CANADA/U.S.A.
C.H.S./N.O.A.
TECHNICAL EXCHANGE - 1977

FINAL FIELD REPORT

MAY to AUGUST

J.R. MacDOUGALL
HYDROGRAPHER

CANADIAN HYDROGRAPHIC SERVICE

CENTRAL REGION

and

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

NATIONAL OCEAN SURVEY

ATLANTIC MARINE CENTER - NORFOLK, VIRGINIA

STAFF EXCHANGE

1977

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INTRODUCTION

This report covers a three month technical exchange between the National Ocean Survey (NOS) and the Canadian Hydrographic Service (CHS).

During the past year the Lakes Survey Center (LSC) in Detroit, Mi., was phased out and its duties taken over by the Atlantic Marine Centre (AMC) Norfolk, Va.

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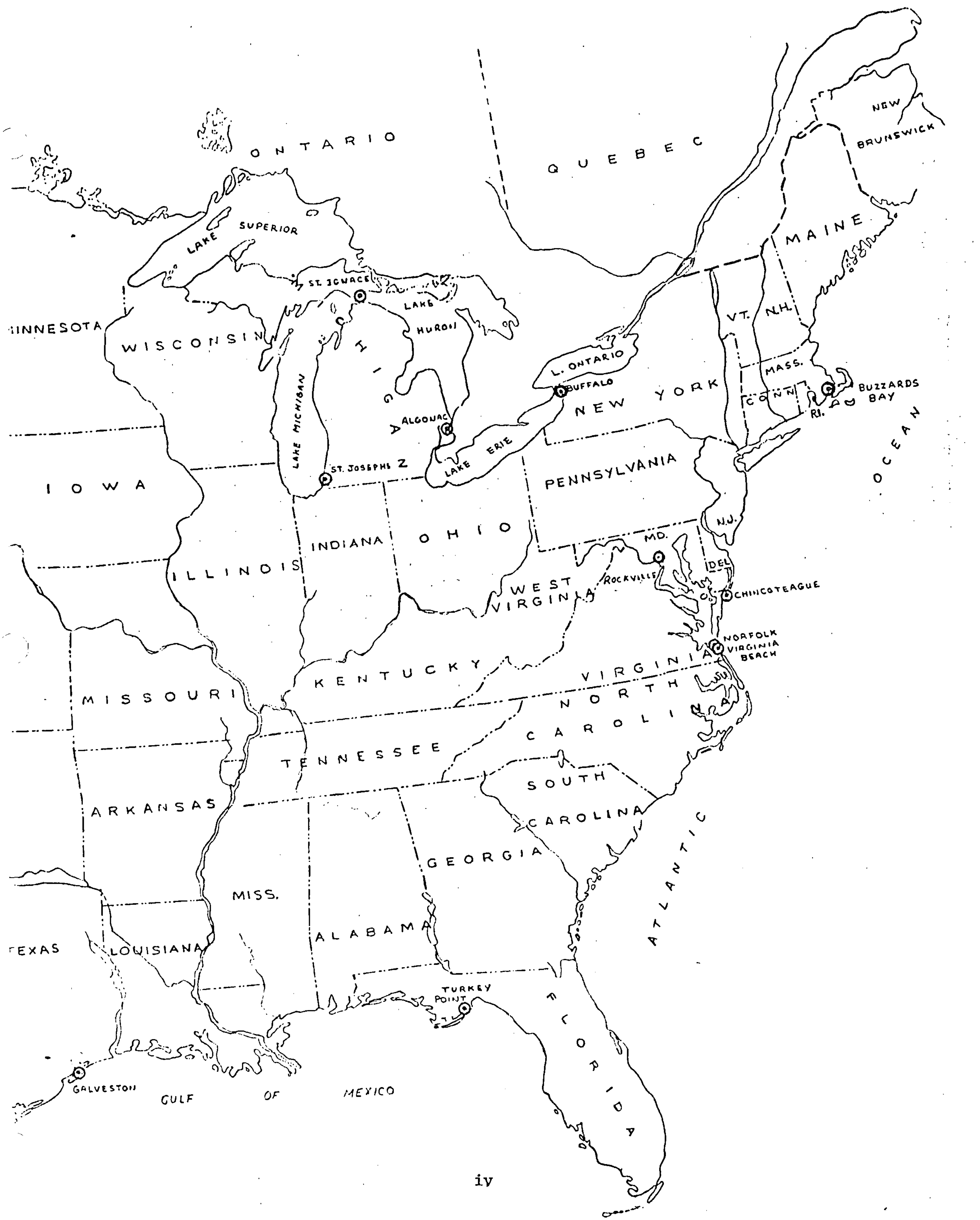

ONTARIO
QUEBEC
NEW BRUNSWICK
MAINE
LAKE SUPERIOR
ST. IGNACE
LAKE HURON
MICHIGAN
INNESOTA
WISCONSIN
LAKE MICHIGAN
ALGONAC
ST. JOSEPHS
L. ONTARIO
BUFFALO
NEW YORK
VT.
N.H.
MASS.
CONN
R.I.
BUZZARDS BAY
OCEAN
LAKE ERIE
PENNSYLVANIA
IOWA
INDIANA
OHIO
ILLINOIS
N.J.
MD.
DEL
ROCKVILLE
CHINCOTEAGUE
WEST VIRGINIA
NORFOLK
VIRGINIA BEACH
KENTUCKY
VIRGINIA
MISSOURI
NORTH CAROLINA
TENNESSEE
SOUTH CAROLINA
ARKANSAS
ATLANTIC
GEORGIA
MISS.
ALABAMA
TEXAS
LOUISIANA
TURKEY POINT
FLORIDA
GALVESTON
GULF OF MEXICO

SUMMARY

The 1977 field season marked the sixth consecutive year of a technical exchange program between the National Ocean Survey (NOS) and the Canadian Hydrographic Service (CHS).

This exchange was arranged through the Atlantic Marine Center (AMC), Norfolk, Virginia, and I had an opportunity to observe and participate in survey operations throughout their region which now includes the Great Lakes.

My counterpart in the exchange program was Mr. Robert Roberson, of the Verification Branch at AMC.

I found the exchange program very informative and personally rewarding. The program is a worthwhile experience, as it facilitates the exchange of ideas and gives one a first hand view of new or different methods of performing specific tasks. The opportunity to discuss these different approaches to problems, with the people involved in day-to-day operations, provides an insight into the subject which can rarely be gained by other means.

U.S./CANADIAN NOMENCLATURE COMPARISONS

Boat Sheet	Boat Board
Brass Disc	Rock Post
Cross Lines	Check Lines
Developments	Shoal Examinations
Fathogram	Sounding Roll
Fathometer	Echo Sounder
G.P.	Geographic Position
Holidays	Areas Missed
Hydro	Hydrographic Survey
Mark	Fix
P.S.I.	Pre Survey Review
Smooth Sheet	Field Sheet
Scanning	Scaline
Stage	Water Level Reduction

NATIONAL OCEAN SURVEY HEADQUARTERS

The National Ocean Survey (NOS) is a division of the U.S. Department of Commerce's National Oceanic and Atmospheric Administration (NOAA) and operates with its headquarters in Rockville, Maryland, and marine centers at Norfolk, Virginia, and Seattle, Washington. See Figure 1-1 for a breakdown of NOS.

The Rockville office prepares the survey's Project Instructions and supports the regional marine centers by supplying such things as aerial photographs and tidal information. The final field sheets are also checked in Rockville, where the chart compilation and production are carried out.

The Project Instructions are very detailed and leave the field units few alternatives. In their preparation, the sources of all existing data in an area are investigated to eliminate errors and unnecessary field work. A Pre Survey Item review is also done, indicating specific items to be investigated and how they are to be developed. The sources of all reported hazards, etc., are included with the Project Instructions.

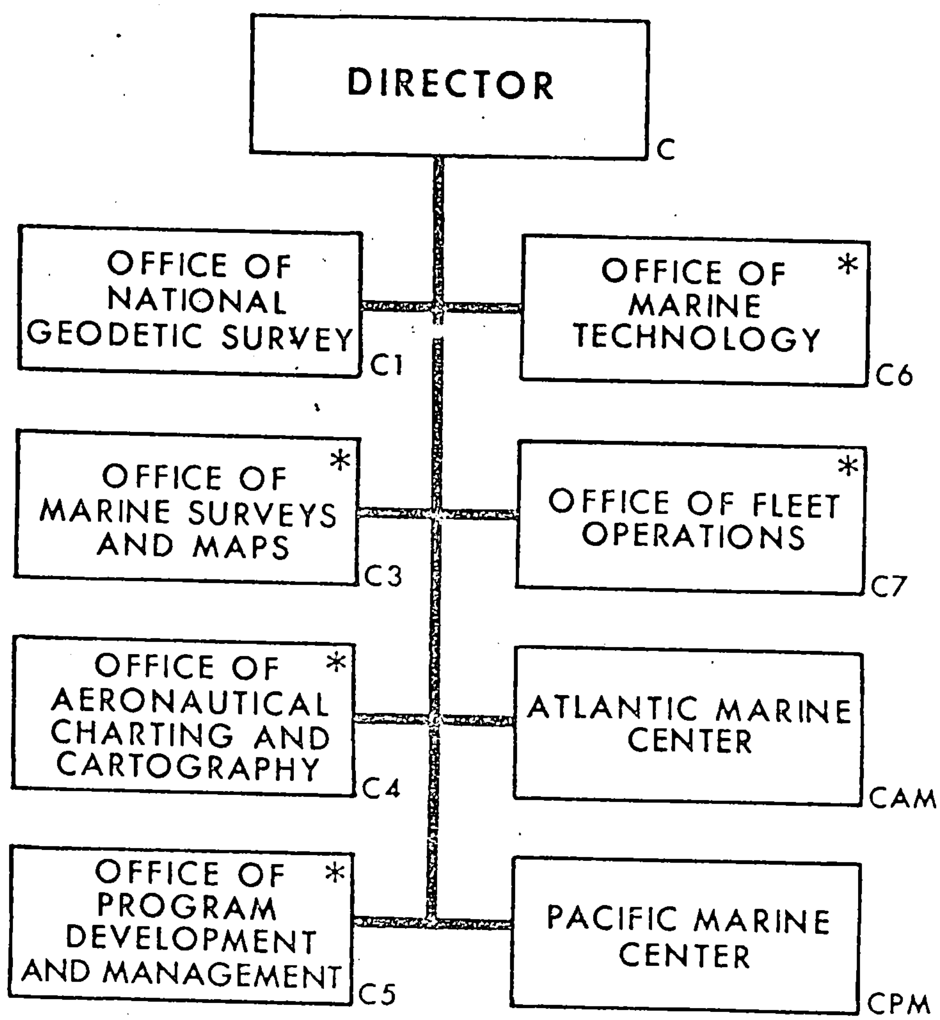
The Photographic Branch provides aerial photographs to the Coastal Mapping Divisions at the marine centers. Aerial photographs are also bridged to form models and then sent to the marine centers where they are used to create shoreline plots and airport obstruction charts. This Branch is also working on the use of aerial photography to determine depths in shallow water.

The Tidal Branch in Rockville also studies the survey areas and using mainly historical data, determine the type, number and positions of tide gauges required. They also determine the reliability of tidal data during the surveys and prepare the actual tidal reductions for all soundings. This Branch is also involved in projects to determine high and low tide limits in areas such as Lousiana, where offshore mineral rights are contested.

Figure 1-2 shows the steps through which data flows, from the issuing of the Project Instructions to the Chart Productions.

U.S. DEPARTMENT OF COMMERCE
NOAA

NATIONAL OCEAN SURVEY



* ASSOCIATE DIRECTOR OF NATIONAL OCEAN SURVEY

FIGURE I-1. NOS Structure.

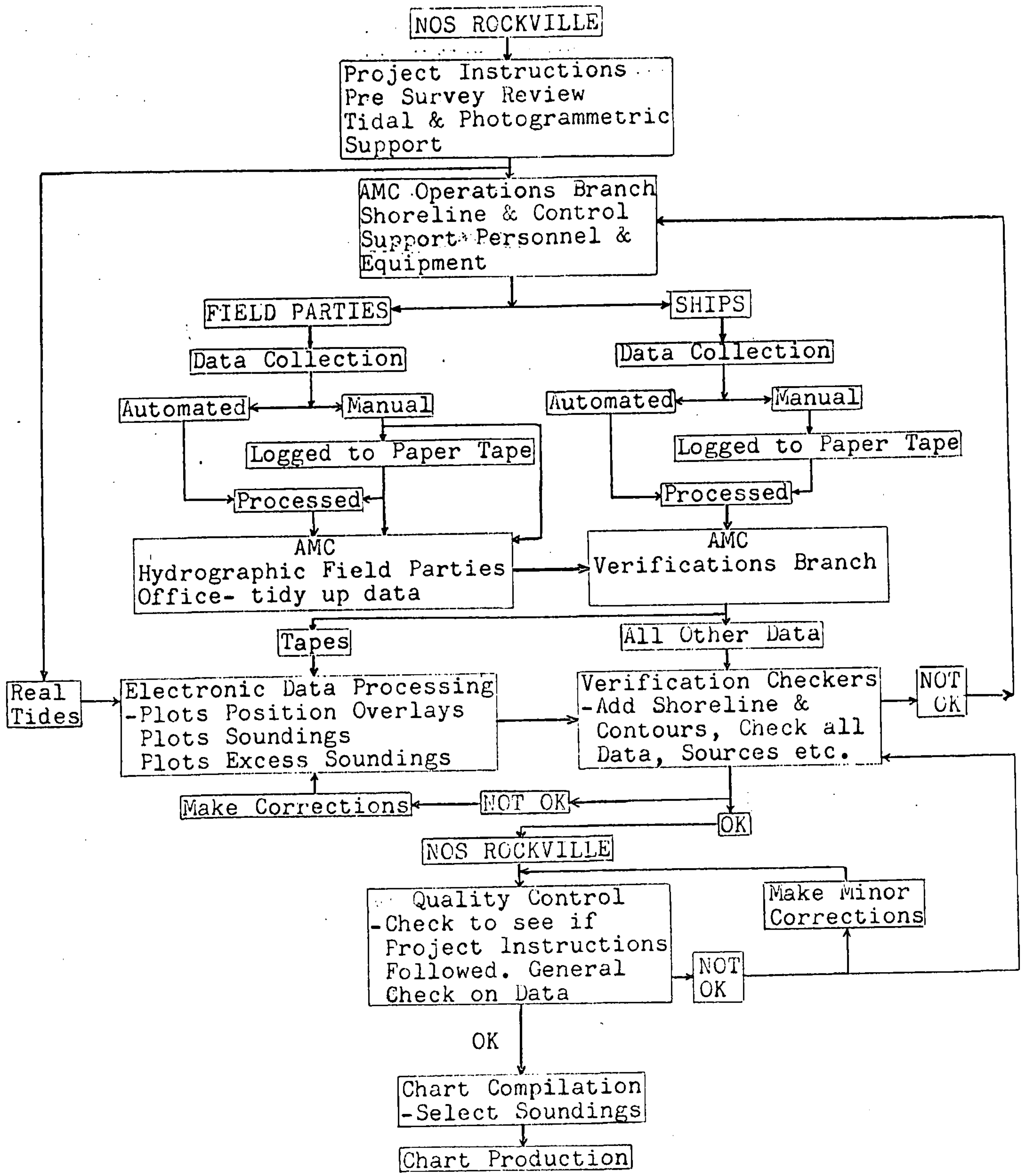


FIGURE I-2. Data Flowchart.

