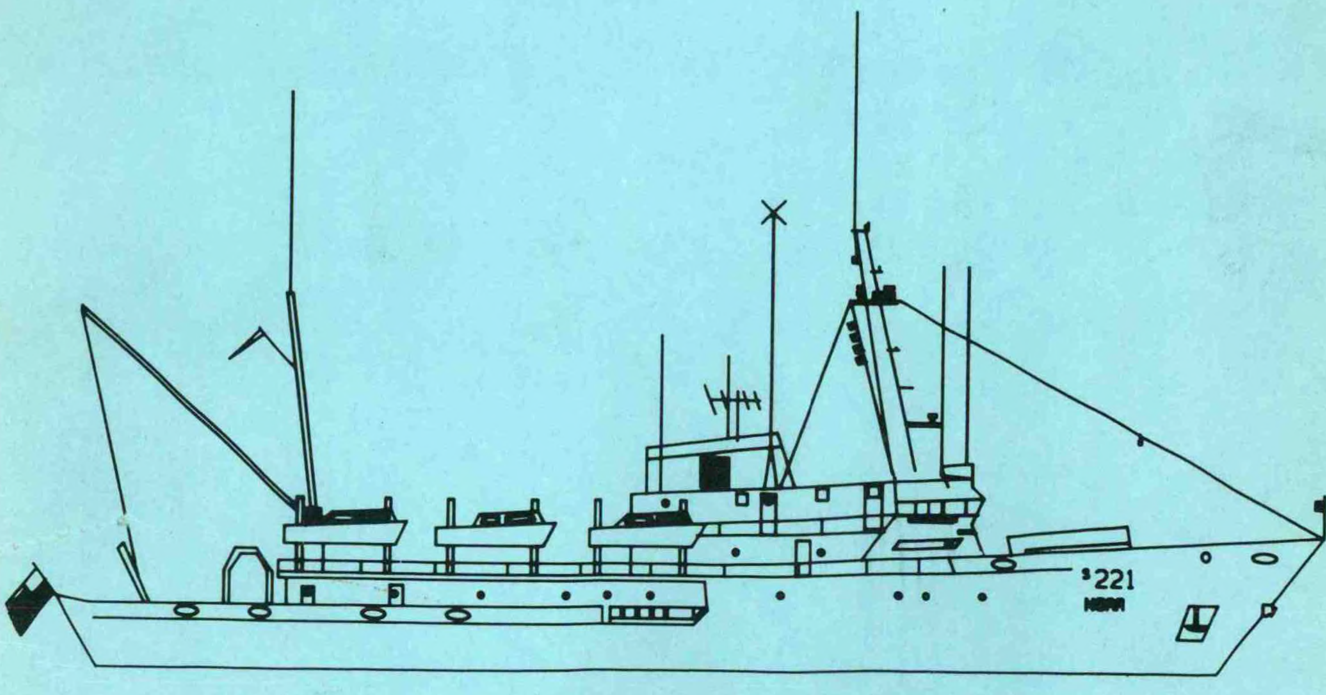
ceedings of the National Ocean Survey Hydrographic Survey Conference

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Ocean Survey Seattle, Washington

January 8-12, 1979



NOAA SHIP RAINIER

Proceedings of the National Ocean Survey Hydrographic Survey Conference

Sixth Annual Meeting
Seattle, Washington
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U.S. DEPARTMENT OF COMMERCE
Juanita M. Kreps, Secretary

National Oceanic and Atmospheric Administration
Richard A. Frank, Administrator

National Ocean Survey
Allen L. Powell, Director

PREFACE

Proceedings of the Sixth Annual Hydrographic Conference are being published for those persons in the National Ocean Survey's Nautical Charting program. Hopefully, these proceedings will be of value to both the participants and people who were not able to attend the conference. For the first time in the history of the conference, processing was not the main thrust of the program. This year the conference was broadened in scope and included papers in all areas of the Nautical Charting program from data acquisition by field personnel through chart compilation at headquarters.

These proceedings identify an individual with each presentation and discussion. The views presented in the papers do not necessarily reflect the policy of the National Ocean Survey nor the opinion of the named person. However, an individual is listed with each paper to provide a point of contact should further information be desired.

RADM EUGENE A. TAYLOR
Director
Pacific Marine Center

JAMES S. GREEN
Agenda

BRUCE A. OLMSTEAD
Facilities

J. RICHARD MINTON
Visual Aids

LT PATRICK D. HARMAN
LCDR WILLIAM A. WERT
Proceedings

SANDOR A. FEHER
THELMA O. JONES
Transportation

CDR GLEN R. SCHAEFER
Conference Director

LARRY W. MORDOCK
JAMES S. GREEN
JAMES W. MASSEY
JAMES W. STEENSLAND
Planning Committee

KAROL M. SCOTT
THELMA O. JONES
Registrations &
Accommodations

JAMES W. STEENSLAND
LCDR DAVID B. MACFARLAND, JR.
PAUL J. SUTLOVICH
MATTHEW G. SANDERS
CDR C. WILLIAM HAYES
Tours

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WELCOMING REMARKS

RADM Eugene A. Taylor
Director, Pacific Marine Center

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Welcome to sunny Seattle! I hope that you will find the time you spend at this conference to be both beneficial and pleasant.

As you know this is the Sixth Annual NOS Hydrographic Surveying Conference. The first conference, held in the fall of 1973, was devoted primarily to hydrographic survey processing. Subsequent conferences have gradually expanded in scope until this one, which now includes all facets of hydrographic surveying, from advanced planning to chart compilation. We have gone so far as to change the name from Hydrographic Surveying Processing Conference to the Hydrographic Surveying Conference. It might be said that it took six years for the processing people to figure out that they alone do not make "good" surveys, and that other people had a lot to do with it. It might also be said that "this is progress".

Speaking of progress, we are in a time of many changes. This year should see the implementation of digitized line data into the survey processing system. AMC is converting to the Harris Xynetics computer plotting system and will no doubt undergo the tribulations associated with these types of transitions. BS^3 tests have been conducted and the data is now being evaluated. We are another year closer to exploitation of the AIS in nautical charting and to the follow-on system to the HYDROPLOT. These, and many other changes, will impact on all of us here. We need to be informed on what others are doing, and we need to contribute from our experience so that we all progress consistently with one another and in the most effective direction. We should take this opportunity to gain from the experience of others. A primary purpose of these conferences is the dissemination of information.

We should also use this conference to identify problems we are having, and hopefully, gain sufficient information to solve some of these problems. There are problems that we are aware of and may have addressed during previous conferences. For some of these, we can only contribute our experience and views to those offices and individuals charged these responsibilities. I have heard comments that these conferences are not effective because some of these problems are not resolved. The conference does not solve the problems; the individuals in the responsible offices do. Perhaps, however, this conference can lead to the solution of more problems than conferences have in the past. This year, in preparing the report of the conference, appropriate recommendations will be extracted and forwarded to the responsible office for consideration.

Our organization has two marine centers across the country doing essentially the same types of data acquisition and processing of hydrographic data. This conference is the only time that the headquarters and both marine centers get together at the "working" level. Besides the benefits of exchanging information, the conference serves a valuable purpose in helping achieve standardization within our organization.

I have attempted to cover why I consider this annual conference important and necessary. It is an "opportunity" for us all to be more effective.

RADM Powell has asked me to ask the attendees of this conference whether a journal type publication in the area of hydrography and marine charting should be initiated in the future. The journal could be issued quarterly or semi-annually and provide a means of disseminating technical information. I ask you to consider the value of recommending and supporting such a journal.

WELCOMING REMARKS

CAPT J. Austin Yeager
Deputy Associate Director
Office of Marine Surveys and Maps

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Rear Admiral Powell has asked me to convey his regrets that he is unable to attend this Conference and to express his sincere interest and wishes for a worthwhile and productive meeting.

He particularly wanted to get across his appreciation for the way in which the revised processing system has been successfully implemented. Without the support and cooperation of all concerned, the fairly radical departure from a long accepted procedure could have failed with some spectacular and disastrous results.

The revised method is more than "just working." Based on some recently compiled statistics, the Marine Centers have absorbed their added responsibilities without an increase in the time required to process and verify smooth sheets. In fact, there appears to be a small decrease in the average hours required per sheet.

If the reduced time required by headquarters personnel is included, the total reduction becomes quite significant. Overall the effort per sheet has been reduced by 3-1/2 manweeks and throughput is within 1 year for 50 percent of the sheets being handled under the present system.

Substantial gains have been made. However, constant attention and examination will be required to maintain balance in the collection, processing, and chart application phases.

This balance is essential if we are to have any hope of producing an up-to-date suite of products that meet the needs of what has become a wide variety of users.

Although our basic mission is to produce nautical charts, we have developed a unique hydrographic data base that extends far beyond this limited use. In addition to nautical charting, this data base is used for bathymetric mapping, shoreline erosion studies, estuarine modeling, and marine boundary determinations.

In addition, we now have an entirely new product requirement facing us. Congress recently passed legislation requiring that we locate and chart all natural and man-made obstructions to fishing on the Outer Continental Shelf.

I mention these things to illustrate the demands being put on our data and the uses of it. This should help explain why the recent equipment requirement studies contain such large data storage and processing capabilities.

We have just finished a first cut at requirements for post-1980 acquisition and processing systems, and one of the trends in that study is to concentrate as much processing and analysis as possible with the acquistion unit and to provide the unit with adequate hardware and software to handle it.

Serious comment and input on just how far we can go with a philosophy like this must come from people in this room and those in the field.

Presently we are tinkering with the system balance I mentioned earlier. The West Coast Hydrographic Field Party, the swath survey system aboard the DAVIDSON, airborne laser developments, and photobathymetry are examples of collection efforts which have a potential to seriously impact the total system.

The enormous amounts of data which can be collected by the BS^3 have a major potential to overload the system and this must be carefully watched and monitored. What we do with it, how we filter it, how much we retain and in what form are serious questions that require answers in the very near future.

I recently attended a technical information exchange meeting between the Defense Mapping Agency, Soil Conservation Service, U.S. Geological Survey, and National Ocean Survey. If a single theme or direction came out of those meetings, it was that we all are irreversibly commited to digital acquisition, processing, and application of mapping and charting data. All are creating massive data bases. Some, I am sorry to say, are extremely single purpose in nature. Most of us feel that the direction the National Ocean Survey is pursuing is logical, basically sound, and will result in a system and multipurpose data base that will provide the balance and flexibility we need to do our job.

REVIEW OF FY 1978 PROCESSING STATISTICS

CDR A. J. Patrick
Chief, Marine Surveys Division
Office of Marine Surveys and Maps

ABSTRACT

This paper presents the processing accomplishments of the Marine Centers and Marine Surveys Division for FY 78 with comparison data from prior years.

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The following figures illustrate the FY 1978 accomplishments of the Marine Center Processing Divisions and the Marine Surveys Division Quality Control Branch. Also shown are figures illustrating, on a quarterly basis, various aspects of the processing system beginning with the quarter ending March 1976.

Figure 1 is a fiscal year summary of the quality control processing of hydrographic surveys. It is compiled on a monthly basis and serves as an attachment to the Monthly Activities Report of the Marine Surveys Division.

Figure 2 illustrates accomplishments relative to the planned Processing Production Milestones generated for the quarterly Management by Objectives (MBO) report.

Figure 3 illustrates the number of surveys requiring various degrees of processing on October 15, 1977, and 1 year later on October 15, 1978.

Figure 4 illustrates the decline in the number of surveys which are scheduled to have their processing completed.

Figure 5 illustrates the extent to which the requirements for processing surveys within 1 year is being met.

This completes the portion of this presentation outlining how the processing system fared in FY 1978. The following figures provide information on the extent to which the number of surveys received and processed has varied on a quarterly basis since March 1976.

Figure 6 illustrates the combined total of the number of quality control surveys received and processed at the Marine Centers per quarter.

Figure 7 illustrates the number of quality control surveys received by each of the Marine Centers per quarter.

Figure 8 illustrates the number of quality control surveys processed by the Marine Centers per quarter.

Figure 9 illustrates the number of quality control surveys received and processed at the Atlantic Marine Center per quarter.

Figure 10 illustrates the number of quality control surveys received and processed at the Pacific Marine per quarter.

Figure 11 illustrates the number of quality control surveys received and evaluated at Headquarters per quarter.

DISCUSSION

CDR Patrick: (responding to a question from CDR Smith regarding processing backlog): I believe that the surveys sometimes stay on the ships longer than 6 weeks after completion of the field work.

CDR Patrick: (responding to a further question from CDR Smith): My feeling is that the turnover of processing personnel is not that insignificant. The processing division are subject to losing people also.

Mr. Green: We are also cyclic. We may have many surveys up to a point close to completion, and then we may revert back to where everything is in the beginning processing phases. So the processing output is also cyclic.

CDR Fisher: I noticed on your data points--I think they were quarterly--I can see on the surveys received that it is cyclic, going up and down, just one or two data points, rising up again, getting a delay coming off the ship or whatever, but when you see three or four points all showing a downward trend of sheets coming in, then I would suspect possibly your acquisition is down. I was wondering, do you make any interpretation on that when you see that kind of thing taking place over a year?

CDR Patrick: What we are trying to watch out for mainly is a drastic decrease somewhere in the system. Oftentimes we don't have this information until it's too late to do anything about it on a real-time basis other than acknowledge the fact that it did happen and attempt to determine the cause.

Mr. Green: I would say we are receiving less surveys from the field these past years than we have previously. We are also getting more hydrography on these same sheets. There is a great deal more development going on which is resulting in less surveys but larger and maybe more difficult surveys to process, but maybe better surveys also.

CDR Patrick: There are quite a few things that enter into the complexity of the sheet--not just whether it is an inshore or an offshore survey.

FY 1978

MARINE SURVEYS DIVISION

QUALITY CONTROL PROCESSING OF HYDROGRAPHIC SURVEYS

Month Ending	OCT 15	NOV 15	DEC 15	JAN 15	FEB 15	MAR 15	APR 15	MAY 15	JUN 15	JUL 15	AUG 15	SEP 15
HQ. QUALITY CONTROL BRANCH												
(Surveys on hand Sept. 15, 1977: 14)												
Q.C. Surveys received	9	6	5	8	9	7	9	10	11	10	7	14
Q.C. Evaluations completed	12	9	11	2	7	3	9	12	9	11	7	8
Q.C. Evaluations to be done	11	8	2	8	10	14	14	12	14	12	12	19
A.M.C.												
(Surveys on hand Sept. 15, 1977: 68)												
Received for Processing	8	5	7	10	8	0	4	5	4	4	1	5
Surveys Processed	5	3	4	2	5	4	5	6	8	7	7	9
Remaining to be done	71	62	65	73	76	72	71	71	66	63	58	54
P.M.C.												
(Surveys on hand Sept. 15, 1977: 50)												
Received for Processing	1	2	6	2	9	0	0	3	0	2	3	0
Surveys Processed	1	6	2	5	6	3	5	4	5	0	5	7
Remaining to be done	50	46	50	47	50	47	42	41	36	38	36	29
MARINE CENTER TOTALS												
(Surveys on hand Sept. 15, 1977: 118)												
Received for Processing	9	7	13	12	17	0	4	8	4	6	4	5
Surveys Processed	6	9	6	7	11	7	10	10	13	7	12	16
Remaining to be done	121	108	115	120	126	119	113	112	102	101	94	83

Figure 1

FY 1978

PROCESSING PRODUCTION MILESTONES

HYDROGRAPHIC SURVEYS

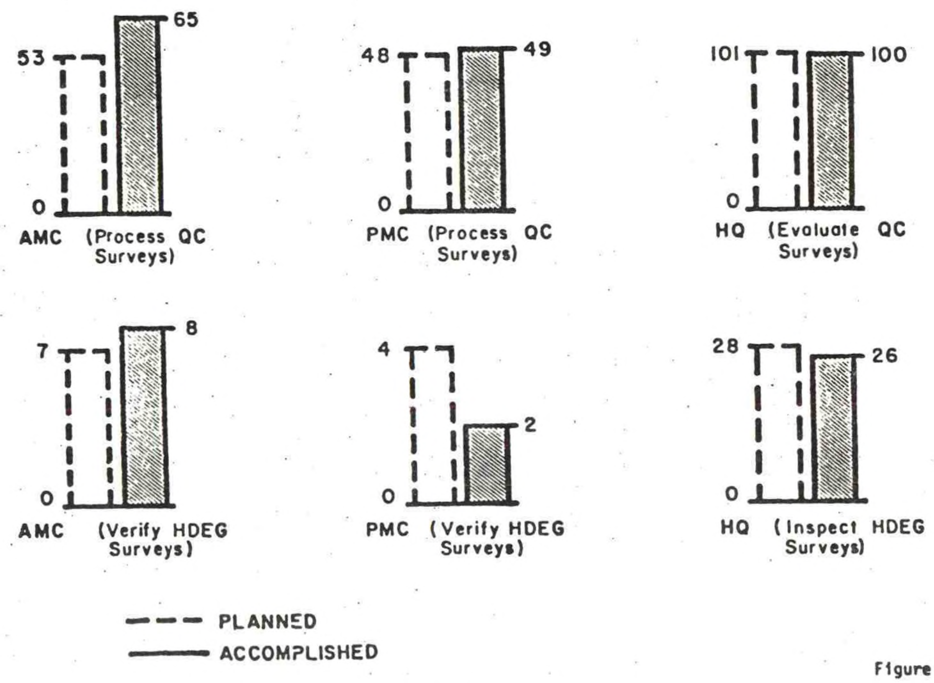


Figure 2

SURVEY PROCESSING

Category	No. of Surveys Oct. 15, 1977	No. of Surveys Oct. 15, 1978
LIMITED PROCESSING TO BE DONE	49	45
WIRE-DRAG SURVEYS	3	12
PROCESSING TO BE COMPLETED	136	106
SOME PRIORITY PROCESSING TO BE DONE ON THE SURVEY BEFORE IT CAN BE PLACED IN CATEGORY 1	6	6
REVIEWED SURVEYS TO BE GIVEN ONLY CURSORY INSPECTION	37	24
SURVEYS REVIEWED AND GIVEN A PRELIMINARY INSPECTION	0	0
SURVEYS HAVING A PRELIMINARY VERIFICATION AND REVIEW	16	16
TOTAL	247	209

Figure 3

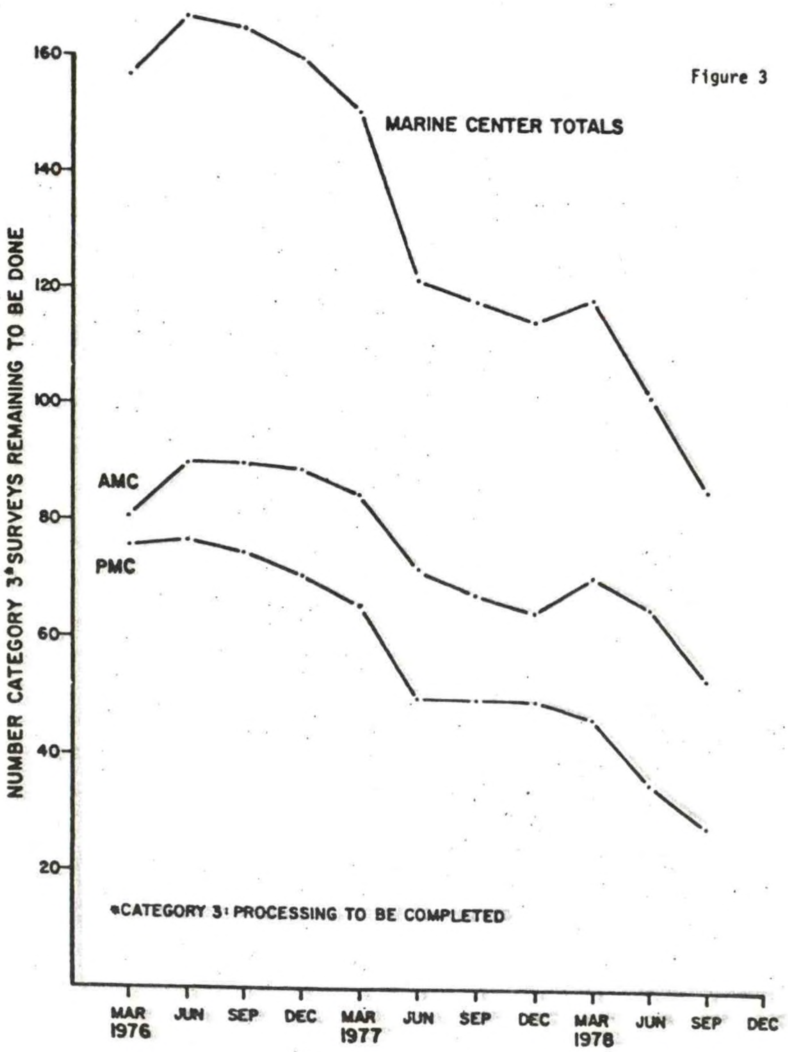
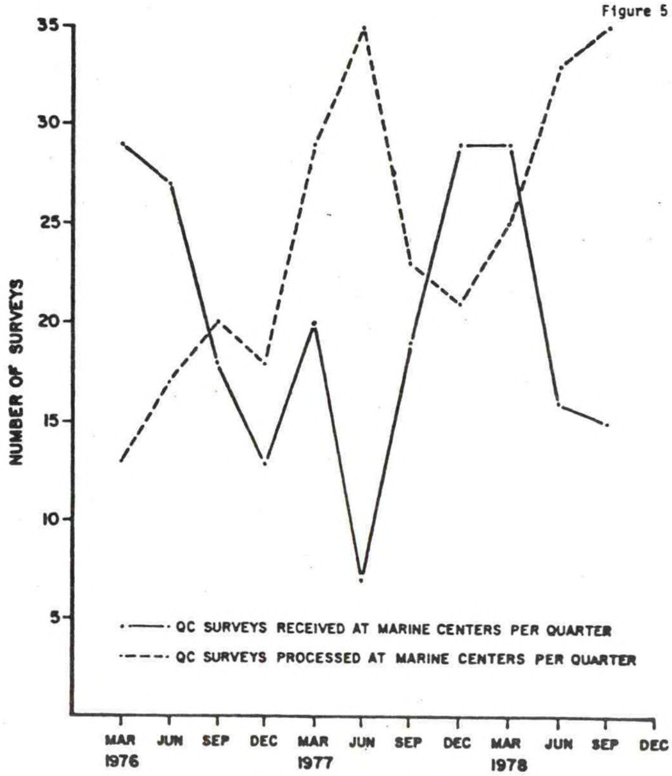


Figure 4

STATUS OF ONE-YEAR TARGET
PROCESSING AT MARINE CENTERS
SINCE SEPTEMBER 1975

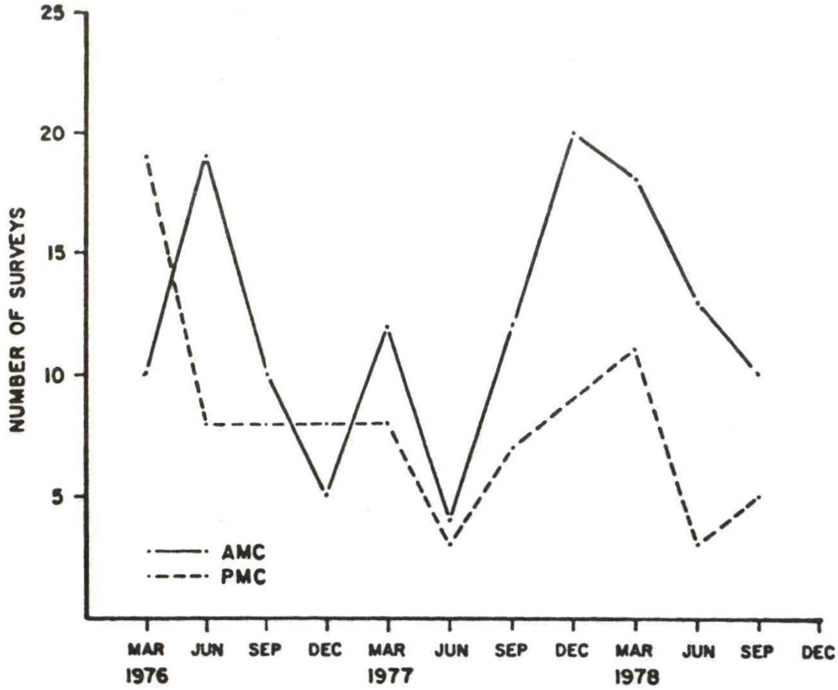
	AMC	PMC	TOTAL
QC Surveys received from field between September 1975 and September 1977 plus those received and verified since September 1977	106	71	177
Surveys for which processing was completed within 1 year	56 (53%)	50 (70%)	106 (60%)
Surveys completed but not within the 1-year target (as of September 1978)	38 (36%)	19 (27%)	57 (32%)
Surveys which are incomplete (as of September 1978) but have been in the Marine Center more than 1 year	12 (11%)	2 (3%)	14 (8%)
Ratio of QC Surveys completed to surveys received from field between September 1975 and September 1977	94/106 (.89)	69/71 (.97)	163/177 (.92)
Surveys received from the field before September 1975, in work and completed by September 1978, but not necessarily within the 1-year target	56	47	103
Including these additional completed surveys, the ratio of surveys completed to surveys received would increase to	150/106 (1.4)	116/71 (1.6)	266/177 (1.5)
HDEG* Surveys completed during above time frame (December 1976 through September 1978)	18	7	25
*Because of concern for the backlog surveys (HDEG) which remained nearly dormant for a year after the reorganization, the Marine Centers were requested to make a token effort toward completion of the HDEG Surveys. Had total time been spent on QC, the ratio of surveys completed to surveys received would have been:	168/106 (1.6)	123/71 (1.7)	291/177 (1.6)

Figure 5



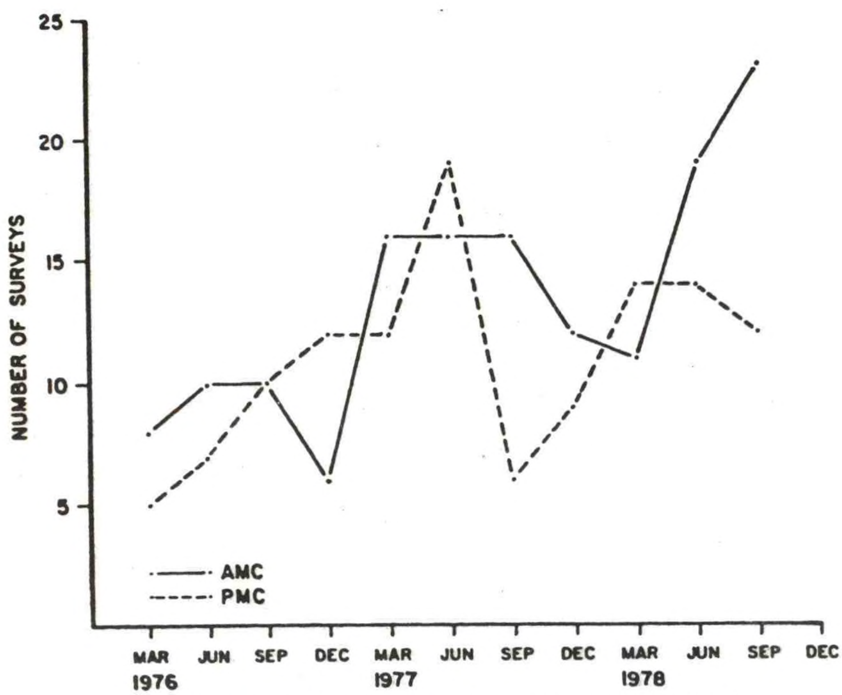
QC SURVEYS RECEIVED AND PROCESSED AT THE MARINE CENTERS PER QUARTER

Figure 6



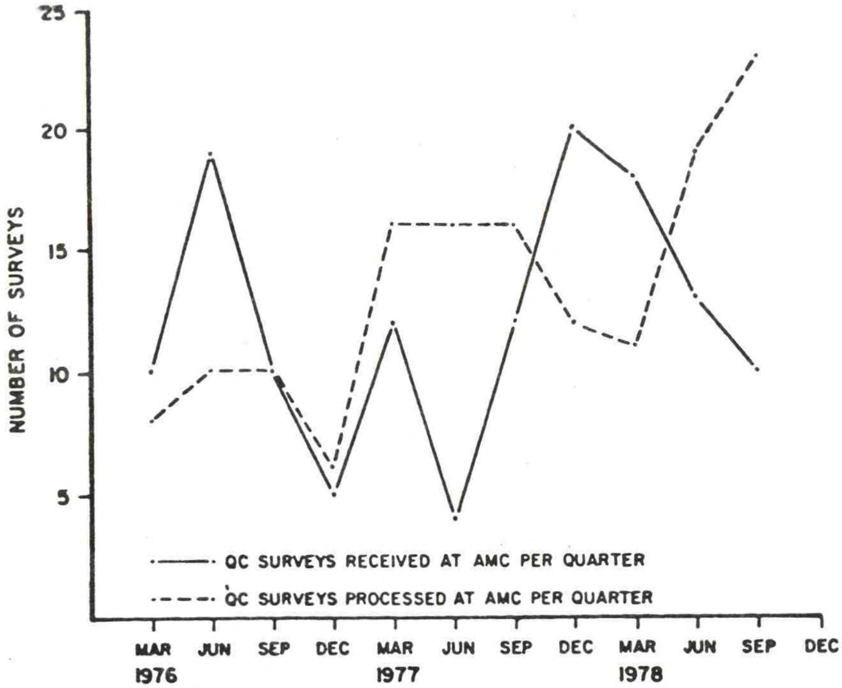
Q C SURVEYS RECEIVED BY THE MARINE CENTERS
PER QUARTER

Figure 7



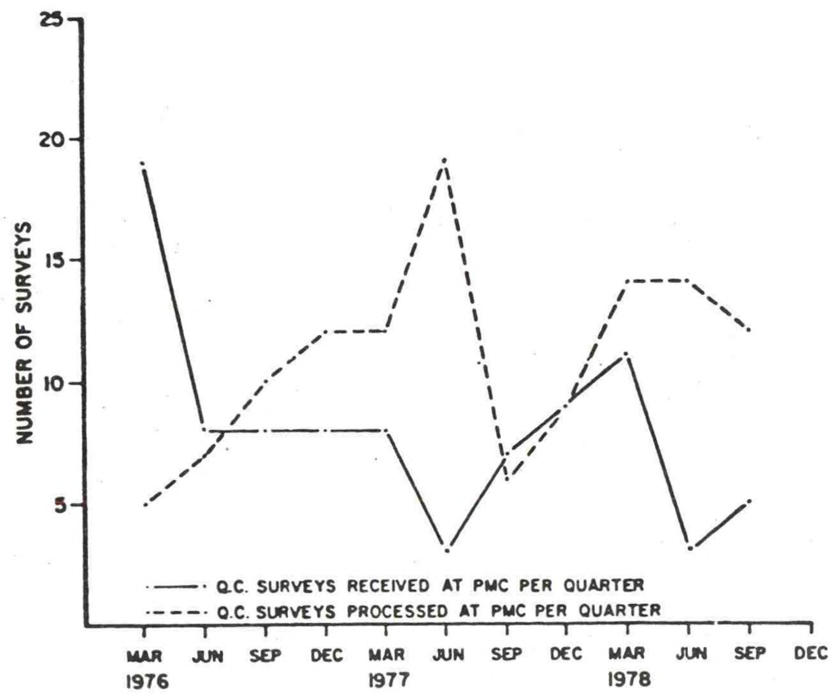
QC SURVEYS PROCESSED BY THE MARINE CENTERS
PER QUARTER

Figure 8



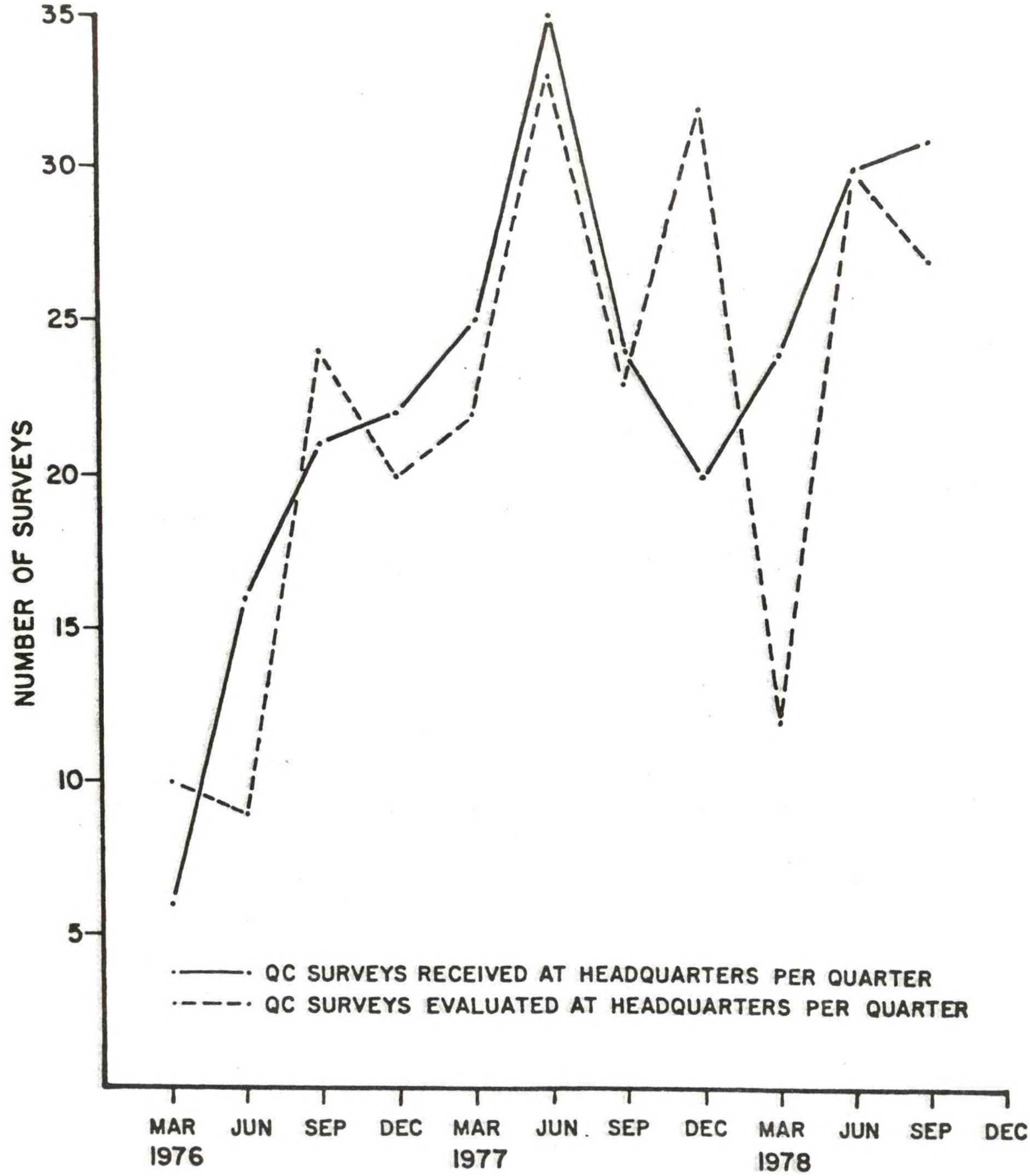
QC SURVEYS RECEIVED AND PROCESSED AT
AMC PER QUARTER

Figure 9



QC SURVEYS RECEIVED AND PROCESSED AT
PMC PER QUARTER

Figure 10



QC SURVEYS RECEIVED AND EVALUATED AT HEADQUARTERS PER QUARTER

Figure 11

REVIEW OF HYDRO-SURVEY VESSEL PRODUCTIVITY

CDR Fidel T. Smith
Chief, Operations Division
Office of Fleet Operations

ABSTRACT

The efficient use of our fleet is a concern of the Office of Fleet Operations. Production, measured in lineal miles surveyed, has gone down. CDR Smith believes we can utilize our present resources more fully.

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The Office of Fleet Operations reviews the use of the NOAA vessels to determine if the fleet is being properly utilized and to see if it is properly manned, outfitted, and operated to accomplish NOAA's programs. A review of the accomplishments of the vessels engaged in marine charting was made recently. Selected results of one of the traditional measures of accomplishment is shown on the following graph.

A major portion of the capital equipment on a hydrographic vessel is for sounding, electronic position control, data acquisition, and data processing. This equipment is primarily used for obtaining and processing bathymetry. For this reason, I have shown the lineal miles of hydrography accomplished for the period 1975-1977. It is rather striking that this measure of productivity has decreased on almost all vessels since 1975. Original justification for the extensive suite of automated equipment was to increase productivity. These vessels are fully automated and yet they are accomplishing less hydrography than they were prior to automation. Why?

Many things influence the amount of work accomplished -- weather, equipment, personnel, type of area, type of survey, etc. A review of these factors indicates that the weather was average and the equipment appears to be operating as well as ever. However, type of area and type of survey have changed significantly since 1975. Previously, the vessels have been engaged primarily in basic surveys of the open coast or the deep sea. Now, fully 30 percent of our ship time is devoted to chart evaluation surveys which are very complex, time consuming, and generate very little bathymetry. It has been indicated by discussions here at the conference that the existing equipment, designed primarily for bathymetry, is not particularly useful for chart evalution surveys.

At present, there are many requests to replace the existing equipment with the next generation, as well as requests to reconfigure the entire system. The requests to reconfigure deal primarily with additional bathymetric capability.

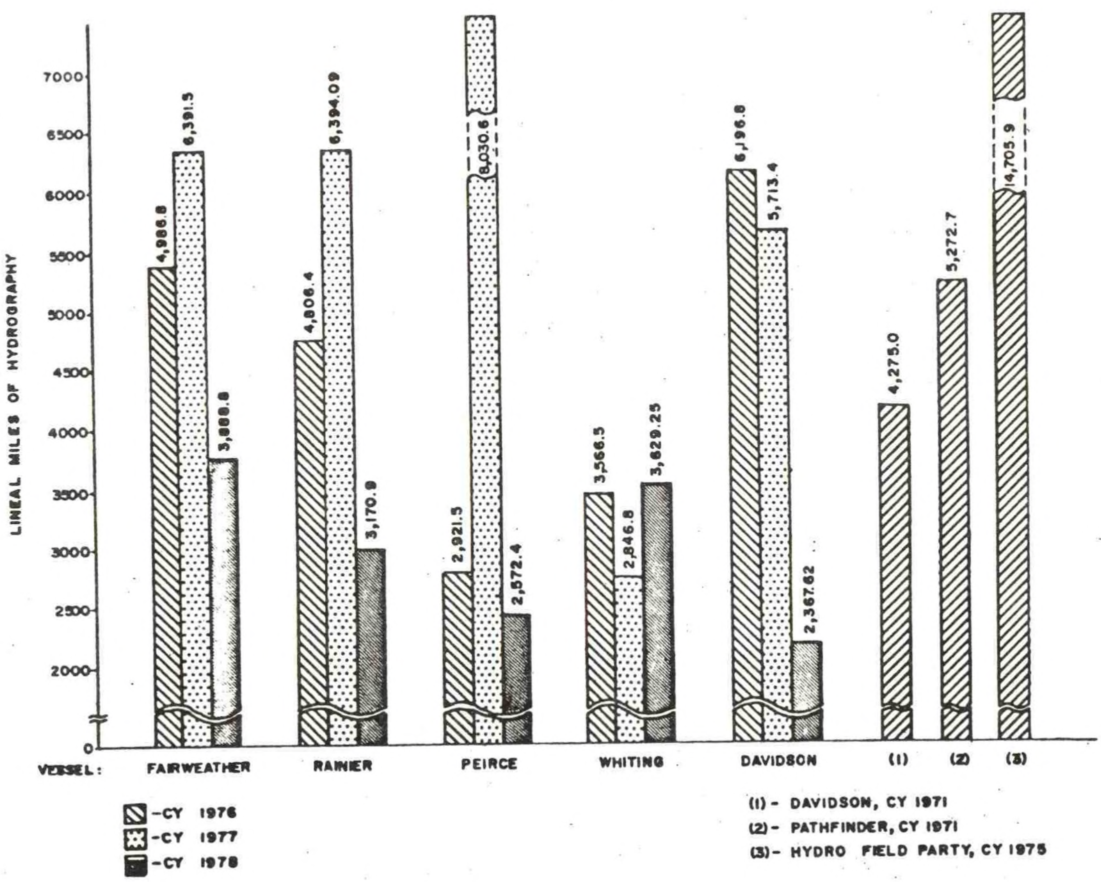
Currently, we have a tremendous capability for bathymetry and, prior to investing in more equipment, I believe we should utilize our present resources more fully. In addition, we need to:

1. Determine the type of surveys needed in post-1980,

2. Determine the best methods to accomplish the work, and

3. Determine the type of equipment needed to accomplish this work.

SUM BY VESSEL



HAS QUALITY OF SURVEYS IMPROVED SINCE 1975?

R. H. Carstens
Deputy Chief
Marine Surveys Division
Office of Marine Surveys and Maps

ABSTRACT

This paper and the discussion following deals with the quality of current methods. Some areas have improved and in some areas quality has declined.

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The years 1975 to 1978 provide a very limited period for an evaluation of improvement in the quality of surveys because few surveys of 1978 are available as yet and new processing procedures affect surveys of only the latter months of 1975. Our conclusions, therefore, may not be too firm.

The quality of a survey may be variously evaluated depending on problems occurring in data acquisition, processing of the data, and compliance with survey procedures and standards. The survey will be affected separately by the work of individuals involved in various survey and processing operations. The quality of the survey should be judged by the deficiencies in their work and the improvements they provided as well as the adequacy of the final product.

Most of the surveys made during the period 1975-78 were not of harbor areas but of alongshore areas, open coasts, and offshore areas. I believe that in general there has been a trend toward improvement in the quality of the surveys of these areas. As received at Headquarters, the surveys show improvement in the investigation and development of most features and a closer attention to conformance with format and plotting requirements. The Quality Control Reports from Headquarters frequently direct attention to deficiencies in plotting, format, or conformance with practices which are singular for that survey and indicate a lack of proper performance in processing or inspection. Although we may have obtained general improvement in quality, our surveys and processing operations are still harassed by deficiencies. A survey may be fouled up by what is done or not done in the field, in processing the data, and even by what is done by the quality evaluator at Headquarters. Much depends on the competence of the participants and the inspection of their work.

I spoke of a possible improvement in the quality of surveys of certain areas. I purposely didn't include surveys of harbor areas where I find little improvement over harbor surveys done 10 years ago. In some instances more items are in need of being resolved than on the earlier surveys. Our problem may be a lack of competence to accomplish such a survey; or it may be that a time schedule has been imposed by the Chief of Party and that sufficient time has not been allowed to adequately complete the survey.

Harbor surveys have been found to be difficult to do. It takes a long time to do them properly; it takes a long time to process them because of the numerous items that need individual attention; and where we have a lack of adequate field investigation, the evaluation and disposition of many features are based on limited information and frequently may be questionable.

Field operations on a harbor survey still suffer from many deficiencies. Among the more significant ones is the failure to provide an investigation and field disposition of many charted items. These may be charted wrecks, piles, pier ruins, obstructions, etc. In harbor areas wrecks of shallow-draft vessels are often pulled near shore or into shoal water and abandoned. Piers may eventually turn into ruins or prior pier ruins may become submerged. Charted piles may be removed or become submerged. Failure to provide a field investigation and disposition of the charted items may mean that arbitrary action must be taken in the processing or chart application. The feature must be arbitrarily retained on the chart or survey or some bold cartographer must decide that because of the age of the feature, its small size, the shoal depth of water in which it falls, or its relative unimportance, that the feature should be deleted. Our charts should not become historical accumulations of all items charted in the past. If a chart cannot be fashioned for practical use, then it will cease to serve its purpose. On one survey inspected recently, piles charted from a 1940 Corps of Engineers survey had not been investigated and were retained on the chart. Falling offshore of an Amoco oil pier, the piles effectively blocked the approach to the pier. Oil barges docked at the pier weekly and I am sure ignored the charted information in their docking. In the same harbor, marine railways charted from the same Corps of Engineers survey of 1940 were still retained as ruins although new piers had been constructed and were shown as crossing the ruins. Continual use of the piers by sailing craft indicated that again what was charted was ignored in using the chart.

The hydrographer must realize that it will be largely through his efforts and recommendations that this type of obsolete information will be removed from the chart and without specific attention to these items his survey very imperfectly serves its purpose. The fact that a feature does not appear on the field sheet does not mean that it won't be transferred to the smooth sheet or that it won't be retained on the chart.

There is a need to develop better equipment and methods for investigating submerged features generally found on harbor surveys. Sounding with a fathometer is usually unsuccessful in investigating small objects such as piles, pipes, and pier ruins. Trawl board dragging has been used with some success. The limited width of the strips makes an economical coverage of a large area impracticable. This method serves better where the item has a position of survey accuracy and the area of investigation can thus be much reduced. An item with a charted "ED" or "PA" annotation does not lend itself to a trawl board investigation particularly with respect to disproval of the item.

In some small harbors the work done by the hydrographer is often very incomplete. Usually a channel leads into a harbor or people wouldn't be able to get into the harbor and build piers and other facilities. On one survey recently inspected I found that the hydrographer had run no lines developing the natural channel through the shoals. To chart the harbor from the recent survey alone would have indeed resulted in an inadequate chart of the harbor. Fortunately our prior survey of 1882 did develop the channel and we were able to provide the route into the harbor. The continuity of deeps leading to piers through shallow waters is often neglected on recent surveys. It is not only the hydrographer's responsibility to reveal dangers in an area but it is equally important that he show the channels that the mariner can use. If he has to run some extra sounding lines to do this, then so be it. He should break off from his regular spacing and run the lines where they will best develop the features.

Another serious deficiency in field operations is the failure to provide a hand lead check on features dangerous to navigation as required by the Hydrographic Manual and to use the hand lead in searching for the least depths. Usually the present practice is to run various lines over the feature and assume that these will reveal the least depth. Often these lines are not spaced sufficiently close together to provide any assurance of a least depth. Where the interpretation of the fathogram may be questionable because of grass, kelp, side echoes, or strays, we have no supporting information to assist in the interpretation. In many cases we are forced to carry forward lesser depths from prior surveys. In one instance in running lines to develop the least depth on a pinnacle rock the Officer in Charge reportedly stated that he was certain the least depth had been obtained because the pinnacle was visible and a line was run directly over the pinnacle. The officer may have thought the line was favorably placed but how can we ignore three prior hand lead soundings all less than the present survey fathometer sounding? If a hand lead had been dropped on the peak of the visible pinnacle on the present survey, the officer's arguments would have been much more convincing.

Comments by Mr. J. S. Green

I do basically agree that in general the surveys have improved since 1975. The 1976, 1977 surveys we have processed; the 1978 surveys we are looking at and processing now. I also agree that we have a long way to go in certain areas. I think our area of biggest improvement lies in the development and the resolution of items on the sheet. I can see a great deal more fieldwork being done resolving these problems than was done in those older surveys. That has a good effect in processing. Although it has given us much more congested data to handle at the scale of the survey, overall I think, it results in a much better survey. I also feel that there has been improvement in supplying more complete data for our systems. Three years ago, if you had asked us to check calibrations for example, we would not have been able to adequately check these because of incomplete data. Today, in most cases, we have sufficient information to check the calibrations. We are finding problems and, as a result, we are checking more of the calibrations. We still are checking the fathograms. We find few fathograms that have not been scanned adequately. In 1973 or 1974 we may very well have found some areas that had not been adequately scanned in the field. We are checking it to a degree for our own interpretation.

In regard to survey notes, I think when we are running our conventional automated hydrography, the notes have improved. It is a matter that people in the field are making a conscientious effort to complete. I can see it's a matter of judgment and experience as to what is significant and what is not significant to record. The manual recording is often incomplete. This year I have made comments on the volumes not being filled out adequately. Some old stamps are missing. We need to know who is doing the work, under what conditions, and various other types of information. This is an area in which we have a way to go.

Mr. Carstens: How about the boat sheets that are received? Are they actually reflecting original information that is useful in the processing? The old boat sheets were plotted day by day, and you could almost see what a hydrographer was thinking; he would have guidelines drawn indicating that he wanted to run over certain shoal indications. If he didn't do it, you would probably surmise that for some reason he couldn't get back to it, but he was conscious that he had a shoal indication that should have been developed.

Mr. Green: The old type boat sheet information which showed lines to be run, shoal soundings to be investigated, etc., is not really seen in the final smooth boat sheets that are given to us. The present boat sheets are compiled some time after the fact. At PMC we ask for the original boat sheets, and we have at times referred to these original boat sheets to attempt to resolve a particular deficiency or a particular problem. We find that we have rolls and rolls of these sheets, so it is a difficult thing to go back through them all to find out exactly which one would have the information, but we do have them available. We have in this past year used them, and we have been able to resolve some problems. We don't always find the information on the final smooth boat sheet.

Comments by CDR R. A. Trauschke

I think without a doubt the quality of the surveys received from the field has improved and improved significantly. We still rescan all the fathograms upon receipt of the survey, and I think the quality of the scanning done by the field is much better. The number of inserts or changes that we make upon rescanning is negligible now.

The notes in the sounding volumes--we used to see quite commonly "at 13:44:50, rock"; no mention of the bearing, how far, what it uncovered, or anything. Now we are getting specific notes: "bares 1 foot, 10 meters on starboard beam", something of this nature. On development work done by the field--specific recommendations are being made, whole paragraphs, pages are devoted to discussing exactly what the field did. In earlier surveys we might find a note, "we investigated this area and didn't find any sign of an obstruction", period. That's all they said. No indication as to the time and effort that went into the investigation so the verifiers could make a realistic appraisal of the situation. I think most of this is pointed up now when we go back and dig up some of these older surveys conducted in 1973, 1974, and 1975, and just see the amount of extra effort required on the part of verification. Chart comparison was almost nonexistent 3 or 4 years ago. No mention was made of piers that apparently are no longer there, where now the hydrographers generally do make a very definite comparison with specific recommendations when it comes to comparison of the chart. The overall documentation and Descriptive Reports have improved. When I first came into processing I grabbed seven surveys and started looking at the velocity tables. On five of the surveys, there was an error somewhere in the procedure. After much digging--it wasn't obvious--one of them was found to be done correctly. The other survey table looked all right, but that was all there was, just a table; there was no background material. Nowadays there is no question in this area--the ships develop realistic and reasonably accurate velocity tables from bar checks and STD observations, and they document what they get. I think the quality has changed dramatically.

There has been much improvement in the scanning of fathograms. The check scanning has been more complete. However, there is still a lot of re-scanning necessary when the chop and following seas are excessive.

DISCUSSION

Mr. Carstens: That Pollick Rip survey was just that way. There was a 3- to 5-foot chop. The hydrographer should not have been out there in the first place. The recorded soundings were not revised for chop and were accepted right from the digital readings. Apparently both the hydrographer and the verifier disregarded the chop and as a result a great many soundings are in error by 2 feet.

Mr. D. E. Westbrook: I want to add something to this discussion that might help to bring out what Commander Smith was talking about before, and that is justifying new equipment in the field through increased productivity. When you do that, you ought to think about increasing the productivity of the processing of that data too. A good, working, heave, roll and pitch correction can do a lot in that respect, and it would save a lot of this fathogram rescanning. Excessive manual scanning and rescanning still has to go on; that's one of the biggest deficiencies that we have right now in our automated systems. I think we can justify the new equipment and better equipment.

