committee on the Safety of Navigation (SON). From there they are proposed as a Draft Maritime Safety Committee Circular and are passed

to that Committee for approval. Following this procedure, MSC Circular 515 'Provisional Performance Standards for ECDIS' was approved at the 57th Meeting of the MSC in 1989. This circular has taken into consideration the various elements of the standards prepared by COE, in particular those to be found in SP-52 and its Appendix on Updating. During its passage through the various IMO Committees, the incompleteness of the PPS in certain areas was noted. This includes details of the standards for Colours and Symbols. It was also noted that there is, at present, no data base available provided by Hydrographic Offices. These matters have therefore become priorities for the IMO/IHO-HGE and for the COE.

The IMO/IHO-HGE has developed a Future Work Plan. In this plan, 1993 has been taken as the target year for finalization of the Performance Standards for ECDIS (Ref. 16). When and if that event occurs it will be possible for ECDIS designed to meet the standards to be used in place of the paper charts. There is, of course, much debate whether this event will materialize and whether it will occur as soon as 1993. Critical to these developments is experience with ECDIS at sea. There is a difficulty here in the lack of data bases. The Norwegian Hydrographic Service and Det Norske Veritas have shown a firm conviction in the future of ECDIS and in order to expedite matters they are supporting another test project, known as SEATRANS. A commercial vessel trading regularly between Norway and West Germany is being equipped with an ECDIS that is designed to meet the PPS. The Norwegian Hydrographic Service is developing a data base along the intended routes. The ship on its regular passages will test various aspects of the ECDIS and its use.

Another activity intended to increase the experience with ECDIS is being carried out by SUSAN, the ship simulation facility at the Hamburg Nautical Institute, working in conjunction with FAT (Forschungsinstitut für Anthropotechnik), the West German Institute for Perception Studies, in which various approaches to colour and symbol design will be studied.

### NON-EQUIVALENT ELECTRONIC CHARTS

By far the greatest practical use of electronic chart systems to date has been made aboard small vessels, such as fishing vessels and pleasure craft. In a recent paper (Ref. 17) it has been advocated that standards must be developed for the less complex systems used aboard these vessels. Many of these systems are relatively simple in design, being some form of plotting device associated with an electronic positioning receiver, such as Loran C. Few, if any, of the systems meet the requirements of the Provisional Performance Standards and therefore cannot be considered as legally meeting the conditions for being equivalent to the paper chart. This means that vessels using these systems must carry them in addition to the paper chart, even though it may be wondered how much attention is actually given to the paper chart.

Based on a proposal by Japan, IMO has instructed the Harmonizing Group to examine the legislative requirements associated with 'non-equivalent' electronic

charts but to give the matter low priority. It appears that there is not yet complete agreement on the need for such standards as legally the equipment is complementary to and not a replacement for the paper chart. Furthermore there is some question in the hydrographic community whether government Hydrographic Offices have a responsibility to set Standards for 'non-official' charts, such as are designated for yachtsman or fishing craft.

### OTHER ORGANIZATIONS

In the development of standards for ECDIS, hydrographers reach out of the immediate, traditional, domain of hydrography into areas of interest to electronic engineers, computer specialists and even, as remarked earlier, into the field of perception psychology. These other disciplines have their own organizations and institutions which must be brought into play. Within IMO itself most navigational matters are handled through the Sub-Committee on Navigation (SON) but if radio communication matters are involved they must be considered by the Sub-Committee on Radiocommunications (COM). Hence one of the early moves when developing the PPS was to refer the updating of ECDIS to that Sub-Committee, which considered it in their 35th meeting (COM 35) in February 1990. IMO has also asked the Comité Consultatif International des Radiocommunications (CCIR) to study the updating matter and this question was put to the CCIR at its meeting in Geneva last November (Ref. 18).

The COE Working Group on Updating, in making its recommendations to use INMARSAT (EGC) SafetyNet, naturally involved itself in detailed discussions with the INMARSAT organization.

Another very active organization in the development of ECDIS standards is the American based Radio Technical Commission for Maritime Services (RTCM). This organization has formed its own special Committee, No. 109, in order to study ECDIS matters. It has developed several editions of its own standards, of which the latest is dated October 1989 (Ref. 19). The RTCM Committee considered the matter of different classes of electronic chart users and different classes of electronic chart to satisfy their needs. It has been evident for some time that the electronic equipment needed to fully satisfy the equivalency requirements, as specified in the PPS, would be too large to fit on board smaller vessels, such as tugs. It was in an attempt to solve these problems that RTCM developed its own ideas of three categories of ECDIS. The RTCM also developed one of the earlier and more comprehensive glossaries for ECDIS. While the RTCM standards provide on the one hand, national standards for U.S. vessels, they have also been taken into consideration by the COE and the IMO/IHO-HGE in formulating their standards.

Earlier mention was made of the West German organization FAT in terms of its work on perception. Two other institutions have also been consulted on this subject. These are the Canadian Defence and Civil Institute of Engineering Medicine (DCIEM) and the Netherlands Instituut voor Zintuigfysiologie (TNO/IZS). Working closely with the West German FAT, has been the Ship

Handling and Simulation Facility (SUSAN), which is part of the Hamburg School of Maritime Studies.

Yet another organization playing an important part in ECDIS developments is the Comité International Radio Maritime (CIRM). The CIRM has participated in preparing standards for other equipment that has been approved by IMO, such as ARPA, and has provided sage advice on the development of the Provisional Performance Standards for ECDIS. Recently it has also provided advice to the IMO/IHO-HGE on the design of non-chart (i.e. navigational) symbols to be shown on ECDIS. The research carried out by all these organizations is of great importance to complement the users' views in establishing the most effective means of communicating visual information from the ECDIS to the navigator.

## DISCUSSION

ECDIS appears to have a futuristic appeal to all who become involved in its development. Some people consider that it is unrealistic that it will replace the paper chart, certainly not in the 1993 time-frame that is planned under the IMO work programme. Other people and groups consider that it is an essential piece of bridge equipment if we are to reach a situation of safe, one-man, bridge operations, a situation that in itself is not universally supported. There is a great difficulty in developing standards for a piece of ship's equipment that has so far only appeared experimentally on ships' bridges. Moves to standardize the system too rapidly and too firmly will result in hampering innovative future developments. On the other hand, manufacturers need to be given some guidance at an early stage on the direction that legislative organs such as IMO are taking. There is an urgent need for practical experience using ECDIS. This can be partially answered by the use of simulation but it also requires actual shipboard experience. There is therefore great merit in the various activities being undertaken or planned in Norway, the Federal Republic of Germany, the USA and Canada.

The development of approved hydrographic data bases is fundamental to the use and evaluation of ECDIS but not all Hydrographic Offices are yet themselves convinced that the time has arrived to seek higher approval for the considerable investment needed to digitize their charts and develop the data bases, at the same time as maintaining their traditional services. The work of the COE Working Group on Regional Data Base Development is essential to define the methodology and technical procedures, but the equally important organizational and financial procedures must also be developed.

In retrospect, one may wonder if the procedure of developing Provisional Performance Standards as attempting to satisfy the 'equivalent' criteria of the SOLAS Convention was the best way to go. It is becoming increasingly clear that ECDIS will serve its greatest purpose, not as an equivalent to the paper chart, but as a completely new kind of navigational instrument that has the potential for integrating a selection of the chart information with navigational information and radar data. As such, it provides the navigator with a system that is complementary to the paper chart rather than equivalent to it. Arguments as to

the value of ECDIS must surely be made on the grounds that it enhances the safety of navigation and not on the grounds that it provides a more economic replacement for an item of existing equipment?

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