ATLANTIC MARINE CENTER

The Atlantic Marine Center (AMC in Norfolk, Virginia, is responsible for charting over a wide area, including the Atlantic seaboard, Great Lakes, Virgin Islands and Puerto Rico. Their field parties operate on a twelve (12) month basis, working in the northern states during the summer months and moving south for the winter. AMC also operates a fleet of survey and research ships.

AMC provides support facilities to both their ships and field parties. This consists of providing shoreline plots, a Hydrographic Field Parties Office to aid and guide the field parties in their projects, electronic maintenance personnel, control, final processing facilities and verification of the field sheets.

The Coastal Mapping Division provides the shoreline plots and also operates horizontal control parties to establish control for aerial photographs as well as in support of the survey parties. They also perform a field edit of their plots to ensure the data was interpreted correctly from the photographs.

Figure 11-1 shows a breakdown of AMC.

Organ. Code: C60000 | Issue Date: 6-3-76

NOAA Organization Handbook

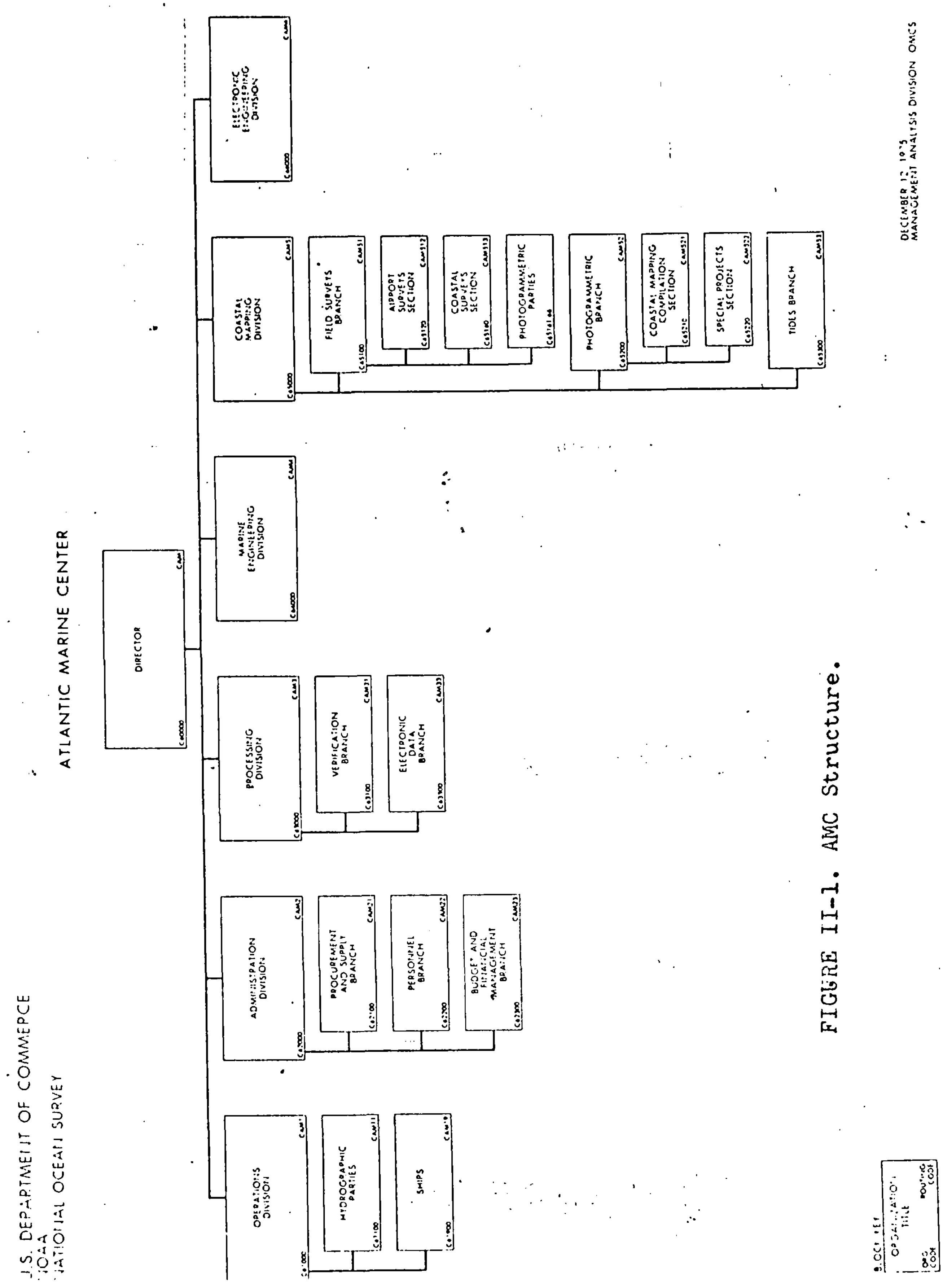


FIGURE II-1. AMC Structure.

DATA COLLECTION AND FIELD PROCESSING

1. GENERAL

(a) Automated

The NOS Hydroplot/Hydrolog system uses a Digital PDP-8E computer in conjunction with two teletypes, a Houston plotter, an echo sounder and a positioning system. Unlike both HAAPS (Hydrographic Acquisition and Processing System) and INDAPS (Integrated Navigation Data Acquisition and Processing System), this system plots the soundings on line while the vessel is underway. The plotted soundings are corrected for the predicted tide and vessel draft.

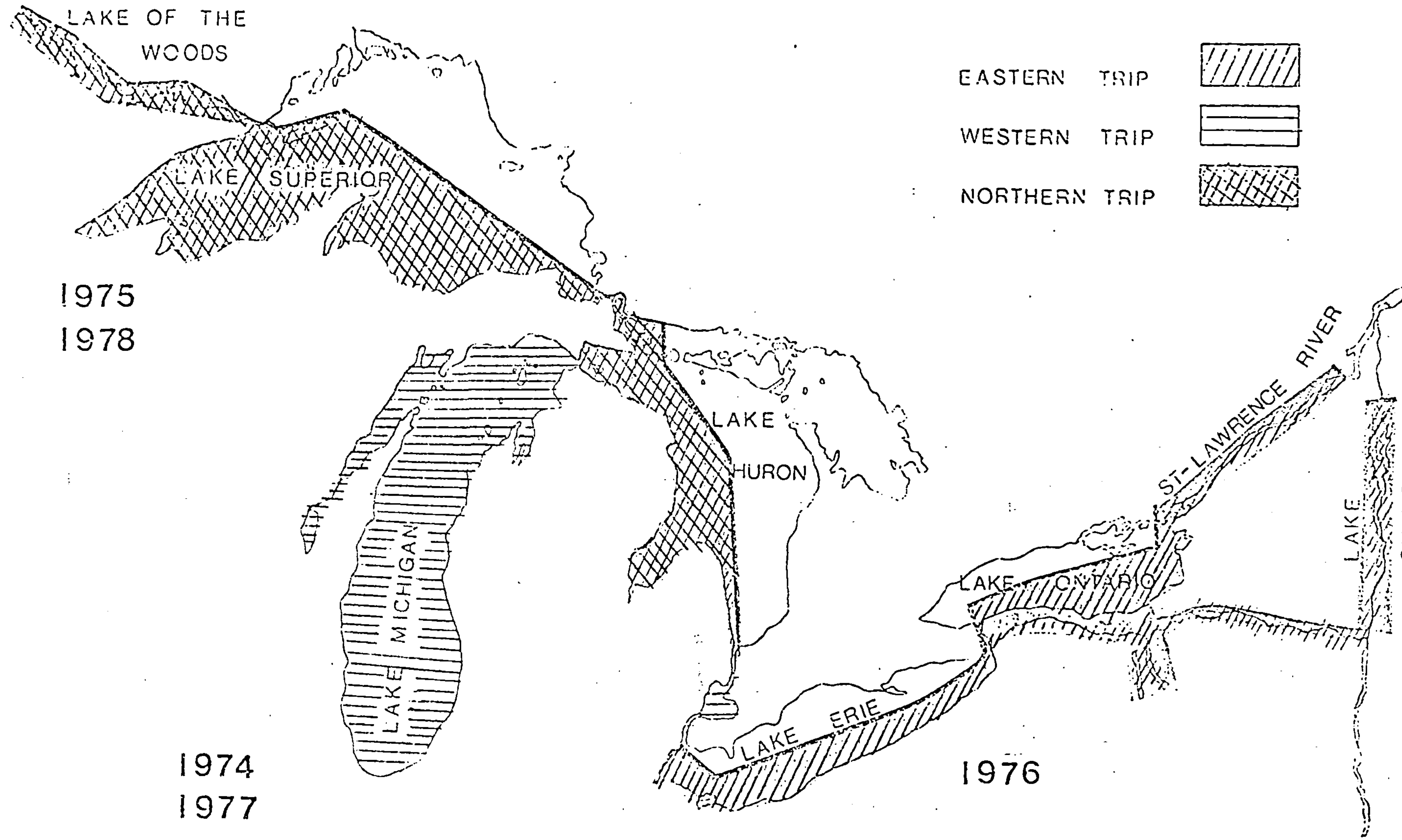
Soundings are selected on a fixed time interval and recorded on punch paper tape. This interval depends on the survey scale and vessel speed since each selected sounding is plotted. Unlike HAPPS and INDAPS, no depth criteria is applied in the selection procedure. The sounding graph must still be manually scaled and the shallow and deep soundings missed by the sounding interval inserted. A corrector tape is punched up and used with the original to create a final field sheet.

All soundings are in feet or fathoms and positions are given in geographic rather than grid coordinates.

(b) Manual

Manually collected sounding data is collected on a time basis also. Fixes are usually called to coincide with the vertical markings on the sounding graph and the data is recorded in hard covered sounding volumes.

All manually collected data is punched onto punch paper tape for final processing and plotting at AMC. Where "see boat board" work is used, fixes are created so this work can also be computer plotted.



REVISORY SECTION SCHEDULE

2. SPECIFIC OPERATIONS

(a) Chart Deficiency

This party was doing revisory work on the Detroit and St. Clair Rivers, Lake St. Clair and Lake Michigan. A sub-party was installing temporary tide gauges throughout the survey area.

Two Mon-Ark launches were used for sounding, with Del Norte used range-azimuth for positioning. Fixes were called by the launch, timed to coincide with the vertical markings on the graph of the Raytheon 719 sounder. The fixes were plotted ashore, using a portable table and drafting machine, as they were called. Additional information and specifications on Del Norte can be found in Appendix A.

The charts contained a considerable amount of land detail, thus requiring a detailed "road check" to verify buildings, land marks and street names. Useful land marks were positioned by theodolite cuts from known control and geographic positions computed using a Wang 700 desk computer.

As each chart was completed, the revised chart and all the related data was forwarded to AMC in Norfolk.

(b) High Speed Launches (Lake Erie)

This party consisted of two launches, the 60 foot steel Equity launch, NOAA 1255, and the 28 foot aluminum Jensen launch, NOAA 1012. The party was based in Buffalo, New York, and was sounding the eastern end of Lake Erie at scales of 1:10,000 and 1:20,000, using the Hydroplot/Hydrolog system. Del Norte was used in the range/range mode for positioning and soundings were obtained with a Raytheon 723D echo sounder. Additional information and specifications on the Raytheon 723D sounder and digital display unit can be found in Appendix B.

The Del Norte positioning system was calibrated regularly using sextant fixes and checked daily by coming alongside surveyed points. The Hydroplot/Hydrolog system allows thumbwheel entry of the calibration correction. The sensitivity of the left/right indicator and sounding time interval are also entered via thumbwheel switches.

Bar checks were taken on a random basis and recorded on a form showing the bar depth, sounding graph depth and digital depth. The sounder was not adjusted to read true depth, but a velocity corrector was computed and applied later.

The launches ran straight lines of 100 meter spacing for 1:10,000 sheets and 200 meter spacing for 1:20,000 sheets. Data was not continuously recorded with the Hydroplot/Hydrolog system. The system was interrupted at the end of each line to avoid recording inaccurate soundings caused by the listing of the launch during the turn. It was also interrupted when stopping for traffic because soundings were plotted on the selected time interval.

Soundings were plotted on plastic (mylar) using the Houston plotter. There were frequent erroneous positions due to the Del Norte readings so each legitimate jog in the line had to be noted or it was assumed to be a position error. Gaps appeared on the sounding line when the plotter wandered off to plot a position some thousand meters away and the storage capacity of the computer overflowed.