Mr. L. W. Murdock: You compared back to 1975, but can you say what the rate in increase of quality or degradation is between the early years of this automated equipment? To get the feel of it, let's say 1971, 1972, when we started using this equipment, versus the first of 1973 to 1975 and now from 1975 to 1978. There was obviously a time when this equipment came out in the field, and there was a terrific learning curve. I was out there, and I can look around the room and see some other people who were out there. A lot of the effort was not directed toward running good hydrography--it was directed toward "How do I use this equipment?" I think now that we are probably leveled out on that learning curve, so what equipment do we need to finish it up, or what kind of additional training do we need? I know the quality went down in the beginning.

Mr. Carstens: Well, it was a learning process in the beginning, that is true, but you look over surveys and some of them are good, some of them are not so good, judgment on some of them is good, and you find deficiencies in others where the judgment isn't good. You have the competence of the hydrographer to consider. In the matter of investigating inshore ruins in the present day we have surveys of harbor areas where many of the ruins have not been considered. There is no field disposition of them. There is no comment on them. We have a verifier who will treat them in one manner, and we have a quality evaluator who might have some other ideas on it. So it is not only equipment we must consider. The oldtime hydrographer had a hand lead, and he was coming up with a lot of least depths that we aren't getting in the present day under present practices. You might think a fathometer has greater ability than the hand lead, but in certain instances it doesn't unless you use it properly.

CDR Trauschke: The most recent harbor surveys that we have done on the east coast have all been at Baltimore. They were done in '74, '75, and up until '76, and they were still done under the old system, "miles brings smiles." At least they were started then and most of the people were still in the transition phase. Since that time we haven't really done much in the way of harbor surveys.

Mr. Carstens: We haven't completed a transition phase. We are still in a transition phase. We don't know that the hydrographer's work would be better, and I don't anticipate it would be very different than in the Baltimore Harbor. We had surveys in Los Angeles, and you fellows at PMC were running into problems with those. You issued instructions to do additional work and clarify the details. Those were more recent, I think, than 1973 or 1974. We still have the same problems. We are still faced with them.

Mr. Green: In Los Angeles we had a bunch of problems on the integration of field edit data and hydrographic data. Old photography is part of the problem. There was a multitude of changes there that just did not get addressed in the survey. It sounded to me, that was what you were talking about.

CDR C. W. Fisher: If you assign a ship to survey a harbor every 7 years, the hydrographers don't remember how to do it. It's just too long in between.

Mr. Carstens: The quality evaluator at Headquarters also has an effect on the quality of the survey. The increase in competence as a result of evaluation experience during the past 4 years is in part an explanation for the more detailed quality control reports they produce. Although the subject matter of some of their comments may at times be of no great importance, their comments are considered justified because of the guidance they will provide in the verification of other surveys. However, the quality evaluators are not without their own limitations and faults. They make mistakes in judgment and are sometimes inept in detecting and rationalizing errors in plotting surveys. However, it is hoped that most of their deficiencies are corrected before completion of the quality evaluation and inspection. Their acceptance of items that have been transferred to the survey during verification is at times also not without fault. Examination of the original records of prior wire-drag and hydrographic surveys not infrequently discloses justification for rejecting or revising the prior plot and deleting the information transferred from that plot. Routine acceptance of information recorded in prior survey volumes sometimes done in quality evaluation is not always proper. For example, on one prior survey a note on the sounding line indicated that a sounding line would encircle a small reef. The first position indicated a rock awash 10 meters to starboard and the final position on line also indicated a rock awash 10 meters to starboard. The line plotted to the end of the reef where a turn was made. The next position ended the line and plotted in a position at right angles to the edge of the reef in depths of 6 to 7 fathoms. The signal fix was checked by replotting. However, by revising one angle by 10 degrees the final position plotted in the vicinity of the initial rock awash which was in accordance with the original note and was considered to be the correct position. The chart was thus relieved of an inconsistency which had been carried for years.

Deficiencies in processing are routinely corrected by the quality evaluators. Occasionally there is a difference in opinion regarding the disposition of an item or a practice to be followed. Usually the opinion of the last person influencing the decision will prevail.

I suppose the Processing Divisions have some positive opinions about the quality evaluations.

CDR Trauschke: I think the quality evaluations serve a useful purpose.

Mr. Carstens: Are they getting to the verifier? We frequently question whether this information we put out actually gets to the verifier.

CDR Trauschke: For the most part they are.

Mr. Carstens: Do they read the quality report, or do you just tell them what you want to tell them about it?

CDR Trauschke: I admit there is some filtering that does happen. When there are some decisions made by this last person in the system which are totally unrealistic and wrong, I don't bother telling the verifier about it. It's our feeling at the Marine Center that the verifier that does the smooth sheet knows this thing better than anybody else, knows the character of the individual that did the work, and therefore his decision or opinion should govern what was intended, what is there, what isn't there. Rudy, you may have some specific examples that we have talked about. But it doesn't do any good for a Quality Control Report to come back with statements like "numerous changes were necessitated in the curves in the junctional areas." What are we talking about? In most cases where I saw examples in quality control it was a line width of the curve that they were moving, and there is no point in bringing that to the attention of the verifier.

Mr. Carstens: If what we had to do was move it a line width, we wouldn't complain about it. It's an eighth of an inch or greater, it's so great you cannot make the curves join. Now, of course, the equipment that the verifier has is rather limited in actually making the transfer and making the curves come into coincidence. But the soundings being transferred are something else again. We might overlook minor disagreements in the position of depth curves, but when we transfer soundings from one sheet to another, those soundings should be in correct positions or we're going to comment on it--we are probably going to change them when they get to Headquarters, because the soundings themselves are much more vital than the curves. It's possibly a matter of the equipment. Using the projector does not always result in an accurate transfer.

Mr. R. D. Sanocki: I would like to add that there is a difference in perspective in some of the changes being done in the quality control compared to what was done at the Marine Center. I am not prepared to discuss the specifics right now. When my turn comes up, I will get into this. A lot of things are just a matter of opinion, and I think we are a little closer to the situation in the Marine Centers, and that our opinion should carry a little more weight as to what the answer is, rather than the rather brief quality evaluation.

Mr. Westbrook: I'd like to say something about the Presurvey Review. My philosophy on that, when I was working on them, was that it was Headquarters' opportunity to tell the field man in advance what he would like to see out of the survey over and above the normal Hydrographic Manual and instructions. When it comes to a harbor area or one of the areas where you know instinctively a hydrographer is going to have difficulty, the Presurvey Review is the place to tell him about it. I think that it could be a deficiency on the Presurvey Review in some cases, particularly if the field man followed it you might have problems later. You should concentrate in Marine Surveys Division on turning out your Presurvey Reviews and making sure the field men follow them, read them, and do the things you want, because then if they don't do those things you do have reason to complain later.

CDR G. R. Schaefer: I might add to that. There is a program set up for this coming field season where we will have some people from Rockville out in the field working on the ships, and also I would like to add that the time that George Myers spent out here a few months ago was very worthwhile in improiving our communications between Rockville and the Marine Centers. Communications between Rockville and the field also may improve much as we have found primarily through the rotating programs between the Marine Centers and the field.

LT D. M. Kuhl: We are talking of quality control during the automated era, and if we look at what we've done, we find that we have automated only the old methods. Until we start looking at quality control procedures in automation we are never going to improve. I mean things like some type of automated scanning that was referred to. It doesn't surprise me at all that we haven't been able to improve significantly, for we just automated the old ways.

Mr. Carstens: I would rather not leave anyone with too great a feeling of euphoria about the status of present surveys. There is still much to be done. There are still deficiencies in them--in plotted information and lack of information--which are far from acceptable. Many surveys as received at Headquarters are in need of revision and even after leaving the hands of the quality evaluator some revision in his work is required. We are still faced with using a significant amount of time to identify the deficiencies and to make revisions as necessary.

ANCILLARY PROJECT PREPARATION PRODUCTS

LCDR Donald L. Suloff
Chief, Requirements Branch
Marine Surveys Division
Office of Marine Surveys and Maps

ABSTRACT

During the process of preparing for hydrographic projects and issuing project instructions, a number of interim products are generated which are not all routinely transmitted to the field units. Among these products are geodetic control reviews, photogrammetric indexes, survey justifications, magnetic indexes, tides indexes, project limits sketches, chart markups, and chart blowups. Although these products are not always of value to the field unit, the units can, if aware of the products' existence, request the items pertinent to a specific survey.

INTRODUCTION

A specific hydrographic project is often identified within a priorities list as early as 5 years before field operations actually commence. From that time until the project instructions are issued, a series of procedures are taken to ensure that all necessary support operations have been completed and are adequate to minimize the problems of the field unit upon arrival at the given area. The existence or adequacy of horizontal control in an area is reviewed and, if necessary, supplemented. A similar review is made of existing shoreline manuscripts of the area. If those on file are not contemporary and new shoreline data are desired, updating photography is scheduled and flown. Other NOAA components and Government agencies are queried concerning possible time-sharing operations during the project. During the preparation of the project instructions, a great deal of data are reviewed and summarized before concise guidelines can be assimilated.

The by-products of these steps include geodetic control reviews, photogrammetric indexes, survey justifications, magnetic indexes, tides indexes, project limits sketches, chart markups, and chart blowups. Some of these products are of recognized value to the field unit and are routinely forwarded. A knowledge of the gamut of these products can assist the field hydrographer in those cases where a particular product would simplify a process or prevent the duplication of an already accomplished effort.

GEODETIC CONTROL REVIEWS

When an area has been designated for a hydrographic survey, the National Geodetic Survey (NGS) is informed of the need for horizontal control and is given the approximate year such control is needed. The standard control density request designates a desired frequency of marks of between 5 and 10 kilometers along the coast and within 2 kilometers of the shoreline.

The National Geodetic Survey's normal response is to assign a reconnaissance party to the area with the assigned purpose of recovering existing control and proposing supplementary control where necessary. The party submits a planning sketch which indicates the verified control and indicates where supplementary control will be provided by NGS. This sketch is provided to Marine Surveys and Maps for comment and filing. This service is normally provided only for the contiguous United States.

Other areas are responded to by an office review of triangulation diagrams and recovery notes. Only in those areas where control is known to be nonexistent or where its extension is recognized as being beyond the scope of the field unit does NGS dispatch a field party.

PHOTOGRAMMETRIC INDEXES

The existing coastal manuscripts are also reviewed to ensure a contemporary portrayal of the appropriate shoreline. If necessary, updating photography is scheduled and assigned to the photographic mission. The coverage of their work is summarized on three indexes.

The Coastal Mapping Job Index is a small-scale summary of all coastal mapping jobs accomplished by the National Ocean Survey and its predecessors. The index indicates the coverage of each job, its respective number, and the scale of the included manuscripts. The index is compiled by region with the breakdowns of Great Lakes (two subdivisions), East Coast (four subdivisions), Gulf Coast (two subdivisions), West Coast (three subdivisions), Alaska (three subdivisions), and Hawaiian and Samoa Islands.

The Photo Index is a larger scale index of an individual job indicating the flight lines and the position of the photograph centers labeled with photograph numbers.

The Job Index is a large scale index of an individual job which indicates the area of coverage of each manuscript. The manuscripts are identified by number and scale.

SURVEY JUSTIFICATIONS

As is the case with all components, the National Ocean Survey must request ship time from the Office of Fleet Operations for vessels from which to conduct hydrographic surveys. In support of these requests for ship time, survey justification statements are prepared for each proposed project. The statements contain summaries of those agencies or groups requesting the survey and the bases for those requests. A brief history of charting in the area is included together with future plans. The statement also describes the nature of vessel traffic transiting the area and offers insight into planned future developments.

MAGNETIC INDEXES

The Solid Earth Data Services Division of the National Geophysical and Solar-Terrestrial Data Center, Environmental Data Service, occasionally requires magnetic observations in conjunction with a hydrographic survey. When such requirements are assigned, they are accompanied by chartlets which indicate the approximate locations of the required observations and the existing horizontal control stations in the area which may be utilized as magnetic stations.

TIDES INDEXES

An assigned survey area is reviewed by the Oceanographic Division to ensure that a primary gage exists in the area for the tidal datum. All areas of the United States are presently covered by primary gages. However, historic information may indicate areas of questionable or unusual tides. In such areas, a long-term (1 year) gage will be established. When resources permit, such gages are established prior to commencing the hydrographic survey.

A more specific tides review occurs at the time of the survey to establish the data needed to reduce the soundings to chart datum. The requirements for the tides stations thus selected are presented in the project instructions. Historic information on previously occupied sites is made available. Accompanying the data are chartlets which indicate the station location, the station number, and the type of station for each respective survey project.

Upon receipt of an approved sheet layout for a project from the Marine Surveys Division, the Oceanographic Division will assign the tides stations required to be in operation for each hydrographic sheet or portion thereof.

PROJECT LIMITS SKETCHES

In conjunction with the preparation of specific project instructions, a project limits sketch which indicates the approximate extent of the survey is constructed. These limits are generally bounded by surveys of a contemporary nature or, in some cases, merely terminated by the nature of the project. To establish those surveys with which junctions are to be made and also designate all prior surveys which are to be compared with during the course of the survey, the master survey index file is examined. The relative location of these junction and prior surveys are indicated on the project limits sketch to supplement and clarify the lists contained within the project instructions.

When the draft project instructions are compiled, a list of the required junctions and prior surveys is forwarded for reproduction and transmittal of the appropriate sheets to the respective Marine Center Processing Division. The Marine Center is responsible for ensuring the receipt of all necessary material and the proper distribution of the sheets.

CHART MARKUPS

In preparation for the compilation of a Presurvey Review, the latest edition of the appropriate chart or charts of the area is reviewed for data source. The charts are annotated with symbols representing the source of the respective sounding or feature. These sources are normally prior National Ocean Survey hydrographic or topographic surveys, U.S. Corps of Engineers' surveys, U.S. Power Squadrons' reports, or Chart Letters. After the chart has been marked, those items whose source or resolution is questionable are normally assigned as Presurvey Review items. Only in areas of featureless bottom is no effort made to identify the sounding source.

CHART BLOWUPS

On request from a field unit, the Marine Surveys Division will coordinate the blowup of any charted area to any requested scale. In order to do this, the Division must be given the chart to be reproduced with the area to be enlarged clearly marked and the final requested scale stated. The areas requested normally should correspond to the sheet layout for the survey. Each area to be enlarged should have the chart number and edition inked somewhere within its limits for reproduction. The requesting unit may also mark any other information desired for reproduction within the limits of the area. The densification of grid lines is an example of a commonly used addition to the chart.

SUMMARY

A number of interim products are generated during the time elapsed from identification of an area for hydrographic survey to the issuance of project instructions. Not all of these products reach the field unit automatically nor are all of them necessary for any given survey. However, a knowledge of the existence and content of the products will enable the hydrographer to request these appropriate to the particular survey.

SUPPLEMENTAL DISCUSSION POINTS

It must be recognized that, although an extensive effort is applied to identification and retrieval of source information for item investigations, the system is by no means as efficient as would be desired. All chart applications are indexed on a chart standard. From this index, the various sources are retrieved. Unfortunately, it must be recognized that the National Ocean Survey file of source information is by no means as complete and extensive as it could and should be. This deficiency is particularly acute in the wreck source file. Frequently, for example, the pertinent Notice to Mariner's are the only sources received at Headquarters and field. However, the U.S. Coast Guard will have compiled these notices from radio logs, letters, and investigations, which contain significant details which are never available at Headquarters, and hence to the field units. Another area of deficient field information is historic prior surveys supporting Great Lakes charting. Although the field unit's frequently suspect, and occasionally justifiably so, that inadequate source searches are being addressed in Rockville, it is important to recognize that all too often the files themselves are insufficient.

The field units should be aware that a great deal of information is available from the previously mentioned chart standards and within the Marine Chart Division area teams. A knowledge of these products and an awareness of how to access it can be beneficial to the field hydrographer. An example of such a product is the fixed and floating aids to navigation listing available for each chart. This list identifies the aid, geodetic position, and source of information for each charted aid. The key to accessing these materials is interplay between the various office areas and field units.

SUGGESTED CHANGES
to the
HYDROGRAPHIC MANUAL, FOURTH EDITION

LCDR Donald L. Suloff
Chief, Requirements Branch
Marine Surveys Division
Office of Marine Surveys and Maps

ABSTRACT

Since the inception of the National Ocean Survey and its predecessors, a number of documents of various nature have been generated to control the procedures used in hydrographic data acquisition and processing. The current edition of the Hydrographic Manual is the fourth edition of consolidated instructions bearing that name. It is recognized that, if the Manual is to stay abreast of the constantly changing state-of-the-art, regular changes to the Manual must be generated and distributed. Such an effort is beyond the scope of a single individual and is rather the responsibility of each hydrographer and cartographer. As the coordinating body for publishing changes, the Marine Surveys Division should be sent all recommendations for Manual changes. To expedite application of a change, each recommendation should consist of a reference to the section of the Manual to be changed, the recommended revision constructed and worded for insertion, inclusion of any supporting illustrations or tables, and an explanation describing why the change is considered necessary and citing references where appropriate.

INTRODUCTION

The earliest instructions for hydrographic surveying were in the form of manuscripts generated internally and of limited distribution. The first published general instructions were issued about 1860 with subsequent revisions or rewrites in 1878, 1883, 1894, 1908, 1915, and 1921. Finally in 1928 a hard-bound Hydrographic Manual was authored by J. H. Hawley. This was the first consolidation of instructions using this name. In 1942, K. T. Adams authored a revised edition, also in hard-bound copy. This revision actually is considered the second edition inasmuch as the Manual was substantially rewritten and increased in content. The third edition was published in 1960. Authored by Karl B. Jeffers, this Manual was looseleaf-bound for easy addition of changes--only one of which materialized in 1963.

The Hydrographic Manual, Fourth Edition, was officially begun by Commander Melvin J. Umbach under the direction of Captain Robert C. Munson on January 7, 1974. The Manual was finally distributed and authorized as the official hydrographic tenet of the National Ocean Survey on March 20, 1978.

However, although the Manual was published and distributed, it was essentially through the dedicated "cut-and-paste" efforts of Mr. William J. Monteith that this was possible. From the initial page proof prepared by the publisher to the present time, six versions of the Manual have been produced and completely and critically reviewed and still an acceptable drive tape capable of reproducing the Hydrographic Manual is not available. Efforts are continuing to resolve this problem; however, its existence has also hampered efforts to publish updating changes to the Manual.

CHANGE DISTRIBUTION

The Hydrographic Manual has already been distributed to all applicable portions of the National Oceanic and Atmospheric Administration, to other Federal Agencies, to international surveying agencies, to state and local agencies, to universities, to private companies, and to interested individuals. The U.S. Navy is considering use of the Manual as both their basic hydrographic survey guideline and testbook. A number of foreign governments have accepted information contained within the Manual as the most current and reliable available. To maintain this reputation and standard, the Manual must be kept current with the state-of-the-art through regular generation of changes.

The only manageable way of assuring proper and complete distribution of changes is through the receipted registration cards. These cards are maintained on file and provide the basis of the address list prepared for mailing. When a change has been printed and packaged, it will be through regular generation of changes.

Each change will consist of completely reprinted pages for insertion in the Manual, each replacing a corrected page. The use of "a" pages (i.e., page 21a) will be held to an absolute minimum by apportioning a lengthy change or addition of several consecutive pages. There will be no changes requiring "pen and ink" correction on existing Manual pages.

CHANGE 1

Material has been accumulated, written, approved, and submitted to the printer for the first change to the Manual. Approximately 50 pages of the Manual will be affected by this change. An initial target date for distribution of this change was January 15, 1979; however, the continued difficulties in production of the master drive tape has made this date implausible and a new estimate is impossible to make.

Included within the material of this change are explanations of the new project numbering system and the Gulf Coast Low Water Datum, a revision of the explanation of water level requirements, and numerous miscellaneous minor revisions. A new appendix is begun discussing special survey techniques. The first two sections of this appendix included in this change discuss Navigable Area Surveys and Chart Evaluation Surveys.

CHANGE 2

During the preparation for the first change, sufficient suggestions were received to compile a second change. Printing and distribution of this change would be desirable by mid-1979. Presently scheduled for inclusion within the second change are sections on geodetic control data submission, the ARGO and Hydrotrac electronic positioning systems, the Klein side scan sonar, diver investigations, and small boat wire drag.

As can be observed, sufficient quantity of material has been received for two reasonably sized changes during 1979. Although the quantity of change recommendations received in the future would most likely decline, it is anticipated that a change will be necessary at least once a year.

CHANGE SUBMISSION

The identification of material needing revision or insertion in the Hydrographic Manual is beyond the scope of a single individual. It is rather the responsibility of all conscientious hydrographers and cartographers to submit recommendations as they are noticed. Such recommendations should be forwarded to the Marine Surveys Division where they will be reviewed and, where appropriate, incorporated in the next scheduled change.

To reduce the difficulty inherent in evaluating and approving recommended changes, it is desirable that all material submitted be relatively consistent in format and be complete. The individual submitting a change should identify the section of the Manual requiring revision. An annotated reproduction of the appropriate page or pages would be adequate. The revision or addition should be written in such manner that, if approved, it could be inserted directly into the Manual without revising its construction or wording. If any illustrations, tables, or figures are to be included with the change, they should be submitted, properly labeled, with the change material. Finally, an explanation supporting the need for the change should be included and references cited where appropriate.

Submission of material as outlined above represents an ideal goal which should be strived for whenever possible. Such submission reduces subsequent office efforts in interpretation and construction and hastens the incorporation of the material into a change. However, if an individual recognizes the need for a particular change and does not feel either qualified to construct the actual input or have time available to complete the entire package, it is far more important to the organization to have incomplete thoughts or material submitted than for the potential problem to be ignored.

CHANGE APPROVAL

Upon receipt of a recommended change in the Marine Surveys Division, the material is critically reviewed to assure that it is not only technically and grammatically correct, but that it also reflects the policy of the National Ocean Survey. To accomplish this, the proposed change is routed through all appropriate personnel for review and comment. When the final version of the change has been drafted, administrative approval is acquired and the material made available for publication.

SUMMARY

For the Hydrographic Manual to stay abreast of the constantly changing state-of-the-art of available equipment and techniques, regular changes must be generated and distributed. This effort is beyond the scope of a single individual or office and is rather the concern of all responsible hydrographers and cartographers.

As the coordinating body for publishing changes, the Marine Surveys Division should be sent all recommendations for Manual changes. To expedite application of a change, each recommendation should consist of a reference to the section of the Manual to be changed, the recommended revision constructed and worded for insertion, inclusion of any supporting illustrations, tables, or figures, and an explanation describing why the change is considered necessary and citing appropriate references.

By maintaining the Hydrographic Manual, Fourth Edition, through regular and conscientious changes, it can continue to be an exemplary source of hydrographic information for the national and international hydrographic community.

SHIP ALLOCATION PROCESS - SHIP SCHEDULES

LT Evelyn J. Fields
Requirements Branch, Marine Surveys Division
Office of Marine Surveys and Maps

ABSTRACT

The procedures for allocating ship time and ship scheduling is outlined by the NOAA Directives. Each Major Program Element along with the Fleet Allocation Council and the Office of Fleet Operations has a responsibility to ensure that the most effective and most economic use of the fleet is made and still have the missions of NOAA completed. The Major Program Elements have to justify and give priorities to the areas of concern.

INTRODUCTION

The ship allocation process begins with the Major Program Elements. Each year ship time requirements for nautical charting, based on established priorities, are prepared from the Marine Chart Division's priority list and forwarded along with justifications for each area to the Marine Surveys Division. This list of priorities is the result of a semi-annual meeting held with Marine Chart Division, Marine Surveys Division, Oceanographic Division, and Coastal Mapping Division. Representatives of each division meet and reevaluate the priorities with respect to other programs of the Office of Marine Surveys and Maps and various other national needs. After this reevaluation, a new list of area survey priorities is generated but integrated into the overall priorities determined by the Office of Marine Surveys and Maps.

The final list of survey priorities with justifications is forwarded to the Office of Fleet Operations (OFO) in the form of ship time requests. In OFO, the areas of priorities and the priorities of other Major Program Elements are matched with the best available resources for the working area. The finished product is the proposed Fleet Allocation Plan for the upcoming fiscal year. This plan lists the ship and the proposed schedule of operation.

This proposed Fleet Allocation Plan is forwarded to the NOAA Fleet Allocation Council for ultimate approval. The Fleet Allocation Council approves or disapproves each project requested by Major Program Elements, based on how the proposed benefits of each project meet the goals and commitments of NOAA.

ALLOCATION OF SHIP TIME

The Office of Fleet Operations allocates ship time according to the ship's capability and primary purpose. An attempt is always made to select the least expensive platform capable of doing the job. Some vessels are designed and equipped for resource assessment, biological, physical oceanography, and other projects of this type. Other ships are designed for marine charting surveys and scientific investigations. Every effort is made to keep within the design purpose of the ship; however, if a lesser platform is capable of accomplishing a specified mission, then that platform is recommended to the Fleet Allocation Council. Changes which affect the assigned mission of the ship, except circumstances which involve safety of navigation, natural disasters, etc., are also made by the Fleet Allocation Council.

Request for ship time by Directors of all Major Program Elements are forwarded to OFO on July 1, 15 months prior to the fiscal planning year. At this time a general outline of anticipated requirements for the first quarter of the next fiscal year is also due. Along with the request for ship time, justifications for each program and a list of program priorities are also included in the package sent to OFO.

The requests are reviewed and evaluated by OFO in accordance with priorities, guidelines, and available resources. Finally, OFO assembles a proposed fleet allocation plan with recommendations, for presentation to the Fleet Allocation Council by October 1, 12 months prior to the fiscal planning year.

After approval of the fleet allocation plan by the Fleet Allocation Council, OFO issues notification of approved time block allocations to Major Program Elements and Marine Centers. The Marine Centers and Major Program Elements proceed with the development of Project Instructions and detailed sailing schedules. The sailing schedules are prepared by the Marine Centers in collaboration with the Major Program Elements.

RESPONSIBILITIES

There are several elements involved in the ship allocation process and scheduling. Each of these entities has a responsibility when requesting ship time.

First, the Fleet Allocation Council is the final authority within NOAA on the fleet. The council is made up of five voting members and a number of observers and user-representatives who are nonvoting members and sit in on the meetings. The voting members are:

1. Associate Administrator of NOAA
2. Associate Administrator of Fisheries
3. Associate Administrator for Research and Development
4. Associate Administrator for Oceanic and Atmospheric Services
5. Director, NOAA Corps

The observers are:

1. Associate Director, OFO-Executive Secretary
2. Director, Office of Program Evaluation and Budget
3. Assistant Administrator for Administration

The user-representatives coordinate ship use matters affecting research or operational programs within their respective organizations and interacts with the Fleet Allocation Council. There is one user-representative for each program element, and the programs are:

1. National Ocean Survey
2. National Marine Fisheries Service
3. Environmental Research Laboratories
4. National Weather Service
5. Office of Sea Grant
6. Office of Ocean Engineering

The council has three main functions. It has the final authority within NOAA for allocation of ship time, reviews proposals for ship operations presented by or through user-representatives, and periodically reviews the efficiency with which the ships support NOAA or other Agency programs. It directs necessary actions to correct discovered deficiencies.

Second, the Major Program Elements are responsible for:

1. Documentation and justification for ship time requests.
2. Documenting and justifying requests for changes in the approved allocation plan.
3. Preparing project instructions for each project.
4. Monitoring quantity and quality of program accomplishments.
5. Providing requirement justification to support budget request for new ships and ship's equipment.
6. Supply resources necessary to install, operate, and maintain equipment needed for the special project.
7. Provide scientific and technical personnel to operate and maintain equipment for special projects.

The third element is OFO and their responsibilities are:

1. Ensure efficient and effective use of the Fleet.
2. Coordinate ship time requests and provide Fleet Allocation Council with a recommended plan.
3. Combine ship time requirements when possible.
4. Ensure the ship's equipment and instruments are available and in good order.
5. Establish and maintain an efficient equipment replacement system for ship's equipment.
6. Provide logistic, technical, and administrative support necessary for the successful accomplishment of assigned missions.

The Marine Centers are charged with the responsibility of:

1. Preparing deatiled sailing schedules and assisting with the operational planning and support related to the project.
2. Providing ship support such as funding, personnel, procurement, efficiency and effectiveness in the conduct of assigned missions.

SUMMARY

In conclusion, the allocation of ship time passes quite a few obstacles before the time is actually allocated to any Major Program Element. Each program element is responsible for justification of the time requested. There was a brief discussion on how the Office of Marine Surveys and Maps decides on the priority area for nautical charting programs. The semi-annual meetings, with the divisions of the Office of Marine Surveys and persons from the Marine Center, realign the areas of priorities, putting some ahead and dropping others back.

The responsibilities of the Major Program Elements, the Marine Centers, OFO, and the Fleet Allocation Council have also been discussed. Each of these components has a different basic responsibility, but each is ultimately tasked with efficient use of the fleet in carrying out the missions of NOAA.

DISCUSSION

LCDR Schneble: I've always had a question about this: ships are given projects, but they're not given schedules with which to get them done. On the other hand, it always seems that some place along the line the surveys are supposed to leave the area by such and so a date. Is that the Fleet Allocation Council that says, "you will be done with that project by such and such a date?"

LT Fields: No, basically what happens is that there is so much time allotted for a project, and that time, from my understanding, is brought about by a consensus between OFO, the Marine Centers and the Office of Marine Surveys and Maps.

LCDR Suloff: The date that is given a project is governed by the '62 guidelines. If that is the date you are referring to.

LCDR Schneble: C3 generates that. That didn't come from the Fleet Allocation Council?

LCDR Suloff: It comes from the Fleet Allocation Plan, but the information in it comes from agreement between the Marine Center on sea dates.

CDR Fisher: I have a question on chart evaluation sea dates. Does Fleet Allocation actually look at the number of days that C3 would put into that versus the rest of the year, or do they not care and address the whole year and say, "you can take this portion," or, "you can split the portion up any way you wish."

LCDR Suloff: I think what you're asking, Carl, is that for fleet allocation we submit requests for ship time. We request it by (1) what we really need and expect to get, (2) what we could really use and don't expect to get, and (3) by what we would use if somebody gave it to us. And so we ask for sea days to fill in what we expect to get as our number one priority.

CDR Fisher: I'm new to it and I really hadn't had it defined as to who splits it up, and then it is further complicated in that it appears that, once the time is allocated, the program manager can slip in a number of special projects and different things in there and has quite a wide degree of latitude to do that.

LCDR Suloff: I had one thing that occurred to me while Evelyn was talking, and perhaps this is a problem that came up also in conjunction with Fidel's talk, that C3 as the program element for the hydrographic ships has one thing in mind as being the most desirable and effective use of the vessels to accomplish the programs of C3, and it occurs to me that the efficiency of the ship use is being evaluated by OFO on completely different standards, and perhaps that's wherein our problems lie. The efficient use of the vessels as OFO sees it is not what C3 sees as the most effective use of vessel time.

CDR Smith: I think the difference there is that what you are addressing is your most effective use of the time that is allocated to you, while our concern is the most effective use of the vessel, given all the program requirements. You are using the resources allocated to you as you see fit for your priorities. We're not into making program judgments, saying that chart evaluation surveys have more priority than fisheries research projects. The problem we have is that everybody needs a ship.

LCDR Suloff: But it seems, Fidel, that you have made a program judgment inasmuch as you don't try to justify other use of ship time by a somewhat arbitrary progress report which you have submitted for the hydrographic ships, that being mileage.

CDR Smith: I try to stay out of program justification, as you said. What I'm trying to justify is, do you need a ship. Do you really need a ship? I know you need equipment; I know you need personnel to do the job, but do you really need a ship? Whenever you take a ship to an area where you don't need the platform, but you need the resources, then from OFO's position this platform is a waste. For example, you don't need a ship to survey Miami Harbor.

CDR Fisher: May I finish one more item. I started getting into some special projects. You talked some about project efficiency and the complications of doing a hydrographic project, and one of the things I felt impacted the PEIRCE quite a bit, and I know from comments that it impacted the WHITING and the MITCHELL also, is that a command goes into an area to commence a hydrographic survey, a basic survey, it's laid out and everything. Then, the special projects start rolling in. We are talking about three or four a year. And, if you are talking about setting up Raydist or Argo or Hydrotrack or whatever, going away and leaving the area for ten days, when you come back the probability of that system still being up and operating or being able to be turned on is low. Time is lost each time it is necessary to reinitiate your work. I think this is having considerable impact in the field, and it is becoming very difficult to carry out a survey in an orderly progression. For instance, I believe that the WHITING this past year was breaking to do LORAN calibration, and was breaking to do other special projects. It would work out much better if these extras were before or after a given project. I won't argue the point whether it should be done or not, because a lot of these extras are politically motivated, but I hope that I can get some support here that this is raising havoc in the field.

LCDR Suloff: The time frame is politically motivated also.

CHART EVALUATION SURVEYS

LCDR Donald L. Suloff
Chief, Requirements Branch
Marine Surveys Division
Office of Marine Surveys and Maps

ABSTRACT

The National Ocean Survey (NOS) recently instituted a Chart Evaluation Survey (CES) program designed to expeditiously provide hydrographic data in response to a recognized need for timely maintenance of published charts. This survey program is designed to address several primary areas of concern. Chief among these concerns are the investigation of all discrepancies which result from the necessary charting of reported data prior to field verification and the resolution of deficiencies reported or discovered subsequent to the most recent chart production. Field units assigned to the program also evaluate the adequacy of existing hydrographic information charted by employing a system of reconnaissance sounding lines and actively pursue the verification or revision of the information published in the appropriate Coast Pilot. Finally, a public relations effort is emphasized to inform the boating community and other nautical data users of the products and services of NOS and to obtain from them feedback pertinent to improving these products and services. Expanding use of the CES program provides NOS with flexibility in survey operations necessary to satisfy chart data requirements in an expeditious manner within time constraints mandated by the cyclic chart printing schedule without being restricted to the relatively slow and expensive procedures of complete hydrographic surveys. In those areas discovered to be inadequately charted or in need of extensive updating hydrography, this program serves the additional purpose of documenting deficiencies and justifying a basic survey effort.

INTRODUCTION

Although the program involves recently adopted terminology and documentation by many of its major concepts have been previously employed in other programs. These programs--Chart Revisory Surveys, Chart Deficiency Surveys, and Chart Adequacy Surveys--had evolved through the years and were the basis of the CES.

As early as 1937, the Lake Survey District of the U.S. Army Corps of Engineers employed a Chart Revisory Survey program to update the United States charts of the Great Lakes and their major tributary waterways. A triennial investigative survey coverage program assured contemporary coverage and chart maintenance of these waters. This program continued after responsibility for Great Lakes charting was transferred to the National Oceanic and Atmospheric Administration in October 1970. Key aspects of the revisory survey program included reconnaissance soundings in the approaches to each harbor, along the important waterfront areas, and in all other water areas privately maintained for commercial and recreational boating; verification of prominent landmarks and aids to navigation; surveys to include both natural and manmade changes to the nearshore or waterfront topography; and the updating of the Great Lakes Pilot.

NOS has identified and investigated specific items for many years. These "items of opportunity" were kept in active files at the Marine Centers and assigned to vessels operating near a particular item. Frequently these items would be maintained in files for years awaiting assignment. In more recent years, a mobile field party has been assigned full time to the investigation and resolution of these "deficiency items." Chart Deficiency Surveys thus were oriented towards the investigation and resolution of items of recognized concern.

Having a somewhat different purpose, NOS initiated a Chart Adequacy Survey program in 1973. For the first time, a major hydrographic vessel was assigned to a project specifically dedicated to investigate the adequacy of existing charts. Ship time was allocated and a specific area of investigation was defined for these projects. This program included the more important aspects of the chart revisory and chart deficiency programs; however, the additional manpower involved enabled the survey to cover a much larger charting area with a correspondingly greater public awareness of and participation in the effort.

The similarities of these three programs made it apparent that a single, all-encompassing program would be desirable and would be easier to administrate. This resulted in the CES program being developed in the spring of 1978. This program retains the flexibility of its predecessors by utilizing all or any part of the basic objectives. Perhaps the most important aspect of the CES, however, is the comprehensive outline of desired reporting procedures.

There are three factors that have been positively effected by the evolution of the CES. Although the total requests for surveys and the acknowledged deficient areas have not changed appreciably, the portion of the NOAA fleet dedicated solely to the hydrographic mission has diminished to six vessels and five field units. As recently as 1971, the hydrographic fleet consisted of nine ships and three field units. To help cope with this decline in available units, it has been determined that some survey requests and many deficient areas can be addressed and brought to a contemporary status without implementing a basic hydrographic effort. Considerable time and expense can be saved by using a CES program. The field unit moves into the charted area, resolves the identified problem items, investigates the associated chart waters, and makes its recommendations relative to the chart depiction. If it recommends no further surveying action and office inspection confirms this recommendation, the appropriate charting changes are made and no further surveying effort is assigned.

If, on the other hand, the field unit recommends that a basic survey is justified and office review confirms this recommendation, a priority is assigned to the project for future surveying. The CES recommendations provide excellent justification for the project and identify specific difficulties which can be expected.

Another positive effect of CES is in the realm of public cooperation and relations. Since basic hydrographic operations are frequently conducted along open coastal areas and in relatively unpopulated regions, much of the boating public has no contact with the work of NOS. Most of the CES work to date has been in more congested harbors, waterways, and population centers; therefore, considerable contact with the public user has been possible with the associated benefits of user recommendations and publicity.

PREPARATION

Although the identification of a project area may occur years before the field work is initiated, actual preparation for the project usually commences approximately 6 months prior to field operations. Far and away the most time-consuming portion of the preparation is the selection and documentation of the deficiency items. Each chart to be addressed by the field unit is researched by an office cartographer and the source of each sounding and feature ascertained. Any soundings or charted features that are questionable in any way are identified for investigation. Included are wrecks, ruins, submerged obstructions, reported shoalings and charted channel depths. Files are checked for all pertinent background information which consists of prior surveys, cooperative charting letters, Notice to Mariners, Local Notices to Mariners, private letters, etc. Before an item is assigned to an investigating unit, however, it is evaluated for its possibility of resolution. Certain items are of sufficiently nebulous source that there exists essentially no chance of resolution; therefore, such items will not be assigned. Charts are annotated to identify all items needing investigation, the recommended method of investigation is stated in a cross-referenced description, and all appropriate background information is assembled for reference. When all background research has been completed for a particular chart, it is not uncommon to have as many as 40 separate items identified for specific investigation on a harbor chart and 10 items assigned along a coastal chart.

The charts are also marked with recommended vessel tracks for reconnaissance purposes as required by the particular project. These tracks are generally positioned to obtain soundings over noted bottom features and important channels with the rationale being that these areas would be more susceptible to change; therefore, investigative soundings obtained along these tracks would be apt to illustrate any possible bottom change.

During this preparation period and at least 3 months prior to beginning field operations, specific project instructions are written by NOS Headquarters. The instructions cover specific objectives of the total program which are applicable to the particular project, amplifying appropriate sections as necessary. Anticipated special support needs are identified and references made to unusual surveying or data processing techniques required. The instructions, complete with marked charts and supporting information, are then sent by Headquarters to the feld unit.

Deficiency investigations consist primarily of those items which have been identified for examination by the office reviewer prior to the field work. The field unit should conduct additional source investigation upon arrival in an area by contacting the local office of the U.S. Coast Guard, U.S. Corps of Engineers, diving clubs, and other pertinent marine interests. Frequently such contact will reveal previously unknown information concerning the items and may, upon occasion, resolve them. The field unit is encouraged to investigate questionable items uncovered during their own surveys or through contacts with local persons. Some of the items can be resolved by visual examination and others by standard hydrographic techniques. However, a large number of the items require modified wire sweep or drag techniques with subsequent diver examination to assure absolute resolution. It is hoped that the future will see the use of side scan sonar to help resolve questions on subsurface items investigated by the CES.

Reconnaissance hydrography is the primary basis for recommending either the acceptance of the chart as produced, for making minor revisional changes to the chart, or for the assignment of a basic hydrographic survey effort in the future. The density of reconnaissance soundings will vary depending on bottom characteristics, history of the area, known dynamic processes affecting the area, and traffic volume. Whenever reconnaissance lines indicate a need for basic hydrography, immediate coordination is effected between the field and office to evaluate this indication of need. The extent and urgency of the need are evaluated, and it is determined whether the need should or can be addressed immediately or whether it must be assigned to a future hydrographic survey of the area. Changes to the original instructions are provided as necessary to the CES field unit should additional basic survey efforts be required in the investigated area prior to continuing the investigation of other assigned tasks. To minimize problems associated with comparing the reconnaissance scale of the existing charts and are plotted as overlays. Although this differs from standard NOS practices, it enables rapid and direct field comparison. If it is apparent that additional development is necessary in a particular area, a larger scale survey can then be addressed.

Within harbors, reconnaissance is made along active slips and pier faces to verify charted depths and contours. The orientation and density of the sounding lines are determined by the general size of the vessels using the facilities and the complexity of the charted depiction. Adequate data shall be collected and recorded to permit evaluating charted hydrography. One sounding line should be run along the approximate track of the keel of vessels approaching and mooring to the pier. Additional reconnaissance work is carried out in the remaining areas of the harbors concentrating on water areas outside the maintained channels.

The charted waterfront planimetry is visually compared to the existing planimetry in sufficient detail to assure that the charts accurately portray the area. Cartographic factors such as scale of the chart must be given consideration. When discrepancies are discovered which are within the field unit's capabilities, they are resolved. Frequently U.S. Army Corps of Engineers surveys, construction drawings, private surveys, and city or county maps are utilized by the field unit to expedite their field operations. Of course, such documents must be confirmed by the field party to assure that they meet NOS surveying or charting standards before they are used as a data source. If the discrepancies are beyond the scope of the unit, recommendations must still be made for resolution, such as scheduling chart updating photography or more extensive surveying effort.

All charted landmarks or other fixed aids to navigation are evaluated for existence, accuracy of position, and usefulness to navigation. Accompanying recommendations suggest the addition or deletion of landmarks. During the course of the survey, floating aids to navigation are also checked for charted accuracy. At the same time, the appropriate Coast Pilot is evaluated for the accuracy and completeness of the information describing the area of operations. Revisions or changes to the current edition of the Coast Pilot resulting from the CES efforts are submitted to NOS Headquarters in accordance with prescribed reporting standards.

The field unit makes random checks throughout the survey area to verify the accuracy of the predicted tides or water levels which are available to the mariner.

Every opportunity is taken to obtain user evaluations of the NOS products. This includes comments and suggestions concerning existing chart layout, scale, format, color, availability, accuracy, etc. Users also may suggest new products for NOS to address or changes which may be applied to existing products. The evaluations were originally addressed in a questionnaire which was distributed in a variety of methods; however, an extremely poor return rate discouraged this format. Recently, person-to-person interviews with a wide range of the boating public has proven a far more effective method of gathering input.

The field unit also makes a concentrated effort to reach the public describing its particular current effort and the services and products of NOAA in general. The news media is encouraged to feature the unit in programs describing the NOS mission and the specific project being addressed. Open houses are held whenever and wherever possible. Perhaps most important are meetings with personnel of the local office of the U.S. Army Corps of Engineers, U.S. Coast Guard, U.S. Coast Guard Auxiliary, U.S. Power Squadrons, Sea Grant marine advisors, port authorities, pilot's associations, and commercial fishing organizations.

PROCESSING

Because of the special nature of these surveys and the need to reduce the time between field data acquisition and chart application, special modifications are made to the data processing routine established for conventional surveys. Whereas normal surveys undergo meticulous verification at both the NOS Marine Centers and Headquarters, the CES are shipped promptly to Headquarters without Marine Center processing of data. The field unit, therefore, is responsible for processing all revision data to a point where it can be applied directly to a chart with a minimum of additional data reduction or evaluation required by Headquarters personnel. Extreme care must be exercised to assure that the plotting of data on chart overlays or plotting sheets is done neatly and accurately. All sounding data are reduced using appropriate vessel corrections and correctors determined from predicted or real-time tides/water levels observations. Many revisions or comments concerning land and water features are made directly on chart copies. A concise yet comprehensive Descriptive Report is included for each chart addressed so that the office cartographers can readily determine and evaluate the merits of procedures employed by the field hydrographer. It is particularly important that the techniques employed in investigating discrepancy items be carefully and completely described.

Upon receipt of the survey data in NOS Headquarters, the information and recommendations are carefully reviewed at two different levels and the final comments and recommendations assimilated. This finalized product is forwarded to the appropriate cartographers who apply the new information to the manuscript from which the revised chart will be published.

SUMMARY

The National Ocean Survey has accepted the Chart Evaluation Survey program as a valuable addition to its charting program. Whereas basic hydrographic surveys presently require an average elapsed time of 11 months (the NOS goal is 12 months) from the completion of data acquisition to their availability for chart applications, the CES surveys are ready for charting within an average of 8 months after data acquisition. Furthermore, it should be recognized that the special data from CES cover a much broader coastal area and are concentrated on items of more critical interest to the mariner than conventional surveys would normally provide. For this reason, CES are becoming increasingly important to NOS as the Agency strives to keep their charts as current as possible.

The current rate of discrepancy item resolution has shown improvement over earlier years. A number of factors have contributed to this increase in resolution rate. The increasing familiarity among field personnel of the unique surveying techniques and information reporting procedures coupled with closer coordination of operations between Headquarters and the field unit has had a positive influence on effectiveness. More judicious office selection of items for investigation has also contributed. It is anticipated that further resolution may result from the recent publishing of definitive survey guidelines and reporting procedures.

Finally, the CES has served to resolve the possible need for more comprehensive surveys in many areas and to provide justification for more comprehensive surveys in the remaining areas. Information thus derived increases the total effectiveness of the NOS hydrographic program and further assures the best use of the survey resources.

SUPPLEMENTAL DISCUSSION POINTS

The original Chart Evaluation Survey (CES) concept tied the survey schedule very closely to the chart printing cycle. This concept proved to be unrealistic and is no longer instrumental in determining survey priorities.

The normal routing of CES data includes the prompt shipment of the data from the collecting field unit to the Marine Chart Division in Rockville. If the Marine Center desires to clear these records, there is no objection. However, there should be no processing done at this level; records should merely be checked for completeness and organization.

One possible product of a CES survey is a justification for a basic hydrographic survey. Whenever this occurs, the unit addressing the basic survey will be provided with the CES data.

Although the selection of Presurvey Review items and CES items are essentially the same, their collection is accomplished by two different areas in Rockville. There is no duplication of effort; however, there is a substantial variance in experience levels. Unfortunately, the group selecting and assigning CES items is essentially inexperienced in these processes and consequently is struggling to respond adequately to the program. There is little question that combining the two functions within the perview of our group would enhance effectiveness; however, administrative policies have prohibited this consolidation.

The CES program has been providing valuable information to the charting program. As a result, the program has continued to be included within future survey plans at either the present level or at slightly higher levels of attention.

TRACKLINE DATA REQUIREMENTS

W.J. Monteith
Manager, Chart Planning and Technology Group
Marine Surveys and Maps

ABSTRACT

This paper covers the general topic of track line surveying from the statutory requirement of collect data to format specifications.

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Track Line Requirements - DMA and NOS

A. Under what authority are track line survey data collected?

B. Where are the data required?

C. What are the systems for collecting and processing these data?

D. How are track line survey data used?

E. What is the format by which the data are transmitted to DMA or NOS?

F. What survey specifications exist from which track line data accuracies may be assessed?

Track Line Data Requirements - DMA and NOS

My presentation on "DMA and NOS Track Line Data Requirements" will cover the topics shown above.

A. Under what authority are track line survey data collected?

The Defense Mapping Agency is required by statute to provide international nautical charts and marine navigational data for use by all United States ships and for navigators in general. They accomplish this mission to a great degree through dependency on other entities for their charting data.

The National Ocean Survey is also required by statute to conduct oceanographic and hydrographic surveys, to perform related research investigations and analyses, and to provide charts and maps for marine and air navigation.

The collection of track line data by each agency is sanctioned under their respective charting mandates.

B. Where are track line data required?

The United States is dependent upon the oceans for our national defense. It is important that our naval forces be prepared to deploy and operate on short notice in any geographic location of the world's oceans. To be effective, our surface and submarine naval forces are required to navigate with far greater accuracy than vessels engaged in normal commercial marine endeavors.

The oceans are also rich sources of food, energy, and minerals. Recent years have seen the national and international focus concentrate on the oceans as important sources of minerals and energy. As we approach the 21st century, deep-sea mining is expected to increase as an important source of strategic metals, such as manganese, nickel, and cobalt.

Much can be said to justify ocean exploitation. However, one must be cognizant of the need to collect information to prevent unwarranted exploitation and unnecessary damage to the ocean's resources.

One area where track line data is required is in the development of known seamounts in the vicinity of the Northern Marianas Islands. As the time approaches for NOS to accept responsibility for charting these waters, the number of requests from commercial fishermen for such information is expected to increase. A sparseness of bathymetric data exists over a wide oceanic area, and it can be assumed that other uncharted seamounts may exist.

Maritime shipping continues to increase with the growth of domestic and international commerce, and seagoing vessels continue to increase in numbers, size, and speed. This growth results in constant demands for expansion and improvement in quality, quantity, and display of all forms of nagivational information. Examples of the required information are reports of tide stages; water currents, soundings; geophysical phenomena, such as magnetic disturbances, volcanoes, and earthquakes; drifting sea ice; shoal waters, obstruction or hazards to navigation; and waterborne commerce.

The contemporary survey program of NOS responds to these data needs in the nearshore areas. It is in the offshore or far reaching ocean areas where the majority of information on the oceanic environment is needed. The majority of NOS operations are usually limited to United States and territorial waters, and it is, therefore, difficult for NOS to respond significantly to the general data needs. However, NOS vessel operations can still provide bathymetric data for use by NOS or DMAHTC.

C. What are the systems for collecting and processing these data?

Track line data are obtained from various governmental agencies and from foreign and United States merchant and survey ships. All United States ships, both governmental and privately owned, are encouraged to collect and transmit track line data to either DMAHTC or the NOS.

Track line data are usually collected by NOS "vessels of opportunity" having specific requirements directed toward the verification of reported seamounts or searching for shoaler depths. The scope of effort is not allowed to significantly interfere with normal vessel time and travel.

Recognizing that a large potential exists for increasing our present bathymetric knowledge of the oceans through the voluntary efforts of both civilian and military personnel aboard these ships, cooperation is still essential in selecting track lines consistent with areas having a definitive data need. It is possible that relatively minor alterations in normal sailing plans can result in acquiring substantial amounts of valuable data that may not be otherwise collected.

Those vessels which are dedicated to the collection of hydrographic and/or oceanographic data and staffed by professional personnel, should be able to respond to the need of track line data easier than the conventional commercial carrier. If for no other reason, their instrumentation provides more accurate vessel position and depth information and is better suited for deep water, offshore data collection.

The systems for collecting and processing these data will, of course, run the gamut from crude depth recorders combined with equally crude positioning devices which collectively require all data to be manually recorded and logged; to the state-of-the-art in sophisticated source data acquisition systems characteristic of our modern-day oceanographic and hydrographic survey vessels. Whether it be manually recorded data or data recorded by automated means, these data will be welcomed by both NOS and DMAHTC.

D. How is track line data used?

Track line soundings are used as the best data available to fill "holidays" on charts published by either NOS or DMAHTC. These holidays generally exist where basic systematic hydrographic surveys have never been accomplished or where contemporary survey standards have not been satisfied.

Historically, NOS has used track line data acquired almost exclusively by NOS vessels. Alaskan waters appear to be the exception with data having been obtained from commercial fishermen and the Russian Atlas.

DMAHTC has used data obtained from any viable private or governmental source. They have recognized the potential volume of track line data collected by civilian and military vessels and have not been overtly concerned as to how the data were collected.