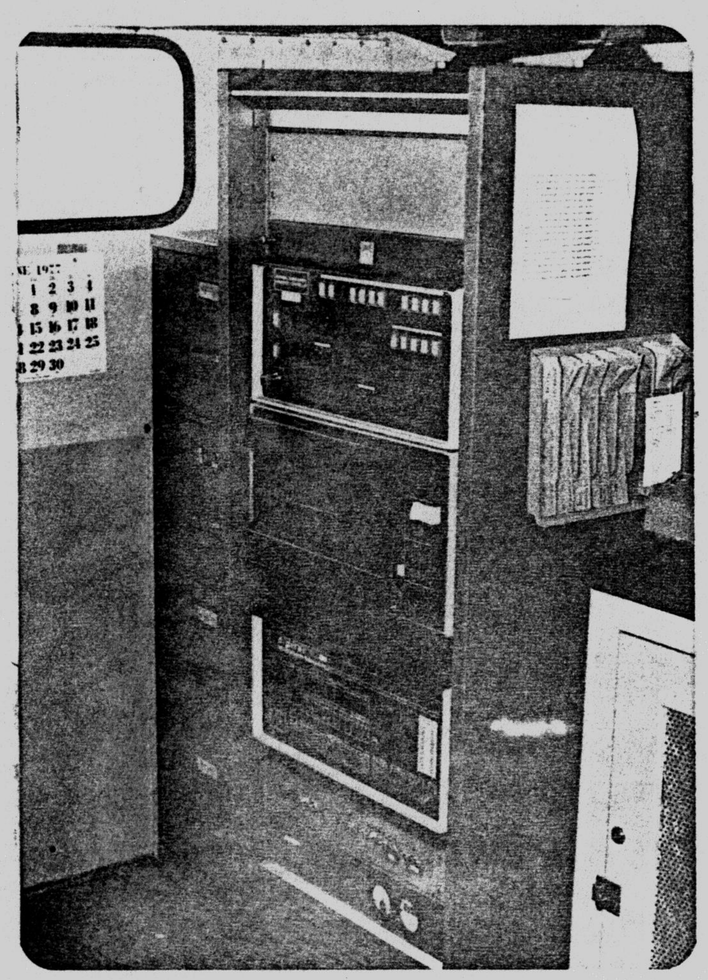
Bottom samples were taken at 6 centimeter intervals at the survey scale using a simple clam-type grab. This sampler worked quite well. The samples were identified and retained to be sent to the Smithonian Institute to be studied.

A predicted water level tape was created and used for the on-line processing, but tide gauges of the ADR (Automated Data Recorder) and "bubbler" (pressure type) types were installed on the survey area to record the actual water levels. Local residents were hired as gauge observers and all gauge records were sent to NOS in Rockville, Maryland. The Tidal Branch there supplies the actual reductions to AMC to be applied to the final field sheets.

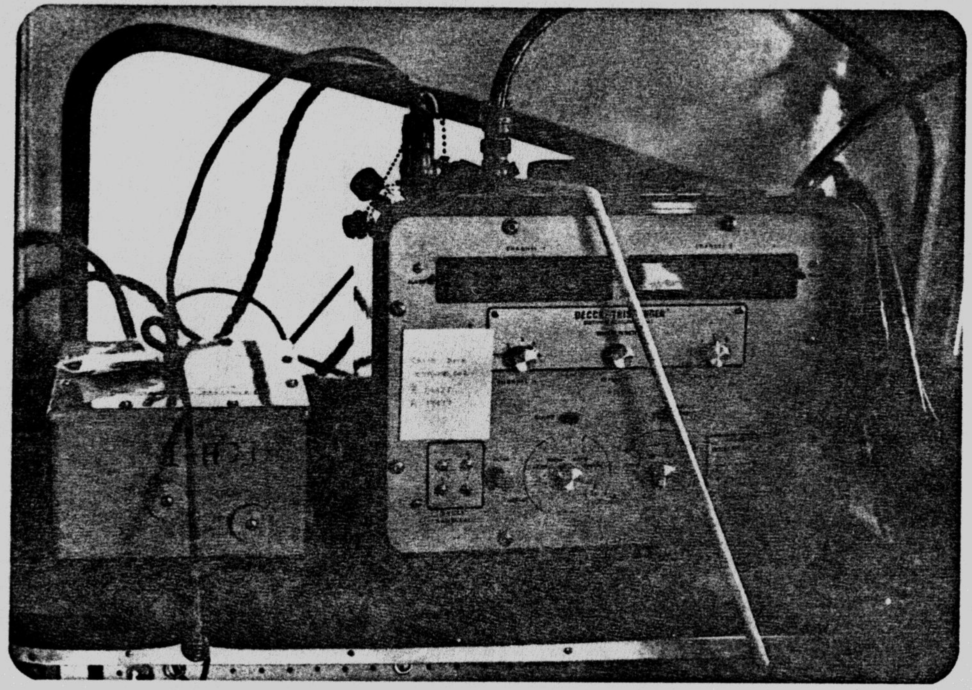
At the end of a sounding day the sounding plot was removed and checked for bad positions using multiple dividers to see that the soundings looked to be positioned correctly. Since the launch was running constant courses and speeds, the soundings should be equally spaced. If this was not the case the position of the sounding was corrected by time and course (T&C) from the last good fix. This correction was indicated on the teletype print out of the recorded depths.

The method of sounding selection also necessitates the manual scaling of the sounding graphs to locate peaks and deeps and also to check the digitized depth of each sounding against the graph. The acceptable tolerance is ± 0.5 feet. These additions and corrections are also noted on the printout, then the scaling process is repeated by different people as a check. A corrector tape is then punched up using the teletype or a logger connected to the teletype.

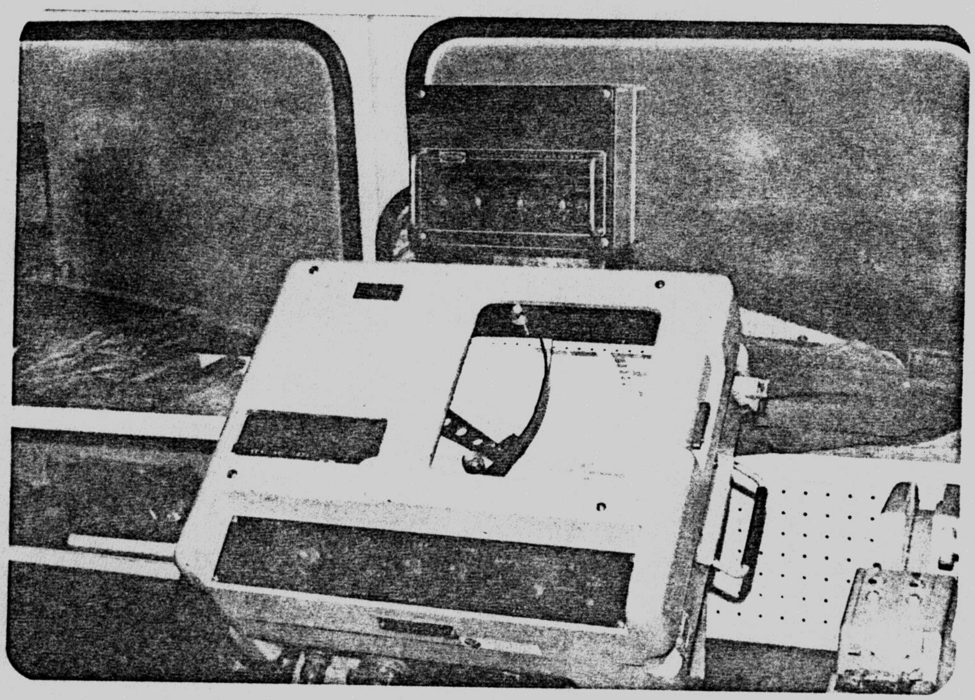
The final field sheet was plotted by combining the original and corrector tapes with the predicted tides and sounder velocity correctors. The corrector tape overrides the original tape on a time basis. No new tape of "good" data is created but all the tapes are forwarded to the Hydrographic Parties office at AMC with the finished field sheet at the end of the project.



HYDROPLOT/HYDROLOG SYSTEM

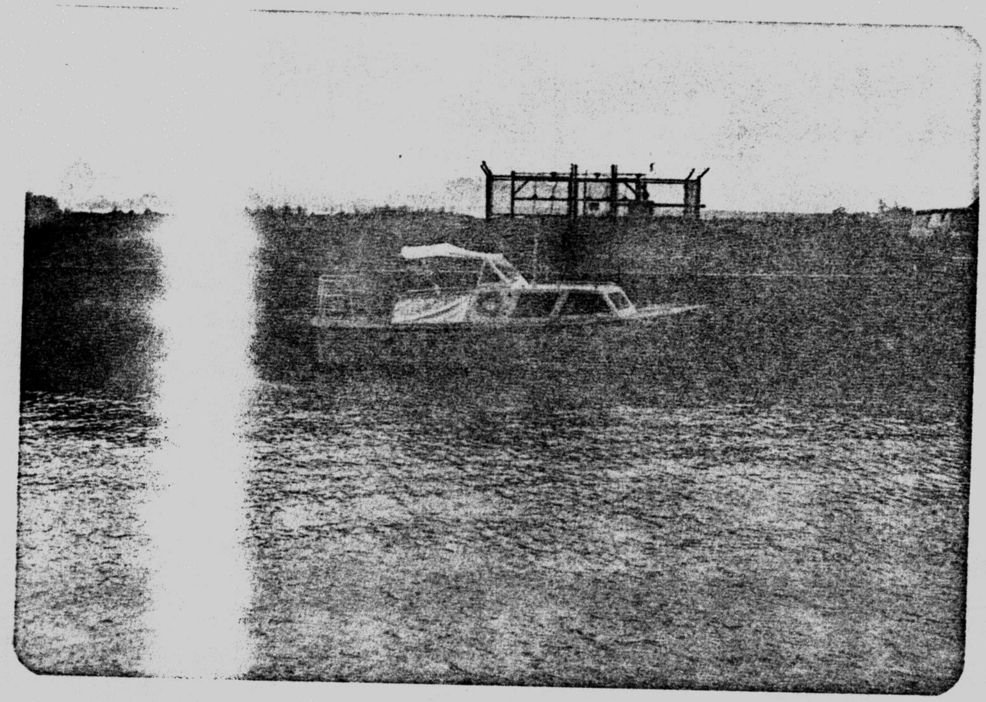


DEL NORTE DMU



RAYTHEON 723D SOUNDER

NOAA LAUNCH 1255



NOAA LAUNCH 1012

BOTTOM SAMPLER

ADR TIDE GAUGE

(c) *Photo Party 62 (Buzzards Bay, Massachussetts)*

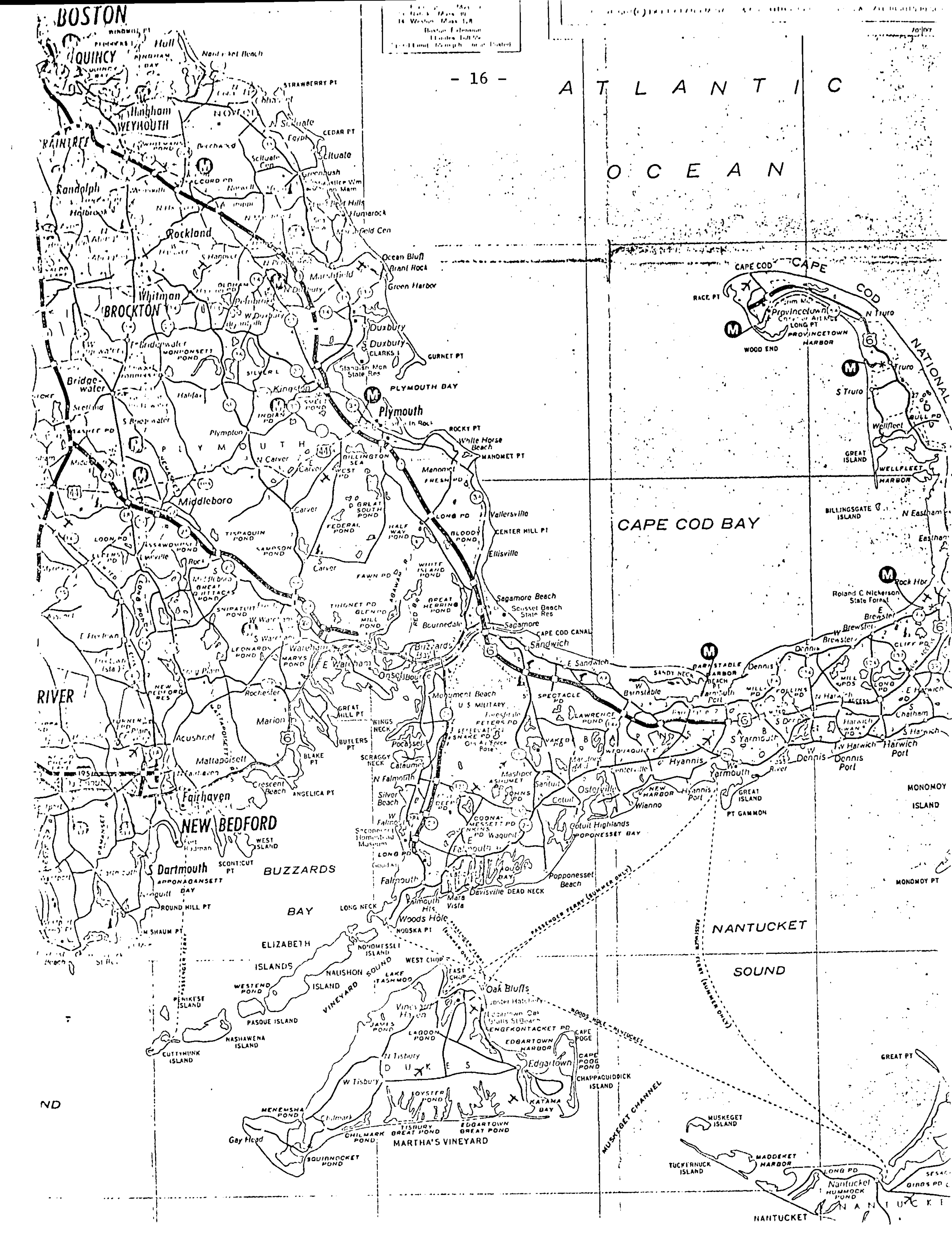
This party was establishing third order horizontal control around Buzzards Bay in support of the NOASS ship Whiting. They were also doing a field edit on the photoplots that were made up for shoreline, to ensure items were interpreted correctly by the photogrammetist.

The party used Wild T-2's and an AGA Model 76 Geodometer in their work. When observing traverse angles, the method of closing the horizon was used for intermediate traverse stations and four regular sets (0^o, 45^o, 90^o and 135^o) were observed to at least three known objects at the start and end points. The Geodometer worked very well in this area where the shots were relatively short and the elimination of a remote operator made the system more efficient than using a Tellurometer, since more than one set of prisms could be set up and left unattended. Third order control points were not monumented unless the ship used them for electronic positioning stations.

The hydrographic survey party does not specify where they want control stations but indicate what approach they plan to use in specific areas. In this case most of the small bays were to be sounded using range/azimuth for positioning, so care was taken to provide RO's (reference objects) so the cut off angle would not be less than 0^o. This was done to humour the computer since the switch from 0^o to 359^o causes plotting problems.

The field editing portion of the project involved a very detailed check of the shoreline by small boat. Both the shoreline plot and the aerial photographs used in its compilation were checked for correct interpretation of detail. All visible rocks were pinpricked on the photographs and their heights above or below water noted. Objects with possible landmark value were noted also. Additional detail, such newly constructed seawalls, wharves and marinas were measured, positioned by sextant and drawn onto the plot.

All survey computations were done by hand with the aid of pocket calculators and survey forms. All positions were computed in geographic coordinates.


BOSTON
QUINCY
Hull
Hingham
WEYMOUTH
Cohasset
N Scituate
Scituate
CEDAR PT
Randolph
Holbrook
Rockland
Hanover
Marshfield
Ocean Bluff
Brant Rock
Green Harbor
Whitman
BROCKTON
Pembroke
Duxbury
S Duxbury
GURNET PT
Bridgewater
Kingston
PLYMOUTH BAY
Plymouth
ROCKY PT
White Horse Beach
MANOMET PT
Plympton
P L Y M O U T H
N Carver
Carver
Middleboro
Manomet
Vallersville
CENTER HILL PT
Ellisville
Sagamore Beach
Scusset Beach State Res
Sagamore
CAPE COD CANAL
Sandwich
Bournedale
Buzzards Bay
Onset
Wareham
E Wareham
Rochester
Marion
Acushnet
Mattapoisett
Fairhaven
NEW BEDFORD
S Dartmouth
BUZZARDS
BAY
RIVER
Crescent Beach
ANGELICA PT
WEST ISLAND
ROUND HILL PT
Pocasset
Cataumet
N Falmouth
Silver Beach
Falmouth
Woods Hole
NOBSKA PT
LONG NECK
Davisville
DEAD NECK
Popponesset Beach
Mashpee
Cotuit
Osterville
Wianno
Hyannis
Hyannis Port
Yarmouth
S Yarmouth
Barnstable
W Barnstable
BARNSTABLE HARBOR
SANDY NECK
Dennis
Dennis Port
Harwich
Harwich Port
Chatham
Brewster
E Brewster
Roland C Nickerson State Forest
Rock Hbr
Eastham
N Eastham
BILLINGSGATE ISLAND
Wellfleet
WELLFLEET HARBOR
GREAT ISLAND
S Truro
Truro
N Truro
Provincetown
PROVINCETOWN HARBOR
LONG PT
WOOD END
RACE PT
CAPE COD
CAPE COD NATIONAL
A T L A N T I C
O C E A N
CAPE COD BAY
NANTUCKET
SOUND
MONOMOY ISLAND
MONOMOY PT
PT GAMMON
GREAT ISLAND
ELIZABETH
ISLANDS
NAUSHON ISLAND
NONAMESSET ISLAND
PASQUE ISLAND
NASHAWENA ISLAND
CUTTYHUNK ISLAND
PENIKESE ISLAND
VINEYARD SOUND
WEST CHOP
EAST CHOP
Oak Bluffs
Vineyard Haven
N Tisbury
W Tisbury
D U K E S
Edgartown
EDGARTOWN HARBOR
CAPE POGE
CHAPPAQUIDDICK ISLAND
KATAMA BAY
Chilmark
Gay Head
MENEMSHA POND
SQUIBNOCKET POND
TISBURY GREAT POND
EDGARTOWN GREAT POND
MARTHA'S VINEYARD
MUSKEGET CHANNEL
MUSKEGET ISLAND
TUCKERNUCK ISLAND
MADDEKET HARBOR
Nantucket
NANTUCKET
GREAT PT
PASSENGER FERRY (SUMMER ONLY)
WOODS HOLE - NANTUCKET
ND

AGA GEODOMETER MODEL 76

(d) Inlet Surveys (Virginia)

This party was working along the Atlantic coast, beginning near Charleston, N.C. and working northward. They were completing Rudee Inlet in Virginia Beach when I arrived and moved north to Chincoteague, Va., with future surveys planned for Ocean City, Md., and Cape May, N.J..

The sounding operation was carried out using a Mon-Ark launch powered by an inboard engine or a 17 foot Boston Whaler depending on the area; and Del Norte, used in the range/azimuth mode, provided the positioning. The fixes were called by the launch and plotted on line, in the launch, using an underlay similar to our Hydrodist underlay.

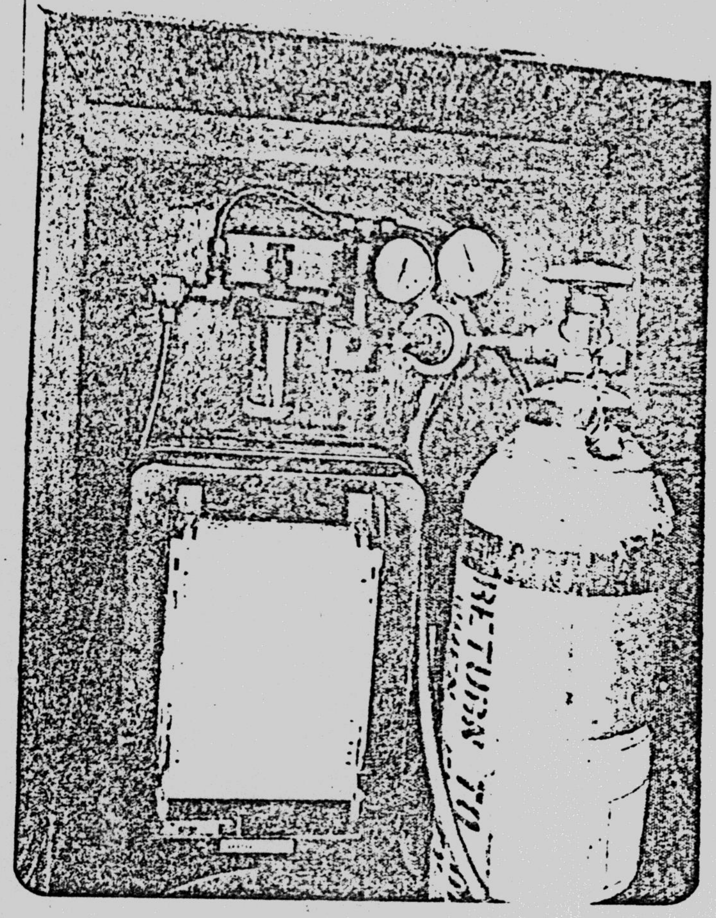
The sounding graphs were scaled manually and the depths recorded in a sounding volume, the graph then was checked for variations in the transmission line and finally predicted tides were used to reduce the soundings. All soundings were logged onto punch paper tape using a "Logger" connected to a teletype punch or by punching them out via the teletype. This was a very slow, tedious procedure, but necessary, since all sheets are computer plotted. The reduced soundings were hand-inked in the field also, to ensure adequate coverage of an area before the party moved.

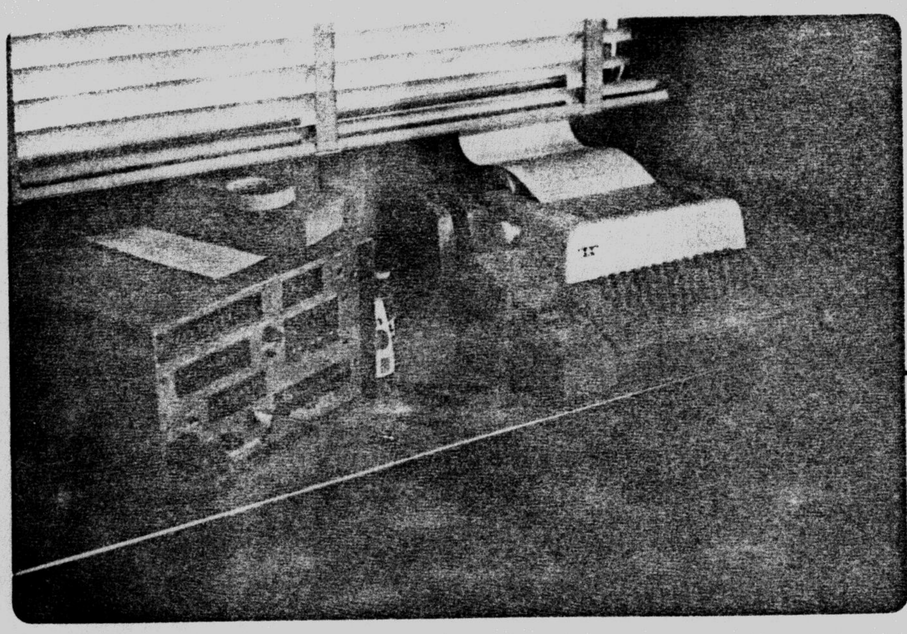
This party was establishing their own temporary tide gauges at sites specified in the project instructions. The gauges were "bubbler" types and were installed at least for the time period specified in the instructions.

BRISTOL

BUBBLER

TIDE GAUGE





LOGGER AND TELETYPE

(e) *High Speed Launch (Gulf of Mexico)*

This party was equipped with one steel 60 foot Equity launch, NOAA 1257, based in Turkey Point, Fla. and working on the Gulf of Mexico. The project was a continuation of an on-going survey of the inshore areas along the west coast of Florida, sounding out to a depth of 60 feet. The launch was equipped with the Hydroplot/Hydrolog system but used Raydist in the range/range mode for positioning. The other equipment was identical to that in Launch 1255, except a strip chart recorder was added to keep track of the Raydist lanes. Additional information on the Raydist system can be found in Appendix C.

Raydist is a medium range positioning system that uses the phase comparison of radio signals to determine the distance from the transmitters. Used in the range/range mode, the manufacturer quotes an accuracy of ±10 feet at 250 miles. In practice this range may be rather difficult to attain.

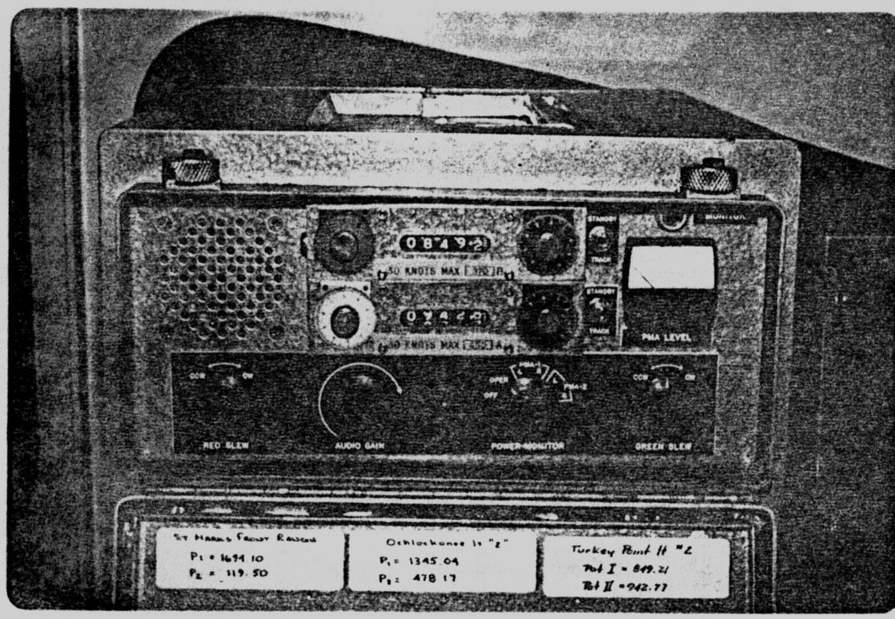
The Raydist was calibrated daily at a fixed light, by boxing the light - i.e., making passes on all four sides of it and using the Detached Position button on the Hydroplot/Hydrolog system to obtain a print out of the lane count. The full lane count was adjusted and the mean of the partial lane counts found. The differences between the means and the known position were entered in the computer via thumbwheel switches to be used on the sounding positions.

Bar checks were taken roughly once a week since the waters of the Gulf were found to be fairly stable with respect to salinity and temperature. This information was recorded and applied to the soundings later.

Sounding lines were run in a North-South direction and coordinates were used to identify the lines because they were easier to work with, but the sheets were controlled by Geographic Positions. The strip chart recorder was used to keep track of the Raydist lanes, making marks when each sounding was obtained. The chart was also manually marked with the lane count approximately every 10 lanes. A sample of the strip chart is included in Appendix D.