E. What is the format by which data are transmitted to DMA and NOS?

The procedure for transmittal of track line data to DMAHTC is documented in "The Guide to Marine Observing and Reporting," Pub. 606. This publication represents the coordinated effort of the U.S. Navy Oceanographic Office (now DMAHTC), U.S. Coast Guard, and of NOAA's NOS. This publication provides guidelines for standardizing the format of track line data and the transmittal of these data. The data are logged on Marine Operations Abstracts designed to be used as a bridge navigation log, and to record fix information and other parameters for eventual smooth plotting of track line information. A Marine Observation and Station Abstract is a worksheet which the ship prepares as its final navigation data product to accompany the smooth plot. This form contains the corrected and properly arranged data consisting of position, course, and speed information. It should be mentioned that prior to the present use of the Marine Operations Abstract and the Marine Observation and Station Abstract, all NOS position data for track line surveys were recorded on NOAA Form 77-15, Dead Reckoning Abstract. Bottom cores, bathythermograph profiles and similar events were recorded on NOAA Form 77-2, Marine Operations Log.

The track line data collected by NOS vessels are usually plotted on either Ocean Survey Sheets (OSS Series) or U.S. Navy Bathymetric Charts which will be specifited routinely in the project instructions issued. Often, the recorded soundings are not plotted in the field but are processed in the office by the requesting agency. Positions are usually taken and recorded hourly and when significant changes in course or speed of the vessel are made. Distance log or revolution counter readings and ship's courses should be recorded with the position data and become part of the basic track line data. Soundings are logged to the closest one fathom at intervals not to exceed five minutes in depths over 100 fathoms and at intervals not to exceed two minutes in depths less than 100 fathoms. In addition, depths of all intermediate peaks and deeps shall be recorded with times of occurrences recorded to the nearest minute. Unless otherwise specified in the project instructions, velocity corrections are applied from applicable historical tables as the soundings are taken. Analog depth records shall be removed from the depth recorded each time a plotter sheet has been completed as the sounding line continues onto a new sheet. If the vessel has the capability, all data should be logged on magnetic or punched paper tape as well.

Commanding Officers may be authorized to develop one seamount per track line providing control is consistent and geometrically strong. Two seamounts may be authorized per month when engaged on other ocean surveys. Developments should be complete to the extent necessary to determine that the feature is a seamount. The officially accepted definition of a seamount is "an elevation of the sea floor having a nearly equidimensional plane less than 60 nautical miles across the summit."

Significant uncharted features discovered during track line surveys shall be reported immediately to the Director of the vessel's Marine Center who in turn shall inform NOS Headquarters. Significant features include uncharted seamounts, submarine valleys, and other similar physiographic phenomena. Reports should include the general characteristics, the approximate size, and the geographic location of the feature.

F. What survey specifications exist from which track line data accuracies may be assessed?

Prior to 1963, the NOS Headquarters attempted to verify each track line plot submitted which included a review of the sounding data as well. All anomalies were resolved and flyers eliminated. Since 1963, however, the track line data received in Headquarters has not been verified except whatever cursory review the appropriate Marine Center might have imposed.

When considering the justification for and uses of track line data, that track line positional data has ranged from dead reckoning to electronic control, and that track line plot scales are quite small in general (1:232,000 to about 1;1,500,000), the need for tightly controlled data accuracies is not as prevalent as in conventional hydrographic surveys. Survey specifications, per se, have not been developed by which definitive data accuracies can reasonably be assessed.

It is recommended that shore ties be made at the beginning and ending of every track line by accurately fixing the vessel's position with reference to fixed objects of known position. Three-point fixes with check angles, cross bearings, or radar ranges are acceptable for shore ties, in that order of preference. When other control is not available, astronomical observations are used to position vessels on track or cruise lines. These observations are similar to those used for routine surface navigation, except that sights are taken with greater precision and care and are computed and plotted more accurately. Observation and computation procedures and the use of astronomic sights are described in several references which can be found in Section 4.10.1.1 of the NOS Hydrographic Manual, 4th Edition. For attaining required precision, computations are made to the nearest 0.1s of time and to the nearest 0.1 minute of arc. These computations will be included as basic data with the other information forwarded for the track line.

Frequent checks on the depth recorded shall be made to ensure that the recorded soundings are on the proper scale. For example, a sounding check should be made when recording on the 4000-fathom range to ensure that the correct 400-fathom scale is being used. Position numbers are assigned when simultaneous comparisons of soundings are made; all graphic records and tabulated data for these comparisons shall be included as part of the permanent survey data.

DISCUSSION

LCDR Schneble: You showed a map that included the Pacific Trust Territories. Is there anything about who, when, where, how?

Mr. Monteith: There is some speculation that it could be a charting responsibility of the National Ocean Survey at some time in the not too distant future. There are plans being made for such a charting program, but nothing that I think we have to concern ourselves with immediately.

CAPT Yeager: It would become NOS' responsibility in 1981.

CDR Fisher: We may not do any charting but it remains our responsibility.

Mr. Monteith: That's a possibility. I do know that we have already received a request from commercial fishermen on the possibility of providing some additional seamount data in the area where commercial fishing is conducted; this came out of Hawaii, did it not?

CAPT Yeager: Yes.

CDR Fisher: What would be the manpower level of effort in marine charting to actually work on this data; in other words, what resources is NOS willing to put forward to do any massaging of it -- you said verification, the whole bit.

Mr. Monteith: Taking the easy way out, in most areas where trackline data are provided, the scale of the chart is such that a lot of processing really isn't required. If you follow the guidelines as defined in Publication 606, plus the Hydrographic Manual, you could have an error that would not be acceptable under conventional hydro surveys -- especially at the scale which we normally conduct our hydro surveys. However, at the scale of the end product to which track line data are normally applied, we don't anticipate a manpower requirement being significant in processing these data.

SHOULD ACCURACY STANDARDS BE BASED ON THE SCALE OF THE SURVEY

LCDR T. W. Richards
Chief, Hydrographic Surveys Branch
Atlantic Marine Center

ABSTRACT

This is not a formal paper. LCDR Richards led a discussion on using photo-picked points for electronic control and the relationship of survey scale and accuracy requirements.

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I have a question I want to see discussed, and that is what appears to me to be an inconsistency in our accuracy requirements for our hydrographic surveys. Specifically, we have a flat requirement that all electronic control stations must be located by at least third-order control, either office photogrammetrically located or by ground survey methods. However, in the Hydro Manual the requirement we place on a launch is that we know where the launch is in relation to the scale of the survey we are conducting. The two systems are not necessarily compatible. If we accept the fluctuating standard, is it not then valid that when we are conducting a smaller-scale survey can we put our electronic control stations on a less stringently accurate point, say a field photo-picked point for Del Norte on a 1:20,000 survey? I know that at one point it was done, and I think Don Nortrup has some background on some of the pitfalls of that system, but I think we cast aside a very viable field technique for locating shore electronic control stations because we didn't have the right constraints in the system.

DISCUSSION

CDR Nortrup: I'd like to comment on what could be done, not what was done. I think your proposal of field photo-picked points for electronic control for small-scale surveys is something that probably should be authorized, provided that there is some redundancy available to provide a self-checking mechanism for all of the photo-picked shoreside signals. It would have to be set up so that there is a set of guidelines and procedures that would make the system self-checking. Not redundant data for photo-picked points but redundant electronic control data, so if you have three electronic rates available they will either agree or disagree -- if they disagree, you have busts on the beach somewhere.

LCDR Richards: I personally would like to see the ability for our field units to put Del Norte and Miniranger onto photo-picked points. It could eliminate the requirement for some very extensive traverses on the East Coast, in the Great Lakes and in Alaska. Any operations officers have a feeling about this?

Mr. Green: We have used photo-picked points for electronic control before and we had problems. When we went to the third order electronic control stations, those types of problems we saw in that project just went away, so it was an effective solution.

LCDR Richards: But was it overkill? To the point where you're increasing the work load on the field unit and eliminating a viable field technique for locating electronic shore stations. One that could save a ship a number of days in the field.

Mr. Green: They were 1:20,000 surveys, and it was apparent at that scale. I like the idea of having the control error being negligible in relation to your navigational error.

CDR Smith: The policy at AMC came about because they had several surveys back in '71 that, when they got to looking into them, most of the origins of problems were in photo-picked hydro surveys. So they arbitrarily decided that photo-picked signals were not the thing.

LCDR Richards: For a 1:2,500 survey the requirement placed upon the electronic control station is the same as it is for a 1:100,000 survey. And I am saying, is that valid? We do have a third-order horizontal control position required of any electronic control station we have used. And the international agreement is 1.5 mm at the scale of the survey, which on a 1:100,000 survey is 150 meters. I am just trying to point out there is an inconsistency between our requirements.

CDR Austin: I think what the question comes down to, though, is that we don't always know what the ultimate application of the data will be. If you vary your positional control with the scale at the time, sometimes it behooves you to make the size upgrade of the scale of the chart.

LCDR Richards: But we do allow the position of the launch to become inaccurate to that point, 1.5 mm at the scale of the survey. Does a location of a rock on a 1:40,000 survey not need to be as accurate as the location of a rock in a 1:5,000 survey?

CDR Smith: I don't think that's true.

LCDR Richards: I'm saying there's a cheaper way, a photogrammetric method that isn't used. In fact there is another method that I don't know if anyone has used, and that is the office photofix form. Has anyone used that for electronic control? It's allowed, but has anyone ever done it? Did it work?

Mr. Sanacki: It looks all right.

LCDR Richards: At what scale? 1:5,000 and 10,000, and was it premarked?

Mr. Sanacki: They weren't marked; they were photoidentified.

LCDR Richards: They were picked in the field?

Mr. Sanaki: Well, the GP was determined for a pier. That was used as a site for the Del Notre. The GP was provided. They just went out there and found that pier corner and set the Del Norte on it.

LCDR Richards: You came straight from the manuscript?

Mr. Sanacki: Right. The point itself, where that corner was.

LCDR Richards: And that is acceptable on the East Coast for 1:5,000?

Mr. Sanacki: It was acceptable for that survey.

LCDR Richards: Well, I won't belabor the point any further. The other point that I wanted to make and bring out from Don Suloff is that scale requirements that are placed on us by our project instructions do affect the accuracy with which we run our hydro. Yet I have had statements from you that, "Well, you can run Upper King's Bay at 1:2,500 or 1:5,000; it really doesn't matter." But really, our accuracy standard doubles when we go to 1:5,000 from 1:2,500. The techniques that we could use at one scale we can't use at another. In Kanehoe Bay we did a 1:10,000 survey, but had we switched to 1:5,000 the technique that we used we couldn't have used.

Mr. Green: We did the same thing in St. Nicholas Island. We did a 1:10,000 survey. We ended up putting out our smooth sheet at 1:5,000, but it was inadequate as a 1:5,000 survey.

LCDR Richards: Because it didn't meet those requirements. It does make a difference to the processing division how we go about conducting our surveys.

LCDR Suloff: The survey can be plotted at any scale. The requirements should be for the scale; however, the scale requirement in the instructions now are more for a reasonable portrayal of line spacing and the requirement for charting action. The past history of survey scale is based on a twice-scale of the largest scale chart of the area to resolve human error in plotting and individual soundings. Inasmuch as virtually all of our charting is now automated, it represents one position and one position only. The Marine Chart Division is willing to accept survey scales on the same scale as the charting scale, so most of our survey scale requirements now are based on the median portrayal of line spacing requirements.

CDR Schaefer: Don, the problem you run into on your smooth sheet is that normally it is produced as a smooth sheet, and the accuracy on that smooth sheet should meet the mapping accuracy standards. Now what we did on this one sheet on the St. Nicholas was that we produced a sheet at 1:10,000 specifications, but we depicted it at 1:5,000 scale, so when you pick up that smooth sheet it no longer meets federal accuracy or mapping standards. So you can't arbitrarily plot it at any scale you want and still meet the mapping accuracy standards.

LCDR Suloff: Not for the scale that you plot it at. In other words, the survey was surveyed at 1:10,000 specifications, which it did meet. For convenience of plotting, you plotted it at 1:5,000.

Mr. Green: That went in as a registered survey; it's a registered smooth sheet that's distributed to whoever wants it as a 1:5,000.

LCDR Richards: I think there is a bit of a problem here. If indeed we can conduct our surveys with the accuracies that are at the scale of the chart, we can have quite a bit more latitude than we have today. But if it's as Glen says, the sheet that they produce or that's going to be the requirement, the field needs to know which one it's going to be, so that they can make their checks to ensure they met those standards. Right now I think all the field is acting conservatively to meet the scale at which they are conducting the surveys. But in fact they may be wasting time if that's not really required.

CDR Schaefer: I might add that the reason St. Nicholas was plotted at 1:5,000 was simply because we couldn't depict enough information at 1:10,000. It had nothing to do with ground control in that case.

LCDR Richards: I made a promise to Captain Mobley before I left the East Coast that I would make mention of the paper that he has written on this subject. I cannot present it here; I don't have the qualifications, but essentially what he is saying is that we should try to define more precisely the Hydro Manual's accuracy standards for area type surveys. He is talking about BS^3, laser and photobathymetry. Basically, as I read his paper, he is saying that we should obtain redundant positions and depth values and that we should perform a statistical analysis on this through automated systems to show that we reach a certain standard deviation value for the scale of survey that we're conducting, and the values that he has come up with to meet the international hydrographic standards are that, on a 1:10,000 survey, the standard deviation would be 9.1 meters, and on a 1:5,000 would be 4.5 meters.

Mr. Green: We were ending up in the data base for today's surveys with a lot more data than is necessary to portray the area at the scale of the survey. What assurances do we have that somebody will not take that data base and try to make something off that data at a much larger scale, because in many areas the data is there.

LCDR Richards: Say we did a 1:40,000 survey, and someone would try to do a 1:5,000 chart from it; is that what you're saying?

Mr. Green: Yes. We have done several areas at 1:20 that really, to portray that area, and this is a different problem, you should have done it at 1:10. You can't cover and show everything at that scale. It's like the St. Nicholas Island survey; we end up with so much data. We plot it at 1:20,000. In the automated file there is a great deal more data. It's almost a 1:10,000 survey. That's the detail the hydrographer had to acquire to resolve all of the problems.

SUMMARY

This question was discussed at length with the following points being made.

A. Perhaps field/office photo-picked control could be used to locate electronic control stations if we are very careful about the field procedures used to pick the control and there is a means to verify the photo G. P. in the office.

B. The scale at which project instructions call for a survey to be run and/or the scale at which the field unit conducts the survey may not be the scale at which the cartographer wishes to portray that survey.

C. Captain Mobley's concept of gathering redundant sounding and position data, performing statistical comparison analysis of this data, and then rejecting or accepting this data based upon specific bounds of standard deviations was presented to the conference.

THE NAVAL POST GRADUATE SCHOOL OCEANOGRAPHY/HYDROGRAPHY PROGRAM

CDR Donald E. Northrup
NOAA Liaison Officer
Naval Post-Graduate School
Monterey, California

ABSTRACT

The Naval Post-Graduate School Oceanography/Hydrograph Program has only recently been implemented. Following is an overview of that program.

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There are not many people at the Conference who are directly affected by the Naval Post Graduate School (NPS), Oceanography Program at Monterey, so I will be brief. If anybody is particularly curious about the curriculum, the environment, or anything that may be of interest to prospective students, I will be happy to talk to them individually.

The program at Monterey was proposed initially about 1971 by the Naval Postgraduate School. At that time NOAA did not see fit to support such an academic program. By 1976 there was an increasing concern regarding the level of competence of field personnel involved in hydrography. The NPS proposal was reconsidered and found to be a desirable option in the existing circumstances. In cooperation with Naval Oceanographic Office and Defense Mapping Agency, the proposal was formalized and the program implemented. The first students in the Oceanography/Hydrography program began studies at NPS. Current enrollment includes seven NOAA officers (lieutenants and lieutenant commanders), three Naval Oceanographic Office civilians, three Defense Mapping Agency civilians, and three allied nations naval officers. I might point out that all of the second year students are here for the conference.

In establishing this program, the curriculum was set up basically around the existing oceanography curriculum at the Naval Postgraduate School. Seven courses were added to the Oceanography Department course offerings to provide the Hydrography option material. Included are four courses in hydrography, per se, one course in photogrammetry, one course in geodesy, and one course in cartography.

One of the immediate benefits of the program, as I see it, is the drawing together of personnel from various organizations involved in the same type of work, i.e., hydrography. The cross-fertilization of ideas is beneficial to all involved.

One thing that struck me in sitting through the sessions so far today is that all the discussions have addressed very detailed, in-house concerns. Leaving an operating unit and going to an academic setting frees the perspective a great deal. We are able to consider the essence of hydrography and all possible alternatives to the accomplishment of the task.

Whether the program is beneficial to NOAA is yet to be seen because no graduates of the program have yet returned to operating units. The first graduates will return to operating units in late summer '79. One thing the program has done automatically is to identify a group of very qualified officers with the hydrographic operations of the organization. They enter the program knowing full well that their future assignments are going to be pretty closely tied to hydrography.

DISCUSSION

LCDR Pickerell: Don, do you have the DAVIDSON coming down?

CDR Nortrup: Yes, part of the curriculum in hydrography courses per se is a cruise quarter, when in essence we will go out and do some surveying in Monterey Bay. The DAVIDSON will be down on February 26th, for a two-week period, and her purpose for coming down is to make available her facilities to carry out this cruise exercise.

HOW WILL PUBLIC LAW 95-372 IMPACT NOS?

W. J. Monteith
Manager, Chart Planning and Technology Group
Nautical Chart Division
Office of Marine Surveys & Maps

ABSTRACT

NOS has studied the authority, purpose, and requirements of Public Law 95-372 (Outer Continental Shelf Lands Act Amendments of 1978) and has identified areas of concern and potential proposals to meet the requirements of the law with a new product, a Fishing Obstruction Chart.

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Authority

The Congress and President have mandated the Secretary of Commerce with the task and responsibility of identifying natural and man-made obstructions on the outer continental shelf which pose as hazards to the commercial fishermen engaged in operations in those waters. The Secretary of Commerce has in turn tasked the NOS with the responsibility of locating and charting these obstructions to satisfy the needs of these fishermen. The specific authority for the development of Fishing Obstruction Charts is contained in Section 407, Title IV of Public Law 95-372, Outer Continental Shelf Lands Act Amendments of 1978, enacted September 18, 1978.

Pursuant to the objectives, requirements, and provisions of this Act, NOS has developed a preliminary plan of action and is currently in the process of expanding the details of this preliminary plan in an attempt to gain funding and personnel supplemental increase authorizations. The following comments will be an attempt to clarify the impact this Act could have on future NOS charting operations.

Purpose

The success or failure of routine bottom trawl operations employed by a commercial fisherman to harvest fish, shrimp, crabs, or other desired marine life, depends heavily on his knowledge of natural and man-made obstructions, such as mud lumps, coral heads, shipwrecks, exposed well heads, valve assemblies, or other debris which collectively lie on or near the ocean bottom.

The Marine Navigation Charts presently produced by the NOS contain obstruction information considered hazardous to commercial shipping or recreational boating.

Commercial fishermen are annually incurring millions of dollars in damage to their trawl equipment and fishing boats as a result of hanging or snagging uncharted natural and man-made obstructions which exist on the outer continental shelf. The damage incurred is usually in the form of torn or lost trawl nets, broken towing cables or wire ropes, and the loss of associated hardware. Occasionally winches and other vessel deck gear may be torn from their mountings and structural damage sustained by the vessel due to a hard hang. It is estimated that the 4,000 shrimping vessels which operate in the Gulf of Mexico annually sustain $16-20 million in damages directly attributable to snags and hangs.

Compounding these dollar damage estimates is the value of the harvest lost at the time of the hang and the subsequent harvest lost during vessel downtime as repairs are made.

The fact that obstructions exist which adversely affect the commercial fishermen has been recognized for a long time. However, definitive data on these obstructions as to the nature or type and the location of each has not been available; or if available, not at desired charting accuracies. Even if data were available, such data display on present nautical charts would seriously impair the quality of the chart for use as a navigational instrument because of the resulting complexity of the chart. Historically, the design and format of the nautical chart have been toward promoting safety in marine navigation, and not toward any other specific user group. To date, this primary charting concern has been accomplished by locating and displaying those features considered hazardous to the safe transit of commercial and recreational vessels. Only those features considered critical such as reefs, shoals, rocks, wrecks, or other obstructions have been routinely located and charted.

It had become evident that the commercial fisherman had a special charting need which was significant and which was not being addressed. This need could be satisfied only through the construction and publishing of special fishing obstruction charts. This would require the acquisition of bottom obstruction data, here-to-fore not considered important in the production of conventional nautical charts. It would be the intent of these special fishing obstruction charts to provide information necessary for the commercial fisherman to avoid hanging and snagging his gear on obstructions located close to the bottom, with an end result being to eliminate his associated damages, and to increase his fishing harvest.

Requirements

To fully respond to the purpose or objective of the Act will require that NOS determine the special requirements of the obstruction chart user and to design a chart to satisfy these needs. This will include determining the most effective scale and chart coverage consistent with the varying geographic needs of these fishermen. These charts will include the display of all navigational information needed for position control of the fishing vessels transiting to, from, and within their fishing grounds. Intensifying or subduing feature display will also be a consideration in designing the chart as will the development of special symbolization designed to clarify obstruction information while at the same time avoiding problems of illegibility.

The charting plan designed to satisfy the intent of the Act must address three specific questions:

1. What will an obstruction chart consist of?

2. What data are available to produce an obstruction chart?

3. What data must be acquired or collected to produce an obstruction chart?

What will an obstruction chart consist of? As early as 1947 the Coast and Geodetic Survey produced their first fishing obstruction chart. In 1977, NOS produced two experimental fishing obstruction charts of Alaska waters in cooperation with the Northwest and Alaska Fisheries Centers of the National Marine Fisheries Service.

Based on these initial experiences, it has been decided to determine regional requirements for obstruction charts through an extensive users' survey using outside contractual support. The first charts produced will be given wide distribution for evaluation by the users. The initial chart parameters developed from the contracted users' survey will be reviewed against the feedback received on the initial charts produced and used to form the basic specifications for the full suite of Outer Continental Shelf obstruction charts which are currently estimated to total 230.

What charting parameters are presently being considered as possibilities for inclusion in the general cartographic specifications for an obstruction chart? It is expected that not all fishing obstruction charts will be alike but will be structured according to the differing but special regional fishing needs of the Outer Continental Shelf.

These charts are expected to include:

- Fishing Obstructions consisting of the presently charted data and any additional obstruction data acquired from other authoritative sources.

- LORAN-C Lattices which will provide the primary means of ship/vessel control. A subdued LORAN-A lattice might be included where appropriate as well to provide the fishermen a graphic conversion of existing LORAN-A operational information to LORAN-C as LORAN-A is phased out. The LORAN-A lattices will eventually be deleted from future charts.

- Supporting information which will include all necessary aids to navigation such as sea buoys, passing buoys, and entrance aids to ports or harbors. All fixed lights visible over long distances will be shown, as well as marine and aero radiobeacons, and radio broadcast stations.

- Oil Platform Structures which will be identified on the chart by their company name, geographic location, lease block numbers, and structure number, letter, or name. This same information is listed on a sign appearing on the structure and will provide basic orientation information to the chart user.

- Sea Bottom Configuration which will be displayed by closely-spaced and subdued contours, by limited depth zone background color tinting, and by judicious selection of soundings and bottom compositions affecting trawling, anchoring, and marine life attraction. Soundings considered critical will be emphasized as compared to support soundings which will be subdued.

- Zones of Pipeline Movement which will be shown if the area of movement can be determined. All pipeline valving and related hardware locations will also be charted if this information can be acquired.

- Safety Fairways, including territorial and fishing limits.

What data are available to produce a fishing chart?

As stated above, chart parameters such as coverage, scale, electronic positioning lattices, aids to navigation, bathymetry, bottom characteristics, symbolization, etc., are all design factors to be considered in the design of a fishing obstruction chart.

The identification and classification of "what is an obstruction?" is a more difficult matter. The primary objective of this plan is to produce charts which will accurately portray the location of natural and man-made objects considered hazardous to fishing operations employing bottom trawls. Objects which project short distances above the bottom (underwater stubs) must be located and delineated in much greater detail than would be expected or required on conventional navigation charts.

NOS intends to fully utilize existing obstruction and hydrographic data from the following sources:

- Fishing Companies where extensive hang and snag locations have been logged.

- National Ocean Survey records where an indepth analysis of existing survey records may be of value in providing obstruction data.

- Bureau of Land Management where offshore leasing agreements could provide information on man-made obstructions resulting from offshore oil exploration.

- Sea Grant Universities where information has been collated on Outer Continental Shelf obstructions encountered by commercial fishermen.

- National Marine Fisheries Service cruise data which logs hang and snag locations encountered in their operations.

- U.S. Navy obstruction/wreck list.

- Other Federal Agencies.

It is worth noting that even though obstruction data may exist from these sources, it does not mean that NOS can be assured of their availability. Oil companies and commercial fishing interests have closely guarded information they deem proprietory to their respective operations and have often refused to release it to other users in the past.

What data must be acquired/collected to produce an obstruction chart?

Obstruction charts will require more detailed and densified hydrographic data on the ocean floor than have been required historically in the production of navigation charts. The density of data will depend on the need of the user which is dependent upon the type of fishing operations conducted and the character of the bottom as determined by both natural and man-made obstructions.

A real question exists as to whether state-of-the-art electronic hydrographic survey instrumentation can economically acquire the data necessary to produce charts specifically for bottom trawling operations. Side scan sonar would require a return resolution capable of distinguishing a small object projected less than 3 feet above the bottom and being further capable of separating this object from other spurious traces attributed to or generated by electronic noise signals or fish. Wire-drag operations would be equally difficult and extremely time-consuming.

Program Plan

It was recognized that the almost one million square miles of Outer Continental Shelf area, the short time constraints imposed by the Act, and the limitation of existing NOS resources and personnel would require extensive contract support if NOS were to succeed in publishing obstruction charts.

It is to be noted that the total effort needed for the development of the fishing obstruction charts depends to a large extent on the results of the user requirements study and the acquisition and evaluation of available data. The program presented represents a "most likely" program and it is expected that the results of initial contract and in-house investigation of user needs and data availability could modify it greatly.

In closing, it is worth noting also that the amount of field surveying required, number of charts, compilation effort, and other aspects of the program are all subject to change, and the total program now envisioned could be found to be substantially less or substantially more than adequate.

DISCUSSION

CDR Austin: What about the question of liability?

Mr. Monteith: Let me quote the act:

> With respect to any claim for damages filed pursuant to this title, there shall be a presumption that such claim is valid if the claim establishes that (1) the commercial fishing vessel was being used for fishing as located in the area affected by the Outer Continetal Shelf waters; (2) a report of the location of the material, equipment, tool, container or other items which caused such damages and the nature of such damages is made within five days after the date on which damages were incurred; (3) [which is important to NOS] there was no record on nautical charts or in the Notice to Mariners on the date such damages were sustained that such material, equipment, tool, container, or other item existed in such area; and (4) there was no proper surface marker or lighted buoy which was attached or closely anchored to such material, equipment, tool, container, or other item.

That particular section is Section 404 of the Act which deals with the "burden of proof" for a claim. The National Marine Fisheries Service has the responsibility of deciding whether a claim is valid in the payment to the fishermen for the damages incurred. As far as the liability is concerned, I don't think that is a problem for us. Right now most of the information we have been able to ascertain as being available on these obstructions deals with LORAN-A type positional information, and a lot of the published information shows one line of position and a depth. So really we're going out on this program with very little definitive data that we can really hang our hat on. I don't consider liability to be a problem on this. We're creating a special suite of charts for commercial fishermen, but primarily in support of the National Marine Fisheries Service in effecting the Act.

Mr. Lunday: These 13 bodies to do the compilation -- is that with the idea that the automated information system is going to work in 1979?

Mr. Monteith: We hope so. Well, let me clarify again, the first two things we have to identify is (1) what are the user requirements, and (2) the existing data -- what is the credibility of the data or availability of the data we could use to generate per se an obstruction chart. Do not treat an obstruction chart as a nautical chart. It's going to be a different animal. It's going to have color-tinting schemes that will probably rival a bathymetric chart more than a nautical chart. Our symbolization alone may take entirely different shapes than what you have seen before on a chart. We may have directions of hangs and snags and whether or not the snag actually turns out to be a hang. There are a lot of things that we are considering. A scale of 1:100,000 might be the basic scale at which we produce the charts; that's what the total figure of 230 charts was determined from.

Mr. Lunday: One other thing on personnel -- did you say 230 charts over a period of five or six years?

Mr. Monteith: Well again, if you accept the fact that everything is in not much more than a planning or discussion stage, if you want to look at this a little later, you will find that those charts that have been laid out off the Atlantic Coast, and this one of the Gulf and part of the Atlantic Coast are at a scale of 1:100,000. In the Gulf of Mexico alone we are looking at something like 70 charts. From the tip of Florida up to the U.S./Canada border we are looking at at least another 70, and we are not into the Alaska waters yet. The number of 230 that I mentioned previously took into account the fact that we believe there will be extensive water areas of the Outer Continental Shelf that will not require charting. We are interested in providing obstruction charts in the area where the commercial fishermen actually are conducting operations, with emphasis again on those waters where oil exploration or offshore development is either taking place now or will be taking place in the very near future.

CDR Fisher: In working with Bill Marvin in this area a few years ago, the clammers and trawlers had better LORAN equipment than we had. They didn't worry about calibrating it; they were worried about repeatability, not absolute position. They go back and work an area, and then they'll move over and work another area 25 feet over, so they have really very accurate systems, not the system you discussed.

Mr. Monteith: You can take exception to my use of the word "calibration," Carl; we are looking at repeatability.

CDR Fisher: But the other thing is, did you read in the Act that when they had a hang they have to determine what they hung on, and they go to court on that basis? It sounds like they have a burden of going down and finding out what it is.

Mr. Monteith: Providing, of course, that the obstruction is on the chart. And that was one of the things I alluded to in my presentation here, that we intend to put information on the chart as to the type of structure or obstruction which has been located.

CDR Fisher: I thought that was all either/ors; in order words, it's either this or this or this.

Mr. Monteith: Well, in that one it was not an either/or. It is something that will be a requirement.

CDR Fisher: Unless you have a major equipment procurement in as far as what we do or what contractors you can get, it is going to be very difficult to do that. Your highest degree of success will be following the court cases and adding them as they went.

Mr. Monteith: We have had considerable discussion in the office on this; it's something we feel will greatly impact our operations in the near future. There is even a requirement for color-coding by the oil companies, to color-code their structures and their appurtenances that would pose an obstruction.

CDR Fisher: Do you plan to mount any hydrographic surveys with NOAA vessels in the next 7-year period?

Mr. Monteith: Probably, but the extensive effort again will be, at the present time, contractual. We have made a request for supplemental funding to OMB. They responded that (1) it's premature, (2) it requires additional detail, which is part of the comments I made about expanding our present plan. This was our first go-around, and we are presently expanding this plan to try to live with the requirements of OMB in order to get -- not just the funding -- but the personnel slots as well. Without both personnel and funding, we will be in a difficult position to respond to the mandate that has been imposed upon us.

ARE WE SATISFYING THE CHART COMPILER

Andrew J. Lunday
Nautial Chart Branch
Marine Chart Division
Office of Marine Surveys and Maps

ABSTRACT

Several areas where the hydrographer and data processors could help the cartographer are suggested.

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"Continual and unrelenting demands and pressures on the National Ocean Survey for accurate nautical charts of the coastal waters of the United States and her possessions have led to the development of new concepts and techniques in surveying, innovations in cartography, and the introduction and use of sophisticated automated data acquisition and processing methods."

This is the first sentence in the foreword written by Rear Admiral Allen L. Powell, Director, National Ocean Survey (NOS), for the July 4, 1976, 4th Edition of the Hydrographic Manual. It should serve us today as the challenge that clearly demonstrates the need for communication between our fields of avocation.

In general the hydrographic surveyors and processors do satisfy the chart compiler. The surveys are of a high quality and the following comments are intended to suggest ways in which our job could be simplier and more cost effective.

The following list of suggestions and remarks solicited from cartographers of the Nautical Chart Branch, Marine Chart Division, Office of Marine Surveys and Maps (C321) is designed to provide areas for discussion which may lead to improving various phases of survey requirements and processing of hydrographic data. It is hoped that dissemination of some of these ideas may also help to satisfy the requirements of the chart compilers.

Survey Format

1. A plot of the hydrographic survey would be desirable at the same scale as the largest publisher or proposed chart in a given area. The plots would be more convenient for office processing and analysis by Marine Chart Division personnel as well as application to charts by cartographers. Applications to nautical charts would be expedited and the need for reductions would be eliminated.

More care should be taken so the survey will fit on material which does not exceed 36 inches in the least direction (width or length) at the given scale of the survey.

Reduction of surveys for chart application are presently done on a Xerox 1860 reducing machine. The limits of the material in the original document size is strictly 36 inches and duplicate documents are limited to 28 inches, making a 50 percent reduction necessary to capture the entire original. This machine uses a step process for deriving reductions at various percentages of the original size. Further reduction introduce slight distortions within the copy caused by lens aberrations, and readability becomes worse as more steps are made.

2. Blue line work presently shown on the hydrographic smooth sheets has been the source of some problems as it does not reproduce well. Data that is shown in blue on the smooth sheets fades or is lost with the first reduction on the Xerox 1860, previously mentioned above, and must be intensified between reductions by hand, creating a chance of error and oversight.

3. The hydrographic symbols on the smooth sheets should conform to those used by the Nautical Chart Branch for compilation and in a format that is more easily adapted to the Automated Information System (AIS) now in the process of being adopted by the Marine Chart Division. One example would be the rock awash symbol at or near the sounding datum used on hydrographic survey smooth sheets, Figure B-2, 3, 4 in the Hdrographic Manual, July 4, 1976. The nautical Chart Branch used two symbols: ✱ for rock awash, and ⁜ for rocks at or near the sounding datum. A uniform symbology would speed chart application and ease conversion of data to the AIS. This would also minimize possible oversight by a compiler working from reduced copies of a hydrographic survey.

Another example would be the new square green postside day-beacon symbol recently adopted by the Marine Chart Division, September 6, 1978.

4. Plot soundings on hydrographic smooth sheets in fathoms and feet in areas where the largest scale chart is plotted in fathoms. Many charts in Alaska and Hawaii are printed in fathoms and in fathoms and feet. This step would eliminate extensive conversions before chart application and reduce possible errors due to conversions.

5. Provide a plot of the Pre-Survey Review Items with the hydro sheet descriptive report, this would aid the cartographer in locating items without hand-plotting.

Hydrographic Content

1. Add special notes to the smooth sheets. Certain notes in the descriptive report that refer to special or unusual offshore conditions; i.e., "strong along-shore currents between two locations," would aid the cartographer if added to the smooth sheet. It would help alert the cartographer to possible Notice to Mariners corrections or that a special note on the chart would be helpful to the mariner.

2. Do not indicate shoreline on the survey smooth sheets. Generally the shoreline on hydrographic surveys serves no purpose to the compiler as this information has been applied to charts from the topographic survey sheet which usually precedes the hydrographic survey.

3. Re-emphasize the sections in the 4th Edition of the Hydrographic Manual on wrecks and obstructions. The growing importance and significance attached to this type of information is due to recent legislation by Congress concerning the fishing industry. Some descriptive reports are so vague on the particulars needed by the compiler that it is practically impossible to determine the correct method of charting.

Other Suggestions

1. There is a need for communication and feedback on survey priorities. The Nautical Chart Branch occasionally has to partially apply surveys they consider critical because those hydrographic surveys were considered low priority and as a result were not processed by the Marine Surveys Division. An update of which Category 1 and 4 survey sheets are going to be processed in the future would be helpful in planning chart application by Area Teams.

2. With recent developments in the field of automated cartography, it is important to stress the quality of surveys. The Chart Evaluation Survey program is designed to resolve discrepancies reported and evaluate the adequacy and/or accuracy of hydrographic information on existing charts. Partially investigated deficiencies or partially developed navigation hazards are of minimal value and can even result in more confusion. Moreover, there is the very great possibility for erroneous information to find its way into the AIS where it would be very difficult to detect and correct.

The Nautical Chart Branch Area Teams have the final responsibility of applying the data directly from field reports to NOS nautical charts. It is emphasized that these field reports must be as complete as possible, and furthermore, they must be reliable.

HYDROPLOT SYSTEM TODAY

LCDR Gregory R. Bass
Marine Data Systems Project

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I am presenting this information at the request of Mr. Jack Wallace, Office of Fleet Operations, Rockville. I defer any detailed questions to him.

There is due to be released at the end of February a new set of software for the HYDROPLOT System. The first part of the HYDROPLOT manual is becoming outdated and has been re-written.

I. RK 111-Hyperbolic/Range-Range On Line Data Acquisition Program will filter out the erroneous "flyers" which presently cause the plotter pen to move greatly out of position. There is a routine to smooth and extrapolate Del Norte and Mini-Ranger readings. The program will type out signal strengths at the teletype. The antenna distance "ANDIST" will be recorded on the Master Tape Corrector record. The on line program will be compatible with Argo. There is an option for not plotting which thus eliminates the need for RK160 and RK161 real time hydrolog programs. The control latitude "CLAT" has been simplified into a degree/minute/second format.

II. RK210-218 off-line programs are all revised to utilize interrupt processing. This will speed up the plot programs by permitting simultaneous plotting, typing and computing.

III. A new program RK220 - Topo-Shoreline plot will be introduced. This program will accept a paper tape of shoreline and independent points, and plot them at survey scale. Future uses of this program will be to plot pre-survey review items, junction soundings and charted features also at survey scale on the boat sheet.

IV. Some hardware augmentation on the class II's is also coming. The data processing systems will have floating point hardware, dual density-duel drive floppie disks and OS/8. The OS/8 will permit shipboard personnel to write their own routines in Fortran.

SINCE HYDROPLOT IS TO BE WITH US FOR NEXT X YEARS...

LCDR Richard A. Schiro
NOAA Ship FAIRWEATHER

ABSTRACT

This paper deals with the possibility of improving the HYDROPLOT system prior to the 1980's upgrade. It is expected that any replacement for the HYDROPLOT system is years away and during this interim period improvements can be made.

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Those of you that know me, know that I have an opinion on most things, but this time I am not here to give you my opinion, but I am looking for some ideas or a consensus as to what short term improvements we could make to the HYDROPLOT/HYDROLOG system. There are those who think we should be doing absolutely nothing to it, now that new systems are going to be coming on line. This question mainly came about through discussions with Jim Green. I used to sit and tell him about all the things that the AIS is going to do, and he used to say, "Yes, but it isn't here yet." This is true, and I think it is also true of where we are with the data acquisition/processing systems today. What I am after is possibly improving the data quality or providing an easier time for those who have to use these systems. If we can make it easier, maybe we can also increase the productivity.

The "when" is, I feel, the real crux of the situation. We have talked about the post-1980 computer upgrade, BS^3 and laser systems, and there will be presentations on them later. I am not aware of any decisions that are being made or any planning for the phasing in of these systems. For some of these, I guess, we are not really sure when they will be ready to use operationally. But there is going to be a considerable amount of lag time in my opinion -- two to three years--even if we decided right now to go with these various options. So what are we doing in the interim? Obviously that depends on how long the interim is. I don't think there is anyone that can say with any definiteness what that time period is, and a lot of these things would depend on when, and how would we phase in these systems.

I think there are three areas for potential improvement. The first is hardware. Because of the way the system works and decisions are being made about future systems, this is probably the area where we can expect least improvement. Possibly we could have HYDROPLOT/HYDROLOG with a heave-roll-pitch, sidescan sonar, multibeams or broad-beam transducers. However, until it is decided what the sensor mix would or should be, I don't see very much hope practically for doing anything in this area. I could be wrong.

The other possible hardware area would be in computer/logger peripherals. Supposedly Class II's are going to get a floating-point processor, floppy disc, which would give us random ocean storage capability and FORTRAN-IV. Another improvement might be magnetic storage media, which some of the new systems already employ -- magnetic tapes, cassettes, or floppy discs. Also, a faster and different plotter might be advantageous such as the printer/plotter that the BS^3 has, which can produce a quick plot of the day's data and, maybe, resolve the problems that we now go through in the various stages of plotting and replotting and getting bugs out of the data. A quick way of getting a plot out might speed up the processing. I think this also probably gets back to an area of deciding whether or not, with the new systems in the future, do we want to keep the idea of a boat sheet. That's an unknown, and there are various opinions on that as well. If that could be determined, we might be able to get a faster plotter interfaced with HYDROPLOT/HYDROLOG which would also be usable with the newer systems, so that money wouldn't be lost.

The next area includes software, and again some possibilities I thought about were digital source document data in G.P. form, which is along the lines of a product that several of us have been working on. An expanded version would include all the symbology that we use now -- that would be a possibility. With FORTRAN we could make use and borrow software products that are already available. I really think that the main reason why we have had such trouble in maintaining HYDROPLOT/HYDROLOG and getting new changes out is just due to the assembly language itself. With some of these other software products, you could not just pick up a product and, if it works at the Marine Center, expect it to work on a ship -- it requires some adjustment. It is certainly a lot more feasible to move a piece of software like that rather than to reinvent the wheel. This could possibly include the excessing software that's used at the Marine Centers now, and where we are doing developments we could excess out those soundings which weren't important. Contouring routines would be a possibility, but I don't know if that would be worth the effort. Smooth tides or zoned tides are a possibility. Then we could also get into another class of software. I think basically our systems are automated loggers and nothing more than that; in fact, I think we lost a little bit when we compare with the old manual methods, because there we had a third LOP, we had a DR as the man was plotting the data. I think we could do more to analyze the data that we are collecting now, like maybe fix strengths, DR in the heading and comparing that with the actual rate that was collected in the field, and if there is a significant difference, possibly flagging that as a problem or erroneous data. We could do system checks with cross lines possibly. It also might include, depending on the line spacing and the development in an area, what is the probability that we have detected a navigational hazard. Maybe we could print out that we have a 63% probability that we have detected a shoal. Another class would be data checkers. We have some of them now, but maybe with the floppy disc we can load the corrector and the master tape and run a consistency check before we ever go to the plotter. And possibly utility computations, which would include positioning error contours, which would better give us a handle on what is our error budget with a particular system given the geometry and other constraints. And possibly it could include some geodetic packages. I know supposedly we are buying HP calculators. In my opinion, I sort of hate to see that, because here we are with another machine that has its own language, that somebody is going to have to program and maintain. It seems like we're going in the opposite direction.

The conclusion to this is, I don't know. Now that I have thrown out a few things I'd like to open it up for discussion.

DISCUSSION

CDR Fisher: I think it is excellent to be addressing this, because there seems to be such an emphasis on the beach areas, and one thing that I was just involved in a little while ago that worries me about the post-1980 system is that the Class IIIs do not have any high-speed processing technique. You just mentioned the floppy disk. Recently those two ships put together a joint justification for this equipment, the reason being that they are still what I would consider five years back as far as editing techniques, low-speed editing, teletypes, etc. And it was approved by the Director of the Marine Center, but when we went to Rockville, C3 looked at it and said, "No, we have a post-1980 system coming along, and therefore we won't put this system on Class IIIs." Even on the original study it said it would go on the Class IIIs as soon as money was available -- I read all through that; Jack Wallace and I went over it. That sounds like sour grapes, but I think it was done poorly.

LCDR Schiro: That's a valid point, and I think that's the crux of what I've tried to present. That might be a valid decision. Computer procurement is really a mess, to say the least, in the federal government, and someone might have the knowledge, and at some point there should be a line drawn, to say, "You're not going to invest any more money, given the fact that we have limited resources and other plans in this area." But again, I don't believe that that decision point is here. It depends on the time frame, what might be reasonable and what might not be reasonable. I would like to see it addressed. Given the fact that these future systems are coming and I believe in them, I think that we are going to need a suite of systems to do all the various jobs that NOS is going to be faced with, but until that mix and until that time frame is decided, what do we do for our people now?

CDR Fisher: I am wondering, on that argument about the post-1980 system, how many times it will be used. I am wondering just how many things come out of this meeting here or any subsequent meetings that will be tabled by saying, "A future system will address that."

LCDR Schiro: Well, Mr. Green said that if we identify a strong consensus, maybe we can type something up and generate a letter to formally address this. It's more than just bandying it back and forth if some sort of consensus could come out of this. With strong opinions, maybe we could do something.

LCDR Bass: Regarding your initial question on time, the post-1980 system was supposed to be installed in late '80. The funds weren't acquired, so now it's late '81. The funds still aren't acquired, so that is a very tenative date. The last of the new equipment wouldn't even be installed in the last of the fleet ships until '83, assuming we get the money. Yes, I agree that between now and '83 is a pretty long time and we ought to either develop routines to carry us through that period and do a little experimentation right now to integrate these new technologies into existing systems, so when the post-1980 equipment arrives it won't be such a shock.

LCDR Schiro: Even if we start buying equipment, let's say it's '81 -- let's say it's '80 -- let's say it's tomorrow -- how are you going to phase it in? Are you going to do it one ship at a time? A class at a time? If so, software has got to be developed. It is a long time frame. I don't know when these decisions are going to be made, but it would be nice to realize that a range of things could be done, the reasonableness depending on the length of time.

LCDR Goodman: I couldn't agree with you more about the present system. I think primarily, although we have automated techniques, it's automated logging, and as a result we have lost some of the means of quality control. As far as what we do now, I think perhaps we have a procedural problem. We make certain proposals. Where do we get those proposals answered? I think, rather than trying to establish a list today of those things we could all agree upon, the better thing would be to establish a small group that is a proxy for us.

LCDR Schiro: That's a good point. I think we are taking a step in that direction with Captain Mobley's position in the C3 staff, maybe it needs to be enlarged upon. That was an encouraging sign.

Mr. Westbrook: I have always thought that a good development would be a good heave-roll-pitch meter and sensor, regardless of the other type of equipment that is on board -- this would be a great advantage. Is it feasible, if we did have one of these that really worked, could you incorporate it with the HYDROPLOT system?

CDR Hayes: OMT spent three years building a heave-roll-pitch meter, and the thing is still sitting back in Rockville. In six months Datawell Corporation put one together and put it on the DAVIDSON. They can order as many copies as they want. They are here; all you have to do is buy them.

Mr. Westbrook: Do they work?

CDR Hayes: Yes. The one at Rockville will never work.

Mr. Westbrook: I don't care who made it. But there again, I think that something like that should be able to be approved, saving a lot of rescanning that is necessary now. It would be beneficial no matter what system you have.

LCDR Goodman: When I first got to the MITCHELL, I was rather frustrated by all of the scanning that went on myself. Again, I go back to the problem of having a place to make a decision. The scanning now could be solved with simplicity for certain areas. It could not be solved on the West Coast without the type of system that Captain Hayes was talking about, but we could do certain types of very simple smoothing algorithms, real-time, on line now. The problem is finding someone who would say yes or no.

LCDR Schiro: Right before I left Rockville, as you know, I was infamous for this post-1980 requirements document and got a lot of flak on that, but I really wasn't talking about sensors -- I was talking about processors. I'm not going to say that those aren't other important questions to be addressed, and yes, it is very frustrating, especially with the way things are divided up in the organization, to reach a consensus or even to find a group that you can go to or a person to go to to make those decisions.

LCDR Goodman: With regard to your concern, I am aware of a couple of simple types of algorithms that do the same thing that the scanner does now. It is much better than the qualitative approach that a man does with his eyeball with a sense of judgment.

Mr. Westbrook: One of the reasons we were hesitating to go in that direction was the idea that, once you had something like that and figured that you were satisfied with it, it really isn't the right way of doing it because of the fact that you have sand waves and all of these other things that you may be averaging out. He has a point, that if you knew where to use it and used it correctly, it probably would be good, but then you might be likely to be satisfied and not want to go to doing in the real correct way. But in the interim, somebody perhaps should have developed that and used it to save a lot of trouble.

LCDR Goodman: We are entering an era, though, where we are going to have to get a lot more educated. A question came up earlier about the algorithms for smoothing the horizontal control. That algoiythm is being built, and we are going to accept it. The hydrographers should be able to make decisions as to whether this algorithm fits their situation.

Mr. Carstens: I would be more radical and say that when the sea exceeds a certain limit they should knock out the digital reading and force the hydrographer to manually scan the fathograms. We are getting a lot of fathograms that do not take into account the sea in properly averaged amounts. At the Marine Centers we recognize the the quality of the sounding is not adequate -- it is much more adequate if they manually scan. When you talk about quality of data, our surveys don't measure up in many respects.

LCDR Schiro: I think that's stating the obvious, and I think there are many factors that go into that fact, and that's one of them. Another is knowing what sort of error bounds you have on what you're collecting. We don't do that a lot of times. We say, "If this is third-order control, the arc intersection should be greater than 30 and less than 150, I've calibrated and I've baseline checked, and they ought to be pretty good." I'm not so convinced that we always know what we should be knowing about our information.

CDR Hayes: I would agree to a certain extent with what Ray says about fathograms with sea conditions being a swell measuring three, four or five feet, and maybe you should hand-scan. But if that's a problem, then you should throw them out. Because with the Ross fathometer, not only have you got a problem with swells, but there's roll and there's pitch, and you don't know where that sounding is coming from or whether you're measuring a slant distance or what. If you're talking about hand-scanning because of that, then throw the fathogram out -- it isn't any good.

LCDR Schiro: I would like to ask, shall we do anything? Even that basic. As opposed to saying what. That always depends on one's priorities and viewpoints and what resources we have. Should we do something, and if so, maybe we can identify a couple of areas that are most important, realizing that some of these newer systems will have mechanisms to control some of those things like heave, roll, pitch.

CDR Nortrup: Bob Hopkins came down and talked to us about BS^3 recently. One of his oversights, if you will, was that the depth selection routine that's now used in BS^3 could be applied to HYDROPLOT very effectively, and it appears to me that this depth selection routine plus the heave-roll-pitch unit for the HYDROPLOT could pretty much solve everybody's complaints.

LCDR Schiro: I agree with you. I really think we're going to need BS3. I think we're going to need the laser, and I think we're going to need a broad-beam transducer and a heave-roll-pitch sort of like the way the launches are now. No multi-beams. The laser isn't going to take care of all of the areas. I think we are going to need at least three sensors, four if you throw in sidescan, in the 1980s to do our job, which is why I came down so hard on that -- maybe too hard, but I don't think so. Processing capability and computer capability. I wasn't saying which was the best sensor or prejudging them; I think we need a system that is flexible to handle any one of those four and not have to be involved in waiting for a contract programmer or one person as assembler because no one else knows it -- I really think we are going to need all of those options.

Mr. Mordock: Beside heave-roll-pitch, the thing that makes BS^3 work is software. If you can get the heave-roll-pitch, that's the only initial hardware cost; then there are software costs. I haven't told Bill yet, but on the sheets I just sent back to Rockville on the BS^3 there are some bad soundings in the HYDROPLOT. They get through that because there isn't the software there as with the BS^3. That's pretty fantastic. And that was pretty dirty software.

LCDR Schiro: That's another thing I am saying -- even if we throw post-1980 upgrade on top of the laser and BS3 and all of the rest, even if the decision were made right now, we are talking at least three or four years. And maybe we want to go plodding along as we have been plodding along for three or four years. That might be a valid decision, but I think it ought to be an informed one.

LCDR Pickrell: When you're talking about the heave-roll-pitch, to make good use of it, you are going to need it pretty extensively in most of our vessels. But that also means with that you need a magnetic recorder, doesn't that? And you're also going to need a lot more software that hasn't been developed, which, in order to get that in three or four years, or five or six years, is going to have to be done in high-level language, because we have seen that the assembly language programing doesn't do it. So you are talking about a whole effort, it seems to me, that may take three or four years, or five or six years as well.

LCDR Schiro: Possibly by identifying some of these common denominators we might be able to do something for the hydrographer in the meantime, plus get a jump on all these things we are going to have to be doing anyway.

LCDR Pickrell: I think one good starting point, even without this hardware, or without all of it, would be to get a FORTRAN-compatible floppy-disc or magnetic system, preferably floppy disc, to go on all the ships. One of the main reasons for keeping to assembly language all along is to maintain standardization, which I think is a valid point. But, if you can't get the support, which we haven't been getting, we have to do something. If a little bit of standardization goes by the wayside, as long as someone from the Marine Centers or somebody on the ship is smart enough to see that it is good, then I think that is a viable way to go to get some aid in the near future.

LCDR Schiro: I think the main reason we had assembly language was the limitation of the machine, but yes, it was also standardization. I believe I would much rather have the capability of our people to make contributions to the system, so I would rather open it up a little bit and have a plethora of talent, routines, capabilities and expertise working on the system, and I would rather take a chance. I still think that most of our people are reasonable; we follow pretty much the guidelines we're supposed to when running hydrography now, I think we can do the same thing for software development as well. I hope. I trust.

IS THE ROSS FATHOMETER ADEQUATE FOR ITEM INVESTIGATION?

CDR Carl W. Fisher
Chief, Operations Division
Atlantic Marine Center

ABSTRACT

This paper discusses the advantages and disadvantages of a narrow beam transducer when doing item investigations. Other techniques are touched on such as wire drag, side scan sonar and the BS^3.

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This is certainly not a new topic nor will any of the concerns presented be astounding. However, it is time we discuss how little we may be achieving with this fathometer, the impact on survey efficiency and some of the options open to hydrographers to improve the situation. Discussion of reports of successes and failures of various field units after my presentation might be in order to begin assessing the magnitude of this problem.

Prior to open discussion on this subject, I would like to present some technical information on fathometers, results of experiments conducted while aboard the PEIRCE, and finally, recommendations to be considered by both hydrographers and management. The selection of an appropriate transducer beam width is a problem especially if the same fathometer will be used for mainscheme hydrography and item investigations, which could include items of relatively small cross sectional area such as rock pinnacles, wrecks, etc.

It appears that NOS has primarily emphasized the specification that a fathometer measure the depth of water directly beneath the transducer very accurately. Prior to the Ross fathometer, NOS used fathometers with wider beam widths such as the Raytheon 723. One of the problems with wider beam widths was that on sloping bottoms, the signal returned from the side of the beam first, which might have been shallower water, and was recorded instead of the deeper point directly beneath the transducer. This problem has been well documented in manuals, etc. However, I did find a letter from Ross Laboratories to the Pacific Marine Center on this subject dated 13 December, 1971, most interesting. Included with this letter were plots of the beams produced by Ross, Raytheon, and Edo (PDR) transducers. I would like to refer to these plots to show all concerned what the problem is.

In order to compare beam widths, we will select the angle from side to side of the main beam, not the side lobes, at the 3db level. The Raytheon 723 transducer has the capability of producing a beam 15° in one direction and 60° in the other. It could be installed with the wider beam either fore or aft or athwartship. The Edo (PDR) transducer has a presumably conical beam of 45^o. The Ross transducers originally installed in the early 1970's had 5^o x 10^o beams which I believe were installed with the 5^o beam athwartship. However, in the past couple years, these have been replaced with Ross transducers with a 7^o conical beam, which is actually 6^o. All Jensen launches were requipped with 6^o conical beam transducers. The plot of the 6^o beam is not from the 1971 letter but was produced by NOS.

Our rules for selecting line spacing for a survey and for interpreting fathograms as to strays, side echoes, etc., were developed when NOS was using the wider beam transducers. The questions now are:

1. Was any revision of procedures considered necessary due to the more recent narrow beam transducer?

2. Has there been any study made to determine the probability of missing unknown pinnacles, etc., on mainscheme lines and item investigations (i.e., were more detected in the years prior to the Ross fathometers than now)?

3. Are fathometer searches during item investigations considered adequate or are field units now using more non-fathometer-type techniques to compensate for the deficiency of the fathometer?

4. Is it possible to adequately survey the bottom with any of these techniques so that when an item is not found, its existence can be disproved?

5. Has the impact of the use of narrow beam transducers on survey adequancy and efficiency been assessed? For example, did we sacrifice more than we gained to obtain a very accurate sounding directly beneath the transducer?

6. Can we accomplish the accurate depth requirement and the investigatory search by a mixture of varying beam widths and techniques?

I'd best address an obvious comment now; that being, the requirements of ITEM 6 may all be met by the new BS^3 system. However, to put this in perspective, I am talking about predominately launch hydrography being conducted now on basic hydrographic surveys and on chart evaluation surveys. I do not believe we have any near-time projection to equip all ships and launches involved in these types of surveys with BS^3 systems.

Now to address these questions in order:

1. The Ross 6^o conical transducer actually sees little of the bottom when running a scheme of hydrographic lines, i.e., in 50 feet of water with a flat, level bottom the beam swath will be 2(50 ft. x tan 3^o) or 5.24 feet, considering the launch is not rolling and a signal strength of 3db. For comparison, the 15^o beam of the Raytheon 723 fathometer would see a swath of 13.17 feet. The line spacing would have to be considerably reduced from its present criteria to insure detection of unknown items and

features on mainscheme lines, and in fact, is being extensively reduced for assigned presurvey review items and item investigations. I have heard reports of field parties conducting fathometer searches at 5 meter line spacing over areas up to 500 meters wide. This, for example, amounts to 100 lines and still would not see all the bottom in say 50 feet of water, but should detect any item of reasonable size.

In March, 1977, the PEIRCE participated in a study with the NOS Engineering Development Laboratory (EDL) to quantify the accuracy of the acoustic portion of the hydroplot system as deployed on a Jensen Launch. The residual bias and precision were documented in a report dated 30 September 1977. However, in addition to the stated objective of the study, I found another aspect quite interesting. The test was conducted in protected waters near Miami in an area with a flat bottom ($\pm$ 1 inch) extending over a 25-foot by 10-foot area. The water depth ranged from approximately 10.5 to 11.5 feet during the test due to tides. In order to insure the same bottom was sounded each pass, its limits were marked on the bottom with two water-filled, 55-gallon steel drums laid perpendicular to the track line with an approximate cross section of 3 feet by 2 feet. Angle brackets were welded on the drums to preclude "rolling." Surface markers were moored on a one-to-one scope along the track line, in a manner similar to the marker buoys for the tow-boat on a Water Ski Slalom Course, with just enough space between them for the launch to pass through to insure that the launch passed over the same track each time. The intended use of the barrels was to provide distinctive marks on the fathograms when the launch was sounding the bottom between the barrels. Fifty-four passes were run in the same direction at three knots (600 rpm) over a four-hour period. Three of the passes were disqualified due to operator error. There were only 13 of 51 passes where both barrels were observed by the fathometer. This amounts to only 25.5% of the time that targets of this size were seen in approximately 10 feet of water. It is appropriate to state that the missing of a target was due both to beam width (in this case 1.05 feet) and sweep speed of the fathometer. The effect of sweep speed was minimized by operating the launch as slow as possible. I know these results should not surprise many attendees here. After being Commanding Officer of the PEIRCE for two years, I can report a few successful returns off wrecks, etc., with the Ross fathometer but usually at considerable expenditure of time searching and an overall success rate of less than 25%.

Discussions with verifiers suggest that they have seen fewer strays and side echoes of the type previously recorded by the Raytheon fathometer. There are still many indistinct strays, apparently caused by fish but do not "break the trace." Returns, if any, off wrecks seldom show indicators such as scouring, etc., as illustrated in the hydrographic manual.

In response to Question 4, field units are using a number of techniques to supplement or even replace fathometer searches for item investigations. Usually, the techniques used are dictated by the availability of the equipment. The PEIRCE's only alternative to splitting line spacing to unreasonably small distances is to implement more small boat chain drag, wire drag and wire sweep techniques and/or conduct leadline searches.

There will be a presentation on this topic at another time but suffice it to say the PEIRCE now expends considerably more time on PSR items and investigations than say three years ago.

In 1975, the DAVIDSON evaluated the use of a side scan sonar and submitted a report with the following recommendations:

1. "That a state-of-the-art side scan sonar system be adopted by NOS as an operational tool."

2. "That two complete systems be procured and one each assigned to the Atlantic and Pacific Marine Centers."

3. "That one or more individuals be thoroughly trained in the use and interpretation of side scan records and be available for assignment to various ships as the need arises."

There was no direct comparison of the side scan system to searches with the Ross fathometer but the comparison with small boat wire drags or sweeps did prove interesting, especially to a field unit now expending considerable time on wire drags and sweeps. If an item was actually found, the side scan sonar achieved this in one-sixth the time as the wire drag or sweep. However, if the item was not found, then in addition to performing the side scan sonar search, the wire drag or sweep was conducted in an attempt to disprove the item, resulting in an expenditure of seven/sixths the time. Attendees will discuss the pros and cons of side scan sonar at another time during this meeting. For the record, there was one side scan sonar assigned to the Atlantic Marine Center but it is used full-time on the RUDE and HECK, apparently with reasonable success.

Other East Coast ships have intermittently leased or contracted boats with side scan units. The PEIRCE contracted a private dive boat in Lake Huron this past year which had a Wesmar Side Scan Sonar aboard. Seven wrecks were located in approximately ten days due to this equipment and the boat owner's local knowledge of the area. Divers obtained least depths. Recently an East Coast hydrographic survey ship initiated a request for a side scan sonar to use on a Chart Evaluation Survey in 1979. The probability of funding for the equipment is very low, and the request will most likely be denied.

What are the alternatives to consider to improve the hydrographer's capability to conduct item investigations and also improve on efficiency:

1. The least desirable alternative is to continue with the present Ross fathometer and/or leadline search techniques, and direct field units to continue reducing line spacing until proving, without doubt, that an item could not lie undetected between lines. A major problem would be the negative impact on survey efficiency and morale.

2. Install a wider beam (i.e. 45^0) transducer in addition to the present Ross transducer with a switching capability to be used with the

hydroplot system during fathometer searches. This would result in more bottom being covered efficiently but would require more interpretation of strays and side echoes. A major problem might be that the wide beam transducer could inadvertantly be used during mainscheme hydrography, thereby reducing accuracy and causing confusion in processing. In addition, the success achieved with wider beam transducers during fathometer searches is, at best, questionable.

3. Improve small boat chain drag, wire drag and wire sweep techniques to insure adequacy of coverage and increase efficiency in use. There is still an unresolved question regarding the ability of small boat drags and sweeps to disprove items. Hopefully, that problem will be discussed elsewhere.

4. Increase the use of side scan sonars for item investigations. To my knowledge, there are presently three Class III survey ships and one hydrographic field party conducting an extensive number of item investigations each year as part of Chart Evaluation Surveys. In addition, these ships and the remainder of the hydrographic field units investigate perhaps a lesser number of items, but still a significant effort, during basic hydrographic surveys. This represents a considerable expenditure to purchase side scan sonar systems for all these field units. Even though this equipment has proven quite effective in locating items, it is not acceptable to disprove the existence of items, and the hydrographer must resort to conventional methods if the item is not found during the side scan sonar search.

5. Expand the concept of the Bos'n Swath Sonar System (BS^3) to include all launches and ships involved in basic hydrographic surveys and chart evaluation surveys. As previously stated, the deficiencies of the Ross fathometer and the problems in conducting item investigations are being encountered now. Does NOS plan to implement such a system on a wide scale in the near future? Is the cost too great? Can the system even be deployed on a launch?

To provide a forum for further discussion, I would like to suggest some areas for improvement. Perhaps some achievable goals might be:

1. Have management recognize the limitations of Ross fathometer and design requirements for investigations accordingly.

2. Initiate a coordinated effort at NOS to develop and approve efficient small boat wire drag and sweep techniques.

3. Have NOS, at the program level, address the requirement for additional side scan sonar systems and, if justified, provide funding. Perhaps a cost/benefit analysis should be made to assess the increase in survey efficiency, especially during chart evaluation surveys.

4. Management should address the requirements for disproving items and match them against the capability of small boats for achievement. Perhaps we are striving for the unattainable. If so, this raises a serious question regarding the concept of chart evaluation surveys.

5. Perhaps the hydrographer should be provided with a mixture of the best techniques available for conducting item investigations (i.e., from the five alternatives previously suggested) in order to increase the probability of success in proving or disproving an item's existence.

DISCUSSION

CDR C. W. Fisher : Asked attendees, "Is anyone aware of an official acceptance of the Ross by NOS?"

CDR Hayes: I can't think of any piece of equipment that we have that is certified, except for the old-time sextant.

CDR Fisher: Here is the problem. If these are true limitations, I feel that at least the hydrographer should recognize limitations of the Ross and what this relates to is starting to think about our project instructions and our requirements for the way we conduct a survey.

LCDR Schiro: Larry and I both read this article called "The Probability of Detection of Hazards to Navigation", and basically the gist of the thing is that you can accomplish a lot more by randomizing your investigations on floor search as opposed to just decreasing the line spacing. Now, I know we all sort of know that, but given the fact in a peak month you will spend X time running sounding lines in some sort of pattern it seems that, in an academic environment -- perhaps the statisticians in postgrad school can give us a handle on this -- we ought to spend some time investigating what is the most efficient way of searching for them with the line scheme. Again, I'm not saying that we shouldn't just rely on that, because you're going to go ahead and sweep the thing, but given the fact that you are going to spend X time, how might you maximize the time spent searching for an item.

Mr. Mordock: I'm not positive it would help for investigation once you possibly know an item is there, but I have investigated a little bit -- again, somebody from the hydro school might want to pick up on this -- it won't be long before we can get historical data from the data base, and I think using surface modeling techniques and the digital shoreline, which I think is going to be realistic in the next few years, we can take an area and come up with the best possible random method to run that area to detect shoals. It's going to take computer software and the kind of computations involved will have to be done either at headquarters or the Marine Centers. . . .

CDR Fisher: Let me get us back to the point. You talk about randomizing the survey, but are we engineering around this problem, or is our basic problem the fathometer?

Mr. Mordock: I don't think we are. I think what we're going to say is what kind of fathometer are you using and what kind of a statistical confidence interval do you want to establish. Do you want to be 90% confident that you have detected all shoals that are, say, less than 10 feet? Given this data and given the analyses, I believe it is conceivable to come back with a random pattern to run. Now the machine has also got to tell you how to run it, because with random lines, if you don't connect the dots properly, you'll never get it to run. So not only has it got to show you where to go, it's got to show you how to do it. But no, I think it should be engineered for any beam width and any confidence interval for any shoal less than such and such a depth, given the historical data.

CDR Fisher: I feel that any of our hydrographers who have been working with this data for twenty years or so must have had some inkling of what we have accomplished in the last ten years, especially on repeated errors. I see the comments come back on surveys, and I see items that were found on prior surveys that were not found on subsequent surveys. We're not really sure that they're not still there; it's just that they weren't found. I talked with a verifier earlier from AMC and asked the question, "Do you guys see the strays and the indications of something that cause you to go back and look, and is it correct to say you felt you saw fewer?" I think perhaps we made a mistake, and I'm not sure NOS wants too much made of the mistake, but this Ross may not have been the thing to use the last ten years.

LCDR Richards: Last year about this time, EED and PMC had promised to put a toggle switch for a wide-beam transducer and narrow-beam on the Ross. Was that done? What were the results of it?

Comment from floor: This was installed on the RANIER, was evaluated and they are preparing a report.

CDR Fisher: It's an idea. The thing is, it may be -- for want of another word I will have to use "bastard" idea, because we kind of bounced around the problem and we are getting to a thing I will quote LCDR Schiro on, and that is, "Maybe what we need is a mix." About the only thing we can do as hydrographers going out there is mixing techniques. At last year's hydro conference I made the suggestion that we get some coordinated development on small boat wire drag or sweep techniques. No action on that. Each ship, in trying to make up for the deficiencies of the fathometer search, are working with it. There is some cross-pollenization of ideas and information; it is getting from one unit to another. But it is sure a long way from techniques that we could have for ensuring that the wire is down to a certain depth. As I say, since making that request last year, the biggest problem that has come up is this policy question -- "Can you actually disprove an item?," and I wasn't actually aware of that until just a couple of months ago, and then that was laid on LCDR Suloff to take back to Rockville to look into. And then the last recommendation is for a standardization of equipment, procedures, and especially the approval criteria for item investigations for chart evaluation surveys. It's been kind of up in the air, and it started out that the ship wasn't meeting the criteria. The ship improved somewhat, and then as the education factor of classic wire drag techniques -- were learned by the people in the requirements that then the approval tightened up and fewer were approved. I expect in this coming year that it will be very tight, very few will be approved, and this raises a whole question as to chart evaluation surveys, are they accomplishing what the Director of NOS thought they would -- I believe not.

Mr. Carstens: Another marked disadvantage of the Ross or any high-frequency fathometer is the type of tracing they come up with when they cross a grass or kelp area. A lot of times the bottom under the grass or kelp isn't indicated at all. Either you accept what you see on top, or you reject it. If you reject it, the hydrographer actually should be watching those areas and going back with a hand-lead to come up with depth in those areas.

CDR Fisher: Part of the problem is our not recognizing the limitations of the Ross. I agree with you on that. I don't completely agree with the feasibility of a leadline drift study to come up with an item. I've attempted it; maybe I just don't have the skill that our predecessors had, but in water with no visibility, and I felt like I was trying to hit the pickle at the bottom of the barrel blindfolded. It is a technique that's cited as valid, but I think what we really want to do is make a decision on the Ross, and it is something we don't want to totally write off to being solved by the future post-1980 system. I think it would be good, Captain Hayes, if you commented on the BS^3 system. I don't think BS^3 is going to solve all our problems on this, because I'm talking about predominantly Jensen launch hydrography.

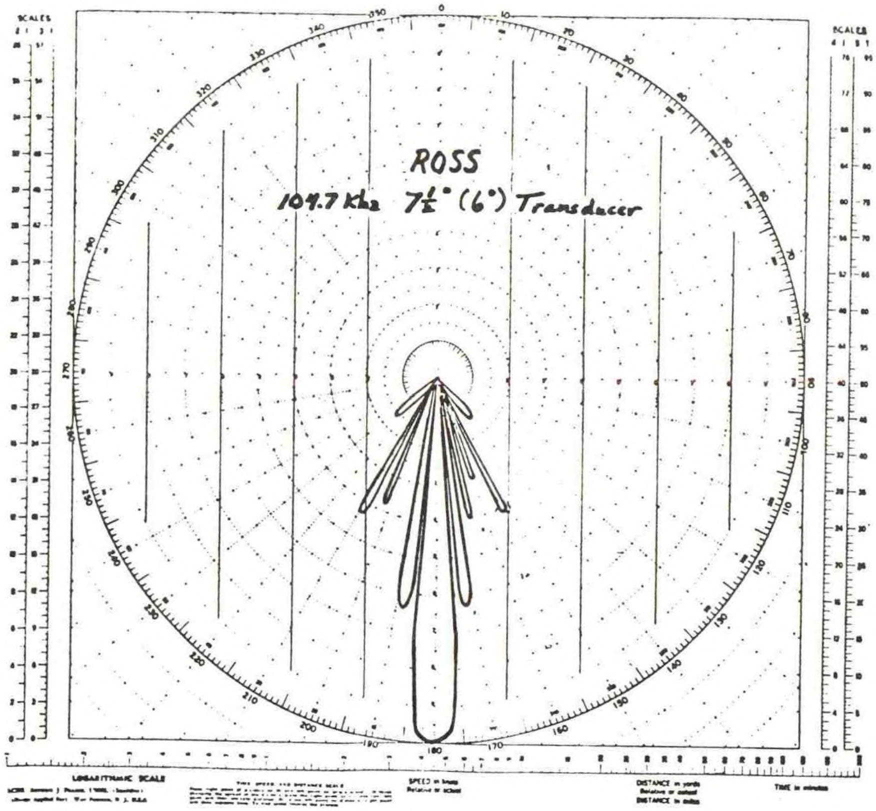
CDR Hayes: It probably won't do anything for you. You won't find very small objects -- we're talking about pilings or masts and that sort of thing. It's called a bathymetric swath survey system, and it does bathymetry.

CDR Fisher: We haven't heard one horror story about not finding something other than what I pointed out, the barrels and stuff like that.

CDR Smith: EDL did a study on acoustic determination, and the barrels would be a very poor source of acoustic return.

CDR Fisher: Well, all I can say is that you can't ensure the acoustic returnability of the wreck that goes down either. If we have no other horror stories, can I call on Bob Trauske about watching a ship sink and trying to find it with a Ross, just to provide perspective.

CDR Trauske: A couple of years ago we took a group of VIPs out to watch them sink a liberty ship on Fish Head Bank. They blew the bottom out of it and she went down. We had two buoys, one on the bow and one on the stern, on a one-to-one scope showing how the ship aligned fore and aft. We waited until after all of the bubbles had come up, and we followed the Hastings Raydist boat over the ship fore to aft. I don't know at the time what fathometer they were using, but they got a beautiful trace silhouette of the thing sitting on the bottom. We went back and forth over there a half a dozen times and never got anything. When we crossed it aforeships we did get an indication of something. This was only in about 60 feet of water.


ROSS
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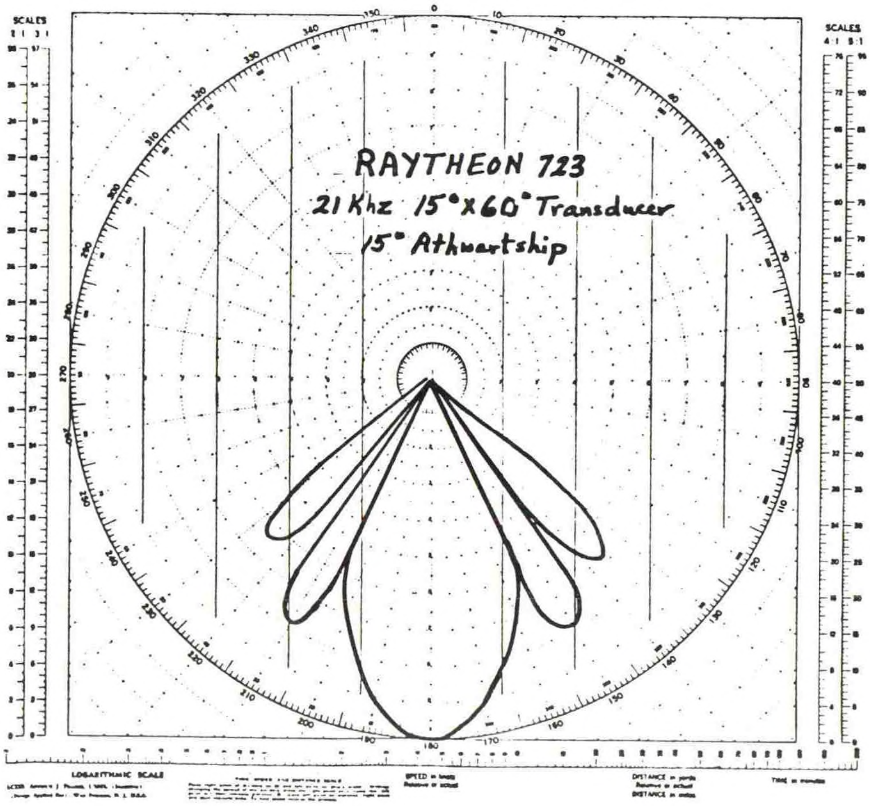
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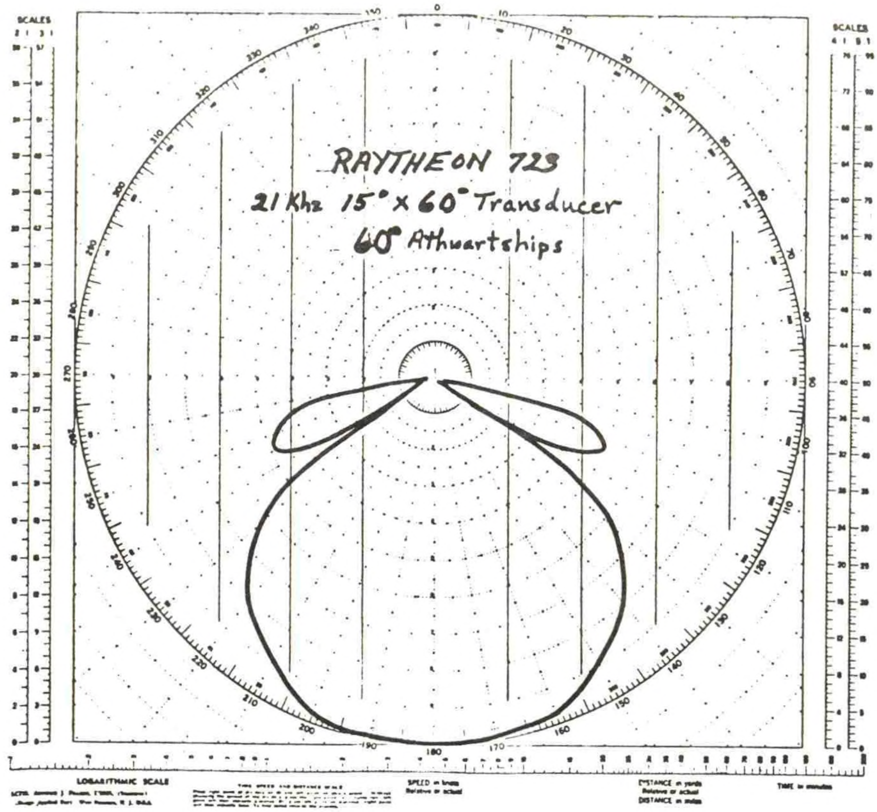
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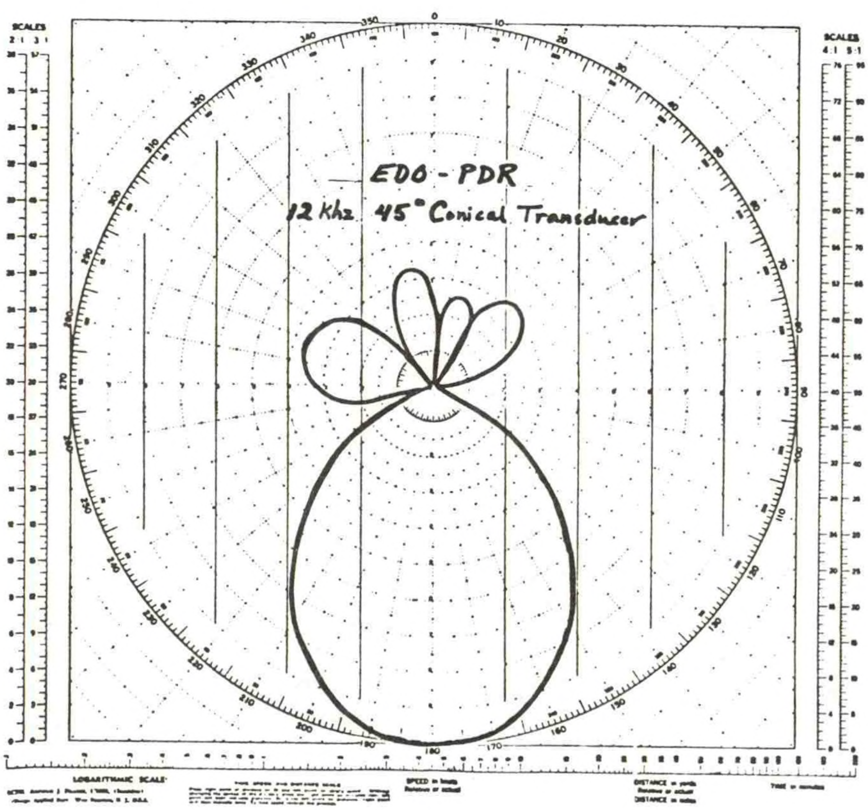
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12 Khz 45° Conical Transducer

ITEM INVESTIGATIONS

LCDR Donald L. Suloff
Chief, Requirements Branch
Marine Surveys Division
Office of Marine Surveys and Maps

ABSTRACT

This paper offers a definition of item investigations and describes the processes involved in researching and assigning items for investigation. Recommendations are offered identifying the methods a field unit can employ in investigating a given item and describing the subsequent documentation. The paper further outlines the office procedures used in evaluating a given investigation and its subsequent application to the chart. The fact is emphasized that not all items on a given chart are capable of field resolution and thus are not assigned for investigation; furthermore, that not all of the items assigned can be absolutely resolved.

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The National Ocean Survey has identified and investigated specific items for many years. "Items of opportunity" have been kept in active files at the Marine Centers and assigned to vessels operating in the vicinity of a particular item. Specific items for investigation have been identified within the Presurvey Review of a given hydrographic project. Recently Chart Evaluation Surveys have stressed the investigation and attempted resolution of specific items.

Item investigation may be defined as the total effort expended to resolve the questioned existence of a specific obstruction or feature. Absolute resolution requires the unquestionable disproval of the feature's or obstruction's existence or the accurate location and least depth of the assigned item. The effort is normally initiated by an office source search and evaluation which is followed by a field unit investigation. The results of this investigation are ultimately evaluated by office personnel and appropriate charting action applied.

Types

There are three general instances where item investigations are identified and assigned; two instances are office initiated and the third identified in the field.

A Presurvey Review is prepared by the Marine Surveys Division for each hydrographic survey. This essentially consists of items identified and assigned for investigation within the limits of the given project. An essential portion of all Chart Evaluation Surveys is the investigation of items within a given harbor area or stretch of coastline. These items are identified by the Marine Chart Division, but are similar in most respects to the Presurvey Review items.

The field identified items may be of two types. The Marine Centers may have on file items which have been reported by private individuals or groups which require field verification. They are typically assigned to field units working in the vicinity of or transiting near such an item. The field unit itself may identify specific items for investigation during the course of its survey or while discussing the area with the maritime public.

Origin

Of the office originated investigations, both the Presurvey Review and the Chart Evaluation Surveys are subject to a similar preparation process. The charts within the area to be covered are carefully reviewed. The source of every sounding and feature is researched and established. These sources are normally prior National Ocean Survey hydrographic or topographic surveys, U.S. Corps of Engineers' surveys, U.S. Power Squadrons' reports, or Chart Letters. After each chart has been reviewed, those items whose source or resolution is questionable are normally flagged for investigation. Before actually assigning an item, however, it is critically evaluated regarding the probability of resolution. The likelihood of adequately resolving some items without a full fledged wire-drag survey employing precise techniques is very low. Any item designated by PA, PD, or ED falls into this category. Such items will not be assigned to the field unit unless their proximity to vessel traffic areas and their potential danger to navigation is so great that the difficulty in resolution is overridden.

As previously mentioned, the items of opportunity on file at the Marine Centers originate from private letters. The items that are identified by the field unit can originate in several ways. The most common source are features which are discovered during the course of the hydrographic survey. All such indications of shoaling or bottom features must be resolved. While interviewing various marine interest groups, information concerning previously unknown features or obstructions may be reported. Every effort should be made to resolve such reports prior to leaving the area. While comparing the present status of an area with the latest edition of the appropriate chart, discrepancies may be discovered which require additional investigation, particularly along a developed shoreline. A classic example of such a discrepancy is the charted pier or piling which no longer exists. Not only must this change be described, but the area must be carefully searched to prove that no submerged ruins remain behind. Without this resolution, the charting action normally would be to chart submerged ruins in the area previously occupied by the pier or pile. On infrequent occasions, the field unit may discover items requiring investigation not assigned by the office examining prior surveys.

Priority

Inasmuch as those items assigned for special investigation are recognized as potential problem areas prior to commencing general survey operations,

they should be holed at a slightly higher priority than the basic hydrography. Correspondingly, they should be investigated under nearly ideal conditions by experienced personnel employing the best available investigatory tools.

Investigations

Upon arrival in the working area, the field unit should attempt to supplement the source information provided by the office by contacting the local office of the U.S. Coast Guard, U.S. Corps of Engineers, diving clubs, and other pertinent marine interests. Frequently such contact will reveal previously unknown information concerning the items and may, upon occasion, resolve them without additional field effort.

The initial onsite investigation may consist of a visual inspection. This is only applicable on near surface or bare items. Such inspections should occur at low tide and calm water with maximum underwater visibility. A sonic sweep for submerged objects or features is best accomplished with a low-frequency fathometer. This will maximize the bottom coverage of the sweep. At best, however, such an investigation will cover only a small percentage of the bottom. If available, a side scan sonar is far more likely to locate a bottom feature. Under some conditions, a leadline search may be the best available means of determine a least depth. A buoy is set at the location of the shoalest fathometer depth obtained and the immediate area is extensively searched with leadline or sounding pole. A wire drag or wire sweep is more likely to locate a bottom feature and may be the only manner by which such a feature may be disproved. An in-depth discussion of a variety of such techniques follows this paper. Although seldom an efficient method to locate an item, diver investigations are important in identifying features and determining their least depths. Although no written rules exist, certain guidelines setting the extent of coverage required for an item investigation have been used for a number of years in assigning items to wire-drag vessels. The understood limits of a search require a 1/2-mile radius circle centered on an item of known position and a 1-mile radius circle centered on an item of approximate or doubtful position. Recently an effort was initiated by those assigning items for investigation to further reduce the required extent of the search. The degree of certainty of the charted position of the item or bottom configuration in the surrounding area can reduce the area. Where possible, the item will have an accompanying statement describing the required extent of the search.

Documentation

The most complete and adequate investigation may not result in satisfactory resolution of an item if it is not properly and completely reported. A form was issued for Chart Evaluation Surveys which provides a good guideline in reporting investigations. The item investigated and its source must be identified and the time of the survey given. All appropriate records used in completing the search should be referenced. The geodetic positions, both charted and observed, should be listed. Control used in the investigation is briefly described. The methods employed in investigating the items should be listed; any unusual methods must be described. The weather and sea conditions existing during the investigation should be described. Any item discovered must be completely described. Not only is this important for proper charting and filing, but it may prove invaluable in future years when the area is again surveyed. Most important is the hydrographer's recommendation for charting action. If the hydrographer cannot make a well-documented positive statement concerning an investigation, it is unlikely that any charting action will result.

Office Evaluation

Upon arrival of a survey in Rockville, the survey is evaluated for its compliance with the project instruction. The items are examined for the adequacy and completeness of the investigations. Adequate control and extent of coverage is assured. The survey method is critically examined to assure that it conforms to National Ocean Survey standards. At the conclusion of this review, a charting recommendation is attached an the material passed to the Marine Chart Division cartographers.

Cartographer's Application

To properly chart a new item, the cartographer essentially requires an accurate position and a known depth of the object. If the charting action requires the movement of an already charted feature to a new location, positive identification of the feature is required. This assures the cartographer that there is in fact, only one item, rather than two items close to each other. Generally, these actions are routine.

However, the removal of a charted item based on a survey recommendation frequently presents difficulties. It is not unreasonable to require the same degree of investigation of all field units as is required of the wire-drag vessels although this may make resolution of some items practially impossible. Thus, the extent of investigations must describe circles of 1/2-mile radius for items of known position, 1-mile radius for items of uncertain position, or as modified by the project instructions. The bottom clearance of any drag must be within 3 feet of the bottom on the Atlantic coast and in smooth waters, and within 5 feet of the bottom on the Pacific coast. Obstructions discovered must be cleared by not more than 2 feet in harbors and channels, 3 feet in other areas of less than 60 feet, and 5 feet in areas deeper than 60 feet. Wire lift should not exceed 3 feet in waters less than 60 feet and 5 feet in waters greater than 60 feet.

The cartographer's final charting decision will be based on the scientific evidence presented by the field unit and a prudent portrayal of that information.

SUMMARY

In order to maintain the most accurate possible portrayal of actually existing conditions on its charts, the National Ocean Survey must attempt to resolve all questionable features presently existing on the charts or reported by the maritime public. To accomplish this end, item investigations are assigned to field units in a variety of manners. Through careful research, investigation and documentation, many such assigned items are resolved for proper charting. However, all hydrographers and cartographers must be cognizant of the fact that the uncertainty of many reports or charted features make their resolution either impossible or impracticable.

Supplemental Discussion Topics

In the course of investigating items in a near-shore environment, extensive changes in the existing shoreline topography as compared to the available charting source will be identified at times. There are three general methods of responding to such recognized changes. In many cases the shoreline changes are due to construction, in which cases private or governmental drawings will generally be available. These drawings should be field verified before transmitting for shoreline updating. Minor changes can be corrected by plane table methods. If response to the change is beyond the scope of the field unit, recommendations for updating photography should be submitted.

Existing cooperative charting programs have encouraged the submission of chart updating items from the maritime public. These items, if charted, are generally annotated with the limiting qualifiers of PA, PD, ED, or reported and frequently end up as items for investigation. Inasmuch as these items are the most difficult to resolve, it is important that they be carefully evaluated prior to charting. Such filtering does occur in the Marine Chart Division. However, the standard approach of this group is the prudent portrayal of the possible existence of a submerged or dangerous feature.

Although charting policy makes item disproval difficult in many cases, successful investigations can and do regularly occur. To enhance the likelihood of successful investigations, the selection of items for investigation has attempted to prejudge the probability of resolution and only assign those items whose resolution is likely.

The acceptability of small boat wire-drag surveying techniques has been questioned in the past and will continue to be questioned until comprehensive tests can be made on the actions of a towed drag under a variety of conditions. However, until such tests can be accomplished, a well-controlled and described drag will be accepted as a surveying tool.

SMALL BOAT WIRE DRAG

LCDR Donald L. Suloff
Chief, Requirements Branch
Marine Surveys Division
Office of Marine Surveys and Maps

ABSTRACT

Although no definitive small boat wire-drag system exists, this panel discusses the requirements that must be met by such a system and presents four systems that have been used by the National Ocean Survey and by the British Admiralty. These systems are contrasted to the system presently used aboard the NOAA Ships RUDE and HECK.

INTRODUCTION

As was discussed in the Item Investigation paper, it is not unreasonable to require the same degree of investigation of all field units as is required in the wire-drag vessels, although this may make the resolution of some items practically impossible. Briefly, these requirements include a maximum clearance of 3 feet from the bottom on the Atlantic coast and in smooth waters, and 5 feet from the bottom on the Pacific coast; obstructions discovered must be cleared by not more than 2 feet in harbors and channels, 3 feet in all other areas of less than 60 feet, and 5 feet in areas deeper than 60 feet; and wire lift should not exceed 3 feet in waters less than 60 feet, and 5 feet in waters greater than 60 feet. The area of coverage, unless stated otherwise, must cover a circle of 1/2-mile radius for items of known position and 1-mile radius for items of uncertain position. With these guidelines in mind, four different types of wire drag are to be addressed. Although no final solution is offered, this presentation should provoke thought and illustrate systems presently available. We will be presenting the description of four different systems, how each system is deployed, how the system is controlled both in vertical aspects and horizontal aspects, and the limitations of the systems.

LCDR Tom Ruszala is currently the executive officer aboard the NOAA Ships RUDE and HECK, a post he has held for the last 2 years. He will explain the method presently used by the wire-drag vessels.

CONVENTIONAL WIRE DRAG

LCDR Thomas W. Ruszala, NOAA

Once assigned an item with the 1/2-mile to 1-mile investigation circle, we look at the bottom contours, because that in effect will determine how we are going to run our drags. The way RUDE and HECK initially prepare for a drag operation is to set out the ground wire, a 1/4-inch stainless steel wire. The ground wire is divided into sections or units of 100 feet. At lengths of anywhere from 300 feet to 600 feet (which is normally used) are intermediate weights. These are 35 pound weights; at the end of the drag are 85 pound weights. Each of these weights is suspended from the surface by a buoy with 3/16-inch wire. Along the wire itself at 50 foot intervals are what we call toggles. Actually they are small 1-1/2-foot flotation devices which are clipped on the ground wire, preventing excessive sag or in some cases lift. The first drag is usually in the most probable position and, depending on what the bottom contours are, with the largest drag possible which would be 7 to 9 buoys. The effective width is 75 percent of true width because of the catenary effect of the two vessels pulling and the drag of the wire. On the supposition that drag snags or hangs on nothing, additional drags are then run progressing toward each side of the circle. A 600-foot overlap is maintained with the previous drag and at least 600-foot overlap used at the extremities of the circle. The overlap criterion is arbitrary but has been traditionally used.

The drag is initiated by the HECK, traditionally the end vessel, steaming to a setout point. At that point, using Raydist as control, she drops the first or intermediate buoy. The RUDE then comes alongside, picks up the buoy, and both vessels start working out to the endpoints deploying the wire. When they reach the endpoints, they both begin running down the track line. As the wire takes its catenary effect, the testing program begins. The testing program is conducted using a life ring modified with a small winch, 3/16-inch wire, and a 10 foot pole. The pole is coated with a grease and white lead composition. The point where the wire strikes these poles indicate whether there is sag or lift. The testing program is conducted from the ends of the drag inward to the middle. As soon as that is accomplished, it is then rerun. The testing is conducted until the drag terminates. If we find a problem with excessive lifts in certain sections, we modify our operation speed or the amount of wire in a towline to try to bring the lift down to acceptable levels. Horizontal control between the vessels is maintained by Raydist. Both vessels exchange data which enables both vessels to monitor the action of the other. Normally the vessels are swinging in and out, trying to negotiate the currents and the wind and at the same time maintain the strain on the towline. With the exchange of data between the two vessels, they are able to compensate in advance for what would be an adverse type of maneuver. This same system has been used several times using launches which are 20-foot work boats. Just one or two intermediate buoys with about 200-foot sections of wire between are used.

With this system in mind, LT Pamela Chelgren will describe an otter board drag system developed by the NOAA Ships DAVIDSON and PEIRCE and a chain drag system. LT Chelgren has been the operations officer aboard the PEIRCE for the last 1-1/2 years.

OTTER BOARD AND CHAIN DRAGS

LT Pamela R. Chelgren, NOAA

We use two drag methods on the PEIRCE when we are operating in areas that require dragging techniques. The otter board system was made by our chief boatswain. We use fender floats for flotation on the sweep, 3/16-inch wire between boards, and 1/4-inch towline rope coming down off either side of the stern. We take two marker buoys along with us too for working in the area. Deployment of the sweep requires two people passing gear over opposite sides of the stern while the boat moves ahead at idle or slow, depending on the wind and the current conditions. First the floats are deployed followed by the upright lines coming down off the fender floats. The ground wire is payed out next by streaming it out behind the boat. Finally the otter boards are deployed and oriented so that they move downward and outward. This is the most difficult part and may be a real challenge if there is any excess amount of wind or current. The system is fully deployed when the towlines are all the way out, both buoys are taking the strain, and the otter boards are pulling downward and outward. The major problem encountered when using this rig is when a hang occurs while going upcurrent or upwind. When a hang occurs, the buoys will come together. Normally you slow off the engine a bit and go back and see what you have hung, but if you're going against the current or the wind it doesn't take long for the boat to come around off to the side causing you to lose your hang. To prevent this, marker buoys are put over for orientation purposes to enable you to return to whatever was hung. The major problem with the otter board drag is testing the depths at which it is being towed.

The other system used by the PEIRCE is a two-boat chain sweep. The supports are polyform floats; on the outside they are 2 feet in diameter and on the inside are 1 foot in diameter. There are 1/2-inch towlines coming back and the ground wire is 3/16-inch chain. Since the weight of the chain virtually assured that there could be no lift, the drag was set for 3 or 4 feet off the bottom. On most of these rigs, we set up the sweep by changing the length of the nylon or manila rope going from the buoys or fenders down to the weights. The weights used on the two-boat chain sweep are three lengths of old anchor chain on the outside and one and one-half lengths on each of the three intermediaries. The disadvantage with the two-boat chain sweep is that it is a bulky system and difficult to maneuver in restricted areas. The major advantage to the two-boat chain sweep is the capability to sweep a relatively wide area. Both systems were run with a one-third width overlap to offset any steering deviations.

It is apparent that the biggest problem with the system is probably the control of the system, ascertaining that its clearances are within requirements. The United States is not the only country that is involved with wire dragging; however, as far as I have been able to determine so far, we are one of two-the British Admiralty is the other. The Canadians generally ignore wire-drag type investigations. Recently the wire-drag vessels were involved in demonstration of the Admiralty constant tension wire drift method. LCDR Ruszala was aboard the wire drags at that time and will briefly describe this system as employed by the British.

CONSTANT TENSION WIRE DRIFT

LCDR Thomas W. Ruszala, NOAA

The constant tension wire drift basically consists of two torpedoes or fish of about 75 to 100 pounds each. They are suspended from two boats by 3/16-inch wire. Running from one boat, down to the torpedo, to the other fish, and up to the second boat, is piano wire, which is held taut by a constant tension motor. The advantage of this type of a system is that it doesn't require any testing because the fishes are heavy and basically keep in the vertical. Any deviation from the vertical is measured by an inclinometer at both boats. The wire is at a taut stage so will just pass at whatever depth you set it. A disadvantage with the system is that you don't really run through the water, but the speed over ground is controlled by the current. In effect you are drifting and only put turns on a boat to maintain steerage. We found that this didn't work very well with our launches. We couldn't maintain the steerage, and the current ended up bringing both sterns together. Another skill that is required is a very diligent observer feeling the wire continuously to determine when an obstruction is finally hung. If the speed through the water is excessive, the piano wire parts, and you have to begin the whole process over again.

Mr. Bill Monteith was serving with the Lake Survey Center when it was absorbed into the National Ocean Survey Headquarters. He served on a field party at the Center for some time, at which time they developed a lightweight system of wire dragging similar to that of the wire drags. There are presently two complete systems available in the AMC warehouse that have not been used to date. He will describe the system and how the Lake Survey Center employed it.

LAKE SURVEY CENTER DRAG

Mr. William J. Monteith

The sweep employed is very portable, very lightweight, and is stored essentially on two 4-foot diameter aluminum reels. The sweep can be used with vessels ranging from 25 to 60 feet in length, one acting as a guide vessel or control vessel, the other as an end launch. A main-tenance or monitoring skiff is also used to monitor the sweep while it is being towed through the water. The system consists of 1-inch nylon towing lines which vary in length depending upon the depth of the drag, ranging from 200 to 500 feet for most drags. The horizontal wire is a 3/16-inch wire fabricated in 500-foot sections with each section consisting of 50-foot segments. The segments are separated by metal bars, each bar containing a hole to which the vertical would eventually be fastened. In normal sweeping operations, the horizontal wire seldom exceeded 1,000 feet. I would hesitate recommending anything in excess of 1,500 feet because it becomes somewhat unwieldy. The vertical wires or uprights are 12-foot sections with each section consisting of 2-foot segments. The segments had rings connecting the general wire configuration such that you could collapse them as if you were folding a piece of wire. Normally, however, the wire is stored on 4-foot diameter reels. The first vertical section did have a capability of changing the depth of drag by 1-foot increments, but after that you were involved with 2-foot segments. We normally would sweep anywhere from 6 feet up to 48 feet depth of water. The end floats were steel barrels or drums ranging from 30 to 55 gallons in size. The weights on the ends are 50 pounds; the intermediate weights are 10 pounds. The intermediate floats consist of beach balls that are contained in wire frames that are collapsible. The frames consist of two rings, the outer diameter of the inner ring being the same size as the inner diameter of the outer ring, so that they fold up quite handily. The beach balls in a nondeployed condition are collapsible. The entire sweep can be assembled within 1/2 hour and fully deployed in that period of time. Since the 500-foot or 1,000-foot sections had intermediate verticals spaced at 50-foot intervals, we did not feel a need for flotation devices. Each intermediate float, in addition to having a snap arrangement to be connected to your vertical sections, also had a weighted staff on the top such that, if your drag or sweep was being towed upon the bottom and the tension would be relieved, your float would definitely tip. It was very easy to monitor the float on that basis. Any other situation that would be violating the sweep as it is being towed through the water gives a very definite "v"-ing. Again the end weights that we used are 50 pounds. There is no reason you could not use 100 pounds except that a 55-gallon drum would probably be used in lieu of the 30-gallon drum. The midweights can be either 10 or 20 pounds. We found that 10 pounds were more than adequate.

The sweep can be easily maintained. If you break the horizontal wire, which is a 3/16-inch airplane-type wire, it can be replaced or repaired very easily with the standard NICO press sleeves that the RUDE and HECK also employ. If you snap a vertical for some reason, they are replaced by the maintenance skiff with just a pair of pliers and some spare wire they carry with them.

Deployment of the horizontal and vertical sections is accomplished from the two reels. They are deployed by two people on the launches and one in a small skiff who keeps tension on the horizontal wires being deployed. Retrieval of the system requires essentially three people on the launches, primarily to remove the weights and the vertical assemblies and to store the vertical assemblies on the reel. This avoids clutter on the afterdeck as the floats, endweights, and barrels were being collected there.

The preferred horizontal control of the system is to provide position information on the end barrels. If we use a transit cutoff system, this is entirely feasible. Since the system is used in an investigation or reconnaissance in restricted waters and not operating at great distances offshore, this is generally feasible. On the other hand, you can use transit cutoff on the launch, you can use sextant on the launch, or you can use electronic positioning on the launch. In each of these cases you use a pseudoposition for the actual end barrels. The verticals can be tested on land to make sure that under tension conditions they measure 12 feet including the deployed distance of the weight below the surface floats. Buoyancy tests have been conducted to determine how much of both the end barrels and the intermediate floats actually submerge in the water.

There are, of course, some limitations to the system. Because it is a lightweight system, you are adversely affected by sea conditions. The length of the horizontal is also a limiting factor depending on the area of operation. Towing speed is very critical; if you tow too fast, you are going to get an erroneous sweep depth because the floats will be riding too far to the stern and you will be getting unacceptable lift.

However, there are a number of advantages to the system. It is extremely portable and is managed easily, both in deployment and retrieval. Unless excessive tow speeds are attempted, it is easy to control during operations. Storage requirements are minimal. The system requires little preparation time. It is an excellent reconnaissance and shoal water investigative tool. You can run circles, straight lines, or patterns with this type of system. I believe that the operations that are defined in the Wire Drag Manual for heavy-duty dragging are applicable to this type of a system. The system tells you what is happening beneath the surface through the tipping of the buoys and the "v"-ing of the wire as in the convention wire drag operation. In my experience in the field, I would not hesitate to recommend this as a very valuable investigative tool for chart evaluation survey, and, for that matter, for conventional hydrographic surveys where applicable.

SUMMARY

In summary, it is impossible to say that there presently exists a single system available that would satisfy our need for small boat wire drag to fulfill the requirements of an item search. The desired system must be easily deployed, controllable, and cover the maximum possible area. In addition to the systems that we have discussed during this panel, other possible systems may be found described in the Hydrographic Manual, the Wire Drag Manual, the Admiralty Manual of Hydrographic Surveying, Volume II, and Ingham's Sea Surveying. Certainly small boat wire drag is an area requiring additional investigation and testing; hopefully, those of us that are interested in it will continue to investigate and try to develop a system which will solve the needs of the organization in disproving items.

REPORT ON SIDESCAN SONAR

LCDR Thomas W. Ruszala
NOAA Ships RUDE and HECK

ABSTRACT

Sidescan Sonar has proven to be a valuable tool for the hydrographer. This paper discusses the experience of the NOAA ships RUDE and HECK with the operation of a Klein Sidescan System.

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About a year ago the RUDE and HECK received a Klein sidescan sonar system. Since there has been no formal program or evaluation scheduled with it, what I have is basically an outline as to the type of equipment and its performance thus far. On several item investigations, it was the primary survey tool, whereas on other occasions the sonograms were recorded for comparison with wire drag and diver investigation.