The processing operation was very similar to that on the Lake Erie survey with a few exceptions. The Raydist system eliminated the need to insert time and course type corrections and on this party the officers scaled the sounding graphs, and they were scaled only once. Another difference was a second processing unit in a trailer ashore. This enabled the party to plot the smooth sheets while the launch was out sounding, greatly speeding up the production of the finished product.

Tide gauges were installed in cooperation with the State of Florida Natural Resources people and local residents hired to observe the gauges. One of these gauges was installed on an open, sandy beach and I had an opportunity to participate in its installation. This ADR type gauge uses a 4 inch PVC pipe as a stilling well, and the pipe and supports (4" x 4") for the gauge were set in sand, approximately 150 feet offshore, in 6 feet of water. A diver uses a jet pump to force water down around the pipe and supports to loosen the sand, then the pipe or support is easily sunk into the sand which quickly settles to hold them firmly upright.



RAYDIST RECEIVER

(6) *Wire Drag Operation (Gulf of Mexico)*

This party was using two 90 foot vessels., the Rude and the Heck, and was based at Galveston, Texas. The project area was located approximately 40 miles off Freeport, Texas, in the vicinity of a proposed offshore tanker terminal, called SEADOCK. Raydist in the range/range mode was used for positioning. The two vessels function as a unit, with the Commanding Officer of the party in charge of the Rude and the Executive Officer in charge of the Heck.

The wire drag consists of 1/4 inch airplane cable in 100 foot lengths, with aluminum toggle bottles attached every 50 feet. At 600 foot intervals a weight and an intermediate buoy are attached. The uprights to the buoys are 7/16 inch cable and their lengths are adjusted by cranks on the buoys. Each end of the drag is marked by large "End Buoys".

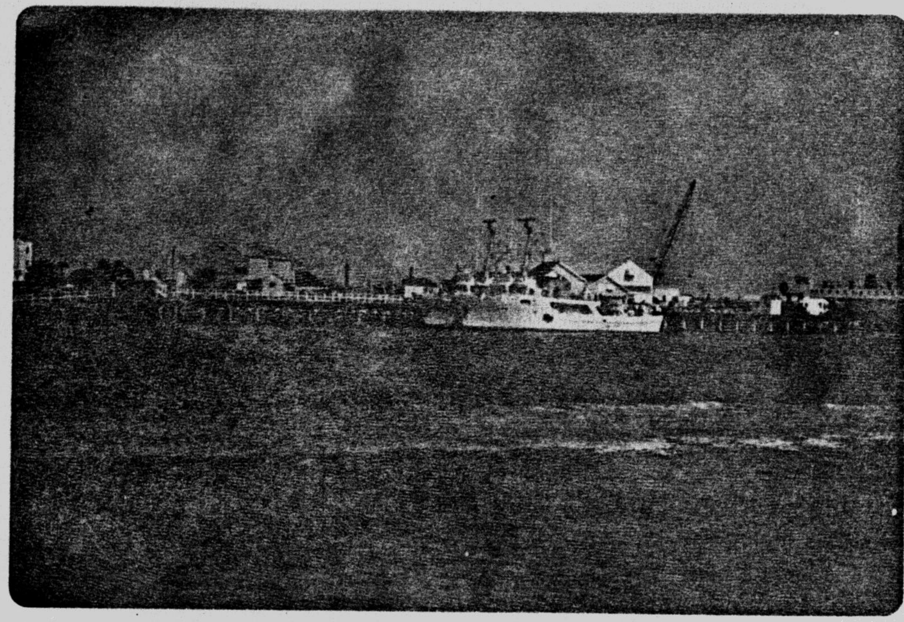
In practice, a circle having a radius of one mile is drawn on the boatboard, around the position of the reported obstruction, then overlapping drag passes are planned to cover the area. A few lines of sounding are normally run over the area to determine the depth setting of the drag. The vessels each carry half the wire drag, so it is set out from the center, near the perimeter of the search area. Once all the drag is out, the vessels maneuver until the end buoys are aligned with the proposed drag path. Because the main engines idle too fast for dragging, auxillary engines powered by the vessel's hydraulic system are used.

Raydist positions of the vessels were taken every five minutes as well as gyro bearings to the other vessel and the end buoy nearest each vessel. The Rude was the guide vessel (GV) and the Heck the end vessel (EV), so fix information from the end vessel was transmitted to the guide vessel where the positions of both vessels and both end buoys were plotted. The end vessel plots her fixes also. A telemetry system has been devised to transmit fix information between the vessels and have it printed out on a teletype and also to punch paper tape.

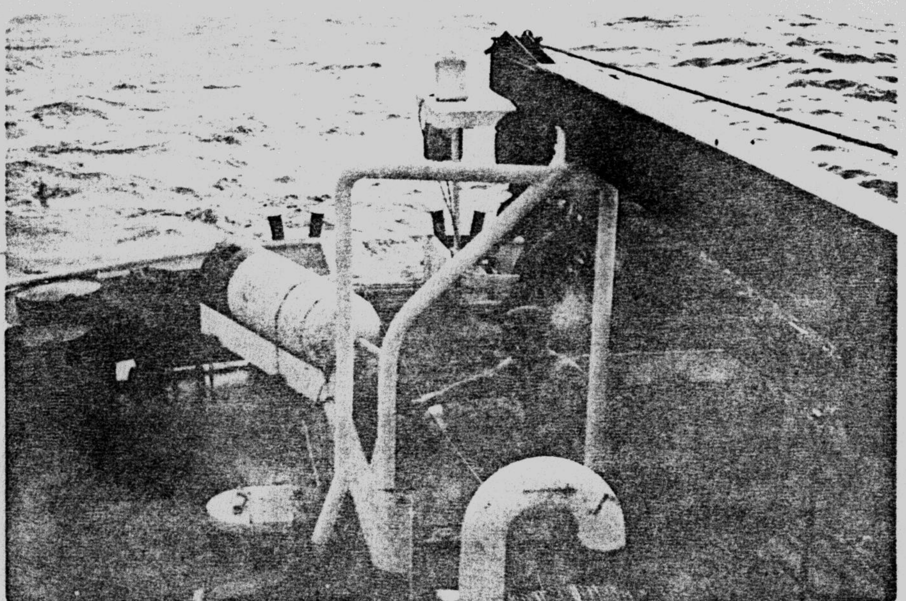
The actual depth of the drag was checked quite simply. Each vessel put a launch over to check the depth using a length of small diameter metal pipe attached to a small cable supported by a life-ring. A crank was attached to the life-ring and was used to adjust the depth. The pipe was smeared with white lead and tossed in just in front of the drag. When the drag passed over, it struck the pipe and knocked off the white lead from the actual depth of the wire down. The effective depth of the drag was checked section by section and the depths recorded. If the drag was more than 4 feet above the desired depth a "holiday" was created in that section of the drag and extended until the effective depth dropped within limits again. The dragging speed was around 1/2 knot, dragging at a depth of 120 feet.

When a snag occurs, the wire drag takes on a V shape that is easily noticeable, and the launches notify the vessels. Normally, a diver is sent down to investigate and obtain a least depth on the obstruction.

Weather and Raydist problems combined to give this party much grief. The Raydist was calibrated off Freeport using sextant fixes, then the vessels steamed the 40 miles to the working area and dropped a temporary buoy. This buoy was used for full lane checks each day but when the Raydist system lost lock, the vessels steamed the 4 hours back to Freeport to recalibrate. The strip chart recorder was useful if the lane loss all occurred at one time, as the loss could be scaled from the graph. However, if it was the result of several lane jumps all the work previously accomplished had to be scrapped. In an area of frequent thunderstorms this becomes a very serious hinderance.



RUDE AND HECK



SETTING OUT THE DRAG

(g) NOAA Ship MT. MITCHELL (Lake Huron)

The NOAA ship, Mt. Mitchell, using St. Ignace, Missouri as a home port, was engaged in sounding operations on the western end of Lake Huron using Hydrotrac for positioning. The ship is 231 feet long and carries two 28 foot Jenson Aluminum launches and two 26 foot "Plastic Pigs".

This project covered the American portion of northern Lake Huron and was being covered at various scales depending on the water depth. This was accomplished as follows:

Greater than 180'	. . . . 800 m. spacing	1:50,000
120' to 180'	. . . . 400 m. spacing	1:50,000
Less than 120'	. . . . 200 m. spacing	1:20,000

The inshore areas will be sounded by launches using either Del Norte or Hydrotrac in the hyperbolic mode.

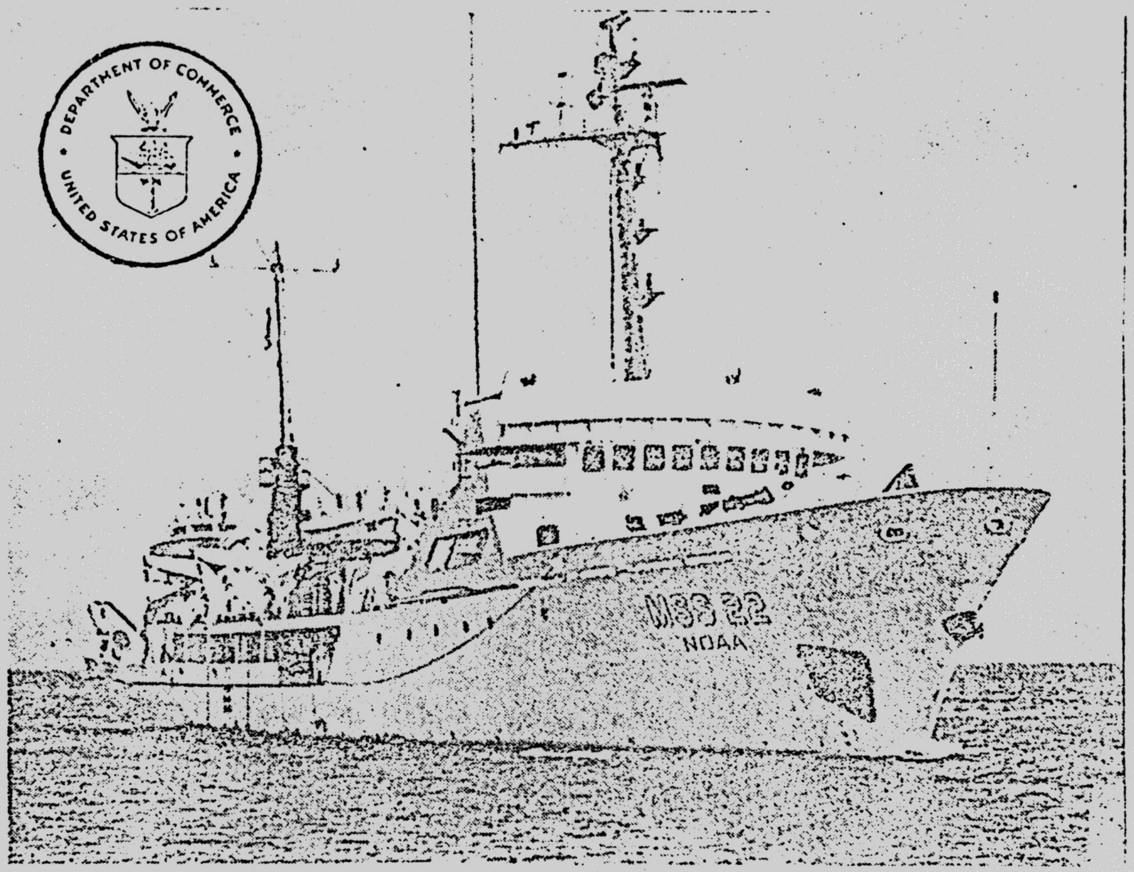
The ship was equipped with the Hydroplot/Hydrolog system combined with the Hydrotrac positioning system and a Ross Model 5000 echo sounder. A strip chart recorder was used with the Hydrotrac positioning system. The sounding operation was carried out on a 24 hour basis and some stability problems were encountered with the Hydrotrac system at night. This was attributed to atmospheric interference and the propagation of the ground wave over fresh water reducing the operating range of the system. The ship was sometimes forced to run only half lines at night.

The Hydrotrac system used in the range/range mode is limited to a single user but in the hyperbolic mode it is a multiple user system. The Hydrotrac system was calibrated over a wide area using Del Norte, which in turn was calibrated by sextant fixes. The system was fairly stable and rarely shifted more than .1 or .2 lanes. The mean of the readings in an area can be entered via thumbwheel switches. The Hydrotrac positioning system used

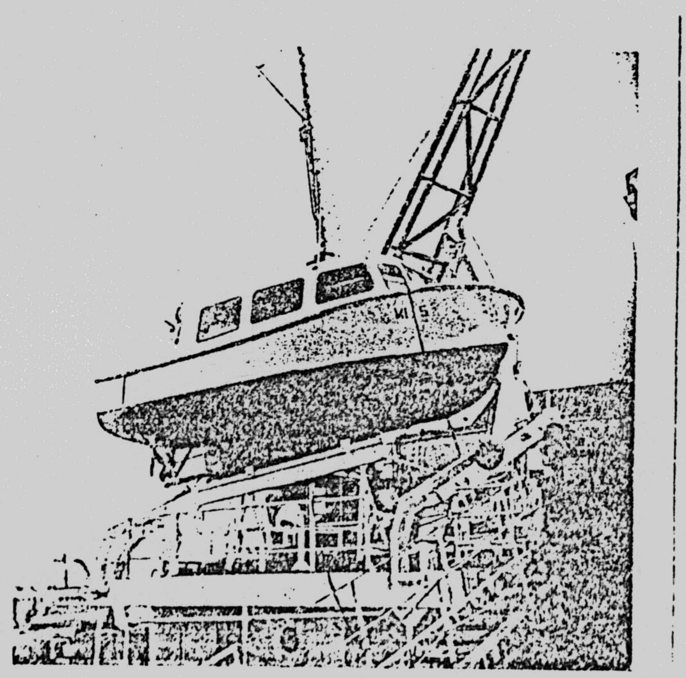
100 foot TV type towers with insulated bases for shore stations. See Appendix E for more Hydrotrac information.