The sidescan sonar system is basically a three-component unit; there is a two-channel graphic recorder, 100 meters of cable which can be ordered in larger amounts for deeper type investigation, and a towed transducer. The recorder is actually the primary unit, and is capable of both automatic and manual tuning. The automatic tuning accepts all signals and records them equally, whereas the manual mode is somewhat different in that the three gain controls interact and are controlled by the observer to determine the initial signal coming into the system and to establish the gain current for various conditions. Our experience is that this automatic tuning process produces a very good general picture, that is sand ripples, small bottom rocks and the like. However, with regard to wrecks, pinnacles, and shoals, the strongest return and best pictures were produced using the manual tuning mode. The paper used with this recorder is a wet, electrosensitive paper. The cable is steel, covered with a synthetic-jacket. Regarding the transducers, we actually received two types. The 100 kHz fish is designated as general-purpose. it has a one-degree horizontal band width, and is the one we used exclusively throughout the season. It is rated with a maximum range of 500 meters per side. The second transducer is a 200 kHz type, designed for shallower water with a reduced range of up to 300 meters per channel. We found one disadvantage with the 100 kHz fish last week while attempting to locate some 20 foot containers for the Coast Guard. Using a Jensen launch and the Ross fathometer, a considerable amount of noise was recorded since the Ross is also 100 KHz. After some comparisons, it was decided to keep the fathometer running and read through the over print. Both transducers are equipped with a 40 degree vertical beam, the axis of which is tilted 10 degees below horizontal. However, this can be modified when ordering from Klein. Regarding the beam width, you actually have coverage from below the fish, which is due to the side lobes, to the extremity of the range. In shallower waters, the range is really that distance covered by the signal before the intersection with the bottom. As a general rule, the fish is run at a height above the bottom equal to one-tenth of the selected range. In most cases this created some problem, since we were working in waters of 40 to 60 ft, thus a range of 200 or more meters was not practical due to the signal prematurely intersecting the bottom.

In general, our evaluation of the system is positive. One advantage is that it is very portable. Initially we were cross-decking the recorder, cable and fish between the RUDE and the HECK depending which vessel was going out. Eventually, it remained on board the HECK as a matter of convenience. Additionally, it is a rugged system, compatible to any launch operation. Another of its assets is the spare parts kit. It is extensive and when used in conjunction with the trouble shooting section, can reduce potential down time. Thus far, our Klein side scan has about 70 hours of operation. we have experienced 6 and a half hours of down time, which is about 9%, accounting for four problems.

The most important aspect of the side scan system is the tuning. Reiterating an earlier comment, manual tuning is far superior to automatic, however the reason for this advantage can itself be a disadvantage. Manual tuning requires a far more skilled operator/observer. Also, constant attention is needed with the graphic recorder. Too often the optimum point of sensitivity would periodically drift off, causing overburn to one of the channels. Consequently, this results in a survey void, the degree of which is dependent upon range, tow fish speed, and amount of time the channel was not functioning properly. This adversity can be minimized by an attentive operator, however, it cannot be effectively eliminated. A second problem, which is actually operator uncertainty, occurs when side scanning in an area with a uniform bottom. The absence of distinctive features, such as rocks or ledges, creates some difficulty when trying to ascertain the reliability of the manual tuning. A workable alternative in this situation is to check signal reception with a buoy or some known structure within the area. A comparison must be made in order to determine the quality of the sonograms. Another consideration is the transducer speed over ground. This is dependent upon the pulse repetition rate, which decreases with the range increase, and the surface area of the object being searched for. Also another factor is the possible orientation of the object which could contribute some to a significant amount of signal attenuation. Dove tailing these aspects with our vessel capabilities, we basically kept to a standard operating speed of from 1.8 to 2.4 knots using the hydraulic drag motors. This proved satisfactory in the water depths at which we were operating.

In addition to the aforementioned, the sea condition is another factor which must be given consideration. The transducer produces side lobes both above and below the signal axis. Besides providing the downward looking capability, the transducer also records sea height. This can cause a recorder burnout of the initial signal if the fish is towed too close to the surface when a sea is running. To alleviate this, a reduction in the initial gain is necessary, however, such action could possibly negate other signals. Another alternative is to lower the transducer, but this in turn reduces your range capabilities. Generally, when operating in waters greater than 50 or 60 feet, especially when searching for larger objects, sea conditions are not as pertinent, but when surveying harbors, estuaries, and rivers all environmental and operating parameters must be considered.

The sidescan system was used both in Chesapeake Bay and New York Bight. The least water depth that we operated it in was 24 feet, and the smallest object searched for was a Coast Guard surface navigation buoy, which is 8 ft in diameter and roughly 26 feet long. The location of the buoy took approximately two days, basically because this was also our field instruction period with the system. Nevertheless, it effectively saved us approximately three days of wire drag operations. Another item in the Chesapeake Bay was a 60-ft barge located in the Yorkspit Channel. After approximately 90% of the one mile radius circle was wire dragged and two weeks of work expended, we used a weather day to investigate a possible discrepancy in the original reported position. Within 20 minutes of commencing side scan operations the barge was located 1.8 nautical miles south of its charted position. In effect, the sidescan in this case alleviated a potential question as to whether or not the barge was outside of our investigation circle and saved us about four days of additional wire drag time to complete the item. The system itself was not instrumental in locating the remaining seven items in Chesapeake, basically because one was found on the DE-723 Fathometer, while the others were readily located by setting out drags in the most probable positions. However, the sidescan was compared to both wire drag and diver observation, and it was determined that if it was necesary we would have been capable of finding four of the seven items using the side scan system. The other three items were a congestion of pilings, metal rods and miscellaneous bottom debris.

In New York the sidescan system was not used on four of seven items, which were charted in polluted waters. Our procedure when using the sidescan is to follow up a contact with diver investigation and our capabilities for diving in polluted waters were inadequate at the time. The most effective use of the Klein System was in disproving a 360-ft shipshaped object which was initially recorded on an EG & G sidescan sonar system. Subsequently, it was reported, charted and incorporated as one of our items. Since its position was fairly good, we decided to use the Klein system with the DE-723 fathometer. The object was recorded and successive sonograms made as the transducer was towed closer to the bottom and nearer the object. The latter was determined to be a geological feature approximately 360 feet in length with what appeared to be a four to five foot vertical height. After a number of crossings with the DE-723 and the sidescan, these four to five foot heights were actually shown to be a series of trenches about six feet in depth. For insurance, a wire drag to 60 feet was run and the item completed. All considered the sidescan saved us approximately two weeks of work in the New York area. There were two additional wrecks which were located; a 75-ft ferry boat and a crane barge off the New Jersey coast. This was accomplished by using LORAN-C rates provided by local divers, in conjunction with a sidescan search. A total of about three days was saved on both items.

In closing, there are several comments which I wish to emphasize. First, the sidescan does not in itself disprove the existence of an obstruction or wreck, but at present its value has been in the timely location of an item when standard methods of investigation are not feasible. Therefore, unless a comprehensive study is made to determine the confidence level of detection, the present use of sidescan on items charted as Position Approximate or Existence Doubtful becomes more a matter of academics or field practice rather than effective investigation. Secondly, I would like to again mention that the effectiveness of the system is primarily dependent upon the quality of human interpretation. A large number of moderately qualified operators is of less value than a few highly competent and skilled observers. Accordingly, the side scan system should be used as often as possible so as to maximize operator exposure. Also, the ultimate comparison is possible when the operator is afforded the opportunity to inspect in situ, the item recorded on the sonogram. A diver sketch or description is an acceptable alternative. Comparisons of an open barge, for example, versus a small pushboat, or rock, prove very helpful in sonogram interpretation.

Finally, regarding cost-effectiveness, the RUDE and HECK realized a savings of about 21 work days using the sidescan system. This translates to approximately $24,000 when considering the average daily operating costs of the drag boats. Since the Klein system cost $41,000, it can be stated that it has already paid for half of itself this field season. Furthermore, due to the nature of our operations, history has shown that the temporary down time of one vessel causes lost survey time for both. However since the addition of the sidescan sonar, vessel productivity has increased. It affords a new type of flexibility to survey operations. When one vessel is required to remain in port, the other now has the option of side scanning. The system is a valuable instrument, and although not time tested as some of our existing methods for item detection, it is without question a new and beneficial mode for the location of submerged wrecks and obstructions in our coastal waters.

DISCUSSION

Mr. Carstens: How many people became highly qualified in interpreting the sonograms?

LCDR Ruszala: In all honesty, I don't think that any one of us is highly qualified; we're still learning.

LCDR Schneble: They have things that you can retune to slant back with different tuning. You don't have that on yours?

LCDR Ruszala: No, we do not on our system.

CDR Fisher: You made a comment regarding the efficiency I wanted to bring out, that being that due to the slow speed of towing sometimes you would employ the option of going back to wire drag or sweep rather than slow speed. If you are faced with putting out 4,000 ft of wire or doing a

4,000-ft sweep versus a sidescan, you may choose that, but for the rest of us that can't put out 4,000 ft, and we are talking of something like 200 at the most, that makes the sidescan look much more attractive.

LCDR Ruszala: My comments were relative to our operation, and as far as speed and coverage, we do get more out of wire drag. For us the versatility is, as I mentioned, when one ship is temporarily down for some reason or when weather precludes wire drag, the option to sidescan now exists.

Mr. Redman: What was the maximum range at which you ever operated?

LCDR Ruszala: 200 meters on each side was the maximum range we operated at. Basically, this was due to the water depth we operated in. Following the general rule of keeping the distance of the fish off the bottom equal to 10 percent of the range, precluded a range greater than 200 meters. For example, at 200 meters, the transducer should be towed about 20 meters (66 feet) off the bottom. In water depths of 40 to 60 feet this was impossible, therefore we usually used the 150 meter range.

LCDR Suloff: Inasmuch as sidescan is only good for locating items, not disproving, and a hefty portion of its cost is the recording mechanism, do you feel that the recording mechanism is worthwhile as opposed to an Cathode Ray Tube (CRT) display.

LCDR Ruszala: Definitely. It affords the opportunity to review what you are seeing, a comparison between that and other objects. In effect, the sonograms provide a data source to the operator, thereby assisting him in future operations. If the search is for something substantial on a relatively flat bottom and in a known local area, then a simple CRT would suffice, however, with the addition of variables, the CRT becomes less effective and the graphic recorder more practical.

LT Chelgren: With a slightly different unit that was only $8,000 -- a hull-mount transducer, they could change the angle to to whatever angle that you wanted and had a range of 6,000 feet. That was an excellent unit, but there was no recording.

LCDR Ruszala: That sounds like the standard commercial fishfinder. The added cost for the recorder is well worth it. As I mentioned earlier the sidescan is only as good as the ability of the operator to interpret the signal. Also, I feel the sonograms would become mandatory if you were searching an area, plotting positions and establishing overlap.

CDR Fisher: As to the problem of tuning, especially when you have two boats at seas like this, have you proposed anything for engineering assistance. It seems that a daily capability could be developed, something equally as outstanding as a bar check. It seems that it would be something in the line of transponders or something to give you a base line reflection back to employ each day, rather than try to find it.

LCDR Ruszala: You could use that or some type of parabolic reflector with a weight and place it on the bottom -- the more often you plan to use the sonar, the greater the advantages of constructing a calibration marker.

REPORT ON THE ARGO DM-54
Stability Tests

H. B. Redman
Office of Fleet Operations

ABSTRACT

This paper describes the ARGO DM-54 System. NOS is considering the use of this system for use as electronic control of hydrographic surveys. Early experience raised a question about the stability of this system. This paper discusses additional testing of the stability of the system.

INTRODUCTION

A field acceptance test of the ARGO DM-54 system was performed by the MT. MITCHELL during May 1978. The results of the test were ambiguous and raised questions about the accuracy and repeatability of the ARGO DM-54 system. A second operational field evaluation was proposed and conducted in the DELMARVANC area during September 1978. The objective of this operation was to evaluate the ARGO DM-54 for short and long-term stability, day and night. The stability and repeatability of the ARGO system aboard a survey launch was also evaluated.

WHAT IS ARGO?

The Automatic Ranging Grid Overlay (ARGO) DM-54 system was developed by Cubic Western Data.

The standard ARGO DM-54 configuration consists of four land-based fixed stations and up to seven mobile stations. Two- and three-range operations are also possible, with up to 12 and 9 mobile stations, respectively. Each station fixed or mobile, includes a Range Processing Unit (RPU) and an Antenna Loading Unit (ALU). Each mobile station also has a Control and Display Unit (CDU).

The fixed and mobile stations both use 22 to 32 Vdc. An optional power supply which converts 100/120/200/240 Vac (50 to 60 Hz) to 24 Vdc is available.

COMPONENT DESCRIPTION

Range Processing Unit (RPU)

The RPU contains the electronic components necessary to generate, transmit, receive, and process all signals for range measurement. The RPU also contains operator controls and associated circuits for remotely controlling the Antenna Loading Unit (ALU). It also controls indicators for testing and monitoring the status and performance of the radio frequency (RF) portion of the system.

Control and Display Unit (CDU)

The CDU contains the electronic components and operator interface necessary to perform all operational control, range displays, and interface functions between it and the RPU. In addition, the CDU provides output data for such peripherals as strip chart recorders, digital printers, and computer/calculators.

Any of the above units may be interchanged with any other like units, provided that preset frequency assignments are the same in the RPU.

Antenna Loading Unit (ALU)

The ALU contains the electronic circuits and components necessary to match the RPU transmitter output to the antenna. The variable components (inductors and capacitors) are motor driven from the RPU by remote control.

DATA ACQUISITION SYSTEM

The data acquisition system used in the ARGO DM-54 stability evaluation was a Hewlett-Packard 9825 Desktop Computer. The range data was acquired by the computer via a serial I/O interface from the ARGO Control & Display Unit (CDU). The ARGO mobile stations were set to provide range updates once a second using multiple time slots. Four hundred data points at 6 second intervals were acquired by the 9825 system for each range and stored on the data cartridge. In addition, real time was recorded and stored with the range data at the start of each data set and at every 100 data points in the file using a Digital Clock. The acquisition program also monitored the signal quality parameters of each data point.

AREA OF OPERATION

The evaluation took place in the DELMARVANC area. Fixed shore stations were established at Fisherman Island, Virginia, Assateague Island, Virginia, and Avalon, New Jersey. Mobile monitor stations were located at Fort Story, Virginia, and Oregon Inlet, North Carolina.

STABILITY EVALUATION

The test commenced on September 5 with the establishment of the fixed stations at Fisherman Island, Assateague Island, and Avalon. The ground planes used at the fixed stations were similar to the standard installations used by AMC for its 100-foot towers. The ARGO DM-54 equipment was housed in a small trailer and necessary power was obtained locally. Two mobile monitor stations were established at Fort Story within 200 meters of each other. The stations were co-located to determine if the variations would be identical. At the monitor sites, the 17-foot MORAD antennas were used and at the fixed stations the Cubic 27-foot antenna. The selection of the 17' MORAD antennas proved to be a mistake. These antennas were finely cut to 1700 KHz, while ARGO's transmitted frequency was 1652 KHz. After one week of continuous problems and poor data quality, the antennas were replaced by a Cubic 27' whip antenna and a Shakespeare 35' antenna. This change greatly improved the reception of the ARGO signal at the monitor sites and the ARGO DM-54 system operated well with no significant problems. On September 20, Monitor C was relocated at Oregon Inlet and the test evaluation concluded on September 28.

SYSTEM CALIBRATION

One ARGO system was installed on AMC High Speed Launch 1255 along with the H.P. 9825. Calibration sites were located at Virginia Beach and Oregon Inlet. The sites included 4 marked visual signals, 2 T-2 sites and 2 Del Norte sites. Calibration was performed at the Virginia Beach site in the morning of September 26 and then the launch sailed the 90 nautical miles to Oregon Inlet and calibration was accomplished in the afternoon.

RESULTS

The digital range data stored on the cartridges was processed to determine the mean, standard deviation, minimum and maximum value of ARGO range per file. The mean of each file was plotted for the range data collected between September 14 and September 22.

An analysis of the plotted data was made for short and long term stability. The propagation path for R1 was entirely over water. The range of R1 was 18.5 Km. Under these conditions the stability of the ARGO system was excellent. The propagation path of R2 had some land and the distance longer (118.3 Km), but still the short-term stability was good. It was noted that the best case of signal stability had higher AGC select readings than the worse case. No conclusive determination could be made for long term stability. Only 6 and 5 days of valid range data was collected at monitors A and C respectively. Still the stability for 5-6 days was very good.

Long Term Stability (5 and 6 days)

R1 at A	Variation = 0.11 Lanes
R1 at C	Variation = 0.07 Lanes
R2 at A	Variation = 0.20 Lanes
R2 at C	Variation = 0.12 Lanes

A detectable cyclic drift occurred daily. The range values would shift upward during daylight and downward at night time. The effect of varying smooth code was determined. The smooth code at Monitor A was fixed at zero, while the smooth code at Monitor C was changed from 0, to 2, 3 and 9.

The effect of a detuned antenna was also tested. Monitor A was detuned to a value of 23 (recommended 30) while Monitor C was peaked. As expected, Monitor A experienced a larger lane shift than Monitor C (.07 lane vs. .01 lane).

CONCLUSIONS

The evaluation of the ARGO DM-54 system proved that the system is stable for short term, up to 8 hours, at short and medium distances and meets NOS specifications. Not enough data is available to make a determination on long term stability.

There are several features of the ARGO DM-54 system that are superior to other positioning systems. Among these are:

1. Capability to measure three ranges. This significantly en hances the system's reliability.

2. Ability to identify lane count error.

3. Remote controlled antenna turning.

From the results available, the indication is that the ARGO DM-54 does operate as well, and probably better, than other positioning systems presently used by NOAA hydrographic survey vessels.

VISUAL CALIBRATION OF
ELECTRONIC CONTROL BY SEXTANT

LCDR Lowell R. Goodman
NOAA Ship MT. MITCHELL

ABSTRACT

The general content of this presentation deals with the accuracy of the three point sextant fix, a subject as old as hydrography itself. The more specific subject matter addresses the application of the sextant fix with its associated error sources, and the manner in which it is used to "check" or "calibrate" electronic control.

ERROR SOURCES AND EFFECTS

The major sextant fix error sources are as follows:

- Sextant errors
  - Parallex
  - Index
  - Vernier estimates
- Station positional uncertainty
- Random errors in angle measurement
- Two observer eccentric error
- Weak geometry*

*Weak geometry is usually listed as a source of error and has thus been included; however, in truth, the geometry only determines the magnitude of the above listed errors.

The effects of these errors along with the associated fix geometry can be broken into two categories, (1) those proportional to the linear scale of the fix geometry, and (2) those independent of the linear scale of fix geometry. The error sources previously listed then fall into these two categories as follows:

- <u>Proportional</u> to linear scale of fix geometry
  - Random errors in angle measurement
  - Sextant biases (parallex and index)

- Independent of linear scale of fix geometry
    - Station positional uncertainty
    - Two observer eccentric errors

The actual errors associated with a three point fix are best described as an error ellipse created inside the parallelogram of positional arcs (see Figure 1). Probably the most significant of the error sources is the random error in angle measurement. (The incremental uncertainty in the left and/or right angle.)

SPECIAL CASE

In order to provide an initial "feel" for the magnitude of this error as a function of fix geometry scale, the special case formula was derived (see Figure 2.) This formula treats the case where the three objects form a straight line and both the left and right angles are equal. The error calculated, therefore, is half the major or minor axis of the error ellipse (depending upon whether θ is less than or greater than 45°.) The estimated random error in angle measurement "e" is in degrees. One half to one minute of arc is considered by most to be a reasonable estimate. Thus, it becomes obvious that the fix error is directly proportional to "A" and "B" and therefore, directly proportional to the scale of the fix geometry. This special case example then points one to an excerpt from the Hydrographic Manual included as Figure 3 which is apparently incorrect.

GENERAL CASE

For those who wish to address any sextant fix configuration, the general case formula is given as Figure 4. This formula may be more difficult to interpret than the special case formula since the fix uncertainty is presented as the area of the error ellipse.

TWO OBSERVER ECCENTRIC ERROR

This error is created because the two observers are separated by some finite amount. This error is scale independent and is governed by the following equations:

$$a = 1/2D \cot (\alpha/2)$$

or

$$b = 1/2D \tan (\alpha/2)$$

Where a and b are the major and minor axes of the error ellipse, D is the distance, the observers are separated, $\alpha = 180^\circ + \Psi - (\theta_1 + \theta_2)$ with θ_1 and θ_2 being the left and right angles, and Ψ being the angle created by the two base lines (0° for the special case.)

SUMMARY

The intention herein is not to call attention to the weaknesses of a three point fix, but rather to point out some cautions regarding its use as a "calibration" yardstick, primarily in conjuction with the hydroplot system.

Presently, the hydroplot system provides "an indication" of the strength of a sextant fix through the calculation of an "inverse" distance between the sextant fix and the sextant check angle fix. This is probably a weaker indicator of fix strength by far than the pre-automation manual plotting three-armed protractor method. With the manual plotting method, the qualitative fix strength was seen by the ease or difficulty of arriving at a stable protractor configuration.

With the present hydroplot system, the calculated "inverse" may appear to some (especially new personnel) as being computer calculated, and hence, totally complete analysis of the fix, i.e., 5 meters or greater inverse indicates a bad fix. In point of fact, the inverse should be used mostly to verify that the signals being shot are correct, and that an angle bender is not reading his sextant off one degree. In support of this, consider that the right angles for both the sextant fix and the sextant check fix are one and the same. Consequently, random errors in the right angle will not even appear in the inverse. In addition, depending on the fix configuration, geometry error contributions may or may not show up.

CONCLUSIONS

The equations and information presented herein is a mixed bag and includes only highlights of an evolution of concern regarding analytical quality control, calibration of line of sight positioning, uses of the three point fix, etc. The primary concern is that of upgrading to proper, complete analytical quality control at the same rate as the automation of hydrography.

As was stated earlier, only highlights of subjects have been presented; each section could be a paper in its own right. Much of the three point fix error analysis information was summarized from a paper by Dr. Kent Dedrick, Sacramento, California, "Analysis of the Three Point Fix," a paper well worth the hydrographer's time to review.

SEXTANT ERROR GEOMETRY

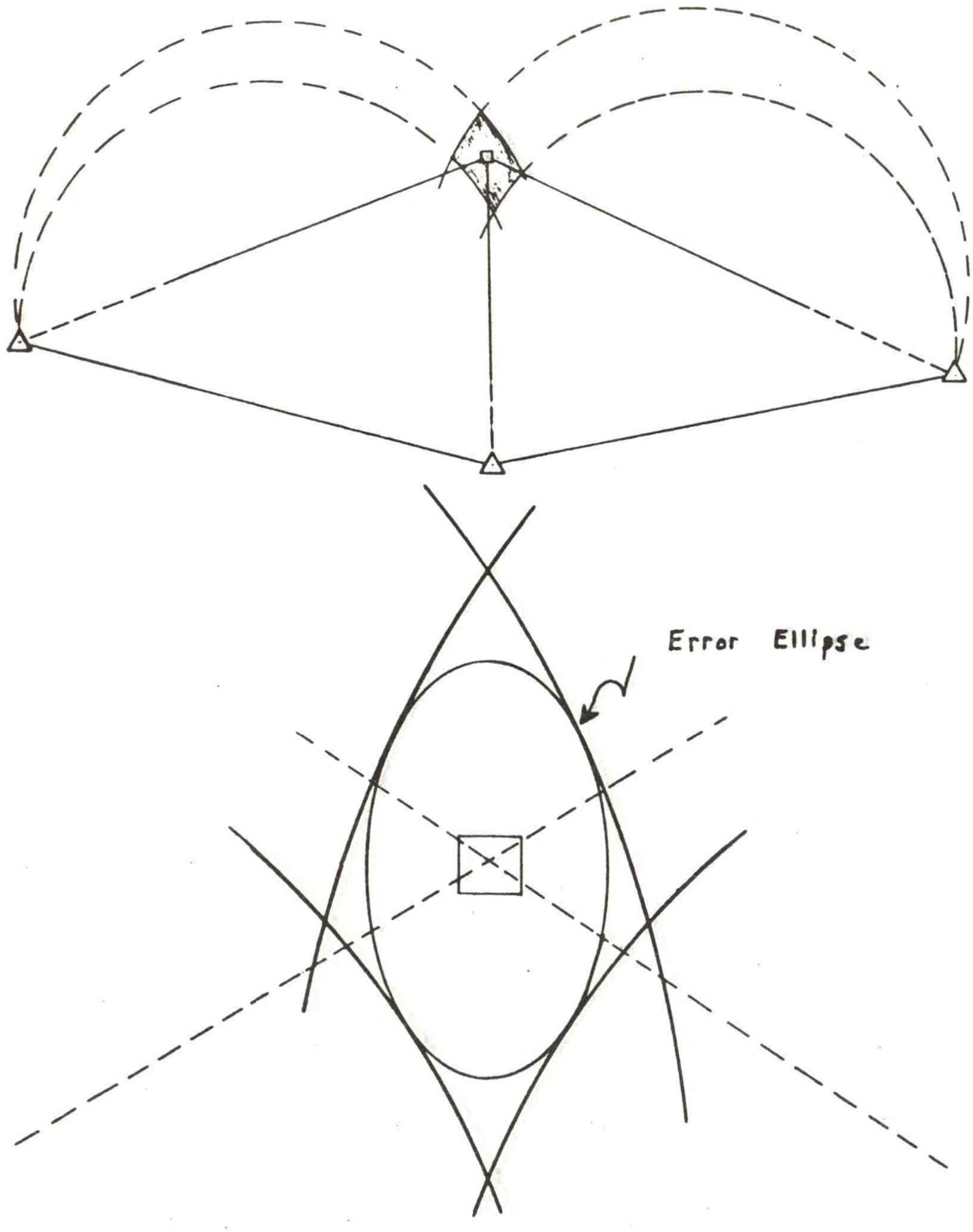
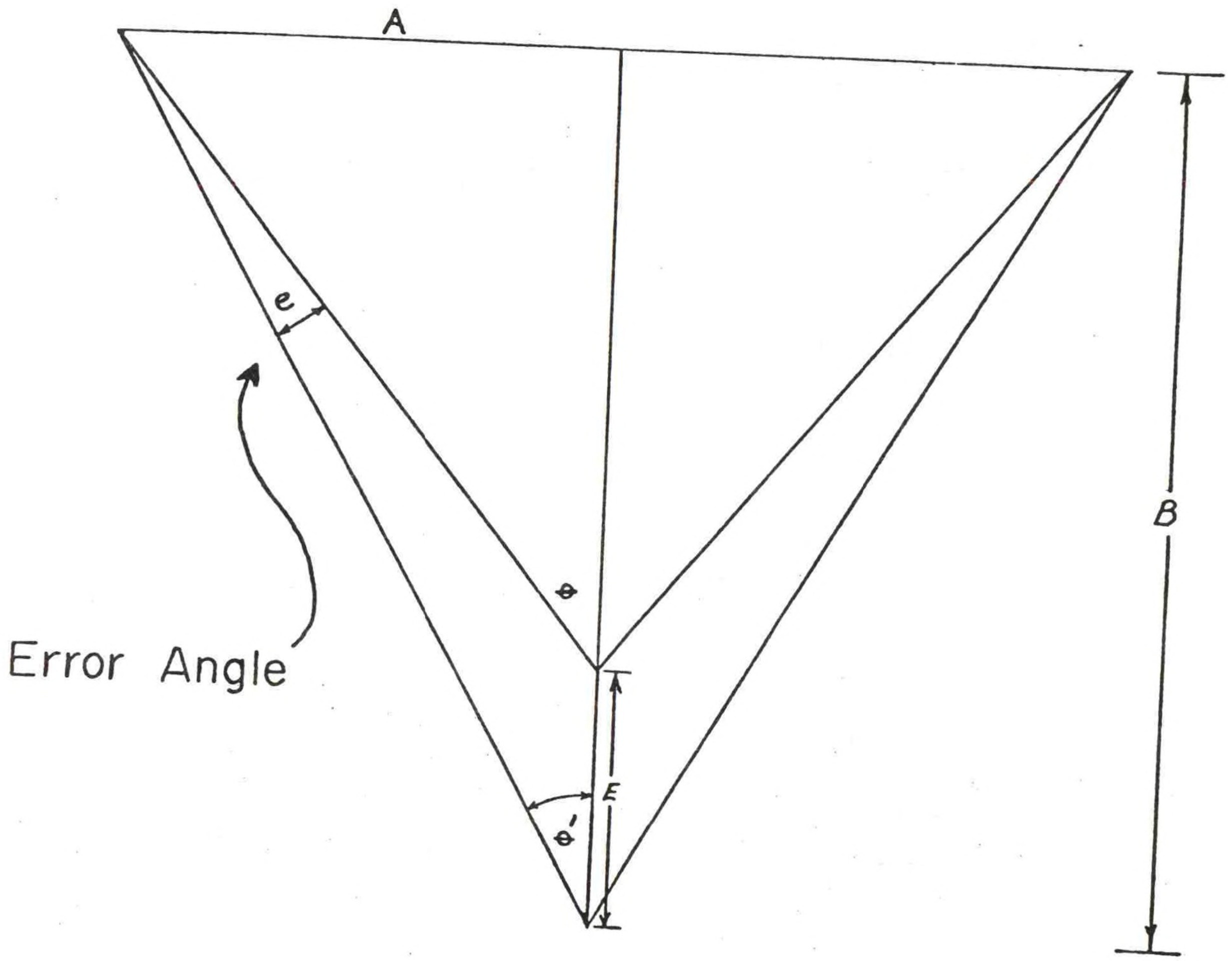


FIGURE 1



$$\text{Error} = B - A\left[\cot an(\theta + e)\right]$$

FIGURE 2

A "WEAK FIX" MESSAGE IS PRINTED IF THE ADDITION AND SUBTRACTION OF ONE MINUTE TO BOTH THE LEFT AND RIGHT ANGLES, RESPECTIVELY, DISPLACES THE COMPUTED POSITION BY MORE THAN 8 METERS. *MAXIMUM ERRORS IN POSITION DETERMINED BY A WEAK FIX RESULT FROM A POSITIVE ERROR IN ONE ANGLE AND A NEGATIVE ERROR IN THE OTHER.

*THIS STATEMENT IS <u>ONLY</u> TRUE FOR CERTAIN GEOMETRIES.

IN MOST CASES, ITS ONLY TRUE IF BOTH ANGLES ARE LARGER THAN 45°.

FOR ANGLES SMALLER THAN 45°, THE WORST CASE ERROR OCCURS WHEN THE SEXTANT ERRORS ARE <u>BOTH</u> PLUS OR <u>BOTH</u> MINUS.

FIGURE 3

GENERAL CASE

$$A = \frac{\pi (n\sigma)^2}{(\sin \alpha)} \cdot \frac{Y_1'}{\sin \theta_1} \cdot \frac{Y_2'}{\sin \theta_2}$$

WHERE:

A = AREA OF ERROR ELLIPSE

σ = SEXTANT ERROR IN DEGREES

n = 1, 2, 3, ETC. (NO. OF STANDARD DEVIATIONS)

θ_1 = LEFT ANGLE

θ_2 = RIGHT ANGLE

Y_1' = PERPENDICULAR DISTANCE TO θ_1 BASELINE

Y_2' = PREPENDICULAR DISTANCE TO θ_2 BASELINE

α = ANGLE OF INTERSECTION BETWEEN POSITION CIRCLES IN RADIANS

= $180^\circ + \psi - (\theta_1 + \theta_2)$

WHERE ψ = ANGLE BETWEEN THE TWO BASELINES.

FIGURE 4

TRAINING IN THE FUNDAMENTALS OF COMBINED OPERATIONS

CDR John C. Albright
NOAA Ship RAINIER

ABSTRACT

This is a report on the current status of the hydrographic training class. A review of the value of this training and the evolution of the present curriculum is discussed.

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Early in 1976 there was considerable concern expressed by a number of people at both Marine Centers, and I am sure at Headquarters as well, over what we felt was the declining level of expertise in the wardrooms of our hydrographic vessels. To make a lot of discussion very short, we were taking new junior officers right out of the training class, many of whom had absolutely no survey background, and putting them into a launch with a very sophisticated, and unfortunately sometimes temperamental data acquisition system, and at the same time expecting them to run high-quality hydrographic surveys, and it wasn't working. We were giving them little training, no background whatsoever in this area and still expecting a great deal from them. Basically what was happening, as you are well aware, was that we were creating people who became adept at operating the systems but had no time to sit back and relax and learn what hydrography was all about.

So at that time, still early in 1976, PMC proposed to the Director of National Ocean Survey several remedies. One of these was that an extensive training course be set up and organized, aimed at new junior officers, survey technicians, and rotating cartographic technicians, which would cover the entire gamut of not merely hydrography but the entire area in which a combined operations vessel becomes involved, and that such a course be set up and coordinated at the NOS level. We realized at PMC that this was something that was not going to happen overnight, and so we proposed that in the interim we would set up what we could with our available resources, which was a one-week long training course. And we taught this for the the first time in April of 1976. In the next two years we ran that course four times, and each session was one week long, and primarily it was a classroom exercise. We did a very limited amount of field work, some tide gauge leveling, and that was about it. Basically it was a classroom exercise in theory of hydrography and combined operations. The emphasis was to give the new junior officer, the future OIC, a look at the big picture of combined operations, try to give them an idea of what happened not only in that launch they were soon going to be operating but what happened back at the project instruction preparation stage, and what happened all the way the smooth sheet stage, something that they were not going to have a feel for once they got on board. These courses were, I think, very well received. They were certainly very limited in scope, but the feedback that we got from the individuals themselves, from the commanding officers in particular, was very favorable. Invariably, the commanding officers' whose reactions we sought, after the trainees had been aboard a while, were highly impressed with what we had been able to do in a short week. Unfortunately, there was no practical training involved, and as you are well aware, to try to teach anything at all about the theory of combined operations, hydrography and all the other areas in one week is barely scratching the surface. What we wanted to present was a very extensive and intensive project-oriented class, and this was the next step.

In early 1978 there became available to PMC a 30 foot launch that was excessed off the RAINIER, a Uniflite boat with a very large cabin which made a very ideal training platform. We outfitted the launch with a complete HYDROPLOT system, Ross fathometer, and Miniranger, and we took our one-week course outline and went through and expanded that curriculum to a four-week course. We included a great deal of field work and practical hands-on experience. We took our launch and our revamped course and went to Admiral Powell and asked for his approval to go ahead and present this training course, but told him that to make it feasible we had to include officers from both Marine Centers. There were so few officers coming out to hydrographic ships at PMC alone that it just wasn't feasible to run the course for two to three people, and we also hoped to avoid a duplication of effort. We limited the course to those officers assigned to hydrographic vessels in order not to have in the course people who might have a lower level of interest than those who knew that four weeks hence they would be in the middle of it. Admiral Powell approved this proposal.

The 5th edition of our Fundamentals of Combined Operations course was presented in July of last year. We had 5 ensigns from that training class, four AMC and one PMC -- I believe two went to the MT. MITCHELL and one each to the PEIRCE, WHITING, and DAVIDSON. We presented to them, in four weeks, a project oriented training session. We started from the project inception, handed them a set of project instructions for a survey of a portion of Shilshole Bay here in Puget Sound and carried the entire project through, exactly as you would aboard ship. We intended to carry it through to completion of a field sheet and preparation of a descriptive report. Time got to us before we got that far, but that was our intent: to start from the very project inception and carry it through as far as the ship itself would normally do. We covered a number of areas, some of which are not normally the responsibility of East Coast ships, but felt it was a worthwhile background for those going east anyway. Horizontal control was one of these areas. We had them set a couple of reference marks, establishing eccentric points for installation of Miniranger stations. We installed a tide gauge, including levels, station report, etc. We did an actual field edit in the Shilshole Bay area with photography that was flown the year before and with a manuscript that had been prepared for training purposes, and this worked out very well. We did our own signal building, prepared our own field sheet from scratch with the HYDROPLOT system, and transferred all the information to it. We ran through the entire launch checkout and after the first day made them responsible for the startup, shutdown and maintenance of the launch. We introduced them to the HYDROPLOT system and software, and ran them through a velocity cast. We spent a couple of days initially running visual hydrography, hand recording in sounding volumes. We had some controversy over this. I pretty much insisted that we start at this point, and the feedback that we have gotten from those students has been very favorable -- they felt it was worthwhile. My feeling was that to start with the sounding volumes and start with the visual hydro gave them a much better feel later on for what the HYDROPLOT system was doing in obtaining depths and the positioning information and producing the plot. We moved from visual hydro into range/range and spent a couple of days doing Miniranger range/range hydro and finished up with some range azimuth hydro, so they had a chance to see the typical modes. We included the daily record-keeping, the statistics, the processing, and in fact tried to duplicate exactly what was done aboard ship on a daily basis as closely as we could. I mentioned we worked in the Shilshole Bay area, and this gave them a tidal range. It gave them a bit of urban harbor-type development with the marina there, and it also gave them some typical coast in the Sound here in one convenient area. We worked them pretty hard, we worked Saturdays and some evenings, but several of the guys, after they got back this fall from their shipboard assignments, said we didn't work them hard enough.

In our opinion the class was highly successful. Both instructors and all five students, however, felt it was too short for what we wanted to accomplish. We didn't have time to finish up the field hydrography; we didn't have time to adequately process the data and carry it through to the logical conclusion. During the post-class debriefing and critiquing, we went down a list of the topics we covered and tried to see what we could cut out or at least cut back on, and invariably every item we came to the unanimous opinion was that we needed more time on it. Our recommendation was that we expand the four-week course to six weeks, and that has been done in the sixth edition of the combined operations class, being taught now at PMC.

We have been asked a number of times what is the real value of the class and what can we teach these people in a classroom environment that they can't learn aboard ship. Everybody is well aware that the ships are short of people, and the common cry is that classes are nice but not essential, and we need these people aboard ship as soon as possible. I think what we can give them in this training class that they can't get once they get on board, is an overview of the entire marine survey program from the project inception and project instruction generation through to the final evaluation and acceptance of the smooth sheet. This is something that, in my experience, junior officers don't get. They get plugged into a production environment and become so wrapped up in trying to make their launch work and run their hydrography that they really don't have a chance to sit down and examine the overall procedure, take a look at the product we're looking for, and look at the whole picture. The training class gives them a chance, in addition to that, to look at the processing area at PMC, the verification stage, and very importantly, I think, to have some time to act as a HIT team member. This is something we started during the first one-week course, devoting an entire day to the HIT team activity. We actually gave them two or three surveys that had recently gone through the HIT phase at the PMC, gave them the descriptive report and verifier's report just as a HIT team member would have, and had them do an evaluation of the survey. When they were done we would sit down and compare their evaluation with that of the HIT team, and I thought that worked out very well. It gave them an excellent idea of the types of problems that we were seeing at that time and are still seeing in our surveys, and the types of deficiencies that they, as OICs, can amend. Finally, the great value of this training class is the opportunity to learn and to think about why we do things as opposed to simply the how. As I mentioned, once you get on board it is really a production environment, and to have four or six weeks in a reasonably relaxed non-production environment, to be able to sit down and analyze the way things are done and to get an understanding of why we develop this way or why this particular orientation of sounding lines is better than another way, is not possible aboard ship.

We have made a great deal of progress in the area of combined operations training. We have moved from being essentially dead in the water three years ago to the current presentation of an excellent six-week course. Involved in this present class are five NOS officers from the last training class, two other NOS officers who received assignments or are hoping to receive assignments back to hydrographic ships and want a refresher and, significantly I think, two Navy officers. The Navy has apparently expressed an ongoing interest in this training and the Coast Guard has expressed an interest in getting some of their people in the class. Admiral Powell has a very strong commitment to this training, so I think the future of the program is very bright indeed.

GEODETIC APPLICATIONS FOR COMPUTER TERMINALS AT THE MARINE CENTERS

CDR Ned C. Austin
National Geodetic Survey

ABSTRACT

Both the Atlantic Marine Center (AMC) and the Pacific Marine Center (PMC) have the capability to transmit geodetic data to the National Geodetic Survey (NGS), National Ocean Survey (NOS), using computer terminals. The Marine Centers can also use the terminals to extract useful information about horizontal control from the NGS Data Base.

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Both the Atlantic Marine Center (AMC) and the Pacific Marine Center (PMC) have the capability to transmit geodetic data to the National Geodetic Survey (NGS) using computer terminals. The National Geodetic survey provided terminals and training to the Marine Centers so that geodetic data would be submitted to NGS in computer-readable form. The Marine Centers in turn have access to all of the routines National Geodetic Survey is developing for handling geodetic data.

The intent of NGS was to begin by developing a capability at the Marine Centers equivalent to NGS field parties. The geodetic data management problems on NGS field parties and at the Marine Centers are similar. NGS horizontal parties manually record all field data and transmit the data to NGS through a terminal at the field party site. Field observations are hand recorded and abstracted. The field abstract is the source for data transmitted through the terminal. Descriptions and recovery information are manually recorded on special forms designed for keying into the terminal. All hand recorded data in the field are considered to be the original field records and are retained for archiving. The requirement for manually smooth typing descriptions, recovery notes, and lists of directions has been discontinued.

On NGS field parties, the terminal is also used to perform the geodetic computations required during the project. Nearly all the geodetic computations performed in the field are done on the terminal as the project progresses. If the party is in a remote area which prevents using the terminal, the party does the field computations by calculator and enters the data in the terminal later. The situation for field parties entering the data in the terminal after the project is analagous to the task the Marine Centers have with geodetic data from ships and hydrosupport parties.

It might be worthwhile for the Marine Centers to have a portable device which could be used in the field to record observations in computer-readable form. Such a device could be used in remote field locations or aboard ship to store abstracts of field observations or the observations themselves and eliminate the keypunching backlog at the end of a project.

National Geodetic Survey vertical parties use such a system to record leveling data. The system is a battery powered calculator-cassette recorder which stores level rod readings on a tape cassette as they are acquired during field work. The calculator is also programmed to exercise some quality control over the field observations. Observations which exceed programmed tolerances are rejected by the recording system. The leveling data in the cassette are normally transferred to the terminal after each day's work. We have, however, also operated leveling units away from party headquarters where the cassettes were mailed back to the field offices.

While NGS field parties routinely use the terminal to transmit field data and perform geodetic computations, the field is not yet using the terminal to extract information from the NGS Data Base. National Geodetic Survey horizontal and vertical parties should have this capability within two years.

The Marine Centers will also find useful applications for the terminal to extract information for planning and supporting projects. One of these applications, access to the Synoptic File for horizontal control, is available today.

The Synoptic File contains information for identifying adjusted horizontal control in the Data Base for management and publication purposes. It therefore is the most current and reliable source of information about the availability of adjusted horizontal control. Kinds of information in the Synoptic File are: Control Station Name and Number, Geographic Position, Date of Adjustment, Azimuth References, and Publication Quad.

For example, questions about a ship having all the available adjusted horizontal control in a project area can be resolved by listing all the control in the area from the Synoptic File. The Synoptic File can also be used to verify station names used in recovery descriptions or to avoid name duplication when new control is established.

The Synoptic File is just one of many files being established in the NGS Data Base. Station descriptions, for example, are also being keypunched. By 1980, all horizontal data published will also be accessible through the terminal.

The Data Base will eventually contain all of NGS' horizontal, vertical, astronomic, gravity, and satellite data. Access to these data will be station oriented. An inquiry by terminal about specific control stations will give access to all available information about the stations ranging from published data to the original field observations.

DISCUSSION

Question: Can you access the synoptic file by specifying a narrow band of longitude up and down the coast and say, "I want all the geodetic data in this area?"

Answer: What I said in my paper may have been a little misleading. The smallest geographic area you can retrieve data for is a 7 1/2 minute quad. Data in areas defined by arbitrary boundaries or specif ed by a radius about a given geographic position are not retrievable at the present time.

Question: Are there other ways to access the synoptic file besides the geographic parameters?

Answer: At the present time, you have to use geographic parameters to access the file. The marine centers will have to contact NGS to learn how to do this.

DOPPLER SATELLITE SURVEYING FOR HYDROGRAPHIC CONTROL

CDR Ned C. Austin
National Geodetic Survey

ABSTRACT

Doppler satellite surveying can be used to establish horizontal control for hydrography. In the relative positioning mode, the spacing of the control established can be as close as 5 km.

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Doppler satellite surveying can be used to establish horizontal control for hydrography. By replacing conventional survey methods, the all-weather, automatic operation of this method of surveying would save ships both time and human resources. This is especially true in remote areas where geodetic control is sparse or inaccessible.

Doppler satellite surveying has become an established method since its origin in 1971. Today this method is used extensively throughout the world. North America alone has over 1,000 stations which were determined by Doppler satellite observations. NGS has used Doppler satellite surveying since 1973 to establish over 200 positions.

In the field, there are basically two modes of operation in Doppler satellite surveying -- relative positioning and point positioning. (See Table 1)

In the relative positioning mode, a minimum of two sets of equipment is required. One set remains at a point designated as a base station; usually, but not necessarily, this is a point with a known position. The other set is used to position the needed control by observing a series of satellite passes at each station simultaneously with the base station.

The coordinates of these stations will be determined relative to the base station; therefore, all the stations will be positioned on the same local datum. The base station can be as much as 500 km away from the other stations and still obtain simultaneous satellite observations. The coordinates for a base station of unknown position can be determined using the point positioning mode. The relative accuracy of all the stations positioned in the project by relative positioning, if 30 passes are observed at each station, will be about 0.3 to 0.5 meter, which would be adequate for nearly all hydrographic surveys.

In point positioning, only one set of equipment is required and each positioned control point is determined independently. The position is referenced to the satellites' Earth-centered coordinate system. The relative accuracy of stations located by point positioning is inferior to relative positioning because of errors in atmospheric refraction and the predicted orbit parameters broadcast by the satellite. The relative accuracy of coordinates by point positioning using 30 satellite passes and broadcast information is about 3 to 5 meters. This would only be adequate for small scale hydrography where the control points are more than 30 km apart. The relative accuracy of point positioning can be improved to about 0.5 meter in 40 satellite passes if precise orbit information is obtained from the Department of Defense. However, the precise ephemeris is available only for two of the five satellites now in orbit. The delay in getting this information, plus the increased period of occupation, is normally considered to be unacceptable for field operations.

In the relative positioning mode, 30 satellite passes will establish third-order control at 5-km spacing. (See Table 2)

If the spacing of control required by the hydrography can be more than 5 km, fewer satellite passes will be needed and the occupation time at each station can be reduced as shown in Table 2.

If the hydrography requires control at less than 5-km spacing, Doppler satellite surveying cannot be used by itself to establish third-order positions. Doppler satellite surveying could be used, however, to establish intervisible end points for a traverse which is connected by conventional ground survey methods.

DISCUSSION

Question: Can the Doppler Navigation System aboard the Ship SURVEYOR be used to position control ashore? I believe the system is the JMR-1.

Answer: It should be the same system used for survey work on land; so the answer is yes, assuming you have the auxiliary equipment like a tripod antenna, weather-proof cases, etc.

Question: Does NGS have excess Doppler survey equipment which can be loaned to the marine centers?

Answer: Unfortunately, no. NGS has only two systems, one for each of our parties. In addition, our systems are early generation equipment. The operational complications are probably prohibitive as far as the ships are concerned.

Mode of Operation	Minimum Equipment	Station Occupation	Coordinates	Relative Accuracy with 30 Passes and Broadcast Ephemeris
Relative Positioning	2 Sets	Simultaneous	Local Datum	0.5 Meters
Point Positioning	1 Set	Non-Simultaneous	Geocentric	3-5 Meters

TABLE 1 - Comparison of Relative Positioning and Point Positioning in Doppler Satellite Surveying

	Horizontal Control Spacing			
	Less Than 5km	5km	10km	15+ km
Number of Satellite Passes	N.A.	30	8	12 hrs
Period of Occupation	N.A.	1-3 days	12 hrs	12 hrs

TABLE 2 - Number of Satellite Passes and Period of Occupation to Establish Third-Order Control at the Specified Spacing Using Relative Positioning

TIDE AND WATER LEVEL REQUIREMENTS FOR HYDROGRAPHIC SURVEYS

LCDR D.M. Spillman
Chief, Tides and Water Levels Branch
Oceanographic Division
Marine Surveys and Maps

ABSTRACT

The Hydrographic Manual establishes the maximum error due to tides to be 0.2 feet. This requirement has increased the number of gauges needed to meet this requirement. LCDR Spillman leads a discussion on tide problems related to hydrographic surveying.

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A question concerning tide requirements which has recently been asked is: "Five years ago I surveyed in this general area and was required to install one tide gage. I went back this year, and 6 tide gages were required. What happened? Why 6 now and one then?" The reason is that the Hydrographic Manual is now interpreted to require, for 0 to 20 fathoms, the error in charted depth due to tide and water levels must be less than 0.2 ft. The Manual may have required that error for a long time, but it is now used when the tide requirements for project instructions are prepared.

Another question sometimes asked is: "I installed several gages, but some of them didn't work and I still received reducers which didn't show problems with the smooth hydro sheet. When you consider an error bend of 0.2 ft., the hydrographer, either in drawing his contour lines or in reviewing the data, will not see a change of 0.2 ft. For example, if you were surveying a ten-mile shoreline with a total tide range change from one end to the other of one foot, in the "old days" you may have been required to install one tide gage; now, five tide gages might be required. But, whether one or five, will the hydrographer see any difference in the charted depth due to tide reducers by reviewing contour lines? Probably not.

DISCUSSION

LCDR Spillman: Are the evaluations useful?

LCDR Richards [Question regarding evaluations]

LCDR Spillman: The evaluation I was referring to was the feedback by memorandum concerning the tide data for a complete hydro project. It was discussed at last year's Hydro Conference and was to be a reasonably informal memo, that is it would go from the branch to the vessel commanding officer. The memo would indicate any problems with the tide data and which data were or were not used and why.

CDR Fisher: I'll make a comment on that. We received an evaluation and it really means something to the hydrographer as far as ADR gages are concerned. Your evaluation is valuable particularly where defects in the ADR data are concerned.

LTJG Kenny: [question regarding ADR gages]

LCDR Spillman: Yes, there are some specific efforts being made to improve the ADR gages, to determine data quality, and to feed that information back to the field. And, yes, one possibility for a data quality check is an instrument that would allow the field unit to graphically portray the punched paper tape data.

Mr. Mordock: [question about numerical modeling of tidal basins for natural frequencies].

LCDR Spillman: Yes; in fact an item was included in the '80 budget for a 12-year program at about a million dollars a year, but it was not approved. It is unlikely that a large modeling effort will be done at this time since resources aren't available.

CDR Fisher: The accuracies of numerical modeling are not consistent with what we require from hydrography. The effort you put into modeling all the places we jump around to and work on, if you wanted to approach accuracy, would be astounding in size. And you can look around and find who else is modeling, but their models are not usually attuned to the needs that we have. So that makes the problem very difficult.

LCDR Pickrell: Are there standard procedures for tide zoning?

LCDR Spillman: There are some fairly specific zoning procedures that are used and some of it is seat of the pants; for offshore tides, the Defant model or modified Defant model is being used. Shore zoning involves determining the velocity and height changes of the incoming tide wave, as discussed in the Manual of Tide Observations.

CDR Fisher: There's a lot more too it, and it is something to research. If you plotted the change and range and number of points and measured it and it was linear, it is proposed that you could apply the computer averaging technique established by a conference in 1974. The place where they don't have the technique established, or where the changes are nonlinear, is along the coast, and that is the seat of the pants and dropping back to the discrete zoning.

LTJG Hillard: Does NOS have any submersible gages?

LCDR Spillman: NOS doesn't. NOAA does. ERL has installed quite a few submersible gages. In fact, during PMEL current measurements in Puget Sound a submersible gage was installed at several sites. Submersible gages will be considered in the development of the new generation system, but right now very little has been done with them by NOS. Submersibles represent some problems, but they could be used for such things as determining ranges, times etc.

LTJG Hillard: In the last couple of years, the Class II ships working in Cook Inlet literally struggled with that, you're out 1,500 ft and can't put an ADR gage in. We put in a number of requests. I don't know whether they turned us down or never had the gages.

LCDR Spillman: I'm sure if a submersible gage were available, what would be said is, "Yes, go ahead and install it. Make an attempt to install a conventional gage there too, and we'll compare the data. NOS does have a deep-sea tide gage, but that's not what is required for Cook Inlet. I am not aware of any NOS submersible type gages.

LCDR Pickrell: What happened to the offshore telemetry system that was designed to transmit real time tide information?

LCDR Spillman: That is now part of the BS^3 system. The program management of the BS^3 system has not been in the Oceanographic Division and the offshore telemeter system is part of the BS^3. I believe there have been some problems with the telemetry system. The person to give you the details would be Wayne Mobley, the program managers, or possibly Nick Bodner who has worked with the telemetry system on the DAVIDSON.

LCDR Bodner: The gage itself worked.

CDR Fisher: I was actually there when we ceased the offshore part, and that was basically the philosophy of Captain Mobley and myself, that the offshore and the effort going into that weren't really necessary. All we needed was a good capability to telemeter to the ship from the onshore stations; we could take care of the offshore complexities either through the Defant model or some other capabilities, so the idea of an actual offshore station, buoy-mounted, etc., was killed two or three years ago. But the continuation, and I think Captain Mobley is using a different acronym for it, is taking the telemetry portion of it and continuing with the concept that we could get it on the hydrographic ships and the McARTHUR, and leave a capability of continuous monitoring of your gage as it is operating, hoping to cut down on the number of times to go to visit it, and also to have the real-time data.

LCDR Spillman: There are commercially available submersible pressure gages; Andera as well as several other companies produce them. These gages have a pressure sensing device with data recorded on Mag tape.

CDR Fisher: In my opinion, on OTS, the offshore portion with the buoys was a failure. I think maybe Jack Fansher might back me up on that. The shoreside part was successful; the offshore part was a failure.

LCDR Spillman: Another possibility is pressure-to-digital, which might be applied to the Cook Inlet situation.

CDR Fisher: Some officer was asking, has a survey ever been thrown out because of bad tide data, and just in the four years I was up there, the answer is yes. One in the Nordyke Island area. The past procedure has sometimes been to use any technique possible to reclaim the hydrographic survey, to the extent that in a survey done down off Hatteras, where the hydrographic gages didn't work, they used values from Hampton Roads, Virginia, which is well inside the mouth of Chesapeake Bay, with relationships from past data. In another case the survey was in Lower Cook Inlet. This was two years back, and there were few checks made on the control stations and on the short-term stations. It turned out the short-term stations all failed, and the control stations failed too, and I think it was the case that that survey was rejected.

LCDR Spillman: That's true, and there has been another survey rejected because of inadequate tide data within the last year. Another point -- I kind of shorted water levels in this discussion. Although I tried to make the discussion cover both tides and water levels as much as possible, much of it went to the tides side. That is because most of the problems at this time are with tides rather than water levels, and because most hydrographic surveys are now being conducted in tidal waters.

PRESENT TIDE AND WATER LEVEL PRODUCTS AND USES

PRODUCTS	APPLIED TO
Observed tide heights	Nautical Charting
Predicted tide heights	Bathymetric Mapping
Tidal datums	Tide predictions
Summaries of averaged tide heights	Coastal construction and eng.
Tidal characteristics (e.g., range and time)	Coastal permitting
	Salvage operations
Sea surface temperature and density	Flood Insurance
Observed water level heights	Determining changes in Great Lakes water volume
Summaries of averaged water level heights	Forecasting Great Lakes Levels
Water level datum	Monitoring crustal movement
	Monitoring sea level changes
	Marine boundary determination
	Determination of coastal jurisdiction
	Storm evacuation
	Legal proceedings
	Weather forecasting
	Beach erosion control
	Coastal zone management
	Research

GENERAL TIDE AND WATER LEVEL REQUIREMENTS

PURPOSE OF OBSERVATIONS:

DETERMINE TIDE DATUM
REFERENCE SOUNDINGS TO DATUM (REDUCERS)
SOMETIMES, CHECK TIDE PREDICTIONS

STATION TYPES:

TERTIARY - MOST FREQUENTLY USED - 30 DAYS MINIMUM
REOCCUPIED - FOR PERIOD OF HYDRO ONLY
3 DAY STATION - TO ASSIST IN ZONING

DATA ACQUISITION SYSTEM (DAS) LOCATION AND SPACING DETERMINED BY:

ACCURACY REQUIRED PER HYDRO MANUAL (FOR BASIC SURVEY
0-20 FM ERROR 0.2')
HISTORIC DATA
JUDGMENT OF OCEANOGRAPHER
KNOWLEDGE OF HYDROGRAPHER

OBSERVATION PERIOD DETERMINED BY:

ACCURACY REQUIRED
HISTORIC DATA
TIME PERIOD OF SURVEY

TYPE OF DAS DETERMINED BY:

AVAILABLE INSTRUMENTS
ANALYSIS PROCEDURES

SPECIFIC TIDE AND WATER LEVEL REQUIREMENTS

DATA ACQUISITION SYSTEM (DAS) SPACING - OVERLAPPING CONTROL FOR ZONING INTERPOLATION AND BACKUP

TYPE OF DAS:

ADR - PREFERRED FOR AUTOMATED PROCESSING AND ACCURACY
GAS PURGED - USED WHERE ADR CANNOT BE INSTALLED

OTHER REQUIREMENTS:

- LEVELING TO BM'S BEFORE STARTING AND BEFORE ENDING COLLECTION TO REFERENCE DATUM TO BM'S AND QC
- GAGE AND STAFF ON SEPARATE STRUCTURES TO REFERENCE DATUM TO BM'S AND QC
- 5 OBSERVATIONS PER WEEK TO REFERENCE DATUM TO BM'S AND CRUDE CALIBRATION AND ENSURE PROPER OPERATION
- 12 MINUTE READINGS ON GAS PURGED TO VERIFY PROPER OPERATION
- LOGGING OF HOURLY HEIGHTS TO SPEED DATA PROCESSING

DATA ANALYSIS PROBLEMS

- BREAKS IN DATA AND LOW QUALITY DATA
- INCORRECT TIMES OR INSUFFICIENT INFORMATION ON OBSERVATIONS
- INACCURATE GAS PURGED MARIGRAMS - OVER DAMPENING, TUBING BREAKS, AND BEARINGS
- NO INSTALLATION OR REMOVAL LEVELS OR GAGE OPERATION BEFORE LEVELING
- UNSTABLE BENCH MARKS
- LACK OF OR INSUFFICIENT BM DESCRIPTIONS
- NOT CHECKING LEVEL ABSTRACT IN FIELD
- INCOMPLETE OR INSUFFICIENT FORMS

PHOTOGRAMMETRIC PRODUCTS AND RELATED PROBLEMS

James W. Massey
Chief, Photogrammetry Branch
Pacific Marine Center

John D. Perrow
Chief, Photogrammetric Branch
Rockville, Maryland

ABSTRACT

This paper combines two discussions conducted in the field of photogrammetry. Only the high points of the two sessions are contained in this paper.

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The Wednesday morning session of the 6th Annual Hydrographic Conference was dedicated to field edit, photogrammetric products, and related problems. Items covered were:

I. The Pacific Marine Center Photogrammetric Branch
II. Field Edit Surveys "Chapter 11"
III. Coastal Mapping Division, Photogrammetric Branch, "products and services."

I. The Photogrammatric Branch at the Pacific Marine Center is operational and performing field edit application on a variety of projects from California to Alaska. Compilation of an East coast project continues on a time-available basis. The branch provides training in photogrammetry and field edit data collection/submission to Pacific Marine Center personnel during in-port periods. Training is also provided for the NOAA officers combined operations training class. This class is designed to aid junior officers assigned to hydrographic survey ships on the Atlantic and Pacific Coasts. In addition, the branch is available to assist or support a ship or shore-based field party on photogrammetry or field edit data collection/submission.

II. A paper distributed at the 5th Hydrographic Conference in Norfolk, Virginia, entitled "Field Edit Surveys" and constituting Chapter 11 of the Manual of Coastal Mapping Field Procedures generated a very limited discussion. This paper does an excellent job of separating field edit and hydro data; gives excellent examples of coordination, cooperation, and communication essential to good field edit and hydrography; and defines normally misunderstood features. Examples of these are bluffs versus cliffs; ledges versus reefs; shallows versus shoals; and grass in water versus marsh. The marine centers are structurally different in the field units used to collect field edit data. This creates the necessity to interpret the manual in some instances. Compatibility between the marine centers is both desirable and necessary in the digitizing format towards which we are all working.

Specific problem areas encountered in field edit data applications are:

A. The Master Film Field Edit Ozalid is now labeled Field Edit Sheet in the lower right-hand corner. This sheet should contain notes to crossreference field edit photographs, information required to resolve discrepancies (except those which can be resolved with a simple "YES" or "NO" directly on the discrepancy print), and corrections to compiled detail, (including deletions).

B. Violet ink is used to give appropriate field edit information on the discrepancy print, field edit photographs, or field edit sheet. Green ink is used to denote deletions on the discrepancy print or field edit sheet.

C. Red on the discrepancy print is reserved for questions posed by the compilation activity while red on the field edit sheet denotes data logged into the ship's Automated Hydro-Log System. A red line outlining the data or area, accompanied by the term "Hydro" clarifies that data incorporated in the hydrographic records.

D. Violet ink only is to be used on field edit photographs.

E. Field edit data submitted on the discrepancy print, field edit sheet, or photography must be submitted in ink. Pencil work is unacceptable.

F. Plane table sheets submitted as part of field edit data must be on stable-base material. Paper ozalids are unacceptable.

G. Images shall be positively identified before indicating on the field edit photographs. Once positive identification is made, the image is pricked lightly on the photograph whose image appears closest to the photograph center and appropriate data added in violet or green ink as required.

H. If there is to be a hydrographic survey of an area and, during field edit, images of features in the awash zone are not visible on the photography, positional data is obtained by the field editor and submitted to the hydrographer. This data becomes part of the hydrographic survey and is not duplicated on the field edit sheet, discrepancy print, or other field edit source materials.

I. If while performing field edit images of data required for hydrographic surveys are visible on the photography, this data is identified and appropriate notes made. This information becomes part of the field edit data. Notes as to the location of the image, time, height and source document (TP-00000) are indicated on the hydrographer's work sheet.

J. Photogrammetric manuscripts are source documents for visible and positively identified images on the photography. Whenever and wherever possible, the photography should be used to obtain the horizontal position of those images.

K. Duplication of data is costly, unnecessary and under the digitizing system towards which we are working, highly undesirable. To eliminate duplication of data, it is essential to have close coordination, cooperation, and communication between the hydrographer and field editor. Each must inform the other of data collected and determine the source document to which it must be submitted. Conflicts in positional or portrayal data can be reconciled on location and correct data submitted.

L. Field edit performed prior to hydrography increases the effectiveness and accuracy of the photogrammetric manuscripts to the hydrographer. This sequence alerts the hydrographer to dangers to navigation (visible and not visible), not plotted on the class III photogrammetric manuscripts.

M. Field editors should submit data for Landmarks and Aids to Navigation on the Form 76-40, supplied by the compilation activity. Additions, corrections, or deletions should appear in violet ink.

N. The compilation activity will depict all charted landmarks and all potential landmarks; as 2.5 mm circles on the photogrammetric manuscript. Charted landmarks are labeled in capital letters; example: "TANK." Potential landmarks are labeled in capital and lower case letters; example: "Tank." It is the responsibility of the field editor to evaluate all landmarks from seaward and submit any changes, deletions, or revisions as necessary on the Forms 76-40's supplied. Potential landmarks need not be submitted on Form 76-40. However, they shall be evaluated from seaward for possible replacement of a charted feature. The potential landmarks will be carried on the class I manuscript as map features with 2.5 mm circles and capital and lower case letters.

O. Shallow lines (differing from foul lines) are a constant source of controversy. These lines are at best the compiler's interpretation of the penetration of the compilation photography. Penetration varies within a single photograph and between consecutive photographs. The shallow line, a hydrographic feature, is provided as an aid in conducting hydrographic surveys. The line should be verified by the field editor with corrections depicted in the field edit data and changes supplied to the hydrographer prior to conducting hydrographic survey operations. Sounding data used in the verification process will supersede the depicted shallow limits. Shallow limits provided by the compilation activity and changes supplied by the field editor shall remain part of the field edit data submitted. During verification, this information is used as a supplement to the hydrographic data when necessary and ignored by the verifier when not needed. Shallow lines not checked and verified by the field editor shall be deleted during the field edit application phase.

P. Additions or changes to the Mean High Water Line, not visible on the photography, must be supported by positional data. Examples: Sextant Fix, Plane Table Sheet, or measured distances from photo identifiable features.

Q. Sextant fixes submitted as field edit data containing tangents to objects are unacceptable. Fixes must include a left or right check angle. Signals used in fixes must be adequately identified.

III. Products produced through the use of aerial photography by Coastal Mapping Division, Photogrammetric Branch, Rockville, Maryland, include Airport Obstruction Charts, Storm Evacuation Maps, Shoreline Manuscripts (TP sheets), Coastal Zone and Coastal Boundary Maps, and Photobathymetry Products. The Coastal Mapping Division is a support division and as such, any product or service it provides strengthens its existence. Notification of extensive shoreline changes should be promptly submitted to the marine centers. Action on these notices may require only a limited time to acquire updated source materials. Notices requiring additional photographic support may delay the processing of hydrographic surveys; therefore, field personnel must insure the shoreline changes are extensive and thereby justify the processing delay and additional cost.

Photogrammetric methods and techniques can be used to obtain horizontal positioning that meets third order accuracy standards. However, it requires the additional education of the photogrammetrist in the data requirements of the hydrographer.

Photobathymetry does not lend itself to Pacific Coast application. However, in areas where it is possible, depths of approximately 60 feet have been recorded. Comparisons with ground truths provided discrepancies of less than one foot. An overview of photobathymetry with regards to hydrographic surveying application, suggests its usefulness to a depth of 12 feet and could alleviate the task of close inshore launch work.

PHASING IN OF ADDITIONAL DIGITAL DATA

Larry W. Mordock
Processing Division
Pacific Marine Center

ABSTRACT

This discussion covers Marine Center digitizing system status. Included are the state of software development, problems encountered, and expected dates of completion.

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The conceptual design as presented at last year's hydrographic conference has not changed. Inclusion of the Wild B8 stereoplotter may necessitate model alignment algorithms and photographically reduced menus, but data digitizing and flow to the hydrographic system should remain consistent with the initial design. Deliverance of the system to production units and resolution of differing techniques between units will undoubtedly necessitate system changes and continued development.

Software development is progressing, and preliminary products are conceivable within three to four months. The hydrographic symbol set is nearly finished; however, certain dimensions specified by the Marine Data Systems Project were changed. The changes were small, and were primarily due to wet ink considerations. A parallel line algorithm has been developed and will be incorporated into the symbol set. The algorithm will realize automatic line weights without manual intervention by plotter operators.

Sheet registration software is completed, and the technique chosen should accompany both the digitizing tables and stereoplotters. The process consists of obtaining parameters and x-y coordinates in table units based on known geographic positions and the projection transforms from the Harris system. A least squares fit registration algorithm will then be employed on the Calma digitizing system to register sheets. The least squares algorithm alleviates defining an orthogonal coordinate system which may prove difficult if parameters such as central meridians are missing from manuscripts or known G.P.'s on photographs are randomly located.

The current parameter file for hydrographic surveys has been modified to contain the topographic file names needed for processing. Topographic parameter file design is defined, and software development will require one to two man-months. Topographic data base design is completed for the digitizing and processing systems, and software to communicate between them is complete. The point elimination routine employed by headquarters has been modified for the Harris system. Xynetics host computer software includes a cubic spline fit algorithm which may have to be incorporated to correctly plot point eliminated lines.

Software to generate topographic data on paper tape for field units is nearly finished. Finalization will require linking existing software to the topographic parameter file, and generating complete listings. Full realization of this service to the field will depend on the Marine Centers' ability to process data transmitted from the Nautical Charting Data Base. Additionally, the format for transmitting topographic data to headquarter's data base remains to be defined. One potentially serious problem may arise due to non-uniformity of cartographic codes employed by various divisions within The National Ocean Survey (NOS).

The last paragraph leads to these final remarks. Optimum utilization of data bases and developmental efforts cannot be realized or accomplished by any single entity in NOS. Coordination between the field units, Marine Centers, Marine Survey Division, Marine Chart Division, Coastal Mapping Division, and the Marine Data Systems Project is essential if we are to succeed in a truly automated marine charting program.

THE NATIONAL GEODETIC SURVEY's FIRST INERTIAL SURVEY

CDR Ned C. Austin
National Geodetic Survey

ABSTRACT

The National Geodetic Survey (NGS) will be using an inertial system for the first time in 1979. The first inertial survey will be conducted along the Louisiana coast to establish horizontal control for hydrography.

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One of the interesting developments in geodetic surveying in recent years is the use of an inertial system for surveying. Many consider inertial surveying as a technological breakthrough which will revolutionize geodetic surveying.

The National Geodetic Survey (NGS) of the National Ocean Survey will be using an inertial system for the first time when we establish horizontal control this year to support hydrography along the Louisiana coast.

Surveying with an inertial system is relative positioning, which means that to determine geodetic positions the system must start at established geodetic control. The inertial system determines geodetic positions by calculating how far it has been moved from the known point. It does this by sensing accelerations along three axes of a gyroscopically stabilized frame of reference. An on-board computer integrates the accelerations to produce the three components of the distance moved.

For surveying, the inertial system is mounted in a truck or helicopter. A plumbing device, fixed to the outside of the transporting vehicle, is used in areas where the vehicle can be brought close to the survey mark. When direct occupation is not possible, an electronic distance measuring instrument (EDMI) incorporated in the system makes the connection to the survey mark. The inertial system provides the required azimuth for this eccentric reduction.

The tendency of an inertial platform to drift out of alignment will cause errors in the survey. To counteract this, some operating constraints are imposed when using the inertial system for geodetic surveying.

1. The inertial system needs to be calibrated for the project area. This is accomplished by resurveying a north-south, east-west pattern of existing geodetic control in the area.

2. The inertial platform needs to be aligned at the beginning of each day's inertial surveying. This procedure requires about one hour and is performed at the existing geodetic control point where the survey

commences. This realignment needs to be repeated after every four to six hours of operation.

3. Inertial surveying needs to be performed in linear, closed-loop traverses where each new point is occupied twice and both ends of the traverse are existing geodetic control. Large changes in direction in the traverse should be avoided. Existing geodetic control should be included in the traverse whenever possible, but at least once every hour.

4. During inertial traverse, the system needs to be brought to rest at regular intervals not in excess of five minutes. In helicopter work, the spacing of new control is usually made to coincide with these stops.

These constraints require careful planning of the inertial survey. Most inertial survey projects are accomplished in two phases. The first phase includes all the routine ground work at the stations; the other phase is devoted exclusively to the inertial survey observations.

On the Louisiana coast project, the survey requirement dictates second-order control at 7-10 km intervals along the coast from the Mississippi River (Southwest Pass) west to Calcasieu Pass, a distance of about 300 km. Here the Louisiana coast is a vast uninhabited marshland accessible only by boat or helicopter.

The National Geodetic Survey will perform the initial phase of the project in February 1979 by employing NOAA helicopter support. All ground work for mark setting and description writing will be accomplished during this phase. The survey mark at each occupied station will be flagged during the inertial survey for identification from the air. In most cases, the station mark itself will be occupied with the inertial system. When it is necessary to occupy a reference mark, an EDMI reflector will be plumbed over the station mark so that the inertial system electronic distance measuring instrument can make this connection directly.

For the second phase of the project -- the inertial survey, NGS will lease an inertial surveying system commercially. The contractor will install the system aboard a NOAA helicopter and provide operating personnel to accomplish the mission. NGS will provide one or two people to assist with the field work, involving mainly station identification and eccentric measurements.

During the inertial survey, 60 stations broken down into nine closed-loop traverses will be occupied. Each loop will take about two and a half hours to survey. The loops will be linked together at existing geodetic control so that overall continuity is maintained.

A typical survey day would contain the following activities. The helicopter refuels close the starting point for the traverse and then lands at the existing geodetic control point which starts the traverse. The helicopter shuts down for one hour while the inertial system stabilizes. Once the system has stabilized, the traverse begins. Typical on-station time in the traverse is two to four minutes. At the endpoint for the loop (an existing geodetic control station), the survey reverses and each station is reoccupied back to the starting point. The helicopter than proceeds to the starting point for the next loop, refuels, and repeats the process.

DISCUSSION

Question: What order of accuracy do you expect to achieve with the inertial system?

Answer: The project instructions for the Louisiana project calls for Second-Order Class II (1:20,000). The manufacturer claims we should be able to do this easily.

Question: Why do you have to stop periodically?

Answer: In the inertial system, you are integrating accelerations twice to determine displacements, so errors will tend to accumulate with the cube of elapsed time. You want to stop for zero updates frequently to avoid large error accumulations.

Question: Can you obtain elevations with the inertial system?

Answer: Yes, you can. One axis of the inertial platform is the vertical, so vertical displacements are determined. I am not sure how accurate the vertical survey would be. The Canadians have reported accuracies on the order of 20 cm $\pm$ 15 ppm.

Question: Can the time between stops be extended beyond five minutes?

Answer: Five minutes seems to be a good time period for Second-Order work based on the Canadian experience. The manufacturer has stated that the stopping interval could be increased to seven or eight minutes.

Question: Will azimuth marks be placed at stations positioned by the inertial system?

Answer: Probably not. The azimuth which is generated by the inertial system is not good enough for conventional azimuth marks. So azimuth for subsequent hydro-support surveys is somewhat of a problem. When possible, we will try to locate the stations where landmark station are available for azimuths. Also we hope to position the stations where supplemental surveys for hydrographic control won't be required. For example, if the station mark is located inshore to give it a longer life, a reference mark would be positioned near the shoreline for hydrographic control.

Question: Will NGS' inertial survey experiences in Louisiana be published?

Answer: I am sure some papers will come out of the project. It sounds like a good topic for next year's hydrographic conference.

NOS AUTOMATED INFORMATION SYSTEM

LCDR Gregory R. Bass
Marine Data Systems Project

ABSTRACT

This paper gives a quick overview of the Automated Information System (AIS). The primary use of the AIS is nautical chart maintenance. Secondary uses include automated plots of prior surveys, shoreline and other data for use by verifiers or hydrographers.

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One of the best ways to describe the Automated Information System (AIS) is to follow one of the data paths that leads into and out of the AIS, namely hydrographic surveys. As you know, the survey leaves the ship for Marine Center verification, where it is massaged and sent to Quality Control in Rockville, where it is checked and turned over to the chart compilers. They post it into the AIS data base and select that new data which they want charted, and that charted data which is superseded. The compiler sends these changes back to update the data base. A tape is generated for a new chart edition and plotted on the Raster plotter. This plot is transformed into the press plates for the nautical chart.

The data base is 3 billion characters of information on our charted area of responsibility, in all the four quadrants of the globe. The data base is composed of every charted feature in this area plus all features that are available for charting. For instance, only a small percentage of a hydro survey actually gets on the chart, but we have all the other valid data, and it is available for charting. If an area actually does change, it will be archived, but in the event we want to call it back, it is accessible. All these charted features are stored only once. If we send a feature into our archives, it will be done for all the charts -- we don't have to worry about having a piece of data linger on one chart due to an oversight.

The primary use of the Automated Information System is to update our nautical charts in a continual maintenance mode. As new data, like a hydro survey, comes in, it will be applied against the charted data base, and the data base will be updated. If a new edition of a chart is to be published, all changes would be already made. The public can get better data in a better presentation in a more timely manner. The concept is that, within three days after receipt of the new data, it will be applied against the charted data base.

Nautical chart maintenance is the primary use -- secondary uses are more relevant to this conference. We can produce, in an automated, machine readable form, all the stored data for a particular area. If the verifier or hydrographer wants data for chart comparison, it can be provided.

Prior survey data is also available and can be plotted at survey scale by the marine centers or by the ships plotters.

Prominent uncharted landmarks may, or may not be in the data base. If they are, they could be sent to the hydrographer for use in calibration of horizontal control.

You are all welcome to stop by Building 2 in Rockville to see the system. The Marine Center verifiers would be interested in our cartographic work stations, because you can actually update our data base with a graphic display in front of you, change the data base and see the changes made.

APPLICATION OF AN AUTOMATED CONTOURING PROGRAM

Dennis J. Romesburg
Marine Chart Division
Marine Surveys and Maps

ABSTRACT

This paper describes the contouring program developed by Unitech. Experience gained from testing and using the program are discussed. Future uses of the program are touched on briefly.

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The automated contouring program employed by the National Ocean Survey's Marine Chart Division was developed by Unitech, Inc. of Austin, Texas. Unitech is a firm that specializes in computer software products. The contouring program was originally begun as part of a Navy project but was abandoned by them and taken over by the National Ocean Survey (NOS). The program was further developed, refined, and tested per NOS requirements and requests, and has evolved to its present status.

Chart 18460, Entrance to the Straits of Juan de Fuca, is the first chart printed to utilize computer generated bathymetry and will serve as a reference in the working application of the contour program.

However, before I get into the actual steps required to obtain the charted curves, I think I should touch briefly on some aspects of the initial acceptance testing of the program software.

The acceptance tests consisted of contour plots performed by the Marine Data System Project, which worked first hand with Unitech in software development, and by the Marine Chart Division's Automated Cartography Group, which was responsible for compiling the chart. These plots covered all types of data, from constructed data sets to actual hydrographic surveys, which were available in digital form. The test plots of the hydrographic survey digital data permitted a visual check between the machine generated curves and the curves drawn by the verifiers at the marine centers. The differences noted were minor, with individual interpretation of where to place a curve creating the disagreements.

In another test, since the chart possesses bathymetry, a portion of a hydrographic survey was contoured using the cartographers from MCD's bathymetric group at Rockville. These curves were compared with machine generated curves for the same area. Again, differences were attributed to unsubstantiated personal interpretation of the data versus the machine generated curve placement. These differences were considered insignificant and the decision was given to use the automated contours on the chart. I should point out that some curves on the chart were smoothed by the reviewer and are indicated on the English proof copy. These revisions were primarily aesthetic in nature and do not necessarily represent errors. Another redeeming aspect of the contour package in this test was the time saving attained. The bathymetry group took one and one-half days to draw the curves by hand for this portion of the survey, while the contour program required less than one-half hour. The one-half hour includes both the generation and plotting of the curves.

Now let's take a look at the procedures required to arrive at the curves. Greg Bass just gave us a picture of the Automated Information System and of the future. This is an example of what can be accomplished using data and software that is now available.

Input data to the contouring package are from various source documents but originate primarily from hydrographic curves. On chart 18460, the sounding sources were Canadian and U.S. Hydrographic surveys. However, before the sounding data can be utilized by the contouring program it has to be available in digital form. Obtaining the soundings within this area in digital form was accomplished in three ways. First, PMC was contacted and the most recent digital survey tapes were copied and sent to Rockville. Secondly, copies of all sounding data that was collected by contract digitizing were requested. This data source includes some 3,000 plus hydrographic surveys from 1931 to the mid-1960's. Thirdly, all additional sources such as the Canadian surveys were digitized in-house on the Rockville digitizing system.

After collecting all available source data, each individual source document was contoured using the contour program to insure the accuracy and quality of the collected data. Any errors found were rectified and the data tapes updated.

Before all soundings were merged onto a single data tape they had to be converted to a single sounding unit from the original units in which they were recorded. These original sounding units were feet, feet and tenths, fathoms, fathoms and feet, fathoms and fractions, meters, and meters and tenths. The sounding unit to which they were converted was meters and centimeters and is the same unit that all sounding values will be stored in the AIS data bank. After all the sounding data was converted to meters and centimeters, it was merged onto one data tape and reconverted to the proper charted sounding values. This was fathoms and feet to 11 fathoms and then whole fathoms on the fathom side of chart 18460, and meters and tenths to 30.5, half meters to 30.5, and then whole meters on the metric side. The charted sounding values were contoured before any sounding procedures occurred to place the depth curve as accurately as possible (i.e., the 20 fathoms curve was drawn between values of 20.77 and 20.78).

The decisions of where to draw the contours created considerable controversy within NOS concerning safety, international specifications, and accuracy of the depth curves. It was decided to continue to chart the curves on the side of safety as we currently do until such time that we go completely metric. At that time a new decision will be forthcoming on where to draw depth curves.

Marine Chart Division is not the only group using the contour program. NOS's Photogrammetry Division uses the program for its photobathymetry effort to plot depth correction factors, and the laser bathymetry project uses the program to plot clarity factor values.

Future in-house application for the contour package appears to be very good. The majority of sounding data received by NOS will be in digital form. Besides our own surveys, the Corps of Engineers is currently collecting data in digital form. We are corresponding with them and have exchanged preliminary data tapes.

Marine Data Systems Project has developed software that reduces the tremendous number of data points generated by the contour program to a more manageable quantity. Present findings are eliminating between 80 to 90 percent of the data points and still plotting the same depth curve configurations. At the same time, the data is point eliminated, or as a separate step, the contour data can be converted from X, Y coordinates to geographic positions for storage in the AIS data base.

Several tests were run using the contour program to generate loran overlay plots. The results were promising and future tests will be made in this area.

A major feature of the automated charting system will be a sounding selection routine to assist the chart compiler. The sounding selection program will utilize the contour program as a basis for making the sounding selection. The contract for software to accomplish the sounding selection is presently in procurement, so additonal details will be forthcoming.

Last year I addressed this conference on the quality of the data coming from the Marine Centers. In closing I would like to restate that all sounding data, both plotted and excessed are utilized by the contour program. Therefore, it is imperative that the sounding data be as clean as possible. This will help reduce the time required to revise and/or correct the data at headquarters.

DISCUSSION

LCDR Bass: How transportable is the software from one computer to the next?

Mr. Romesburg: I don't know. AMC was supposed to be talking directly with Unitech about that. Also, I believe Marine Data Systems Project has addressed the subject.

CAPT Moses: It is a proprietary package, for one thing, and it could cost you to move it from one computer to another. They were talking between ten and 20 thousand dollars.

Mr. Enabnit: When you say proprietary, you mean that the coding is proprietary. We understand exactly what the algorithms themselves are, so that we know how the data is being treated.

Mr. Mordock: Since we do have a program already that works, although it is not as sophisticated as this, if you can get certain people to agree, all we have to do is turn the switch, and draw up final contours using all the excessed soundings. This means there will be some contour lines that don't seem to agree with what the smooth sheet looks like. Obviously excessed data will push contours into different regions. If you get these people to agree, just say it and I will draw these contours for the final sheet using all the soundings in the survey, so the busts will be seen before they get to you.

Mr. Romesburg: At the Marine Chart Division, we decided to use all the survey data including excessed soundings to arrive at the contours we have on the chart.

Mr. Mordock: The more data you have, the better the contours.

Mr. Sanocki: As far as AMC is concerned, we do consider the soundings in excess in drawing the contours.

POST 1980 SHIPBOARD COMPUTER SYSTEM

CAPT Ray E. Moses
Chief, Marine Data Systems Project

ABSTRACT

The next generation of automated data processing equipment is well into the planning and feasibility stage at this time. The procurement specifications are now being drafted. If funding is on schedule the new systems will appear in 1981. The concept is to have a family of computers to meet launch, ship and marine center requirements well into the 1980's.

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A feasibility study was presented to the department two months ago, and approval in concept was granted. The National Ocean Survey (NOS) outlined what they considered to be the major problems that the post 1980 system should solve. We have about 44 ADP systems in support of the fleet, which includes oceanographic activities and the processing at the Marine Centers. Four of these systems are shore-based support systems, 38 of the systems are HYDROPLOT. The MDSP project is not complete -- we still have the AIS to do. We are, however, in a position where we are using a number of subsystems that have been developed as part of the project, processing systems, plotters, digitizers, etc. We have also come to the point where we are having to replace equipment already, even though the project isn't complete. Rich Schiro and others here have worked on the post 1980 shipboard system requirements study, coming up with the background information that was used to write the feasiliby study. NOS has made a number of recommendations and has received approval to go ahead conceptually. This post 1980 system is going to include oceanographic requirements in MESA, ocean dumping, coastal influence zones, etc.

We have a proposed task group to develop the RFP specifications. That list of people is in data operations right now for their concurrence. Hopefully that group will meet for the first time in the next couple of weeks. The timing for specifications, Department of Commerce review, to delegate procurement authority, etc. should and must come off on schedule, or we are not going to get the money by 1981.

The approval in concept reads something like this.

> The NOS policy will promote strict compatibility and interchangeability of all the areas of ADP through the adherence to standards and specifications of hardware and software. The Department will procure through open competition the direct replacements for the 44 present systems, installed with options to procure additional ADP systems through FY 1989 as needs and budget dictate.

They have approval for 44 with options for 56. Each of the additional systems beyond the 44 will have to be justified at the time. Besides compatibility, other benefits to NOS include elimination of the need for sole source procurements, ability to stay abreast of the state of the art of ADP, and reduced costs through efficiency.

Consider the existing system, HYDROPLOT, and the fact that you are not certain of getting the money in '81. I think the question of "do we continue to maintain HYDROPLOT?" pretty well answers itself, because we are going to be using HYDROPLOT for the next four to five years. Once you get to installation, it will be another year or so until you get things ironed out and working properly. We plan to start software conversion early so we can use that to influence the hardware selection. Just to go out and procure hardware without software is a pretty poor way to run an operation.

We are looking for machines that will use high-level language. We are looking for a family of computers so that we can have one with small capability on a launch, more capability on a ship, and even more capability in the Marine Centers and shore processing. We want the system to be flexible, so we can use any number of peripherals from oceanographic to hydrographic and even possibly laser hydrographic data processing. At first there will be at least two configurations, the data acquisition systems and the processing systems. Basically for hydrographic purposes.

I am giving this talk for the computer people in C5 -- they are the ones that did the feasibility study and came up with the approval in concept. The money is in the budget process for '81 right now; it is part of an OFO package of fleet maintenance and upgrade, and we don't know yet whether we will get the money. The feasibility study states that we will derive the following benefits from this flexible approach: We will implement a comprehensive plan to accomplish the objectives of the NOAA fleet. ADP resources management plan enables a better coordination of NOAA programs and NOAA fleet. ADP planning, evaluation and budgeting activities provide a structured long-range ADP plan which is in the best interest of the federal government and maximizes utilization of fleet ADP resources. The cost in the first year ('81) will be a million and a half, second year a million and a half, etc., down to steady-state maintenance costs of $440,000 a year.

DISCUSSION

LCDR Goodman: Do you have numbers for our prior system?

CAPT Moses: Since these are not my numbers, I am not going to try to justify them. The total is over a million each year, with site preparation of $600,000. So the systems themselves would run less than $100,000 each.

LCDR Pickrell: According to that schedule, there is not going to be a phase-in period.

CAPT Moses: There is at least a phasing in procurement -- 13 data acquisition systems the first year, 16 the second, with 8 processing systems the first year and 7 the second. The installation aboard ship is going to be phased over '82 and a good portion of '83.

LCDR Pickrell: Is the software conversion going to be contracted out or done in-house?

CAPT Moses: It will have to be contracted. We don't have the resources to do it.

Mr. Olmstead: Do you have any figures how it will affect production in the field and in the Marine Centers?

CAPT Moses: I don't think that has been gone into. We just know that we do have to replace the existing systems.

LCDR Bass: It appears to be obvious from the questions that we get a combined effort in developing the RFP specs to cover the various areas. There is a great fear that there will be a lot of parochialism. There are a lot of independent groups that want their own way of getting the system, and we have to keep in mind that it is going to satisfy all of the charting effort and will be flexible enough to incorporate other, even unforeseen, methods of data acquisition, even those that are just coming over the horizon, including airborne lasers. It appears to me that we should be able to support all these various functions. There seems to be a movement afoot to get a hodgepodge of hardware, put a system together after we get a few pieces and try to wire them together. One of the outputs of this conference might be a consensus that we do want to spend a lot of time on the development of specs. This mid-'79 date is not all that far away. These specs will be subject to revision, but now is the time to be thinking about collecting our knowledge and getting an NOS-wide system.

CAPT Moses: There are some guidelines laid out in the feasibility study, of course. All of the existing software will be used or usable on this system, converted, etc., but I expect that as with most systems your hardware costs are not going to be your biggest costs by any means. Even though we do have available software, for a lot of the things the software costs will run quite a bit higher than your hardware costs. That is what we have to be careful with, because you can get a machine that will do the things over and over again, but you can't always efficiently use what you get out of the system unless you are very careful with your software.

CDR Schaefer: Would you care to address how this is going to fit into NOS, inasmuch as the presentation originally came from C5. MDSP as it has existed is no longer going to exist. You are talking about Marine Center programs and data acquisition programs, which are now split between C3 and C7. If we want to reply to what Greg has said in terms of having input, where do we go?

CAPT Moses: The reason that this presentation came from C5 is that there is an office at C5, the NOS Office of Computer Management, that has the responsibility for ensuring that all NOS ADP procurement and operations are in accordance with NOS policy and also fits the policy of Commerce, GSA, etc. The funds, as I mentioned, are in a package with fleet operations. The requirements, of course, will come from C2, which will be the new oceanographic office, and C3, or surveys and maps. There is going to be a problem in getting these different groups to work together effectively. The first step is to get the task groups set up to work out the RFP and to actually get them to work. Marine Data Systems Projects is going to move to C3 about the 14th. We will be very deeply involved in representing C3's interests as far as the data acquisition and processing systems are concerned. Just how much influence we are going to have, I don't know. The fact that the money is at least in a package for C7 wouldn't give you quite as much influence as you would want to have. Maybe they will split it up and put the money in C3 for the data acquisition systems. That's a continuing problem, getting everyone working together.

CDR Schaefer: I have a two-part question: (1) Could you identify some members on the task group for me, and (2) is there a possibility that this group may respond by suggesting a certain area or method to consolidate this? As you said, the money is in C7, you are going to be in C3, so immediately they are not going to like you because now you are in C3 and no longer will be a staff function.

CAPT Moses: We still have to work that out. The task group has not been officially approved, and the point is that there is a list of names at OFO right now, waiting for their concurrence. You have a member from C5, Greg Bass as far as MDSP is concerned, Jim Utesko from C3, and someone from C2. There will be one or two from OFO. It was proposed that Admiral Lippold would head the task group, and I am sure they will be getting to the Marine Centers with requests for requirements and information. We are hoping to get Admiral Lippold to head the task group, which will take care of some problems of coordination and making sure everybody's interests are represented.

CDR Schaefer: You stated that software conversion would be contracted, as we didn't have the in-house capability. Is it safe to say that software maintenance will be contracted also?

CAPT Moses: No, probably not. It hasn't been completely settled, but in any software contract you will have to monitor it, and you have to have one person to monitor about every four contract software personnel, so that is in there, and I expect it will be done partly in-house. We do not have the resources to do the whole thing.

CDR Schaefer: So your figures in software include not only programmers but also supervisors.

CAPT Moses: I think it's all mixed together.

CDR Fisher: With regard to continued use and maintenance of HYDROPLOT systems, what are the plans over the next few years until a post-1980 replacement is available and on line?

CAPT Yeager: Until funds for replacement are firmly in hand, HYDROPLOT will continue to be maintained and incremental improvements will be made. Requirements for changes and improvements should be addressed to C3.

LIFE COSTS ($K)
CONSTANT DOLLARS

ITEMS	81	82	83	84	85	86	87	88	89	90	TOTALS
1. Procure new hardware a. Acquisition sys.	13 / 390	16 / 480									$ 870
b. Processing sys.	8 / 600	7 / 525									1,125
c. Spare parts	290	150	200				120				760
d. Mid-life upgrade						400					400
2. Software conversion	6 / 180	6 / 180	4 / 120								480
3. Software maintenance			1 / 30	5 / 150	5 / 150	5 / 150	5 / 150	3 / 90	3 / 90	3 / 90	900
4. Hardware maintenance			4.5 / 135	9 / 270	9 / 270	9 / 270	9 / 270	9 / 270	9 / 270	9 / 270	2,025
5. Site preparation		15	600								615
6. Training	20	50	50	20	20	20	20	20	20	20	260
7. Project mgmt.	3.5 / 105	3.5 / 105	3.5 / 105	2 / 60	2 / 60	2 / 60	2 / 60	2 / 60	2 / 60	2 / 60	735
TOTALS	1,585	1,505	1,240	500	500	900	620	440	440	440	$8,170

(The numbers in the upper left-hand corners refer to "Number of Systems" or "Number of Person-Years" as appropriate)