There was some concern about sounding velocity correctors and some pains were taken to ensure that there was an abundance of data with respect to temperature and depth. Nansen bottle casts and/or BT's were required once a month but were taken more frequently. Salinity and conductivity tests were made originally but their affect was neglible so they were discontinued. However, the temperature was found to be so irregular that Nansen bottle casts using only the thermometers were made more often as well as expendable BT's. The BT's were launched from a tube at the stern of the ship and a trace of the temperature versus depths was recorded on a graph in the Oceanographic Lab. The results from the Nansen bottle cast and the XBT's were compared and the velocity correctors computed and applied to the sounding when the smooth sheet was plotted.

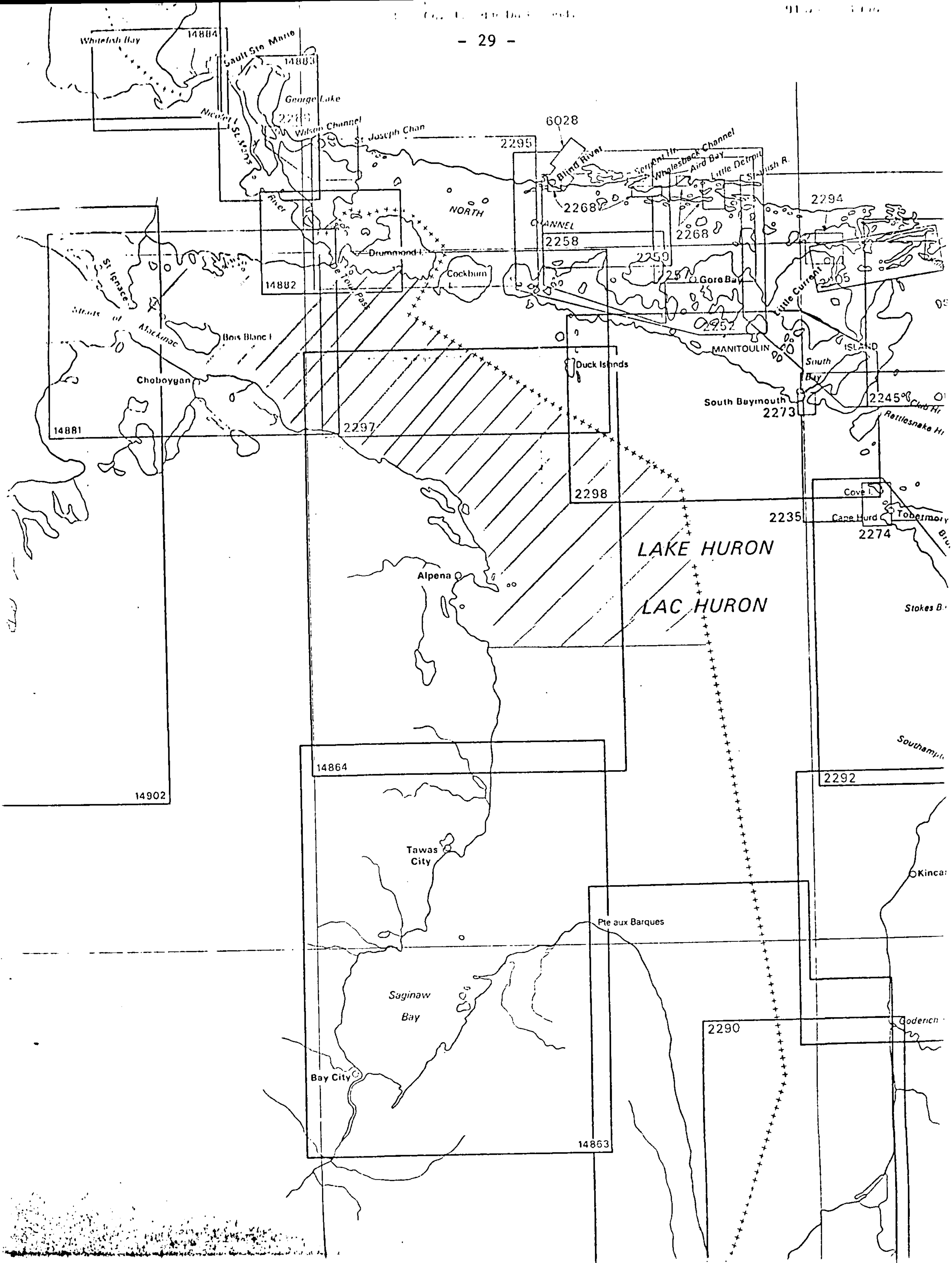
The ship operates as a separate unit, independent of the Hydrographic Field Parties Office, and submit their completed projects directly to the Electronic Data Processing Division in Norfolk, Virginia. On this particular project, no water level corrections were applied in the field but temporary tide gauges were established at Alpena and Presque Isle, Missouri, to suplement the information from the permenent gauges at Harrisville and Mackinaw City, Missouri.



MOUNT MITCHELL



PLASTIC "PIG"


Whitefish Bay
14884
Sault Ste Marie
14883
George Lake
Wilson Channel
St Joseph Chan
Nicolet L
6028
2295
Blind River
Serpent R
Whalesback Channel
Aird Bay
Little Detroit
Spanish R.
2268
2268
2294
NORTH
CHANNEL
2258
2259
2257
Gore Bay
2205
Little Current
Drummond I.
Cockburn I.
14882
St Ignace
Straits of Mackinac
Bois Blanc I
Cheboygan
14881
2252
MANITOULIN
ISLAND
South Bay
South Baymouth
2273
2245
Club Hr
Rattlesnake Hr
Duck Islands
2297
2298
Cove I.
Cape Hurd
Tobermory
2235
2274
LAKE HURON
LAC HURON
Stokes B
Alpena
14864
14902
Southampton
2292
Tawas City
Kincardine
Pte aux Barques
Saginaw Bay
2290
Goderich
Bay City
14863

AMC (FINAL PROCESSING AND VERIFICATION)

Field data, which includes all tapes, smooth sheets, etc., and a descriptive report, is submitted to AMC vis two routes. The Hydrographic Field Parties submit their data through the Hydrographic Field Parties Office where manually collected data is plotted and prepared for final processing. This data is then forwarded to the Electronic Data Processing (EDP) Division. The ships submit their data directly to EDP. The punch paper tapes are kept by EDP and copied onto disc using an IBM 1120 computer, while all the other data is passed on to the Verification Branch. These two divisions work together on the preparation of the final field sheet.

EDP generates an electronic control overlay using a PDP 8 computer connected to a flatbed plotter. This sheet shows all the control stations and the lattices for the particular positioning system used. This is passed on to Verification where the control and their positions are checked. Verification then requests a position plot from EDP. This is a plot of fixes, joined by straight lines. The shoreline can be drawn onto the position plot, then its fit is checked and multiple dividers are used to check the spacing between each fix. Problems with spacing are corrected by time and course (T&C) from the last good fix and the changes noted in the computer printout that accompanied the sheet from EDP. A keypunch operator then makes the necessary changes.

Verification then asks EDP for a plot of the soundings and an excess plot (overplotted soundings) of the sheet. These soundings are now reduced for real tides, the real values of which have been supplied by the Tidal Branch in Rockville. EDP now makes two additional copies of the data, one to store this original "good" data and the second to work with. The shoreline is usually added to this sounding plot and the sounding graphs scanned for scaling errors. The sheet is contoured, which usually detects positional errors, especially when checking the fit of the checklines.

The computer printout of the sounding plot is used to remove or add soundings that are on the excess sheet. When these changes are punched up Verification has an opportunity to change such things about the plot as the origin if necessary. A revised plot may be requested from EDP. EDP now plots the distortion points (a measured meter horizontally and 1/2 meter vertically) on the sheet and the block showing sheet number, etc. A new smooth sheet, excess overlay, position overlay and computer printout are returned to Verification.

The shoreline is added to this final smooth sheet and if problems with the fit appear, both the sounding positions and the photoplots are checked. Additional information such as bottoms, buoys, contours and station names are now added to the sheet and the sheet, together with a critique are forwarded to the Chief of Verifications Branch, who spends 8 or 10 hours checking the sheet over. After the changes he recommends have been made, the sheet and critique go on to an advisor who spends a day or two checking the sheet over and adding his recommendations to the critique. The sheet is then inspected by the Hydrographic Inspection Team (HIT), a body of 6 or 8 senior people. The HIT team checks the sheet and rewrites the report, and returns the sheet to Verification for the changes they recommended. The corrected sheet and the report are then passed on to the Admiral in charge of AMC, who signs the sheet and forwards the data to NOS in Rockville, Maryland. A collection of some of the check forms used by Verification is included in Appendix F.

NOS (FINAL VERIFICATION AND COMPILATION)

The smooth sheet, report and other data are reviewed by the Deputy Chief of Marine Surveys to see if the sheet is acceptable. If it isn't, the data is returned to the Verification Branch in Norfolk to be changed. If it is acceptable, it is passed on to Quality Control, where the sheet is checked against any additional information available with respect to the area, as well as the data used in its compilation. A critique is prepared and the sheet is passed on to the Requirements Branch where the sheet is checked for compliance with the project instructions. Another critique is prepared by the Requirements Branch.

The sheet is again checked over by the Deputy Chief of Marine Surveys, then the Chief of Marine Surveys signs the Quality Control critique and the Associate Director, Office of Marine Surveys and Mapping signs the Requirements Branch critique. The smooth sheet is then passed on to the Chief of Nautical Data Section where all applicable data is added to a chart standard.

The Compilation Branch reduces the sheet to chart scale and selects the soundings that will be included on the new edition of the chart. Some interesting advances have been made towards their goal of producing a totally automated chart.

OBSERVATIONS - GENERAL

1. All soundings were in feet.

2. The survey parties do not normally carry an electronic technician as we do, but use a survey technician who has been given a short, inhouse course in electronics. The Mr. Mitchell does carry an electronic technician.

3. Accurate calibration of electronic positioning systems using sextant fixes can be rather difficult unless the launch is a fair distance away from the stations used.

4. The Houston Instruments Complot Plotter tries to plot erroneous positions obtained from Del Norte when operating in areas of interference, and the Hydroplot/Hydrolog system cannot always store all the soundings collected while the plotter makes its journey, thus gaps occur.

5. Bar checks were taken at various time intervals and the results tabulated on a form showing bar depth, sounder depth and digitized depth. The sounders were not adjusted for vessel draft or to read the true depth with respect to the bar checks. These corrections were applied during the processing operation.

6. The automated survey system, Hydroplot/Hydrolog, was not a totally automated system. Only the plotted depths were recorded, thus the sounding graphs were manually scaled to find the shallows and deeps and the digitized depths were also checked one by one. A corrector tape was manually punched out to include these corrections.

7. The project instructions were very detailed, with specific instructions on how to investigate reported shoals included in the pre-survey review. The instructions also spell out the locations of temporary tide gauges and how long they must be installed, leaving very little up to the party. The NOS headquarters in Rockville is contacted about any necessary

changes and there lies the final decision.

8. The party chiefs were usually officers and all the civilian personnel were hired as survey technicians. This enables the most efficient use of the crew, but prevented anyone from becoming specialized in any one facet of the operation. A normal launch crew consisted of three people, alternating between the wheel and watching the survey equipment. The ships had a regular crew, separate from the survey technicians.

9. NOS used different line spacing criteria for sounding.

   200 m. spacing at 1:20,000 scale
   100 m. spacing at 1:10,000 scale
   50 m. spacing at 1:5,000 scale

10. The verification procedure is very slow and meticulous. Corrections are made by the verification office staff and sheets are not returned to the party or ship that submitted them unless they are incomplete or must be redone. By the time a sheet is returned to the party or ship, it is usually staffed by a different crew, since assignments are usually for a two year period. Great pains are taken to ensure an accurate depth but positions are altered by time and course corrections, often by the office staff. If no course changes are noted in the field data, an erroneous position is assumed and the "good" fixes joined by a straight line.

11. AMC field operations continue on a 12 month basis, with field personnel rarely at their headquarters for more than a few days at a time.

12. The field parties are small operations, usually consisting of one or two launches, each commanded by a NOAA officer. All financing and technical support are supplied by AMC, thus reducing the administrative type work required of the party chief. This could also become a hinderance if the party was operating in an area that was not near a major city and airport, because replacement parts and technical support are

slow in reaching the party.

13. Officers are assigned to projects on a two year basis, thus there is often a problem of lack of Hydrographic experience, since NOAA covers many fields and officers can be assigned to many of these diverse fields.

14. I was impressed with the laser distance measuring equipment. Both the Ranger and AGA Geodometer can be operated very efficiently over rather short distances, because no remote operator is required and prism banks can be set up over several stations and left unattended. They are particularly useful in positioning such things as lights and towers because the prisms can be hand held.

15. The Raydist positioning system worked well except in electrical storms, when, like Mini-Fix, it lost lock. The system was fairly steady at night and can have multiple users in the range/range mode. A range of 100 miles was easily attained off the coast of Florida using 100 foot towers. However, the technicians find it a problem to work on, since the manufacturers coated all circuit cards with a black epoxy.

16. The Hydrotrac positioning system appeared to work quite well, although its range was greatly reduced due to the propagation of the ground wave over fresh water. At night it remained stable to a range of at least 40 miles. In the range/range mode this system can accommodate only a single user.

17. The Chart Compilation Branch in Rockville, Maryland are working on the production of a chart by totally automated means. They have acquired a laser plotter that can plot a complete chart in 50 minutes and are making advances in computer selection of soundings and digitizing contours.

CONCLUSIONS AND RECOMMENDATIONS

The overall purpose of both the NOS and CHS is basically the same, the production of a chart that is the most accurate, current, and complete possible.