****FLEET ADP PROCUREMENT****

```
                           |1979        |1980        |1981        |1982        |1983
                           |JFMAMJJASOND|JFMAMJJASOND|JFMAMJJASOND|JFMAMJJASOND|JFMAMJJ...
DEVELOPE RFP SPECS ------  |XXXXXX
DOC REVIEW --------------------- XXXXX
VENDOR COMMENTS ---------------- XX
GSA REVIEW (DPA) ------------------- XX
RFP ON STREET ----------------------- XXXXX
EVALUATION AND AWARD ------------------- XXXXXXX
SOFTWARE CONVERSION --------------- XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
PROGRAMMER TRAINING ----------------------- XXXXXXXXXXXXXXXXXXXXXXXXXXX
SHORE SYSTEM DELIVERY ------------------------- X
E. T. TRAINING ------------------------------------------ XXXXX
SHIPBOARD INSTALLATION ------------------------------------- XXXXXXXXXXXXXXXX
SHIPBOARD MAINTENANCE ----------------------------------------------------- XXXX...
SOFTWARE MAINTENANCE ---------------------------------------------------- XXXXXXX...
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RESULTS OF BS^3 TESTS

CDR C. William Hayes
Commanding Officer
NOAA Ship DAVIDSON

ABSTRACT

This paper describes the BS^3 system and what it is and what it is not. A comparison test was done in Puget Sound between the HYDROPLOT System and the BS^3, results of this test are briefly discussed.

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I've been asked to give you a presentation on the results of the BS^3 Tests conducted on the DAVIDSON during this past season. While the results from the data are not fully available, that data which has been analyzed has produced excellent results. So much for what I was asked to do. If you have any questions on the data, please hold them for Larry Mordock.

It might be helpful for me to give a quick review of what this system looks like. The system has been actively under development somewhere between two and three years. If you are familiar with the effort that went into HYDROPLOT, I think you'd agree having an onboard, online system in that period of time is quite an achievement. Henry Shek told me there is a paper out which admits how much this effort has cost -- it is approaching four million dollars. Not to confuse the issue of cost, that is mostly software, ship time and a lot of other things. The hardware itself ran somewhere around $400,000 to $450,000. The results are presently on the DAVIDSON, making it, in my opinion, the finest hydrographic ship in the world today.

The sonar system has a pair of projectors that fire alternately port and starboard. The receiver units pick up the return signal. After some signal processing, you ultimately end up with what are essentially 21 return echoes, quite similar to a standard fathometer (Figure 1-2). I say similar because there are things that happen in the processing that make it considerably different. In a normal fathometer, the signal is sent out in a square wave form or square pulse, and when it comes back it is generally noisy. Very little happens to it except that when a preset signal level is reached, its timing stops. This particular system (BS^3) takes all of the sound coming back, munching and scrunching it, and when you get down to this stage (Figure 3-7) it says, this stuff is sidelobes and throws that away, and it finally shapes this a little bit better and comes up with something that is reasonably square. The basic difference between the B^3 sonar and something like the Ross is that, with the Ross, when you hit a ramp level or a detection level the time is measured. The BS^3 actually measures two times. It measures when it reaches (Figure 3-10) this level (to -t) and when it decays to that level again and then selects the center. It becomes very important because of the geometry of the equipment. When the soundings are directly under the ship, this isn't critical. When you have large angles, 40 to 50 degrees out to the side, then the geometry says you had better get a more precise position of where it is, because the sonar unit is not only determining the depth, it is also determining the geographic position of that sounding. In doing all of this, the BS^3 is actually averaging a lot of sound coming from that area. It is not getting the least depth. It gets an average depth in its 5 x 5 degree sounding area. In the same sonar unit is the gating (Figure 3-20) which is displayed in the upper center portion of the sonar unit. You can hook up any kind of sounding equipment to the guts of the system -- you can hook up a Ross fathometer and it will still do the same kinds of things. It won't do swath mapping, but it will produce HYDROPLOT type data. The tide measurement system is a breadboard type of equipment at this stage. The BS^3 will accept real time tides and you can telemeter three tide stations.

Other components are a PDP-11 with floppy disc, and included is a set of Quantex cartridge drives which is sort of your notekeeper -- the notes on the side of the sounding printout, a remarks column, if you will. In the Camac unit you have all the interfaces as we have been using them on launches and HYDROPLOTs which would probably occupy one and a half racks, rather than the small space of the Camac. The PDP-11 has its own Camac (Figure 1-5, UNIBUS). The Gould plotter is where the real-time swath plot comes out. Our input/output to the system is a CRT. This fall we ran simultaneously with the BS^3 system and the HYDROPLOT system online. They were linked as far as time is concerned, so we were using the same navigation data and running on the same track, positions, etc. In some cases, the BS^3 shows contours on both sides -- it does not show contours which are deeper than the soundings under the vessel. The soundings are accumulated, but they are not shown in real-time. In comparison, the Ross didn't get very many of the little hummocks and peaks. We then ran the patch test. Anchoring the ship, we dropped a target (a Christmas tree), took a leadline sounding at the target, and then over the origin of the patch test -- the spot we were going to make repeated runs over. We ran 30-some leadlines comparisons. The leadlines statistically came out worse. The BS^3 system was somewhat in between, and the Ross was very steady statistically. After that we ran a criss-cross pattern over the patch or over this origin site, and ran some 75 of these. I don't have the results of any of that -- the people in Marine Technology at headquarters are going to take a look at them, massage them and see what they can come up with statistically as to what the system is or is not doing. Earlier I mentioned that the system was using soundings considerably different from the way that the Ross, Raytheon or other types of digitizers are using them. What happens in the BS^3 system is that we are gobbling up essentially all of the returned sound, all of the pings that come back. In your Ross digitizer, you set the interval and select. Even though you have a graphic record which is essentially everything, the digitizer is only picking up at set intervals. The BS^3 digitizer is taking all of the signal that comes back. After it gobbles up all that information, there is a post-processing routine where you chop the bottom up into manageable-size blocks, and that routine works through that data, intercomparing it -- any that really looks odd, that are excessively deep or excessively shallow, which are not supported by other soundings immediately around it, are rejected and gone forever -- they are bad data. After that process, inside of that block it begins to decide the typical minimum depth for the block and the typical maximum depth for the block. Since these are representative of all the rest of the soundings in the area that it is working in, it then discards all of the others, saves those two soundings and builds a new sounding tape. This is the thing that we send over to Larry Mordock and his people. They begin fondling and grinding it some more. Larry gave me a note this morning regarding what we throw away -- he had 1,859 HYDROPLOT soundings. The BS^3 of that material which we gave him had 6,760 soundings. I frankly have no idea how many million were actually inside before they started excessing. The bulk of the data is never getting of the ship. I would like to conclude by explaining what the BS^3 system is, and what it is not. BS^3 stands for bathymetric swath survey system. It doesn't say that it is a wreck-finder; it doesn't say that it is an obstruction-finder. It says it is a bathymetric mapping tool, and that is one spot where it is limited. It is not sidescan. It's not like the Klein system. In the manipulation of the soundings, it does a lot of different things. It is not a shoalwater system. I would guess that the real limitations of it are 15 or 20 fathoms, because the beam width or a swatch width is 2-1/2 times the depth, and when you get much below that depth, the geometry is such that you have to run excessively narrow-spaced lines. You can do it if you really want that kind of detail, but for the most part we are getting into launch-work if you are talking about this system. Its maximum is shown as about 400 fathoms, 2,500 ft. We have tested it and got reasonable results at something on the order of 700 to 800 fathoms -- how good they are, I don't know, but it does sound in that depth of water. So we are looking at a middle-range system. It is not the real shallow system that may come along, and its not the deep system that will come in terms of Seabeam.

DISCUSSION

Mr. Mordock: To date, PMC has not expended large processing efforts. We have received tides, and will soon reduce and compare data. To date we have expended slightly over half a man-month of programming effort. The navigation plots are all in agreement, and there are no breaks in position. I would like to emphasize a couple of points concerning the navigation plots. For BS^3 data, all that can be done is to track the antenna for a navigation plot. For each sounding selected, I plot a red or a green dot indicating where the sounding was positioned which may or may not coincide with the antenna position. The green dot is a shoal -- the minimum depth of the area you select from, and the red dot is the maximum. Examination of preliminary contour plots indicates that the Ross isn't covering the bottom with sufficient detail to accurately contour. This is a 1:10,000 survey, and the line spacing is not unreasonable for that scale. If one closely examines the HYDROPLOT contour versus the BS^3 contour, it becomes evident the HYDROPLOT system had no idea what was down there. There is a wealth of detail depicted with BS^3 that the HYDROPLOT just doesn't see. HYDROPLOT is missing much of the bottom topography. You will find areas where the Ross and the BS^3 are in agreement, but if there are features extending off to the side or between the lines, BS^3 detects them and the Ross does not.

LCDR Schiro: What is the Marine Center going to be doing with this stuff once you get it together?

CDR Hayes: Their function hasn't changed. It can be plotted out like a very close-spaced HYDROPLOT. Onboard all we are getting are contours.

LCDR Schiro: In that they throw away a lot of the data, do you do a lot of comparison? Do you do consistency checks? Have you plotted this down by some criteria to select?

CDR Hayes: We can't plot it up. We don't have the capability to put the whole survey into the machine. We have to gobble it into chunks, and that is part of this business of chopping up the area and comparing pieces of the bottom, groups of soundings and such, so that it can excess. It is doing it in a very minute way, and it is doing it piecemeal. They have the horsepower there to produce a finished product. I might say that the original bid went out on proposing a system and was 32K in the memory, so DEC came in with a piece of equipment, and we decided after we had it for a short period of time that 32K wasn't enough horsepower. About this stage of the game DEC said, "if we had known you wanted something bigger, that's the way that thing comes, and we had to pull a board out to make it the size you asked for". Suddenly it became 64K, and before we ever got it on board it was 128K. So it has a lot of capacity, but it doesn't have enough to cram all these numbers in.

Mr. Mordock: HYDROPLOT is still just an automated manual process. Out of the 6,700 soundings that BS^3 supplied -- granted there are tides still to be considered I didn't find a single sounding that looked extraneous or bad. However, I know of one sounding that is 300 ft in a 600 ft bottom -- not that the DAVIDSON made a mistake. The captain knew about this. He indicated that the sounding should be pulled from the record. I got it. The point being that we humans make mistakes; but when that machine goes in and starts selecting these data statistically, the probability of retention of anomalous data is drastically reduced.

LCDR Schiro: You gave us an estimate on the whole system; what does the system cost, separate from the sensor?

CDR Hayes: I don't really know. I have numbers on some pieces of equipment -- I have them because I was bucking at the Directors' Conference for making our launches compatible with the 11 system, so that we could get the 8 system off entirely. It turns out, if we had to equip our two launches today with a HYDROPLOT system, it would cost something in excess of about $100,000. The biggest chunk of that is in the handmade controller, which I understand nobody makes but would be happy to make one for us for $20,000. We could equip the two launches for $45,000 and reduce the amount of equipment that's inside. All of it would be in the Camac. There is an LSI11 computer which is sort of a mini version of the PDP-11 that is compatible with the 11. It would do everything that the

HYDROPLOT does now. All the information, programs and such would be on floppy disk so you would have random selection of your programs to shift back and forth. So for half the cost we could convert a launch.

LCDR Schiro: Is that $45,000 per launch?

CDR Hayes: No, that's $45,000 for both including spare parts, installed.

Mr. Redman: What is the final output? I gather you don't produce a boat sheet or smooth sheet.

CDR Hayes: The final output is a Mag tape. Not entirely -- we do have those printouts that I showed you for swath contouring that's real time. The track plot which shows the limits of the swath and the actual track of the vessel.

Mr. Sutlovich: Did your hull speed increase with the BS^3? Could you go faster in the water?

CDR Hayes: Not that I noticed.

Mr. Sutlovich: I mean, can you go faster with your BS^3 in operation that you did with HYDROPLOT?

CDR Hayes: We run at full bore, which is 12. Whichever system you use doesn't make any difference.

CDR Nortrup: In your operating for 100% coverage, do you have a guideline yet for how much overlap would be required?

CDR Hayes: Don Suloff said he was giving us a set of skeleton project instructions for Cape St. Elias for this summer and for us to fill in the criteria. This is kind of a do as you go. I don't know what is going to be decided. Modeling techniques may mean that we don't have to have 100% coverage, because we may have enough data to decide what is the probability of something being between the lines.

CDR Nortrup: A corollary to that would be some comparison of the outer beam depth data from adjacent lines. Do you have a feel for what you are getting, or the kind of consistency? Do you have that kind of information coming in off your test projects.

CDR Hayes: We will have, yes. Both here and on the patch test there was overlap, and in the patch test we were repeatedly driving over that same spot out there.

CDR Nortrup: I think the Canadians admitted in their tests several years ago that they had degradation in the outer beams.

LCDR Pickrell: You said all you could say was that you had covered the area. One of the primary ways that you can make sure that your positioning information is correct is by comparison of cross lines in comparison with others, maybe with the shoreline. Do you have any other procedures to ensure that you are covering the area.

CDR Hayes: Frankly, at this stage, no. I guess that's what we are still working on. And that is exactly why the project instructions are sort of "What should we do about this?" We have to think some of these things through. One of the features that I don't like, and they put it in for clarity in real time, but onboard we only receive the shoaler contours -- the downslope side I don't see. I don't have any way of comparing it when I make my next pass, because I'm getting the shoal side in what used to be the deep side, and I don't have anything onboard to compare it with. So that's a problem. They recognize that, and that's one thing they are going to address. Operationally there are going to be a lot of games before we decide exactly how we are going to make sure of navigation and make sure of the sounding. In real time it is a problem, because we don't know when we have a bust.

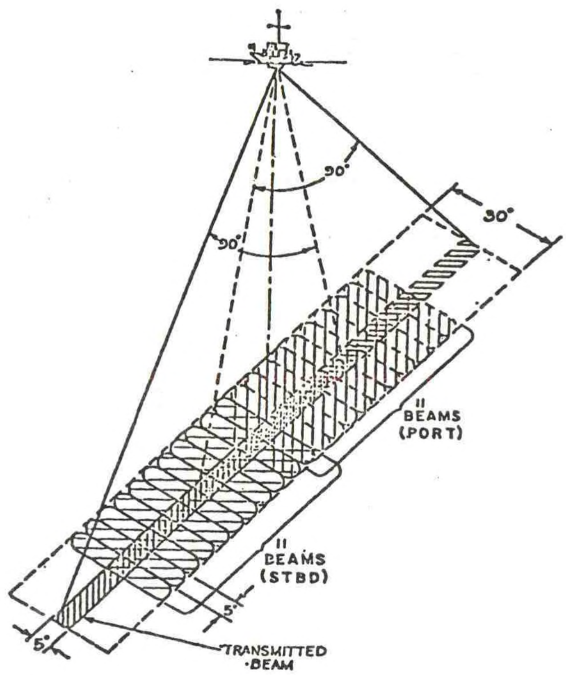

FIGURE I-2. 21 BEAM SYSTEM

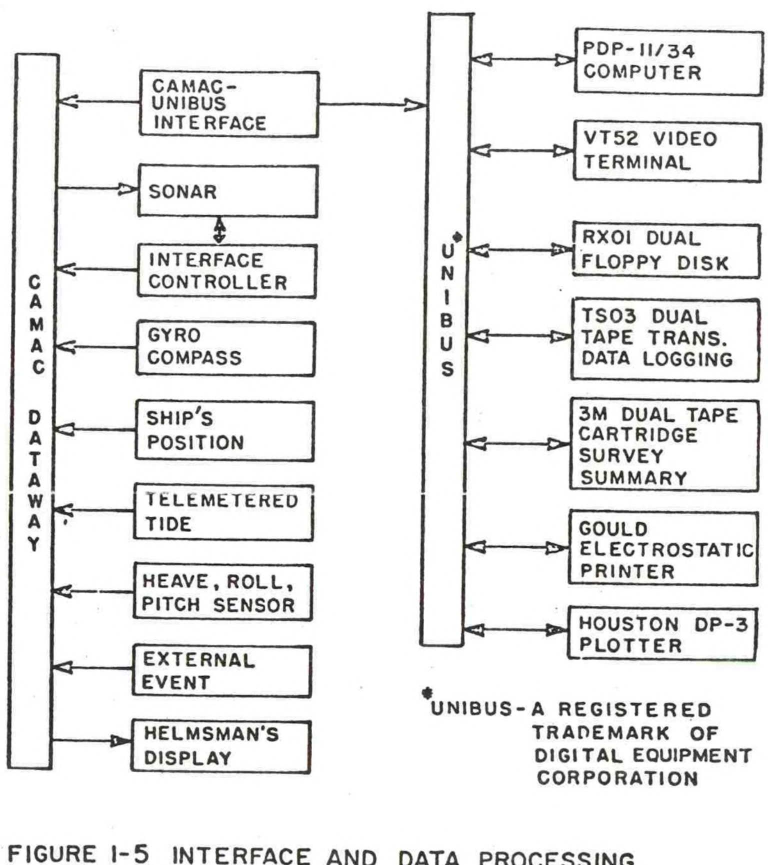

FIGURE I-5 INTERFACE AND DATA PROCESSING SUBSYSTEM BLOCK DIAGRAM

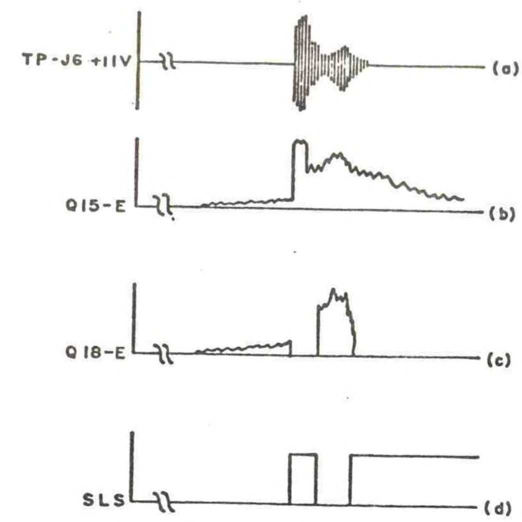

FIGURE 3-7. RECEIVER WAVE FORMS

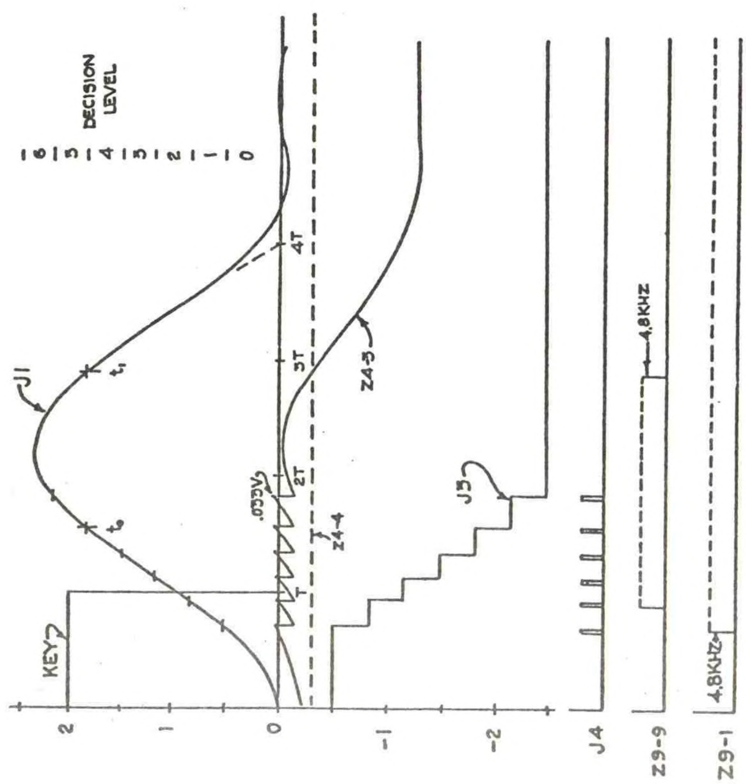

FIGURE 3-10. DIGITIZER CIRCUIT SIGNAL DIAGRAMS

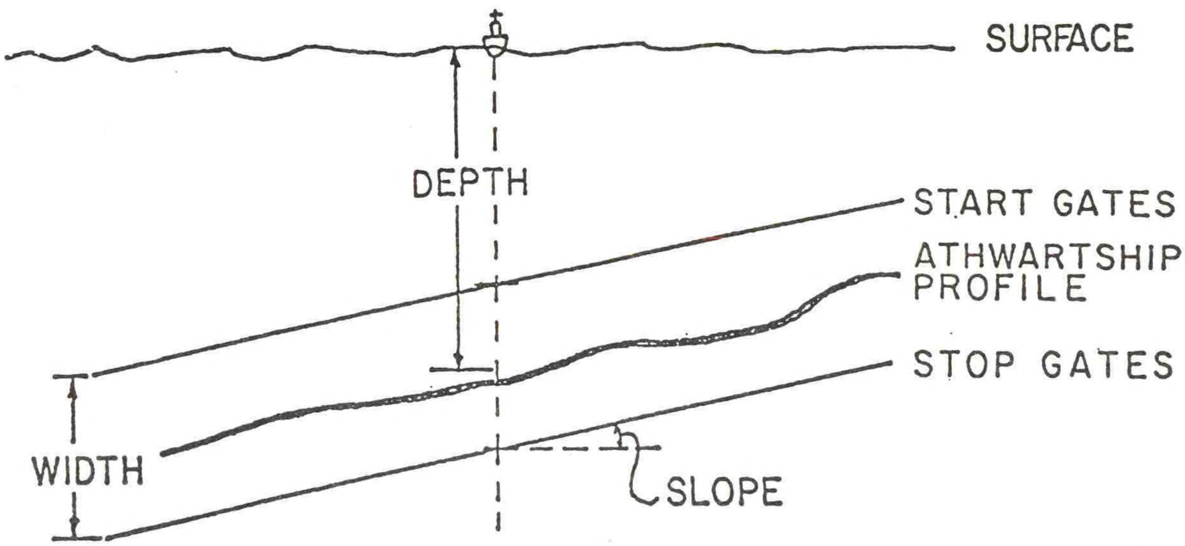

FIGURE 3-20. DEPTH GATES, DEFINITION

STATUS OF AIRBORNE LASER HYDROGRAPHY

David B. Enabnit
Engineering Development Lab

ABSTRACT

This paper reports on the current status of the airborne laser hydrography system. A section of the eastern shore of Chesapeake Bay was surveyed by both airborne laser and by launch sonar. The accuracy and capabilities of laser hydrography are discussed along with cost comparisons.

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The National Ocean Survey (NOS) has been seriously investigating airborne laser hydrography for about three years. At a lower level we have been working on it since 1970. The areas of interest to us are performance, benefits and the drawbacks. We are trying to get to a point where NOS can make an informed decision on whether or not to adopt this technology. If NOS then decides to go ahead most of the information developed during this phase will be directly carried over into the development and implementation of such a system.

Using an aircraft-mounted, scanning beam, pulsed laser system, this technology promises to take large quantities of bathymetric data both rapidly and inexpensively. The major motivation for NOS to adopt laser bathymetry is economic. The system computes depth using the time-of-flight difference between a sea surface reflection and a sea bottom reflection of laser pulses. This time-of-flight difference is proportional to depth.

This slide shows the temporal behavior of the laser pulse. On the left you see a schematic of the laser pulse itself. In the middle you see a representation of the surface return. Immediately following the surface return is volume backscattering from optical scatters in the water, and then comes the energy reflected from the bottom. It really is very much like an optical sonar.

The next slide shows the spatial behavior of each laser sounding. Coming in from the top is the columnated laser beam. It hits the water and immediately begins to spread due to optical scattering in the water. The beam hits the bottom, is diffusely reflected from the bottom back toward the surface, and is collected with a telescope on the laser aircraft.

Some typical operating parameters for an airborne laser hydrography system are: a wave length of 540 nanometers, which is in the green for maximum penetration, a typical laser sounding rate of 400 soundings per second. This is a swath system -- it scans underneath the aircraft at 5 Hz. The swath width is typically 725 ft for a scan angle of 20 degrees. The aircraft speed is bout 150 knots at a nominal aircraft altitude of

1,000 ft. Spatial distribution of soundings which we have had experience with is an average of one per 20 square meters. The percentage of the bottom illuminated is proportionate to the depth and the water clarity.

The technical questions of interest to NOS relate to performance -- what is the accuracy, and what is the penetration that can be achieved with this technology? We have been answering these questions through theoretical studies and through an experimental program where we use a NASA laser system as a research tool. The work we have done so far has been partly supported by DMA and NORDA. I am going to present some of the results we have achieved.

The system accuracy is composed of precision, bias and repeatability. Precision is a measure of the system noise and thus is a fundamental limit on the overall accuracy. We have modeled precision, and the results are shown in this slide. What you see is that at higher signal-to-noise ratios where one achieves a saturation, the imprecision is about ± 5 cm RMS. As one gets to lower signal-to-noise ratios, the system is less precise, and the performance degrades.

After doing this modeling, we flew the NASA laser system, collected bathymetric data and determined the precision experimentally. The following slide shows some of our experimental results. You will see that the data does indeed follow the model, gradually tailing off at saturation to a value of about ± 5 cm RMS at high signal-to-noise ratios, and at lower signal-to-noise ratios, you see the characteristic decrease in precision. Our conclusion on precision is that this demonstrated ± 5 cm RMS precision is significantly less than the 30 cm error of depth which we are allowed according to the hydrographic standards. Also, because the experiment follows the theory so well, we feel that precision is a well-understood problem, although achieving these precisions in a routine operational manner will still require a certain amount of work.

The second part of accuracy that we have been interested in is bias. Bias is a measure of the constant offset between a series of measurements and the correct value. We have been estimating bias by comparing laser bathymetry with a high-density launch sonar survey over a flight test range, thus we're not getting a true bias -- what we are actually getting is an intercomparison between the laser and the existing accepted technique.

I have three examples of results of these laser/sonar intercomparisons. These were all done on the eastern shore of Chesapeake Bay in the Chrisfield area. On the slide, the solid dots are sonar hydro, and the open circles are every fortieth laser sounding; the open circles being connected with a line. The agreement here is quite good. I think the RMS difference is about 0.4 ft. The scale is significantly compressed in the horizontal. That cliff that you see is about a 2^o slope.

The next slide shows some disagreement that we found in a different pass. Here you see the laser is measuring shallow, and it is measuring shallow on the order of one foot. Again we have selected every fortieth laser sounding, and you are seeing every sonar sounding from the launch. Something interesting to note is the end of the launch hydro. The launch was unwilling to go closer to the shore, but the laser flew right on up over the beach, measured the land, the grass, a tidal pool on the other side, dropped back into the water, went up over the shore again -- topography just didn't make much difference.

On the third intercomparison made, the laser is measuring deep on the order of one foot. It is a statement on the perversity of nature that if you set your standards at ± one foot, all of your experiments are going to come in at ± one foot, so you don't know if you succeeded or not.

The biases are not really of concern to us at this point. We have been studying them and have several potential sources for this bias. We really don't feel it is fundamental to the laser technique; we feel it is a systems problem, and we do have enough data, I think, to resolve this before we go to the Director of NOS and ask for a commitment. An interesting thing to note is that if we take the laser and sonar bathymetry profiles and, on an ad hoc basis slide them together, they agree to within ± 7 cm RMS. 7 cm RMS is exactly what you would expect if you root sum square together two systems with a ± 5 cm RMS precision. So whatever it is they are seeing as bottom, the laser and the sonar are both seeing the same thing, and they are seeing it quite consistently.

The third part of accuracy which we have been studying is repeatability. This is the ability to fly the same flight line on different days under different conditions and get the same depths. We compared two lines of laser bathymetry and got agreement to within ± 20 cm RMS. This is entirely consistent with the uncertainty in the actual location of the two flight-lines. Our conclusions on accuracy are that the system is sufficiently precise, that we can repeat measurements; but that there remains a bias on the order of 1 ft which is of uncertain origin and occurrence. We do have candidates for the source of bias and are confident that it can be removed.

One other measure of performance that we have been interested in is penetration. Penetration affects the amount of area which is surveyable by laser and hence affects the economic value of the technique. Because laser hydrography is an optical technique, water clarity is the limiting factor on penetration capability, We describe the penetration capability in terms of a product of water clarity and the depth. That measure of penetration is alpha-D where alpha is the narrow-beam transmissivity and D is the depth. Here we have a slide of penetration for laser systems of different capabilities. What you see along the horizontal axis are measures of water clarity in inverse meter; along the vertical axis is depth, and the curves show the depth of penetration you could achieve for a specific value of water clarity given one of the systems listed. The lowest curve, the alpha-D=2, is characteristic of photobathymetry, the alpha-D=10 curve is the capability which we have demonstrated with the NASA research system during the daytime, and the alpha-D=15 is the capability we have demonstrated with the NASA system at night. Based on our modeling effort and our experimental results we feel that an alpha-D=20 system is certainly within the capabilities of the technology using state of the art technology and still remaining totally eye-safe to bystanders. For some examples of water clarities, I think the Chesapeake Bay typical is about 1.5 inverse meters. In the Caribbean, where photobathymetry has been successful, the water clarity is about 0.3 inverse meters, I didn't carry the curves to these low values of water clarity because the great depth of penetration of the laser systems wouldn't fit on the graph. So the laser is not just a clear water system; it does very well in dirtier water. I think a rule of thumb or a design goal, if you are familiar at all with Secchi depth, we are talking about seeing three to four times the Secchi depth with a totally eye-safe system. These are the results on penetration; I would like to go on now and talk about economics.

Laser bathymetry has a potential of providing a significant cost savings at higher rates of surveying, and since that is the motivation for our involvement, we have attempted to quantify it. To study the economics of laser surveying, a model was developed which parameterizes the cost per square nautical mile of surveying in terms of the capital and operating costs. Estimates were made of the input costs, the model was exercised, and the cost per unit area of surveying was determined. The model is a mathematical formula as most cost models are. and I won't include it here. But I will give you some idea of the input parameters which we used. The original set of parameters looked like this: first cost factors are $750,000 as an aircraft cost, the laser runs about $945,000. Position-fixing system on the order of $125,000. The techniques development or implementation phase runs about $200,000. So a typical initial investment is on the order of $2,020,000. The operating costs which we have accrued in the model are an air crew of two, laser crew of four, overhead for the people (that's the Officers' Retirement Fund, etc.), travel, aircraft maintenance, laser maintenance, for an annual budget of $470,000 -- this is operating at its maximum rate, (flying 600 hrs a year, of which 50%, 300 hrs, is doing laser bathymetry).

If you combine these according to the model you get the curve that shows your cost benefit. It is interesting to point out that, at its maximum rate of production, 1,920 square nautical miles per year, the annual cost is $422 per square nautical mile. For comparison, we have an approximate number for launch sonar, shown at the top, of about $5,000 per square nautical mile. We want to take these numbers in the way they are intended -- this is not a guarantee that you are going to make that difference -- only an estimate of the potential savings considering the costs included in the study. The sonar number used for comparison is subject to a certain amount of dispute. We have instituted a study to quantify that and get us the best number for comparison.

At the lower rates of surveying (Captain Mobley estimated the shallow water bathymetry per year as about 400 square nautical miles) the laser bathymetry becomes more costly because you are paying for unused time, and the relative cost benefit is lower.

Now that we have this cost model and we know to which parameters the cost of surveying is most sensitive, we have been able to work to press these costs downward. As of six weeks ago, we had reduced this estimated cost at the maximum production rate to the order of $342 per square nautical mile. There is a certain amount of handwaving here, and I didn't replot it because it still falls within the confidence bounds of our original estimate. They are about ± 40%, at the 95% confidence range on the cost estimates. As long as I stay within those bounds, I am not going to bother to regraph it. We are still making the point that it is significantly cheaper than the sonar cost appears to be, even given the uncertainty of the numbers we are using.

Our conclusion is that at high rates of surveying, projected savings are large enough that, in spite of these uncertainties in the parameters, we can be confident of significant savings. At lower rates of surveying, our projected savings are not as large, and a decision to adopt the technology should consider the other benefits in addition to cost savings. I think laser hydrography also offers an opportunity for significant manpower and time savings, although the estimates are still uncertain enough that I will only give upper limits.

Many of the results that we have shown so far have been around since April or May. Based on the encouraging way these results are coming out, we expanded the project to consider all the other aspects that have to be considered before making an intelligent decision on whether to adopt laser bathymetric technology. As much of the work is ongoing now, I will just discuss the objectives of some of these new efforts and give you a brief statement of status.

One area of concern to us is being able to assign accurate geographic coordinates for each laser sounding. We would like to be able to perform a 1:5,000 scale survey, which means that you have to position each sounding to ± 4.5 meters RMS. We originally were going to perform an accuracy determination in the aircraft mode of four short-range microwave positioning systems We lost an employee and we were unable to complete the task at the time; it is languishing a little bit, but we will have some statement as to what accuracy we could position the soundings before we go for a decision.

Another area of concern to us is establishing an inventory of water clarity. Using data from the archives, data banks and reports, we have been contouring water clarity and then convolving that with depth to contour the alpha-D extinction coefficient which you saw earlier. This measure shows where laser bathymetry can be performed and thus is a measure of the usability of the system.

We have done an extensive amount of work in Chesapeake Bay and are now finishing up contouring the northern and southern halves of the Bay plus two of the major tributaries. We are also doing contours for each season to see if there is an optimum time of the year to survey. We have some results -- which show percentage surveyable versus alpha-D of the system for the southern half of the Chesapeake Bay in the summer. The design goal of alpha-D=20, which is what I told you we feel we can confidently reach and still remain eye-safe, shows that 57% of the southern half of the Chesapeake Bay can be surveyed in the summer. Last week we obtained results for the spring and autumn, and again, at alpha-D=20, in spring, one can survey 63%, and in the autumn you can survey an amazing 80% of the southern half of the Chesapeake Bay using an eye-safe airborne laser bathymetry system. I expect the winter will be worse than the summer due to the storms and the extensive resuspension of the bottom sediment. 80% is a very large number. By contrast, for a system with alpha-D=2, which is the photobathymetric capability, in the summer one can survey about 4%.

The third area of concern to us is laser hydrographic operations. We are developing an operational scenario of laser surveying to study each step of laser operations. This is to determine that we can use the airborne laser system as we anticipate, that it is not degraded below the point of economic return through operational compromises, to inject some realism into our cost analysis, and to discover operational problems which should be countered during system design. Don Suloff started us off with this chart, and we have added a lot to it. There is a whole text that goes along with it, describing each step and breaking them down. For example, in studying the use of a positioning system, we have taken a set of parameters from an existing off-the-shelf system and plugged them in as we would have to use them for airborne laser surveying. Then we determined whether or not we could actually use one of them for laser hydrography.

There is also an example of economic realism that the scenario injected, which is this launch survey subarea. It turns out that there is water either too deep or too dirty to survey by laser. There are a couple of 90 foot channels through Pocomote Sound and Tangier Sound which we don't expect to be able to survey with a first-generation laser system. This says that what we want to study with cost models is not the cost to perform laser surveying operations compared to the cost to perform sonar operations -- what we want to compare is the cost using a joint system of laser/sonar against using totally sonar. We have started that economic modeling effort and have a preliminary model which we will be putting parameters into. This will let us determine what the economics are of totally surveying an area rather than just doing a head-to-head comparison. An interesting byproduct of this joint survey operation is that, by doing the shallow water with the laser, you are freeing up the launches to work in the deeper water where they are more cost-effective, so you get a cheaper sonar survey at the same time.

Finally, we are investigating impact on NOS of adopting airborne laser technology -- what will be the impact on data processing, data verification, quality control, and chart production systems. What will be the impact on manpower, and finally what are our requirements in laser-surveyable areas.

We think that for a technolocy with a six to ten million dollar total life cycle cost and one which will cause a certain amount of disruption in our present operations, this systems level look is really necessary before you decide whether or not to adopt the technology.

DISCUSSION

CDR Nortrup: How confident are you that you will be able to position individual or discrete depth points?

Mr. Enabnit: In order not to hang one development on another development, we are constraining ourselves to operating with an off the shelf positioning system. We have a lot of experience using these for our present hydrographic operations. The only thing we expect to see is some second-order differences due to the aircraft environment, and we really have no reason to expect these to be large. We feel, however, that for completeness we have to demonstrate or quantify our capability. As a rule of thumb I will say, without proof, we will do as well with the laser system as you are doing now with the sonar system.

CDR Nortrup: Using the same positioning equipment?

Mr. Enabnit: The same types of systems, yes. For the 1:5,000 scale we are looking at short-range microwave line of sight positioning systems. NORDA is looking at the medium range ARGO; they want to go further offshore. We will try to determine positioning accuracy before asking for major support.

LCDR Pickrell: If you are talking about a joint survey effort between launch and aircraft, just taking that particular survey for an example, it seems to me that the aircraft would probably do its surveying in a very short time, while the launch would be out quite a while.

Mr. Enabnit: That's right, but when I say joint survey I don't mean simultaneous. We do joint operations between the photogrammetric people and the hydrographic people now, where photo people are in there years in advance. The same relative time statement can be made about those operations and it causes few problems.

LCDR Pickrell: If the aircraft goes ahead with high-speed data acquisition, do you have any estimate of how long it would take, say, to do the whole Gulf Coast and the areas the aircraft could survey?

Mr. Enabnit: For the area you see here, there are about 55 hrs of flying, and that is a big area. We survey at about 6.4 nautical miles per hour. It's fast. But I have not totalled up for the five-year survey plan how long -- how much air time is required.

LCDR Pickrell: What I am getting at is this -- it seems to me that the aircraft can cover the area in a short amount of time, so your top value is a little bit invalid, in that pretty soon the aircraft would have nothing to do.

Mr. Enabnit: This hopefully will be answered in our studies about what are our requirements in laser-surveyable areas. It is true that the laser does an area very fast, but you can't get a lot of air-hours on an aircraft in a year. They figure an average aircraft flies about 600 hrs per year, of which 300 is doing surveying, so 55 hrs is one sixth of the year's operating time. I don't see too much productivity causing us to run out of places to survey as a problem. If it is, then we can turn around and do reimbursable work for DMA. Where we have the coastal U.S. to survey, they have the rest of the world.

Mr. Green: How do you correct for aircraft attitude?

Mr. Enabnit: This is very interesting. We are ranging from the aircraft to the water, using the laser system itself. Measuring the time of flight of the surface reflection, we can determine the aircraft attitude -- so we have a built-in stabilization using software. Because of this elliptical pattern of the laser scanner. You get sea pitch and roll. Heading is a little trickier, and I am not really prepared to tell you about heading yet. We can do altitude to within six inches, and we use this altitude information also to correct for waves, that is, to do a real-time wave correction.

CDR Nortrup: You are probably going to have a pretty significant amount of cost involved in shoreside support. I did not see that reflected obviously in your operating costs breakdown.

Mr. Enabnit: Only in terms of the survey party itself. We had a two-man air crew and a four-man laser crew -- that's six people total. How you apportion those is uncertain.

CDR Nortrup: It seems that you would be able to keep two or three shore parties pretty well occupied locating control and processing ground-level measurements, so I think this is going to run you a pretty significant cost.

Mr. Enabnit: If so, we will add that cost in. The question is to establish what the cost is. I am hoping here that NGS can bail us all out of this. In establishing control, it is important to realize that these are not added costs due to the laser. If we were going to do launch/sonar bathymetry for the same area you would need at least as much shore party support.

LCDR Schiro: You say a lot of the time of the parties is spent on the ground or zooming across a third of the country to pick up something and then zooming back. I know it is hard to get a hold on, but are you trying to put that in?

Mr. Enabnit: Actually, I didn't say or mean to imply that a lot of time was spent zooming around on errands. We are considering weather and water clarity conditions, historical experience, and other services' data, trying to make this scenario as realistic as possible. We are putting the scenario out for whatever criticism we can draw, and when it gets down to the end there will be issues we can't resolve, and we will just have to say, "Under these assumptions, these are the numbers."

LCDR Schiro: But those comparison numbers between the launch and the laser, do they attempt to take such things into consideration?

Mr. Enabnit: The $5,000 was a historical number, and it is in a documented study which we will put out. There will always be items only estimated and areas where a direct comparison can't be made. That's one reason we like to have a comfortably large potential cost savings -- to cushion the unavoidable inaccuracies.

LCDR Schiro: But what about the $422 in terms of multiple shore parties and scheduling factors.

Mr. Enabnit: No. That only includes those costs that I showed you. When the study comes out, it will have a series of curves where you can get in and say, "I don't believe this number or that number," so let me change it. The curves will give you a new bottom line for values of the parameters which you consider most accurate.

LCDR Schiro: I don't envy the problem, but I was just wondering what the real magnitude is.

Mr. Enabnit: We will get it as close as we can, and with new technologies there is always a risk and some uncertainty.

LCDR Goodman: You might want to comment on the percentage of time the system could be operated based on environmental conditions. It might turn out to be about equal to the launch if you take weather and all the factors that affect it. About 70% of the time you can survey with a launch.

LCDR Schiro: I am not quibbling about that as much as the actual logistics of having multiple field parties.

LCDR Suloff: For those that are not familiar with that area, you stated that it would take 55 hrs of airborne laser hydrography to survey the scenario site. That is an area that was surveyed in the mid-30s. It was 30-some thousand miles of hydro accomplished in about three years -- three field seasons of concentrated hydrography -- to give us a comparison of what we are talking about in time frames.

CDR Austin: I am interested in the safety aspects. What are the physical characteristics of your laser, and what kind of standards do you use?

Mr. Enabnit: We huddled with the NOAA general council several times over a whole series of legal questions, of which eye safety was one, and we asked that very question: "Which standards would we have to meet?", "What do you mean by meeting standards?", "What is the risk if we do not meet the standards?", "Are there conditions under which we could get away with operating a non-eye-safe system?" Their conclusion was that it is the ANSI Class I laser standards which we have to meet. These are the toughest ones. It is for single-pulse, into fully dilated pupil. The safety is established on the basis energy density per square cm on the retina. They are worried about dissipating the heat from laser pulses in back of your eye. We will meet those standards for somebody in a boat looking up as you pass directly over them. If an operator turns the system on and looks down the end of the tube, he is going to hurt himself. It is not eye-safe under those conditions.

CDR Austin: How long would an observer on the ground see a laser -- the actual laser pulse?

Mr. Enabnit: Under the scanning pattern which we used with the NASA system, I think the maximum could be about six pulses, and only under certain infrequent conditions. We are taking this into consideration when we design a scan pattern for an NOS system. It is the number of pulses within a certain period of time, the energy per pulse times the duration of the pulse times the number of pulses, which must meet the standard.

CDR Austin: How often would he actually physically see the laser during a survey?

Mr. Enabnit: He would really only see it once, maybe twice if we come in on a second sweep and the swaths overlap. You know what is going to happen: this plane has been flying back and forth at 1,000 feet all day and all of a sudden it flies right over him. The first thing he is going to do is look up. So we are taking this into account. We are acting as if they will take every possible pulse right in the eye with still no damage. We still meet the standards, although the standards are legal standards, not medical standards.

LCDR Schiro: Do you have a feel for how much data you would get in how much time during an ordinary operating day?

Mr. Enabnit: Mel Grunthal of the Coastal Mapping Division was helping on the flight operations part of the scenario. We decided that when the water clears, and you start to fly, you could fly roughly three four-hour missions in a 24 hour period, and at 6.4 square nautical miles per hour that is almost 100 square nautical miles in an operating day. We are still talking about the data being handled with the same philosophy as the BS^3 has, that the data is significantly processed and reduced in the field.

Mr. Mordock: Has this technology been considered for hull-mount? There you would not have your legal problems with eye safety, and it sounds like we could get away from a lot of the noise and the signal strength problems we have with sonar by going to light.

Mr. Enabnit: We did think about that. The economic advantage comes from the high speed, and you just can't duplicate that with the launch and its limited swath coverage. So it is the high survey rate which says aircraft operations. We could indeed make one operate from a launch. For the eye safety problem -- it turns out that the optical attenuation is exponential with depth, so as you get further out on this exponential curve it really doesn't buy you anything to keep cranking up the power. We are just about at the knee right now, so if I were to put it into the water and crank the power way up it wouldn't buy much.

LCDR Goodman: Your costs have been associated with a reasonably arbitrary estimate of data density on the part of the laser project, and that estimate was one data point per 20 square meters average. That was a rough estimate, just to get some type of equivalency to the present 1:10,000 scale survey. If you decrease that, the cost gets better, and if you increase it, it gets worse.

Mr. Enabnit: That is why I say you should take these numbers in the sense they are intended. We made other assumptions too. Beside the data density, we talked about swath overlap of 20%, we talked about aircraft speed of 120 knots (now we are confident we could do 150 knots in certain operating altitudes), etc. That is why we are publishing this study with curves, so you can tell us, "From my experience this is the most realistic number." We are also doing a separate study asking what is the equivalent density of soundings you need with a laser to get the same understanding of the bottom that you get with the sonars; secondly, can we develop a quantitative measure of knowledge of the bottom in terms of data density against you could test any sampling scheme.

CDR Fisher: How do you handle item investigations?

Mr. Enabnit: With the limited amount of resources and people, we had to pick one or two applications and say, "These I see, at this time, as the dominant uses of the system. Let me study those, and if the technique is marginal or if somebody would like me to go into another area, I will." We have picked two: picked the basic hydrographic survey where you have 100% coverage; and the reconnaissance type of mission. Actually you have two types of reconnaissance, one to determine if you need a survey of an area by going in and running sparse data very cheaply and quickly and the other is the water clarity reconnaissance to determine if you can do a saturation survey on that day. Those are the two applications which we have centered on for our cost work. There are other things like item identification which we find terrifically interesting. You can change the operating parameters of the laser system so that you get almost an arbitrary number of laser soundings on any point on the ground (within reason). If I really want to saturate an area I can do it with this tool. If we use the NASA equipment to fly another mission, maybe we will ask the people who select the items to point one out in our test area, and we will see if we can find it. Some things which do not have an acoustic signature may have a good optical signature. I know that is a disadvantage too when you get to bottoms which are not really distinct or get to some fluff, but for item identification that can be an advantage. This is something we would very much like to look at. We do recognize that it is a very expensive part of existing NOS operations.

LCDR Bodner: How much more developmental time do you think it would require to get a system like this into the inventory?

Mr. Enabnit: It's not really a hardware problem at this point, although there are a couple of nagging questions in the hardware. DMA is funding NORDA to go ahead and build a system. They are building a system which would not satisfy the NOS requirements, either in penetration capability or accuracy. However, they would be forcing a lot of the hardware questions out of our way at no cost to NOS, and we like that. So in terms of development I think our biggest problem, as with most of our hydrography, is data management, data processing, handling it to get accurate high-quality data. You want still some time frame, I am sure. I could give you some numbers which you could put back to back. The procurement cycle for this is probably a year. It is a large-cost ADP-related system, so we are talking one year. We are talking about two, maybe two and a half years in development and fabrication, half a year in testing, and maybe a year in the implementation phase where the developers and the users are out looking at strange bottom compositions, testing for items, refining software, putting in some human engineering, making one last series of modifications, finishing up the manuals, etc. That adds up to five years, and I don't think that is an unreasonable time frame. That's five years elapsed time. That's not five years with 60 people in NOS working on it.

LCDR Pickrell: Not 60, but there certainly would be 10 to 15.

Mr. Enabnit: Not necessarily. In NOS people there are only two right now, plus about 18 people that are giving free help.

LCDR Pickrell: In your cost analysis, it seems like the implementation phase is only $200,000? But when you are talking about developers and users getting together . . .

Mr. Enabnit: The $200,000 is an extra amount of money for special contract work during the implementation phase. In addition to it, one has a full year's operating budget (estimated at $490,000).

Mr. Mordock: Have there been any investigations conducted on delineation of shorelines?

Mr. Enabnit: Yes. I mentioned that we had flown up over the beach, over the grass, into a tidal pool and up and out and down again, and we have seen -- confidently I can say -- that we can measure depths of two feet. Everybody except myself will say one foot. There is no theoretical reason we can't measure to zero depth, which means we would be measuring the shorelines. We submitted a proposal last year to jointly do an experiment with NASA where we would use their system as a laser bathymeter over the water and as a terrain mapper over the shore. We would measure tides, and then using the level surface of the water, the shape of the land under the water from the bathymetry, the shape of the land out of the water from the profile mapping, to project the water surface up or down with the state of the tides. Then you project it into the shore at any state of the tides and have the shoreline. I am keeping quiet about that. It is another application like the item investigation, a very good probability that we can do it, but I have no firm data to support it other than a few times that we have had a look at the very shallow stuff. There are some very impressive capabilities in this system.

EXPEDITING SHIPBOARD PROCESSING

James S. Green
Chief, Verification Branch
Pacific Marine Center

ABSTRACT

This paper deals with expediting shipboard processing procedures within the National Ocean Survey. Are any of our procedures redundant? Would it be quicker to shift some procedures to other units? Are all our requirements valid? Both the paper and the discussion take a critical look at our methods and procedures.

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This session is not primarily concerned in whether we meet the six weeks in field submission of survey data or not, although this discussion will initially touch on that subject. At PMC this year, we have met the six weeks at times and at times not. I estimate one out of four surveys completed have been submitted within a reasonable period -- six to eight weeks. Whether we meet our annual production schedule this year, is not primarily dependent on these late submissions. The limiting factor is presently located elsewhere in our processing system. However, the number of surveys available for processing at both Marine Centers has decreased appreciably this past year. In the coming year, we have the potential for a more responsive system. Although it did not significantly impact on us last year, it probably will be a major factor in the next year.

We have in previous sessions addressed hardware and software that can help us expedite our processing. In this session, we want to discuss the uses of the equipments that we now have, in terms of coming up with a system that will be more responsive.

A large portion of the solution is arriving at a system on the hydrographic survey vessel in which the survey data flows through and out from the ship. This is connected with the expenditure of time and resources after completion of a survey. Although early and late surveys meet the deadlines, problems arise with those surveys in which the ships go from one project to another. Another thing that we at The Marine Centers can do to help is to take a critical look at the data and data formats that we require from the survey vessels. As the system has evolved, we find that we are asking for more and additional data. We need to examine what we are requesting, reconsider the need for such requests and come up with ideas for expediting the data flow aboard the ships. At PMC, the field works officers and I, in planning for a new field season, will be addressing each individual data request in terms of its necessity. I would like comments from field personnel or from AMC as to any ideas they have to expedite data flow.

DISCUSSION

CDR Trauske: You are right. We expect to get a uniform flow of data from the field. With Hydrographic Surveys Branch, which has nearly year-round operation, we get a logical flow -- one or two surveys a month, as the case may be. You run into problems when you come into the field season when three hydro ships come in and in one or two months run and drop out eight surveys on the Marine Centers. As far as making the six weeks is concerned, generally I think about 25% would succeed, and the rest are about two months, ten weeks, or so, which is good when compared to previous times when ten, twelve or fourteen months would go by before we would see a particular survey. Also, we have a little better feeling about surveys which we get from the field quickly. When surveys are held back, for whatever reason, we get the impression that they have had a lot of problems in processing, and if they had problems with getting it to us, we are going to have a great deal more problems. However, in general we receive surveys in a relatively timely fashion after completion of the field work, probably averaging eight or nine weeks.

Mr. Green: At PMC in this particular year, we had some early ones at the beginning, we had some of the final ones coming out on time, but we had the influx of many surveys about this time, at the end of the year. I try to impress on the PMC personnel that, if they are having problems getting data in on time, they should be sure that the field edit data and tide data leave the ship in a timely matter, since any delay with this data, directly impacts the system at the end of the year as far as meeting the annual schedule is concerned.

CDR Fisher: When we are talking about quarterly fluctuations in data coming in, we need to keep in mind that we have a fair amount of units that are not turning data in to your areas for about a third of the season, so you aren't going to see anything in the early part of the season and are going to be working with previous data. I also think that we are going to be having problems getting data off the ship when we reduce the number of hydrographers aboard ship. Class III's are being cut back 25% on the number of officers, and when you consider the peripheral items that come in, photogrammetry, field edit, etc., some of these things are going to bog down. Either that, or you will just not have enough to put out in the field for your daily operations and will have to stop then and process. I really think you will be having more delay in the future because of this.

Mr. Green: One good thing about our present situation is that there are no more surveys. In the next year at PMC we will need the surveys in a timely fashion, or we will be devoting our time to things that we have not had time to verify previously. I see a lot of potential to create a more expeditious processing system if we can develop some methods of easing data flow.

CDR Schaefer: One of the things it would be important to discuss is, in that your manpower aboard ship is reduced, what types of things are you now doing onboard to meet the Marine Center requirements that perhaps can be processed at the Marine Center? An example which I know from our West

Coast ships is that they do very thorough inspection of their data so that it runs right through the computer. However, how much time are they spending making sure that the data they send off is error-free. I'm not talking about making sure they have covered the area; that they need to do. We like it error-free, but can we eliminate some of the shipboard processing?

LCDR Schiro: I think we need to take a closer look at what we are required to submit and see if it is worth the effort and resultant delay. For instance, do we always need to submit position plots? Would the semi-smooth suffice in place of the smooth sheet? Those are rather controversial things to think about, but if we look at them, I think the answer to your question is no. Personally, I believe that the more time you spend on data, you will always find an error that you can correct. You could spend six months to a year going over a sheet, and I think perhaps, for the sake of speed we could settle for something less. How much is it worth in the verification process to have a smooth sheet rather than the semi-smooth? Are some of the products that we produce mainly to offset the load that would result on some of your peripherals, like plotters, etc? That might be valid, but are we doing that for you?

Mr. Green: We should look at our positioning requirements. If we look at why and how we use the data and discover that we possibly can do without, we shouldn't ask for it.

CDR Trauske: What are your requirements for a position plot?

Mr. Green: We have said that we want a legible position number on the field sheet. We have encouraged overlays where there is congestion, and the FAIRWEATHER and some other vessels are making a position overlay, putting the positional data onto another overlay.

CDR Trauske: In our case, the position numbers are on the field sheet -- they are all one; there is no overlay.

Mr. Green: Can you read it?

CDR Trauske: Not always.

LCDR Schiro: I don't think we are going to resolve what we are going to do -- we are just highlighting problem areas for other investigations, but it does speed the process if you don't have to put positions on, require arc overlay lattices, etc.

Mr. Green: These are the things we want to address before you sail.

CDR Fisher: All isn't rosy on the East Coast, in that to make that last plotted sheet with ink rather than ball-point pen you have to watch the plot like a hawk. It takes quite a bit of time, and quite often you are tying up an officer in this. The ink drawing is after-the-fact, in that you have worked everything out on your ball-point pen plot previously, and I am sure it could be cranked out on a Harris in much less time than it takes for us to make those two last black-ink sheets. That could help us a lot in moving data off the ship.

Mr. Green: We should evaluate the reproduceability of the two types of sheets, compare it to the time and effort it takes, and come up with some kind of rectification.

CDR Nortrup: If we can get line data -- manuscript items -- on punch-paper tape aboard the ships, there are hours of work on each sheet that could be eliminated.

Mr. Green: Hopefully we will see some of that this field season.

LCDR Schiro: Another pet peeve of mine is we take the sheet, overlay it -- even if it is a smooth sheet -- and trace out the smooth sheet in pretty blue, and then someone goes over it and traces over it in pretty black. I know we are supposed to verify the shoreline, but the T-sheet is really the accepted document. You don't really go about taking sextant fixes every millimeter along that shoreline. Do we need to have someone go over that in black? Can't we just say, "If there is a problem, leave it blue and we will just put in the new in red." If they are not hydrographically delineated high-water lines, why do we need to retrace over that blue line? We have to contend with a lot of things like this.

Mr. Green: By the time you build the final field sheet, you should not be overlaying and tracing.

Mr. Mordock: A lot of this is due to the fact that we are still thinking in terms of ten years ago in that we have in mind that we are building a smooth sheet that is going to go to Headquarters from the vessel. The field needs a work copy that they can verify to know that they have achieved coverage, but that's where it should end for now with our existing tools. Post-1980, we may stop building smooth sheets -- I don't know.

Mr. Green: We have to remember other users. The field sheet at times will be requested by chart compilation, so we need to consider if that is a valid requirement for the smooth sheet.

LCDR Schiro: Do the chart compilers want field sheets in all cases? I would imagine it would depend upon the priority in the area. You would probably be able to get a good idea of that before the ship goes out there and does the work. Another thing that caused the commanding officer and the survey department a hard time was when I wanted to submit a smooth sheet that had evidence of a erasure on it. It was clearly legible and, I would assume, reproduceable. I think we really need to get away from that if we are truly interested in moving the data off our ships.

Mr. Green: I hope we don't complain about that, and I hope we don't complain if your depth curve is just a hair off. We are after the fact that you have drawn a depth curve, that if there is a problem there you have seen it and done something about it.

CDR Fisher: I would like to make a really radical statement, and that is this: If I read your statement correctly, you said you are caught up, and if the hydrographers don't get a sufficient amount of data off the ship and to you timely, you really will have a problem justifying your existence at the present level.

Mr. Green: I would phrase that a little differently. We have a capability in processing that exceeded the input from the ships last year. We have our backlog down to the point where we have the opportunity to come up with a responsive processing system the way it ought to be. This capability can not be turned off and on with a switch. Management started trying to correct our situation several years ago, and it has taken four or five years to establish our present capability. It is easy to knock it down, but it is very painful and slow to build it up. We have been at the point where we don't have sufficient capability, and I don't think we ever want to go back there.

LCDR Schiro: I wouldn't care if a couple of your people were in an idle loop. For instance, we met our requirements this year, perhaps even exceeded them, and you and I earlier decided we wanted to get together to review the descriptive reports and see what you wanted. To get immediate feedback, I wanted to bring the OIC who is responsible for running that sheet, and we still have not had a chance, although we have been here for four months, and we are leaving next week. So I'm not worrying about a couple of people hanging idle as long as we get more rapid feedback.

Mr. Westbrook: I don't think anyone should figure that the Marine Center people are in any kind of idle mode. If they do get down to the point where they don't have enough sheets coming in from the field to process, there are surveys at the office. They realize that, and they have asked for some of these, so I think the point is that he is trying to see if he can help the field teams get the data in here quicker.

THE NEXT 10 YEARS IN NOS CHARTING

W. J. Monteith
Marine Chart Division
Marine Surveys and Maps

ABSTRACT

This paper deals with future changes in the area of chart production. The gradual phaseout of manual chart compilation procedures with a transition to new automated methods, metrication of charts and the new North American Datum (NAD 1983) are examples of changes occurring in the next ten years.

INTRODUCTION

Basic authority for activities of the National Ocean Survey (NOS) are contained in the Organic Act of February 10, 1807, in which it is directed

> "To cause a survey to be taken of the coasts of the United States in which shall be designated the island and shoals. . . for completing an accurate chart of every part of the coasts. . ."

Department of Commerce Organization Order 25-5B, July 11, 1971, describes the current responsibilities of NOS within the National Oceanic and Atmospheric Administration (NOAA).

As part of its mission, NOS is "to provide the basic maps, charts, surveys, and specialized data required for safe navigation and accurate location." To accomplish this, four basic objectives have been established relative to the publication of nautical charts.

CHARTING OBJECTIVES

1. Conduct hydrographic survey and field investigations to acquire basic data for nautical chart construction and revision.

2. Process and verify hydrographic surveys and other data needed to construct and revise nautical chart and related navigational products.

3. Compile, reproduce, and distribute nautical chart and other products needed for safe and efficient navigation in the United States and territorial coastal waters and the Great Lakes.

4. Design, develop, and apply a computer-assisted system for nautical chart data acquisition, processing, and publication.

Various plans have been developed and published by NOS in recent years to accomplish the first three objectives. The most recent NOS 10-year plan for nautical charting was completed in November 1978 and is presently being printed. It is expected that distribution to all concerned can be made in February 1979. The most significant inclusion in this 1978 plan is a section concerned with the design and development of a computer-assisted system for nautical chart production.

NOS actually began the development of a nautical chart Automated Information System (AIS) in the early 1970's. Under the AIS, chart source documents and data are transformed into a digital format for rapid recall from a central data base storage file for assimilation into the chart presentations. The system is designed for efficient, economical data editing, updating, and manipulation with some functions of the AIS expected to become operational in 1979.

The 1978 charting plan was designed to schedule a gradual phaseout of manual chart compilation and engraving procedures with a smooth transition to new automated methods. It was also designed to provide management with sufficient information for the timely acquisition and allocation of necessary resources. However, the plan made no provision for any major new charting program, such as the fishing obstruction charts which I spoke of on Monday. Such major new programs would have to be supported through combined supplemental requests for resources and personnel.

The NOS nautical charting program and expectations over the next 10 years were developed with the following assumptions:

1. That the AIS being developed will become operational by the end of FY 1979.

2. That full capacity operations (continual maintenance for 1,000 charts and 200 chart reconstructions per year) will not be realized until the data base has been fully developed several years later.

3. That chart production will continue to be a mixture of manual and automated procedures with the manual effort being gradually reduced as the AIS is developed to near full capacity.

4. That NOS can be expected to begin changing nautical charts to metric units when the AIS is operational for certain groups of charts assuming also that Federal policy becomes more specific.

5. That NOS will have a requirement starting in FY 1983 to con vert all NOS nautical charts to the new North American Datum (NAD 1983)

6. That the Marine Chart Division will be required to operate the nautical chart program for at least the next five years (through FY 1983) with no significant increase in funds or personnel above the levels of October 1, 1978.

7. That the present in-house imposed restrictions on new and reconstructed nautical chart construction will continue until the major portion of the AIS data base is operational in FY 1981. Provisions exist for new chart construction, however, if:

   A. They are high in the national interest; such as charts required for the safe navigation of deep-draft oil tankers;

   B. They are required for national defense;

   c. They are high in the international interest;

   D. They have been previously committed for publication;

   E. They are designed to correct prior and serious de ficiencies affecting safety of navigation;

   F. They are prototypes developed to keep pace with ad vancing chart technology and new, unusual user demands; and

   G. They constitute corrective measures for serious chart ing inefficiencies, such as the canceling of two charts by the production of one.

8. That existing established policy and procedures upon which the 1978 plan is based will remain essentially unchanged.

CHARTING REQUIREMENTS

The basic mandates of authority under which the NOS produces nautical charts of the coastal waters of the United States and territories, including the Great Lakes, were cited briefly at the beginning of this presentation. To respond to the responsibilities imposed by these mandates, the Marine Chart Division uses several methods to identify and justify the need for particular charts. Basic to these methods is the all-important fact that NOS charts are produced to satisfy the needs of the users. Because there is such a wide variety of users, the identification and justification methods employed involve a multitude of considerations.

The basic longstanding justification for charts has been that it is the mission of NOS to produce adequate nautical charts for the navigable waterways of the Nation, and to participate in and keep pace with the evaluation of chart standards and specifications as developed through international agreements.

A justification for a chart, however, will be as unique as the chart to which it is related. The vast majority of justifications are developed exclusively from user requests. Whether the justification is related to general standards for the geographic area or a particular local circumstance, a subjective judgment is still required as to the relative strength of the justification. Once a chart is considered justified, a priority of construction is assigned which can range from "immediate" to "as resources permit."

Charting justification input is constantly being supplied by users in the form of unsolicited letters describing chart deficiencies and charting needs. Principal users of nautical charts include those responsible for the defense or national security of the United States; those involved in domestic and international waterborne commerce; and those involved in recreational boating. The nautical chart and associated data are also used by land-use planners, conservationalists, oceanographers, marine geologists, and others having an interest in the physical environment of the coastal zone and continental shelf areas.

The justified requests for new or revised chart coverage are assigned a numerical value ranging from 0 to 10 which assists in placing them in a priority ranking for production.

There is another facet of NOS nautical chart production which is as vital as that procedure which justifies a new chart; that being the justification of an existing chart. The initial justification for each chart is periodically reviewed to determine if a need still exists and if it is being satisfied. Frequently these analyses result in a recommendation to cancel a chart, or to revise the existing format or coverage.

Evaluation of chart results received over the past 10 years, or from examination of the initial justification of existing charts, has resulted in the following geographic listing which represents areas where new nautical charts are needed. The coding opposite each area represents the basic justification for the new chart; for example:

E = Chart desirable from an economic and efficiency standpoint

R = Public requests are on file

C = New layout will provide better coverage of area

The actual priority for new chart construction for the next 10 years will be discussed later in this presentation.

CONTEMPORARY CARTOGRAPHIC AND LEGAL CHARTING REQUIREMENTS

Another factor which will impact the NOS charting program over the next 10 years is the ever-changing state-of-the-art of cartography. The production of a prototype chart, graphic presentation, or user survey to test

NEW CHART REQUIREMENTS

Alaska

Southeast: Sumner Strait; Glacier Bay, Port Lucy to Herbert	E, R
Gulf of Alaska, Northeast - new chart layout	C, E
Cook Inlet: North Part (Chinitna Bay to the Forelands); Kamishak Bay	C, R
Pennisula, South Part: Kodiak Island - new chart layout; Shelikof Strait - new chart layout; Shumagin Islands	C, E, R
Arctic Coast: new chart layout	E, R

California

Southern California	R
Carquinez Strait - Suisan Bay	C, E, R

Delaware - New Jersey - Pennsylvania

Delaware Bay	E, R

Florida

St. Johns River	E
Miami to Key West	C, E
Florida Bay	E
Tampa Bay to Tarpon Springs	R

Georgia

Altamaha - St. Simons Sound	E

Great Lakes

New chart layout	C, E, R

Hawaii

Entire archipelago	R

Louisiana

Barataria Waterway - Bayou LaFourche	R
LOOP (deep-water port)	R

Massachusetts

Buzzards Bay	R

New York

Hudson River	E, R
Lower Bay	C, E, R

North Carolina

Beaufort Inlet	C

Puerto Rico - Virgin Islands

New chart layout	C, E, R

Washington

Haro Strait	R

new ideas will continually assume a high priority in the NOS program of chart production.

Requirements which are expected to critically affect nautical chart planning and production over the next 10 years are:

Automation which will provide relief to the present system of manual chart production so that the existing backlog of required new and reconstructed charts will no longer need to be retained in a deferred status, but can be scheduled for routine production.

Metrication where NOS has issued eight metric charts in response to metric charting commitments for certain international waters. While no decision has been made as to when NOS should start metricating all nautical charts, it is certain that an overall metrication program will not begin until the automated chart production system is operational and available to perform the changeover in the quickest and most efficient manner. A token effort of two new internationally important metric charts per year is planned. It is estimated that routine conversion of nautical charts for certain geographic areas will not begin before 1982. The goal of total conversion of all charts and the phaseout of traditional unit charts will be shown in the final view graph to be presented later.

North American Datum 1983, based on a new geocentric world ellipsoid, will require a shift in position of all detail shown on all charts issued by NOS. The conversion to NAD 83 under manual chart production methods would be a major undertaking and a significant increase in the present work load. It is expected this conversion can be made with the automated system without any noticeable work load increase.

New Chart Layouts will continue to be a requirement as the entire chart suite is continually examined in the effort to stay current with efficient and practical contemporary charting needs.

AO Chart Paper standardization resulted in the NOS in 1975 to begin planning for eventual reconstruction of conventional charts to fit the AO paper sizes. Converting existing charts to AO paper will be a major undertaking and an almost impossible task under manual chart production methods. This conversion will only be feasible if automated methods are used and will be scheduled as a phasein with the charting requirements previously discussed.

Critical Depth criteria to which wrecks and obstructions are classified as hazardous or non-hazardous to navigational safety will impact future chart production if the present 11 fathoms critical depth is altered. A proposal by the International Hydrographic Organization to change the critical depth to 40 meters will not be easy for NOS to make, and if concurred in, will require extensive research of old records to assure that critical data are charted and not overlooked.

Chart Upgrading and Modernization will permit the replacement of many old base plates or color separation negatives which do not reflect contemporary cartographic or charting standards. Many charts on issue do not contain depth curves with proper symbolization; proper tinting of depth regions or low water areas; urban tint to replace excessive street patterns; labels to reduce excessive culture symbolization; good quality type, and good quality line work.

To bring the suite of charts into conformance with contemporary specifications can only be accomplished effectively by employing automated production methods.

ANNUAL CHARTING PROGRAM

The annual charting program for the next 10 years is shown in the next graph.

Some additional information not readily apparent in this graph is:

1. The number of new conventional charts (A-1) includes charts printed in metric and traditional units being counted as two charts because of the compilation work load involved.

2. The number of new small-craft charts (A-3) reflects a separate count even though a conventional chart version of the area may be kept on issue as well.

3. The number of reconstructions (A-4) would include those charts which are reformats of charts still on issue, such as a small-craft chart to be issued as a pocket-fold chart.

4. The number of annual chart printings (A-7) listed represents a straight accumulation of new charts into the 1-year issuance system without considering the effect of offsetting cancellations which can be anticipated; hence a "worst case" report has been indicated. It is expected that any significant excess of the present output of about 500 printings per year will be alleviated by improved printing methods, contract printing, or a combination of the two.

5. The total charts listed are projections as of 9/30/78.

6. (A-10) No figures are presented as this move to AO paper size will require extensive planning and rescheming and will be a subject of extensive future discussions. Some rescheming of charts of the Great Lakes and connecting rivers has been completed through the efforts of the U.S.-Canada Charting Advisors.

7. (A-11) The figures listed reflect the number of charts by Area Team considered to have serious deficiencies or inconsistencies in chart quality. This lack of quality results primarily because the charts have not been upgraded to contemporary cartographic standards.

Annual Charting Program

	End of Fiscal Year 1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
A. MANUAL MODE with automated assistance										
1. Chart maintenance	942	880	492	269	0	0	0	0	0	0
2. New conventional charts(1)	8	10	5	2	0	0	0	0	0	0
3. New small-craft charts(2)	1	1	0	2	0	0	0	0	0	0
4. Reconstructions(2)	5	6	4	4	4	4	4	4	4	4
5. Special charts	0	0	Possible beginning FY 1981: "FISHING OBSTRUCTION CHARTS" and "INLAND WATERWAYS and LAKES CHARTS" programs							
6. Special overprints	70 LORAN-C 17 OMEGA	5 LORAN-C 7 OMEGA	3 OMEGA							
7. Chart printings, annual(2)	500	509	522	531	541	555	565	575	585	595
B. AIS MODE										
Data loading schedule	90 (Area 4)	108 (Area 3)	280 (Area 6) 134 (Area 5)	89 (Area 7) 145 (Area 2)	124 (Area 1)					
1. Chart maintenance(1)	28 (Area 4) (test charts)	90 (Area 4)	478 (Areas 3,4,6)	701 (Areas 2 to 6)	970 Complete	970	970	970	970	970
Percent of total charts(1)	3%	20%	49%	73%	100%					
2. New charts	0	0	3	5	12	8 est.	8 est.	8 est.	8 est.	8 est.
3. New small-craft charts(2)	0	2	1	1	2	2 est.	2 est.	2 est.	2 est.	2 est.
4. Reconstructions(2)	0	0	0	3	6	4 est.	4 est.	4 est.	4 est.	4 est.
5. Special charts	0	0	Possible beginning FY 1981: "FISHING OBSTRUCTION CHARTS" and "INLAND WATERWAYS and LAKES CHARTS" programs							
6. Special overprints	0	0	0	0	0	0	0	0	0	0
7. Chart printings, annual	Same as A. 7.; the AIS is not expected to affect press printing output capability									
8. Metrication, routine	0	0	0	0	Begin Puerto Rico and Virgin Islands; other areas to be determined and scheduled					
9. NAD 1983, routine	0	0	0	0						
10. New layouts: large areas and A0 chart paper(1)	0	0	Arctic Coast	P.R. & V.I. Cook Inlet N	Chesapeake B Fla. B. & Keys Cook Inlet S Kodiak area Great Lakes	Long Is. Snd Delaware B. Alaska, S. Pen. Great Lakes	New England NE Gulf of Alaska Hawaii Great Lakes	NW Coast SE Alaska Hawaii	Undefined	Undefined
11. Upgrade and modernize(1)	0	80 (Area 4)	222 (Area 6	93 (Area 3) 121 (Area 5)	131 (Area 7) 77 (Area 2)	107 (Area 1)				

CONCLUSION

My concluding comments are an invitation to those interested to view the annual fiscal year chart production schedule contained in the draft copy of the 1978 10-year Nautical Charting Plan which I have with me here. The detail for each year, and the realization that proposed production schedules in subsequent years are continually being reviewed and modified, were factors in my decision not to prepare view graphs of these schedules.

In closing, I would like to mention also that survey priority schedules, (geodetic, hydrographic and photogrammetric) are all coordinated in advance of those chart production schedules so that required data is available when needed by the compiler. As with any viable plan, there is some room for bending or flexibility to permit NOS to respond to presently undefined, high charting priorities as they become visible.

ENVIRONMENTAL DATA SERVICE
Summary of Activities and Uses to Which Computerized Data Are Being Applied

LTJG R.B. Crowell
Environmental Data Service

ABSTRACT

EDIS is the agency responsible for disseminating digital hydrographic data to other users of this data. This paper explains EDIS's present and future capabilities and gives examples of the various products it can provide.

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It has long been known that the hydrographic data collected by NOS, (formally the Coast and Geodetic Survey), could meet needs beyond those of nautical charting. The 1960 edition of the Hydrographic Manual mentions that providing basic data for scientific and engineering, commercial and industrial needs was part of the mission of the Coast and Geodetic Survey. With the tremendous growth of interest in the marine environment since then, it is even truer now. Yet many people in NOS seem to have lost sight of this, and concentrated solely on nautical charting.

By ignoring the many other uses for hydrographic data, we also ignore NOAA's obligations to the public, the public we exist to serve. There is a legal obligation to provide access to information and data collected at taxpayer expense, and an ethical obligation to provide maximum service for the money.

That a demand for the data exists is undeniable. Since EDIS agreed to be the agency to disseminate the digital data obtained for NOS's automated information system, requests have come from many sources: from government, private academic, even foreign institutions. Some request only general information; others request data from areas covering thousands of square nautical miles.

The intended uses for the data are varied. The U.S. Geological Survey needed data for computer studies of solid particle transport. The Interstate Electronics Corporation was conducting an offshore dumping site investigation and needed data for the area in question. NASA requested data for correlation of some of their satellite data. A student at Northern Virginia Community College was interested in bottom characteristic data for Chesapeake Bay. Fluor Ocean Services needed data for a study of effects of construction of a proposed breakwater and ship berthing site.

While the major purpose of this data will continue to be for the production of nautical charts, it would not be at all cost effective if it were the sole purpose. Efforts should and, in some cases, are being made to give NOS hydrographic data a broader appeal without detracting from the charting effort. The major change needed is one of attitude. The blinders which have kept the attention of many focused on a small area must be removed.

Changes also can be made in the collection, processing and archiving of the data. Due to present standards few changes, if any, would be major. The preoccupation with least depths, which often operates to the detriment of delineation of the deeps of bottom topography, should be lessened. Least depths are vitally important for charting purposes, but greatest depths can be as important for other purposes. The methods of collecting and describing bottom samples are sometimes inadequate for charting requirements and are usually woefully inadequate for other uses. Increased bottom coverage would benefit all users, including NOS.

Suggestions for other possible changes could come from the users themselves. Some might be practical, others not. The benefits must be weighed against the costs.

Benefits are now being reaped from the changes made in the archiving of data. The requests for data from EDIS's digital hydrographic data base have proved that the demand for it only awaited its conversion to a usable form. Previously older hydrographic data were available on nautical charts, on survey sheets or in sounding volumes. None of these forms is very adaptable to fit the wide variety of needs. By converting these data to a form compatible for use with computers, a successful data resource has been created.

The reasons for its success lie in the advantages computerized data have over charts, survey sheets and sounding volumes: advantages in volume, manageability, accessibility, and versatility.

A much greater volume of data can be stored on magnetic tape than on paper, and in much less space. Due to the decrease in space occupied, the data are more easily managed. Tapes are more easily stored, handled and archived. With the use of computers, data processing and manipulation are greatly improved. Computerized data are also easily accessible. Data are easily and quickly retrieved from magnetic tape for processing, or storing on another medium for use by the requester. Most importantly, computerized data are much more versatile. The parameters which are fixed on the survey sheet are easily varied with computerized data.

With computerized data I have freedom. For a 5 x 5 nautical mile area for which a standard plot can be generated. For any such area of this size, it would be necessary to access, at most, only four tapes to produce a plot. If a standard plot does not suit the users' needs, the data can be gridded. For a different view of the bottom, the user can request two dimensional or three dimensional bottom profile plots.

Nor are we limited to sounding data. A plot of bottom characteristics or dangers to navigation can be produced. The digitization of the bottom samples is one major inadequacy of this data base. Since each word of the description is digitized separately and the data are grouped by degree block, the possibility exists that parts of a description may be spread onto four separate tapes.

These are some examples of standard products now available. With the programming ability at EDIS, it is possible to fill special requests. We also provide data on magnetic tape to allow the user to process and manipulate it himself.

I hope that the many other uses for hydrographic data are evident. The demand for the data exists, a demand for useful and versatile data. Efforts to meet this demand have begun in the archiving of the data. Those who collect and process the data and those who determine how it is to be collected and processed should consider these potential uses. Change need not be difficult. Then, when the public asks, "What are you guys doing out there anyway?," we can have an even better answer than before.

DISCUSSION

LCDR Schiro: We say frequently that we are not sure how accurate our data is.

LTJG Crowell: I have noticed that there are some inaccuracies in digitization of the smooth sheets. We get some double-digitized lines that don't match up. So there may have been some changes when they digitized this.

CDR Fisher: Do you solicit a reason when data is requested?

LTJG Crowell: I hope to get the purposes they intend to use the data for. We don't always have those purposes, but usually we try to ask.

CDR Fisher: Do you know any that have been for legal proceedings?

LTJG Crowell: No -- we hope not to get into that, because I believe that since NOS makes the charts they should worry about the legal end of it because it directly concerns them. They are legally responsible, whereas EDIS is not. We did have one Naval Reserve officer requesting data for the grounding of the ARGO MERCHANT, and we provided him with some simulated fathometer tracings. He wanted bottom profiles of a specific area, but we didn't have data for the area and couldn't provide that. He wasn't involved in legal aspects; he was just writing a paper on the grounding itself.

LCDR Schiro: Could you give us some quantitative guidelines on small companies requesting digital data?

LTJG Crowell: I really couldn't give you any idea about the size. I get requests from companies I've never heard of, but that doesn't necessarily mean anything. Mostly the smaller organizations don't have the facilities to manipulate the data themselves, so they usually ask for plots, and the larger ones usually ask for data on tape. Some people ask for both. We get some requests from fairly small organizations, like the student in Virginia.

LCDR Schiro: Did he want digital information?

LTJG Crowell: It was a she. She wanted it in plot form.

LCDR Richards: I noticed your plot format didn't include depth curves. Is that because you don't have that information?

LTJG Crowell: We are presently unable to do depth contours. I found out about a program that does generalized contours, about three days before I left for this conference. One of the other people in the branch has been working on this, and it looks like probably within a year we will be able to do depth contours too. It is well-suited to our data. This also illustrates some of our versatility. This is not a standard sounding plot.

LCDR Schiro: What about Corps of Engineers and other types of information. Do you catalog that information?

LTJG Crowell: I don't believe we have any other information other than NOS.

Mr. Enabnit: Do you produce a publication that describes the available options, or do they just call and say what area they want?

LTJG Crowell: We have a catalog out for part of the data area. The file is not complete. We only recently received data for California and Hawaii -- it is coming in faster now; it started out rather slowly. We have data for the East and Gulf Coasts which are not yet complete.

Mr. Enabnit: How about a catalog of the products?

LTJG Crowell: The catalog of the area does describe what products we can do -- the standard products. We can do plots by color. Hopefully in the future we will publish catalogs for the different areas, a catalog for the East Coast, Great Lakes, one for the Gulf Coast, one for the West Coast, one for Alaska. They haven't come out because we have only received the data recently. The file should be complete by the end of '79.

CDR Fisher: What is your current level of effort in terms of manpower?

LTJG Crowell: Right now it is one man -- me. We hope to get an increase as more data comes and the workload increases. Previously, my predecessor, Mr. Lawrence, had so little to do, because the data was coming in so slowly, that they were able to use him for other projects within the branch. However, we received approximately 70 degree squares of data, and I have been pretty busy for the last three weeks. So we may be increasing. They hope to get a technician -- GS-4 or 5 -- to help with the file.

LCDR Schiro: What are some of the things that we might do to better serve you?

LTJG Crowell: There is one possibility -- digitizing at Boulder older surveys, prior to 1930. We have data right now from '30 to '65, and one user did request data in that range to compare with the 1900's. He was doing depositional erosional change in Chesapeake Bay, and they had digitized the 1800 survey themselves. We would like to be able to digitize older surveys for requests.

Mr. Westbrook: We have sent some post-1965 surveys to you a while back. Have you been able to process that and use it in the system without any trouble? I know you were programmed for the Asheville Digitized Surveys.

LTJG Crowell: We have one tape of post-'65 data, and it was just a different format, which was easy to adjust to. We haven't really done much with that. I hope that is the way it is coming in in the future. In order to work with the tape, we would probably throw out some of the control data but keep the master tape on file in case users request it.

THE SURVEY STATUS REPORTING SYSTEM

Donald R. Engle
Marine Surveys Division
Marine Surveys and Maps

ABSTRACT

This paper explains the system for reporting the status of hydrographic surveys. The importance of the input from field units is reviewed with a discussion on correcting errors and deficiencies with the reporting system.

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The Survey Status Reporting System was developed in 1972 by D. Westbrook and is designed to furnish consolidated reporting of acquisition, processing and chart utilization of active hydrographic surveys. During its 7 years of use it has proved to be a valuable tool for various management reports with respect to production, potential bottlenecks, and scheduling of work; for predicting time when a survey will be available for use in chart compilation; and for monitoring data flow from acquisition through chart application.

The input to the system consists of four parts, each assigned to separate organizational areas. Each area is responsible for maintaining its portion of the file by monthly updates. Monthly reports are submitted on NOAA form 76-179A through D.

1. Card A format contains data identifying the survey and the progress of field work, and is the responsibility of each ship and field party.

2. Card B format contains data pertinent to the smooth plotting and verification of the survey and is the responsibility of the Marine Center Processing Divisions.

3. Card C format contains data pertinent to the quality evaluation and final inspection of the survey and is the responsibility of the Marine Surveys Division in Headquarters.

4. Card D format contains data pertinent to chart application of the survey and is the responsibility of the Marine Chart Division in Headquarters.

Monthly reports from all sources are collected in the Marine Surveys Division, key-punched on cards, and fed into the computer to update the master disk file. After each monthly update four basic reports and an index are generated consisting of:

1. Ships and Field Parties Report list surveys for each field unit by project number, registry number, scale, type, locality, percentage of completion, and date of forwarding to the Marine Center. Summaries of production statistics are also shown.

2. Verification Report lists surveys for each Marine Center by project number and registry number and shows estimated hours required, hours worked, percentage of completion for each phase of verification, and date of forwarding to Rockville.

3. Evaluation Report lists surveys received in the Marine Surveys Division and shows estimated hours required, hours worked, percentage of completion for each phase of Quality Control or Review and date of completion of Quality Evaluation or Review.

4. Chart Application Report lists surveys by geographic area and by chart number and shows processing status of each survey with respect to applicable charts, and hours required for each application.

5. An Index by registry number of all surveys which have been entered into the report since its inception. In one line per survey it shows registry number, project number, type of survey, locality, years of field work, date survey was forwarded to the Marine Center, date of Verification, processing unit, date survey was received in Headquarters, indication of final inspection and signature, indication of Automated or Manual survey, and additional work data.

The topic for discussion at this time is the Ship and Field Party Report--Card A Format. Ships and Field Parties should prepare Card A input at the end of the calendar month for work accomplished during that month and forward it as soon as possible to the Marine Center, Attention: Chief, Processing Division. The Marine Centers will send these field reports, with their own, to the Marine Surveys Division in Headquarters as soon as possible after the 15th of the month. (The Marine Centers' reporting period is from the 16th to the 15th inclusive; the field's reporting period is from the 1st to the 30-31st of the calendar month.) This should allow ample time for the field reports to reach the Marine Centers before the Marine Centers' reporting date.

Entries on the Card A Format should include all new surveys not previously entered and all surveys previously entered which require updating.

The initial entry of a new survey should be made only after the registry number has been assigned. Every entry to the system must have columns 1, 2, 4, 5, 6, 7, and 8 filled in. The computer will not accept any data without these identifying codes. The initial entry of a survey must be by A1 card (column 1--"A", column 2--"1") and should have all columns through 41 filled in. Subsequent update entries should be by A2 card (column 1--"A", column 2--"2") and columns 3 and 9 through 41 should be left blank unless revisions are required. Update entries will revise prior data entered in that column or columns. If prior data requires deletion rather than replacement, an asterisk (*) in the appropriate column will delete the prior entry. Generally updates consist only of revising monthly percentages of completion of field work and field processing until the survey is complete and forwarded after which it will no longer appear in the Ship and Field Printout and no further report by the field will be necessary. Columns 52 through 55 is an approximate date for boat sheet transmittal and should be logged as early as possible and corrected to actual date when boat sheet is forwarded. Columns 56 through 59 should not be used unless the survey has been returned to the field for official additional work after transmittal to Headquarters for Quality Control Evaluation.

Obviously the status report is only as accurate as the input data. Numerous errors are detected at Headquarters which, if not corrected, would abort the program or output false data. A handout has been prepared for each ship and field party which contains a copy of the original instructions for reporting (annotated as necessary for approved revisions) and some recent Card A formats annotated to call attention to some of the more common errors. Field units are urged to read and comply with these instructions in order to keep errors to a minimum.

APPLICATION OF VELOCITY CORRECTIONS TO SOUNDINGS

CDR Carl W. Fisher
Chief, Operations Division
Atlantic Marine Center

ABSTRACT

This paper discusses the needed criteria for selecting velocity tables. Both international and NOS accuracy standards for sound velocity are compared. The problems the NOAA ship PEIRCE encountered in fresh water are used as examples.

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The problem involved in selecting proper velocity corrections does not involve any crises of the magnitude we have discussed elsewhere during this conference but represents a "loose-end" that needs tying up, perhaps appropriately here at the end. The problem involves the criteria for selecting or differentiating between velocity correction tables. Perhaps there is a well-established criterion and, if an expert here describes such, then there will be at least one attendee, myself, who will benefit from this discussion.

To be honest, I had no problem selecting velocity correction tables as long as there were only one or two Nansen casts or STD casts per sheet and the oceanic conditions were very stable so that the velocity correction curves were similar. However, when the PEIRCE conducted hydrography in the Great Lakes where the temperature profile changes considerably from day to day and from location to location more attention was required. Salinity is almost nonexistent in lake water which allowed the calculation of velocity corrections based solely on temperature and pressure (depth). Therefore, the use of expendable bathythermographs (XBT's) was approved to measure temperature.

Technology provided any easy and efficient means to keep track of temperature changes and XBT casts were taken after all major weather changes and on the average of one cast every three days. I had expected some agreement in the data but as you will observe in this illustration, the temperature structure varied considerably. These XBT data-derived velocity correction curves represent the period 15 June through 9 August, 1978 in the Straits of Mackinac area. In addition to these curves, there was a wide assortment of bar check data. In order to separate these data into velocity correction tables by some standardized method and because I had not been confronted with this situation on oceanic coastal surveys, I searched throughout my Hydrographic Manual and conferred with other experienced hydrographers.

The result of these conferences was that the problem had always been resolved by a paucity of data, i.e., a monthly Nansen cast, at the deepest area of the sheet. If the curves agreed from month to month, an average curve was constructed and standard procedures were used to combine with bar check data. If they varied, and I never was advised of the limits for variation, a monthly table resulted. I also contacted units which had worked in the lakes before, and they indicated the decision when to develop a new table was judgmental. Quote, "When I believed a new one was necessary." Hopefully, there might be a more enlightened expert present at this conference.

Reference to the Hydrographic Manual provided vague guidance. In Section 4.9.5.2 I read, "Velocity corrections seldom vary appreciably over short periods of time in most project areas...however, under special circumstances such as in areas of upwelling, extensive estuarine discharge of fresh water...series of regional velocity curves are required. Regional curves must be carefully studied to determine how they can be best grouped by area or time or to permit drawing average curves."

The Hydrographic Manual at least provided a limit upon which a procedure could be based. In Section 4.9.5 appears the following statement, "For use in correcting echo soundings, the velocity of sound must be known with sufficient accuracy to ensure that no sounding will be in error by as much as 0.25% of the depth from this cause alone." Therefore, each sequential XBT data-derived velocity correction curve that varied from its predecessor or the mean of a group by more than 0.25% at respective depths was assigned a separate velocity correction table.

Bar checks, usually taken twice daily during launch operations, were arranged into groups to correspond to the periods represented by each XBT data-derived curve which varied over 0.25%. An average bar check correction curve was computed for each group and combined with the XBT data-derived curve to form a composite velocity correction curve in the manner prescribed in Section 4.9.5.3 "Combining Oceanographic Determinations with Direct Comparisons."

In effect, this insured that no single velocity correction curve would vary from a group's composite correction curve by more than 0.25% at respective depths. The only problem was that during this period, no curves could be grouped because almost all differed by more than 0.25% from each other at some depth. Again, I refer to the illustrations. In this case, there were twelve tables prepared for hydrography conducted during this period. This may actually be a non-problem due to automation. The Processing Division, AMC indicated no concern at the number of tables because they are all accessed by computer. The burden lies solely upon the hydrographer to make observations and compile, scale and digitize all these tables.

In conclusion, I raise only two questions.

1. Does anyone have a better method?

2. Is the accuracy requirement, that no sounding should be in error by as much as 0.25% of the depth from errors (or differences) in

velocity corrections alone, realistic especially for surveying in waters as variable as the Great Lakes. If the criteria were increased to say 0.5% of the depth in waters deeper than 66 feet, the number of tables in this case would be reduced by half since grouping would be possible. I only suggest this because this criterion appears quite stringent compared to the International Accuracy Standards for hydrographic surveys which state: "For total allowable error in depth (not from velocity correction error alone): an allowable error of one foot in depths from 0 to 66 feet, of 3 feet in depths from 66 to 330 feet and 1% of depth in depths deeper than 330 feet." For comparison, the NOS criteria for velocity correction allowable error would be 0.25 feet in a depth of 100 feet.

This problem may be academic now but we have heard discussion of new capabilities to observe changes in temperature and salinity, such as expendable STD's and XSV's, and plans to survey more lakes. I expect that in the future wider variations will also be detected in estuaries where the temperature and salinity sampling procedures used during prior surveys resulted in observations less often and the conclusion that conditions were more stable between observations.

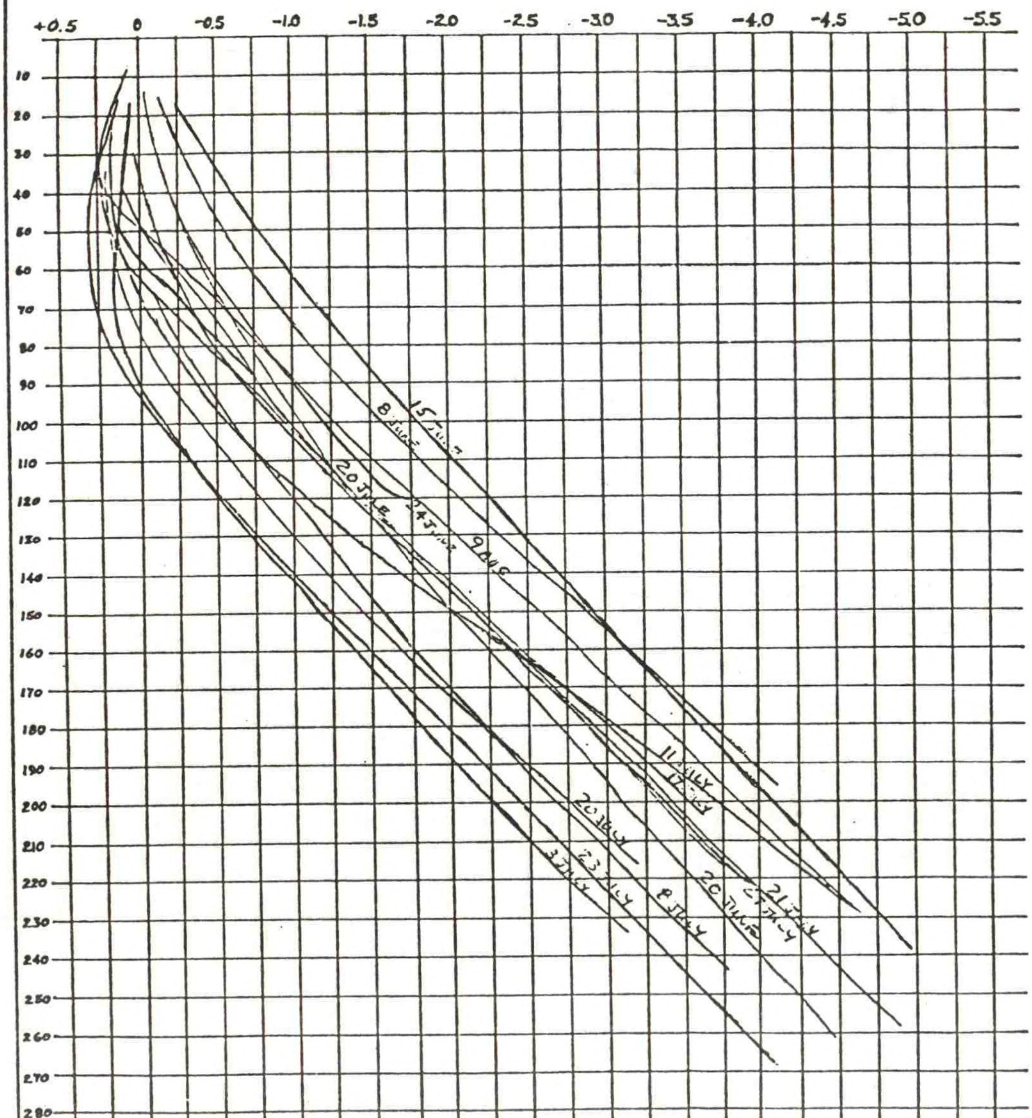
DISCUSSION

Mr. Carstens: Those might be international accuracy standards, but as far as the National Ocean Survey goes, I don't think they are very realistic. If we have 3 ft inaccuracy in 66 ft, that means that we could have conflicts with crosslines of that amount. If we have that much inaccuracy at 66 ft, we are involved in critical depths for supertankers, and I don't think we would accept that as realistic.

CDR Fisher: I wasn't really making a proposal. One possibility would be, in that our computers can handle up to 99 tables, to say that's it. However, you might look at this and say that perhaps the 1/4% criteria shouldn't extend down to greater than 330 feet; maybe at the greater than 330 foot point you could talk about an allowable error of 1/2% of the depth. I expect that we will see a number of tables in excess of ten, and if the MT. MITCHELL had adhered to these criteria in 1977, they might have had something on the order of 20 tables for a ship hydrography sheet.

Mr. Westbrook: I think that the international standards have been brought up before. I think that these are the minimum IHO standards. In many cases NOS exceeds the minimum standards. I'm not saying that I don't agree that we should relax this particular requirement -- there could be some area of relaxation.

CDR Fisher: The first question I had was, "Is this the standard technique, or is there another one?" My reading of the manual at first was that the grouping is an interpretative function, but when you put these other criteria together with that, you have a problem. I did canvass a number of field units and found very few actually applying these criteria.



SOUND VELOCITY CORRECTION CURVES
BASED ON XBT DATA

LCDR Richards: Did you take into consideration the bar check? How far down did your bar check go? Acceptable procedures could extend bar check data down to as deep as 10 fathoms or 60 ft. You can extend that bar check data, that includes the sound velocity error in it, down to 100.

CDR Fisher: I generally found that bar check data in excess of 50 ft began to show a lift of the bar and became questionable at that depth. I really could have done another paper on how the bar check data did match up to the velocity correction data from the Lakes, especially with a smaller sample size for determining means. I did go over this quite a bit with AMC processing, and we found pretty good agreement, in general. We were using the technique of shifting the bar check information over to the XBT data-derived curve, and we did find a pretty good match-up in both cases. In fact, we found in one case an offset from the XBT curve, after applying what we had as our known draft, and we ended up applying an additional correction. So it was fairly definitive. But at other times -- if you are talking about one XBT cast every three days, your sample size for bar checks is very small. We tried to do bar checks morning and evening. If you talk about one of these groupings representing a meterological situation of three days' duration, and you did hydrography during those three days, your probable maximum number of bar checks is six, and usually less than six due to quality of the bar checks.

LCDR Richards: Six per launch, if your ship is running just one launch in one area.

CDR Fisher: We were not always running both launches in the same area. I am talking of a one-ship or a one-launch situation. You can increase the number, but you are still talking about fairly small sample size. To have any confidence at all, you would probably have to be up over 10 bar checks per group.

LCDR Richards: Why would you need more bar checks than you would measurements of sound velocities? You are taking one XBT and saying it is more valuable that six bar checks.

CDR Fisher: It has more validity. My intuitive feeling is that your statement is correct. There are many factors which affect a bar check, such as operator error, and sea conditions. We assessed the bar check, and rejected any that were in the fair or poor category. When you get done doing all this, I believe the sample size is fairly small. In general on a hydrographic project you lump together a lot more bar checks. What happened in most cases was that we moved the bar check data over to the XBT data velocity curve and didn't really adjust the curve for bar check data if it came into a pretty good coincidence. For one sheet we were actually able to do that, but it didn't change the depth values we were scaling.

LCDR Richards: What I was leading up to was that it may be more economical to take more bar checks in the field than try to multiply the amount . . . .

CDR Fisher: I feel exactly the opposite is true. This was very easily checked in the Lakes as far as the accuracy of the temperature value was concerned. You get down in your isothermal layer, and this held very good accuracy by our interpretative standards in addition to what the manufacturer says. I really think this is a better technique that increasing the amount of bar checks or going much deeper. I find there is a law of diminishing returns in the quality of bar checks going beyond 30 or 40 ft.

CDR Hayes: I think we are backing into this problem. We are measuring everything other than the thing we want to know, in other words the sound velocity of water. You measure temperature and ignore other things which seem to be minimal, but if you add them all up it may be as much as the temperature.

CDR Fisher: As long as you are not chasing a gnat, because on this we are also talking $66 a probe for XSV or $24 for XBT, plus a considerable difference in the price of the recorder. There should be an evaluation of these techniques in terms of a law of diminishing returns. I think in the Lakes it is pretty simple. Certainly, if you can measure sound velocity directly, it is always better, but as an oceanographer I feel that it isn't really necessary in the Lakes but is definitely necessary in the oceanic environment. This is a special case. I think this relates directly to the preceding talk, because once you get out there and get going with the system, I will be very surprised if you don't start seeing greater variability in conditions than expected. Or you will start seeing certain runoff periods and will see divergences somewhere along the correction curves, even though you may have a suite of curves that are fairly close. You are going to see divergences like this one, (reference to graph) and that requires another table -- there is no way you can take care of that in the averaging process.

CDR Hayes: You can go up to 99 of these tables, and I don't think we ever, even in the past, spent more than 99 days on a sheet. Even if you used daily correctors, the computer is going to handle it. It is going to plug them in.

CDR Fisher: But the ship will be required to do it. If I may quote Mr. Sanocki, you looked at this data and said, "It looks like you needed to do them daily." That's what it boils down to. I don't fault that decision at all if that is what we are after. I don't know what percentage we are after in the accuracy of the velocity corrections relative to other parameters. I personally feel we beat the velocity to death, and maybe some of the other areas are more critical. I gave this paper with an awareness that this is not a critical problem area -- it may be more so with the BS^3 system, but for us there are a lot of other areas you need to keep a closer eye on than this.

LCDR Richards: I have a question that perhaps Alan Pickrell can answer about the way the PDP-8 computes the final corrector using bar check information that shifts over. Is the critical point that is being derived from this the slope of the curve and not the absolute values?

LCDR Pickrell: It is the absolute value and not the slope. But when you shift the curves, then the absolute value is needed to get the slope, but it is still the absolute value at each point.

CDR Fisher: You could develop a whole discussion on whether you shift the slope of this curve or you shift the bar check data, and there are two schools of thought on this. I can remember very long discussions with Hugh Profitt on this very topic, and the one school is that shifting the bar check data to the oceanographic curve has less areas in it for error, such as operator error, as long as you keep good track of your instrumentation.

REPORT ON THE XSV SYSTEM

LTJG Linda F. Haas
NOAA Ship Davidson

ABSTRACT

The BS^3 introduces the need to correct the position of a sounding beam because of refraction due to sound velocity variations. This paper describes a new system to measure sound velocities developed by Sippican Corporation. Comparison is made with Nansen cast and Martek data. Accuracy requirements for velocity data are discussed and a new standard of ± 2 meters per second proposed.

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During the course of the development of the BS^3 system, it was recognized that there was a growing need for a more accurate sound velocity profiling system than is presently used in NOS. This is due to the fact that many of the beams in the Bosun sonar are not traveling vertically through the water column, and so not only are they subject to variation in the depths that they produce, they also are refracted by sound velocity variations. Therefore, the accurate sound velocity profile system is needed to correct not only the depths but also the positions of those beams.

Presently sound velocity is being determined in NOS by measurement of salinity, temperature, water conductivity and depth. These are the parameters on which sound velocity is primarily dependent, but it can also be affected by turbidity, dissolved gas concentrations, or other things, so it would be better to measure the sound velocity directly instead of through these other parameters. Early in 1977, Engineering Development Lab began investigating various systems to be used to correct the BS^3 system and to meet the specifications that were required for the system. General Instruments, the company that developed the sonar system, came up with specifications of ± 2 meters per second accuracy as opposed to 4 meters per second accuracy required in NOS by the Hydrographic Manual.

As a result of EDL's tests, in April of 1978, along with our BS^3 system testing in Puget Sound, the DAVIDSON spent one day testing the XSV system from Sippican Corporation. The expendable sound velocimeter system was compared with Nansen casts and the Martek casts which are presently used to correct for sound velocity. We also tested the system for repeatability. The unit that we were testing is very similar in construction to the expendable bathythermograph commonly used on the oceanographic ships and on some of the hydrographic ships. Instead of a thermistor thermometer sensor, it has a singaround velocimeter sensor. This consists of a transducer and a brass reflective plate that are spaced 25 mm apart. The transducer emits a very short high-frequency sound impulse which is reflected back by the brass plate and the return impulse then triggers the next impulse from the transducer; hence the name "singaround system." This probe is dropped from a cannon launcher from the stern of the ship. The probe is connected by a fine copper wire back to a deck recorder. The sound velocity is plotted as a function of depth directly. The depth is computed using the free-fall equation; it is not measured directly in the probe itself. The manufacturer's specifications for the XSV are to measure sound velocity to ± 0.25 meter per second and the depth to an accuracy of 5 meters or 2% of depth, whichever is greater. Maximum depth range for the system is 700 meters. The power supply is in the probe itself. There are two very small, 1/2AA batteries which are activated when the transducer comes in contact with the water. Theoretically it is activated when it hits the water. We did run into some problems with its not being activated immediately upon hitting the water, which we solved by soaking the probe for a couple of minutes in a bucket of water on deck before we launched it, and this worked fine. This procedure is not in the instruction manual.

The typical kind of trace we received from the probe is as follows: Up at the top of the plot, the initial trace shows which scale the unit is using. When the probe hits the water, there is an initial deflection, and then finally at the bottom there is a horizontal deflection when the probe strikes the bottom. The amount of horizontal deflection varies quite a bit. With the tests that we ran on the ship, we launched 24 probes provided by Sippican. We did these at the same time that we ran two Nansen casts and a Martek cast -- temperature conductivity unit cast. The Nansen casts were each made with 10 bottles using the standard depths from the Hydrographic Manual. The salinities were determined with the lab salinometer that we carried on board, and the sound velocities were computed using the HYDROPLOT program. This is the usual procedure we use to determine velocity correctors for our hydrography. On the Martek cast, we lowered the probe to the standard depths, measured the surface temperature and salinity and again computed the sound velocities using the HYDROPLOT program. We launched the first seven XSV probes during the first Nansen cast; during the second Nansen cast, we launched probes 8 through 20 and also took a Martek cast at the same time. Finally, probes 21 through 24 we launched while the ship was under way at full speed. The manufacturer specifies that it can be launched at speeds up to 15 knots; we tried it at 12, and we didn't notice much variation in depth accuracy. Four of the 24 were rejected after the initial data was lost because the probe was not activated when it hit the water. The sound velocities were scaled directly from these printouts, and then we compared all three sets of data to see how each measured up to NOS standards.

Puget Sound is not one of the best places to do this kind of comparison, because it is extremely uniform. It is a very well-mixed body of water, and so there was very little variation in the water column. The two Nansen casts produced almost identical velocity curves, so we averaged them. The reject limits are ± 4 meters per second as specified in the Hydrographic Manual. Not only do the XSV units agree very well with the Nansen casts, the extreme high and low readings on any of the probes at any depth also fell within the reject limits. The probes were very consistent in that the mean standard deviation of all depths was only 0.4 meter per second with the greatest deviation 0.54 meters per second.

Sippican, before shipping us the probes, calibrated each probe with a standard reference probe and supplied us with calibration correctors. We did not use them in the tests. None of those were very large: the greatest was 0.8 meter per second variation, but we wondered if it was a random sample of probes or not. An interesting sidelight is that the Martek cast compared very well with the Nansen cast, which surprised us. I don't know how the other ships have been doing, but our Marteks have been giving us pretty poor results. It is easier to use than a Nansen cast, but we don't believe the data to be as accurate, so we were comparing the XSV to the Nansen as our basic standard. So the system is accurate enough to meet NOS specifications and is also accurate enough to use for the BS^3 system. Our field operations officer at the time of the test conducted a cost analysis of the Nansen cast versus the XSV, looking at manhours used for each type of cast -- not comparing the initial outlay for the equipment but how much it costs to actually run each one. He came up with figures, using estimates of fuel costs, material costs, etc. of 14 manhours for a Nansen cast, and this came to a cost of over $500 per cast. It uses approximately 1/2 manhour to launch an XSV probe, and it costs us about $86 including the probe. For a cost of initial outlay, the XSV unit costs about $12,000 for the deck unit and the launcher. The probes are approximately $65 to $70 apiece. In comparison, we carry about 15 Nansen bottles, though we only use about ten at a time. We carry 30 reversing thermometers for use, and a lab salinometer. To completely outfit a ship for a Nansen cast would cost something over $21,000. In conclusion, the XSV is accurate enough for our purposes, it is much easier to use and gives very reliable results.

DISCUSSION

Ms. Scott: As I understand it, it can be operated from a launch too. Would this give us the capability of more accurate velocity corrections in the near shore area of a survey?

LTJG Haas: You could get a more complete picture of what the velocity variations are in a working area. Yes, you could probably get more accurate corrections. The way we do it presently, we have generally been taking a Nansen cast once a month in the working area and using that and applying it to all the hydrography in that period. When we were working in Yakutat this year, for instance, we were working next to some active glaciers which produced a lot of fresh cold water runoff. We discovered there was more tidal variation within a day than there was variation from day to day or from week to week. If we had had this type of unit we could have fired off one every half hour over a tidal cycle and have gotten a true idea of what the velocity was and whether it was worth worrying about.

CDR Fisher: You commented that NOS had come up with a criterion of $\pm$ 2 meters per second, which works out to about 1/8 of 1% on depth for accuracy. Is that the accuracy of the instrument, or is that the criterion they wanted for accuracy in processing data?

LTJG Haas: This was the specification developed by General Instruments. They were the developers of the sounder, and they felt that this accuracy was needed for accurate positioning of the sidebeams.

LCDR Richards: Was there any cost comparison done with the Martek? You indicated during the test that it compared favorably with the other systems.

LTJG Haas: I don't have any figures on the cost of the Martek unit itself. It was interesting that, in this year during a four-month period, we went through three different Martek casts which had to be continually shipped back to PMC for replacement. We had one that was recording depth at a 1:2 ratio to what it should have been. Another one had about a 10 meter error in the depth reader. We continually had problems with it and never really felt it was reliable enough to use. We did use it in Yakutat to look at the changes with the tidal fluctuations of the ice.

CDR Fisher: The cost benefit analysis is not totally correct, in that LCDR Suloff still influences it, and he does require a once-a-month comparison to whatever you use, whether it be an XSV or an XBT, so you aren't completely out of the Nansen cast business, and you don't save the money on the salinometer and the bottles and the thermometers.

LTJG Haas: This would not be to replace the Nansen cast; that is still used as the standard. However, for a more accurate profile it would be better than what we have now.

LCDR Schiro: Are you willing to say it is more accurate even though you tested it in an area which you don't consider very representative?

LTJG Haas: I would say that, as far as consistency goes, it is as accurate as any Nansen cast. It is a very repeatable instrument. It would have been interesting to examine it in Yakutat, but Puget Sound was the place that was set up for a test.

LT Harman: You mentioned refraction as an error in positioning. Is there software to apply refraction to the system?

LTJG Haas: Yes, there is. The sound velocity in the BS^3 system is put in as a table like a parameter table. It is automatically computed on line while the ship is running for refraction as well as for depth correction.

LCDR Richards: Where is the system now, and are there further tests contemplated?

LTJG Haas: The system was on loan to us from Sippican. They developed it in the last year or so. It is probably accessible in the market, but we do not have it. Sippican came out and operated the system during the tests and gave us the results. Commander Fisher has an article from Sea Technology which describes the system.

Table 3

Depth	Averaged Nansen Velocity	$\bar{X}_{XSV}$ (Mean XSV)	Reject Limits Low	Reject Limits High	XSV High	XSV Low
0	1480.39	1480.46	1476.21	1484.57	1480.8	1480.0
10	1480.48	1480.63	1476.46	1484.80	1481.3	1480.1
20	1480.57	1480.61	1476.34	1484.80	1481.6	1479.6
30	1480.33	1480.45	1475.70	1484.63	1481.5	1479.5
50	1480.10	1480.28	1475.91	1484.29	1481.1	1479.9
75	1480.63	1480.60	1476.47	1484.79	1481.3	1480.0
100	1481.06	1481.13	1476.90	1485.22	1482.0	1480.6
150	1482.02	1482.08	1477.79	1486.25	1483.0	1481.1
200	1482.93	1483.01	1478.72	1487.14	1483.7	1482.2
250	1483.87	1483.82	1479.73	1488.01	1484.3	1483.5

FIELD OPERATIONS WORKING GROUP

CDR John C. Albright
NOAA Ship RAINIER

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Considerable discussion was generated on the subject of how to facilitate and expedite data processing and submittal to the marine center. Several recommendations were made, as follows:

1. Preparation of the final "smooth" field sheet is extremely time consuming yet serves the ship no purpose other than providing a check that all changes to tapes have been made correctly. This requirement should be eliminated. If this is not possible because of marine center needs, the cartographic standards should at least be lowered to reduce the time required for hand drafting.

2. Efforts to provide the ship with digitized data for field sheet preparation should be continued and intensified. Associated software development should be assigned a high priority. Digitized data should include photogrammetric and chart information, prior surveys, geodetic control, presurvey review items, navigation aids, and landmarks.

3. The present Descriptive Report should be replaced with a loose-leaf "fill in the blank" format, to the extent possible, which can be filled out by hand aboard ship and typed at the marine center. LCDR Richards will prepare a draft and circulate for comments.

4. A sounding excess routine should be developed for the HYDROPLOT system.

The following general topics were also discussed and recommendations presented:

1. More direct contact between hydrographers and chart compilers is essential for each to understand the needs and problems of the other. Greater input from compilers is desirable at future conferences. It was the unanimous opinion of the conference attendees that a rotating chart compiler program should be established between Rockville and the ships, similar in concept to the existing rotating cartographic technician program.

2. Training in the investigation and documentation of presurvey review and chart evaluation items should be intensified in the combined operations training course.

3. Signal strength meters for the Del Norte system should be developed and procured.

4. Coordination should be provided at the C3 level between the content of and procedures directed by the PMC OPORDER and AMC Manual. SHF calibration procedures is an example.

5. Small boat wire drag equipment should be standardized and procedures documented.

Editor's Note: These comments and recommendations have been sent to the appropriate offices for comment. Changes if any will be implemented per standard practice by the National Ocean Survey.

SURVEY PROCESSING PROBLEMS WORKING GROUP

Mr. J.S. Green
Chief, Verification Branch
Pacific Marine Center

Mr. R. Sanocki
Processing Division
Atlantic Marine Center

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Mr. George Myers, Quality Control Branch, reviewed discrepancies noted in recent surveys completed by the Marine Centers. Differences in survey processing procedures and surveys between the Pacific and Atlantic Marine Centers was discussed in great detail.

It was noted that the Atlantic Marine Center was apparently more effective in the amount of manhours required to process their hydrographic surveys. Time accounting procedures of both centers were reviewed in detail and no significant differences in the time accounting could be discerned. The differences in the nature of the surveys between east and west coasts was also considered. The complexity and magnitude of the surveys did not readily account for the differences. The verification procedures and structure were also reviewed in an attempt to account for the differences. Both marine centers defended their procedures and structure so the reasons for the differences in manhours were not accounted for.

It was noted that the Atlantic Marine Center's smooth position overlays were in black ink and the Pacific Marine Center's in red. After a vigorous defense by each marine center, the Pacific Marine Center graciously agreed to change to black ink for the smooth position overlays.

The requirement for the plotting of SHF arcs on the smooth position overlay or a smooth lattice overlay in congested situations were discussed. Mr. Carstens finally consented not to require arcs on the final overlay for those SHF stations (Miniranger or Del Norte) plotting on the smooth sheet.