There are minor differences in the collection and processing of the field data, especially with the automated systems. This involves the selection of soundings by the Hydroplot/Hydrolog system where soundings are selected on a time basis only, with no depth criteria involved as is the case with HAAPS and INDAPS. The manual scaling of the sounding graphs is a tedious task and emphasizes a lack of total confidence in the "automated system". However, the NOS is much more depth conscious than the CHS, and noting the tendency of the average American to file lawsuits for damages, it may be necessary. In this area, after observing the care taken with depths, one begins to wonder if we, in the CHS do not trust the "automated systems" too implicitly.

The question of whether it is better to collect as much data as possible and then select useable data or to select only the amount of data that can be handled and then including any additonal data that is required arises. The availability of additional data collected during the survey would make the verification procedure a much simpler matter when positional problems arise. The running of irregular lines have become more common since the automated systems came into use, and without proper documentation these lines are extremely difficult to follow.

I would like to thank L. Cdr. D. Yeager for drawing up an itinerary and being very accommodating when other projects were included. I would also like to thank the personnel of the various parties I visited for making this summer a very interesting and enjoyable experience.

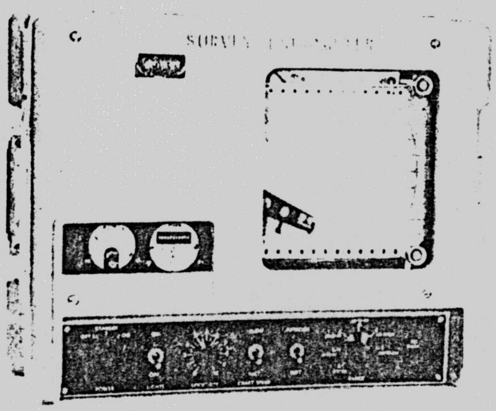
APPENDIX A

Portable Precision

FATHOMETER™ DEPTH RECORDER

with Digital Readout

Model DE-723D



Model DE-723D Recorder (Face View)

Raytheon Digital Display Unit

GENERAL DESCRIPTION

The DE-723D portable Fathometer® recording and digital echo sounder provides permanent analog recording plus digital output for interface with external equipment. By interconnection with position finding equipment and a suitable digital recorder, both depth and position can be provided in permanent digital form.

Frequency of acoustic transmission is 90KHz for optimum signal to noise ratio plus a narrow transducer beam pattern.

Four bit parallel 1-2-4-8 BCD code output from logic circuitry is provided. Additionally, a four digit segmented display is furnished for monitoring the digital information. This monitor presents a large brilliant display for easy viewing in daylight from any convenient viewing angle.

Signal processing and a bottom gate are employed to prevent echoes from fish, debris or other interfering off the bottom objects from registering on the digital unit. In case of conflict, the digital reading is zero.

The DE-723D may be used with any of three different transducers. This permits either temporary installation, using an over-the-side streamlined fish mount, permanent launch type mount or pierced steel hull mount. Only one transducer is required.

The DE-723D is powered by a 12 or 24 volt storage battery (not supplied). It may be powered from a 118v 60 Hz power source with system accuracy dependent on the frequency stability of the 60 Hz power supply.

This depth sounder is splash-proof and can be used portably or mounted permanently. For portability, it is divided into a recorder unit, digital monitor, electronic unit, and transducer. All units have prefabricated cables and quick disconnect plugs.

The recorder unit and digital monitor contain all operating controls. A "fixline" may be be drawn on the chart paper electrically. A sliding window with protective guard permits notations to be made on the chart paper next to the rotating stylus.

The electronic unit contains the logic circuits, transmitter, receiver, power supplies, and the solid state power inverter. The 60 Hz inverter output is stabilized to drive the recorder mechanism at its stated accuracy. A tuned reed frequency meter indicates the frequency of the 60 Hz source.

FEATURES

- Circular arm recording mechanism for high keying rate and uniform stylus movement-free from mechanical failure.
- Uniform magnetic keying for each phase – ease and permanency of zero adjustment.
- Continuous feed type stylus of indefinitely long life.
- High accuracy ±.25% (±3") feet from 1 – 100 feet, .25% of indicated depth above 100 feet.
- High transmitter output and high gain receiver for maximum depth capability.
- Cast aluminum housings, all controls in recessed openings for maximum protection and handling ease.
- Quick disconnect cables and connectors.
- Operates from 12V DC, 24V DC or 118V 60 Hz AC for temporary or permanent installation. Operates from either 12 or 24V DC by an internal plug reversal.
- Under transducer, minimum depth measurement of 1 foot or less.
- Stylus guard allows pencil notations on chart paper right next to rotating stylus.
- Fast and slow (1" and 2" per minute) synchronous chart drive.
- Overlapping phases on chart paper.

PHYSICAL SPECIFICATIONS – RECORDER UNIT: Model 723-40

Height	15"
Width	18-7/8"
Depth	8-7/8"
Weight	55 lbs
Mounting	Portable or bulkhead
Depth Range	One foot to 240 fathoms
Chart Ranges	Phase A 1 – 50 (feet or fathoms)
	Phase B 40 – 90 (feet or fathoms)
	Phase C 80 – 130 (feet or fathoms)
	Phase D 120 – 170 (feet or fathoms)
	*Phase E 160 – 210 (feet or fathoms)
	*Phase F 200 – 240 (feet or fathoms)
Chart Advance	Fast: 2 inches per minute
	Slow: 1 inch per minute
Chart Length	60 feet per roll
Chart Width	7 inches, calibrated over 6¼ inches

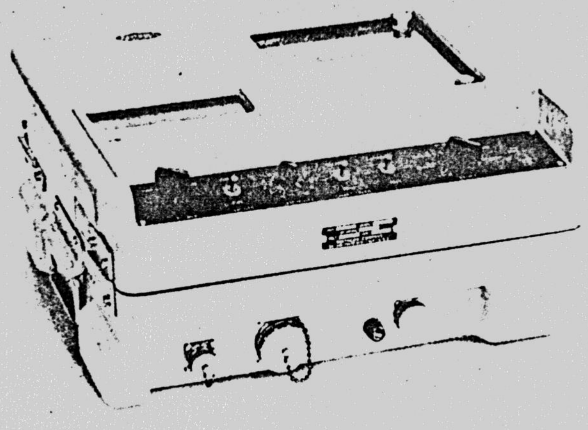
**Chart paper not calibrated for these ranges; use interpolation.*

ENVIRONMENTAL SPECIFICATIONS

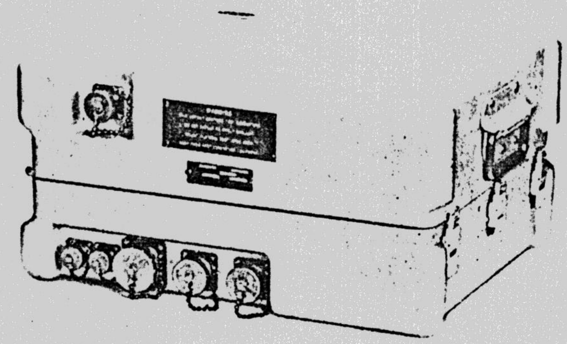
Temperature & Humidity: −10° C to +50° C at 95% relative humidity
Enclosure: Splashproof and corrosion resistant
Application: Equipment operation not affected by shock, vibration, pitch and roll of normal shipboard installation

ELECTRONIC CABINET UNIT – Model 723-42

Height	15-5/16" Bosses 1/8"
Width	19"
Depth	9¾"
Weight	77 lbs
Mounting	Portable or bulkhead

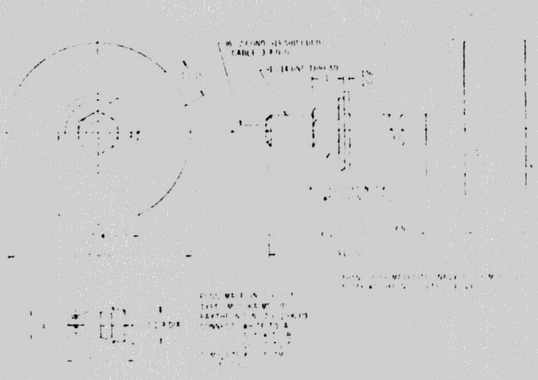


Model DE-723D Recorder (Edge View)

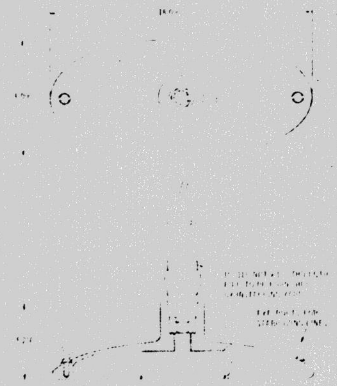


Model DE-723D Electronic Unit

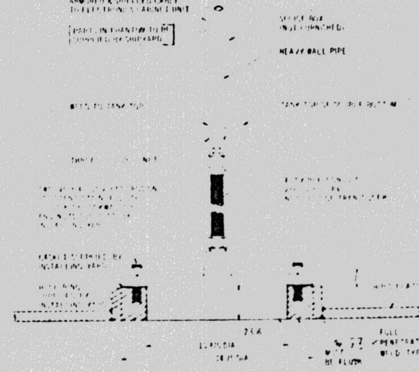
Raytheon Digital Display Unit



723-47 Transducer



723-48 Transducer



723-53 Transducer

ELECTRICAL SPECIFICATIONS

Primary Voltage	AC Operation Nominal 118 ±8 volts; Maximum 136 volts for 2 hours. DC Operation 12 volts nominal ± 1.8 volts and 24 volts nominal ± 3.6 volts, 12 or 24 V operation by reversal of a plug-in unit.
Power Drain	118 volt 60 Hz operation: 100 VA 12 volt DC operation: 11 amperes 24 volt DC operation: 5.5 amperes
Operating Frequency	90 kHz
Transmitted Pulse Length	50 microseconds (damped)
Sounding Rate	Foot Ranges: 10 per second Fathom Ranges: 1-2/3 per second
Accuracy*	1 to 100 feet: ± 0.25 foot on Recorder, ± 0.25% digital 100 feet to 240 fathoms, ± 0.25% of indicated depth **Based on a speed of sound in water of 4800 feet per second, and a line frequency of exactly 60 Hz when operating on external 60 Hz line.*
Phase Position Shift Error	± 0.1 feet on recorder, zero on digital output
Digital Logic Output	Foot Ranges: Four bits, 0 – 240 feet in 0.1 foot increments Fathom Ranges: Four bits, 0 – 240 fathoms in 0.1 fathom increments Four bytes (16 Lead Parallel 1-2-4-8 BCD Code) Logic Code: Four bit Parallel 1-2-4-8 BCD Code Logical 0 = 0.4 V maximum Logical 1 = 4.5 minimum 5 V nominal Output Impedance: 200 ohms External Input: 2 volt or better interrogation pulse. Internal storage updated each transmission except in Hz of interrogation pulse.

DIGITAL MONITORING MODULE: Model 723-41

Height	6¾"
Width	9½"
Depth	6"
Weight	13 lbs
Display	Four digit segmented display reading to 0.1 feet or fathoms. Internal adjustment for display updating time.

SIGNAL PROCESSING FEATURES

1. Time varied gain control
2. Amplitude gate
3. Completely automatic bottom echo tracking gate
4. Digital output prints zero on loss of bottom echo

TRANSDUCERS	Large Ship Skin Mounting Type (723-53) Launch or Small Boat Mount Transducer (723-47) Overside "Fish" Mount Transducer (723-48)

CABLES SUPPLIED

Unit	Description
1	118 V 60 Hz AC power cord
1	DC power cord
1	12 foot prefabricated cable recorder to electronic unit
1	20 foot cable electronic unit to Remote Output, plug attached at ECU end
1	12 foot cable ECU to digital monitoring display, plug attached at ECU end

APPENDIX B

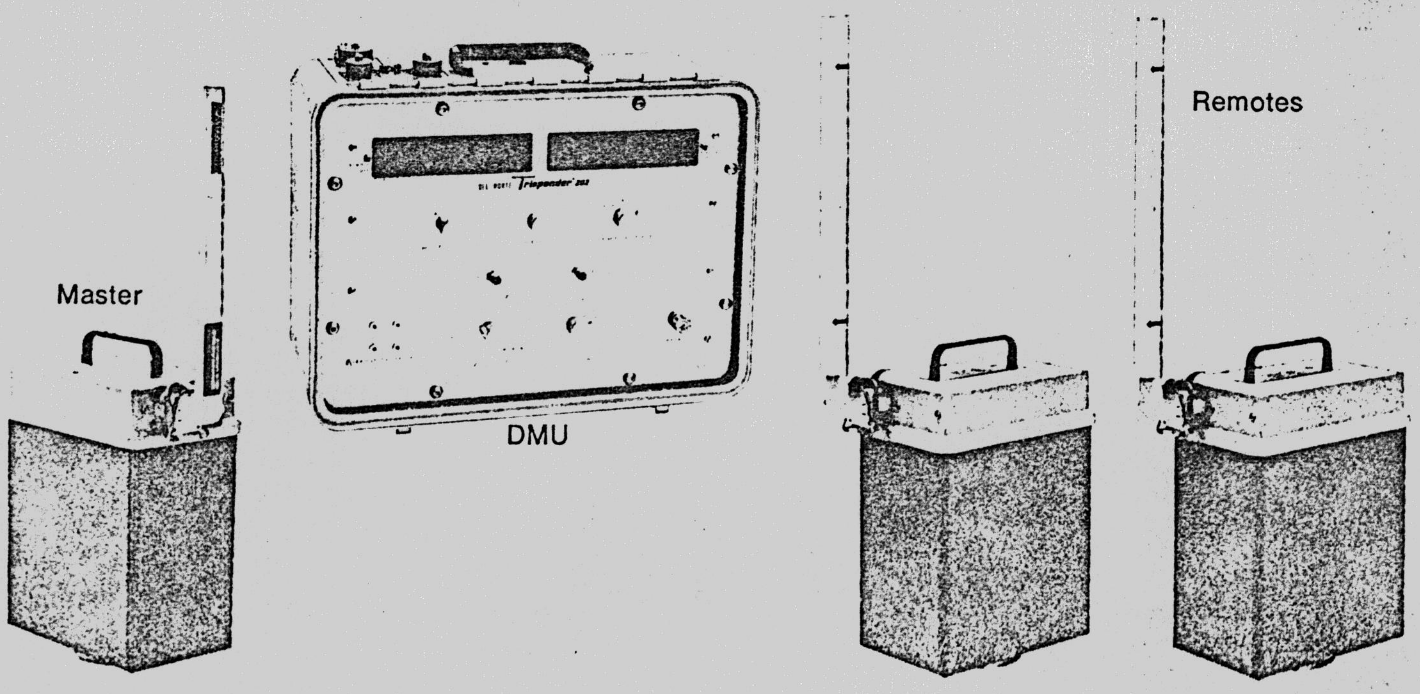
DEL NORTE

Trisponder®

with dual & multichannel control
for accurate positioning of air, sea, and land vehicles

- 80 km range
- 0.5 meter resolution
- ±3 meter accuracy
- battery operation
- field maintainability
- rugged waterproof construction
- measurements in feet or meters
- simple, automatic operation
- immunity to interference
- 10/100 sum digital averaging

Using advanced microwave and digital techniques, the Trisponder provides accurate line-of-sight distance information from a Master to two or more Remote stations. Distance is obtained by measuring the round-trip travel time of signals transmitted between the Master and Remote. Then, 10 or 100 path lengths selected by digital filtering are averaged to determine each distance displayed. Ranges are obtained in a matter of milliseconds, thus providing an accurate track of boats, trucks, helicopters, aircraft, and other moving vehicles. Optional accessories may be added to provide a wide range of sophisticated features.



System Configuration

Del Norte's Trisponder is an electronic positioning system which provides accurate line-of-sight distance information from a master station to one or more remote stations. This is done by measuring the round-trip time of RF signals transmitted between the two stations. Each distance displayed is an average of 10 or 100 measurements selected by digital filtering, which reduces statistical error and increases system accuracy and stability. Each measurement requires only about 1ms, and the indicated average is updated once per second. Signals to and from each station are coded, and thus provide a means of station selection and outside signal rejection. The remote stations are set up at known (shore) locations, and the master is placed (on a boat) where it will have an unobstructed view to the remotes. Range data is observed at the Distance Measuring Unit and may be reduced to x-y position by trilateration.

A standard Trisponder system consists of:

1. A Distance Measuring Unit
2. A Master Transmitter/Receiver and Omni Antenna
3. Two Remote Transmitter/Receivers and Directional Antennas
4. All power and interconnecting cables
5. 2 sets of instruction and maintenance manuals.

Distance Measuring Unit

The DMU controls all Trisponder functions, and contains all operational controls and data readouts. The DMU is waterproof and floats with cover on and air vent closed, and is splashproof with cover removed. The DMU provides signals to the Master Station for transmission to Remote Stations. Signals from Remotes are in turn received by the Master and returned to the DMU to determine distance. Two separate displays indicate distance directly in meters or feet. These data are also available at an external connector for use with accessory equipment such as printers.

Master Station

The Master interrogates all Remote units upon command from the DMU. It is supplied with power and control through a 50 foot cable connected to the DMU. The transmitter/receiver and printed circuit cards are contained in a waterproof case. The Master normally uses an omnidirectional antenna. The entire device can be mounted on an American or European surveyor's tripod or on a length of 1″ pipe with coupling.. For shipping purposes, one of the cover retaining screws is left loose so air pressure may equalize. During operation, all screws should be tightened to render the unit waterproof. In this condition, the Master will float.

Remote Station

The Remote contains a transmitter/receiver which responds upon coded command from the Master Station. It is supplied with power through a 25 foot cable normally connected to batteries. Case configuration and mounting are the same as for the Master. Remote Stations may use either a directional or omnidirectional antenna.

Transponder Interchangeability

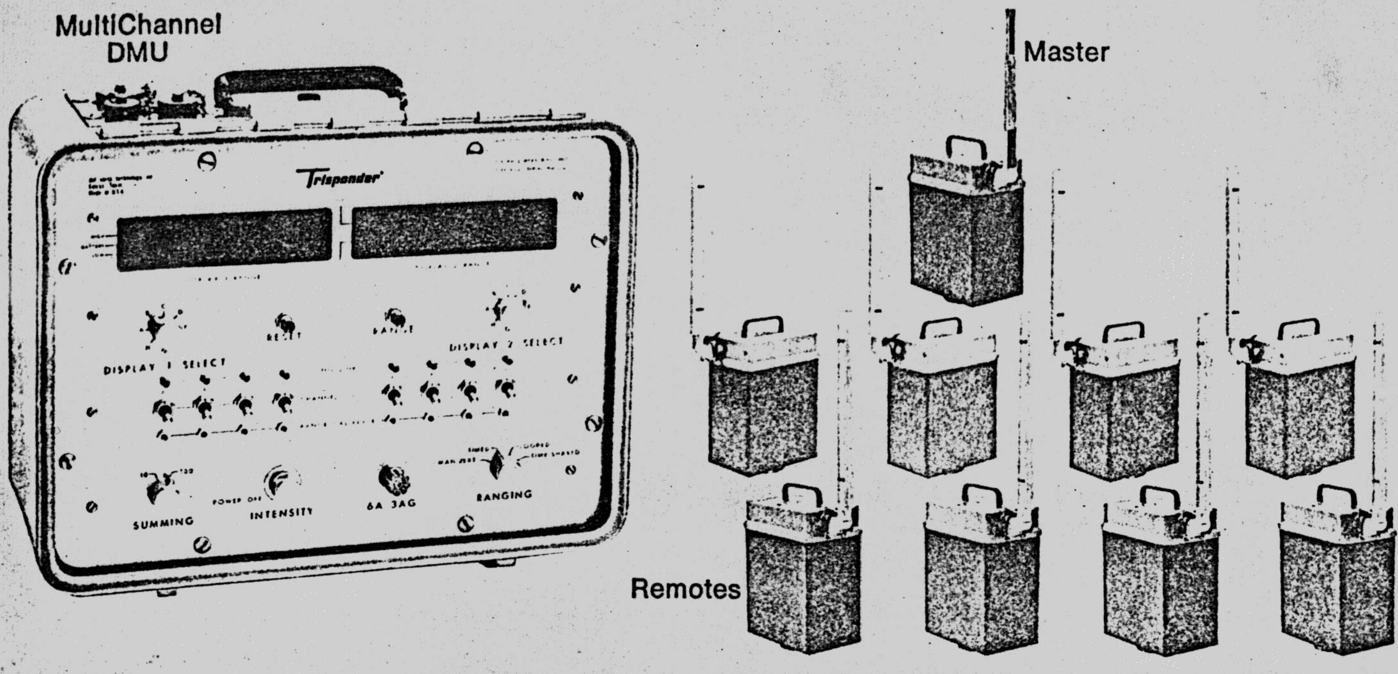
Master and Remote transponders are identical except for transmit and receive frequencies. Since a transponder will operate either as a Master or as a Remote, only one additional station, a Master, is required for complete transponder back-up.

Power Requirements

Power normally is obtained from two automotive batteries connected to provide 24 vdc. Supply voltage may vary over a range of 23 to 32 vdc, but must have a 4a capacity to supply the peak current required during pulse transmission. The standard power and signal cables may be coiled or shortened for a neater installation. Longer cables are available from the factory when required.

Maintenance

The Trisponder is designed so that performance can be checked in the field. If trouble is encountered, the unit or module at fault can be isolated quickly and replaced from recommended spare parts. All major units and component assemblies can be replaced in the field without the need to return the system to the factory for recalibration and adjustment.



Multi Channel DMU for two and three dimensional positioning

- Obtains up to 8 ranges
- BCD output of all ranges
- Displays any two ranges
- Looped or 1 second update

This MultiChannel Distance Measuring Unit extends the capabilities of the basic Trisponder and provides a greater flexibility in positioning air, sea, and land craft. Ranges to 8 Remotes instead of 2 are obtained within the 1-second update period. All 8 ranges are available at the BCD output for recording, while any two may be read on the numerical displays. The MultiChannel Trisponder system is more usually applied in a dynamic situation with the multiple range data being fed to a calculator or data acquisition system.

Operation of the MultiChannel DMU is similar to the basic Trisponder; however, 8 toggle switches select the remotes to be interrogated. Two additional switches select the ranges to be displayed.

Two-dimensional position location accuracy can be significantly improved using the MultiChannel system. For example, 3 Remotes can be deployed and the resulting x-y position will be the average of 3 triangles, instead of the usual 1. Or, if line-of-sight to one of the Remotes should be temporarily lost due to an obstruction, position location can be maintained using the other two. An on-board calculator can do this automatically, or choose the best ranges for reduction to x-y coordinates.

For the x-y-z positioning of an aircraft, up to 8 ground transponders can be placed along the flight path. The 3 (or more) ranges providing the best geometry would be processed for position location. As progress is made along the flight path, subsequent remotes are picked up and initial ones dropped off automatically, thus maintaining favorable geometry and improving the position location accuracy.

TRISPONDER OPTIONS

Time Sharing Adapter

The Time Sharing Adapter (TSA) is a factory installed option to a Distance Measuring Unit so that more than one DMU/Master (Base) can operate in the same RF area. Up to four Bases will time-share in 10 sum using either the same or different remote stations. Additional systems or 100 sum are accommodated by increasing the update interval; e.g., a two-second update is required to time-share three bases in 100 sum.

Serial Output

A serial ASCII data output from the DMU is available as a factory-installed option.

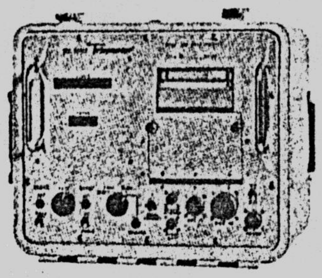
Signal Strength Indicator

A numerical signal strength indicator (0-9) is available as a factory-installed option.

ACCESSORIES

Model 220 Clock/Printer

Provides a permanent record of range, time, event, and auxiliary data. Built-in clock reads in hours, minutes, and seconds. Print-out is on demand, or 10 sec., 1 min., or 10 min. intervals.



24vdc, 3a

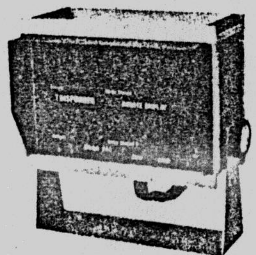
Model 231 Arc Steering Indicator

Displays deviation from a preset range arc or radius set on the thumbwheel switches. Deviation is indicated on the meter, and a Left/Right switch reverses the sense.

24vdc, 1a

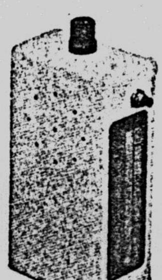
Model 244 Remote Display

Provides a duplication of the range-range data at distances up to 25 feet from the DMU. Supplied with a bracket for bench, bulkhead, or overhead mounting, the Display can be easily adjusted for best viewing angle.

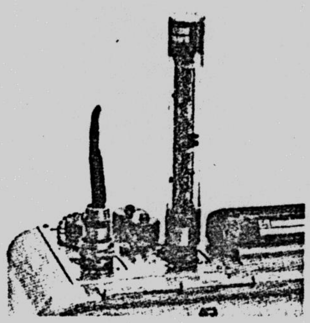


24vdc, 1a

RF Detector

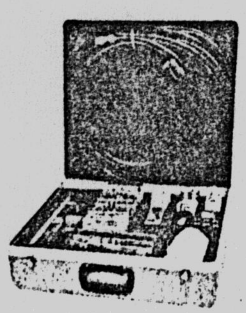


Field Link Simulator



System Spares Kit

Contains a set of replaceable plug-in cards for the DMU, Master, and Remote Transponders. Supplied in a fiberglas case, the kit also includes cable connectors, a power/signal cable, power supply, digital indicator, pilot lamp, fuses, and assorted hardware.



PLOTTING SYSTEMS

Autocarta is a real time positioning, recording, and charting system for hydrographic survey operations. Providing on-board preplot, data acquisition, reduction, and postplot capability, Autocarta includes input interfacing, data terminal, computer, plotter, and left/right indicator.

A ruggedized Track Plotter is available for use on dredges, small boats, aircraft, etc., where portability, battery operation, and weatherproof construction are required. This plotter can be positioned within view of the helmsman, and thus can be used for left/right steering.

TRISPONDER SPECIFICATIONS

Range:	80 Km (50 miles) line-of-sight
Accuracy:	±3 meters (±10 feet)
Resolution:	0.5 meter (1 foot)

Distance Measuring Unit

Display:	two ranges simultaneously
Units:	meters or feet, 6 digits
Output:	BCD, TTL compatible
Voltage:	23-32 vdc
Current:	2a
Size:	40 x 30 x 22cm (16 x 12 x 8½ in)
Weight:	11 Kg (25 pounds)
Temperature:	0 to +67°C (+32 to +150°F)
Housing:	Rugged waterproof case — unit floats with cover closed, and is splash-proof when open and operating

210 Series Transponders

Frequency:	9300-9475 MHz
Mounting:	1" NPT and Tripod, 3½"−8 & ⅝ BSW
Voltage:	23 to 32 vdc
Current:	.4a standby, .7a transmit
Size:	36 x 16 x 27 cm (14 x 6 x 10½ in)
Weight:	7 Kg (15 pounds)
Temperature:	−30 to +70°C (−22 to +158°F)
Packaging:	Waterproof — unit floats
Antennas:	360° x 30° 180° x 5° 87° x 5°

Trisponder

A Product Of

DEL NORTE Technology, Inc.

1100 Pamela Drive, P.O. Box 696, Euless, Texas 76039

Phone (AC 817) 267-3541

4-75 Printed In U.S.A.

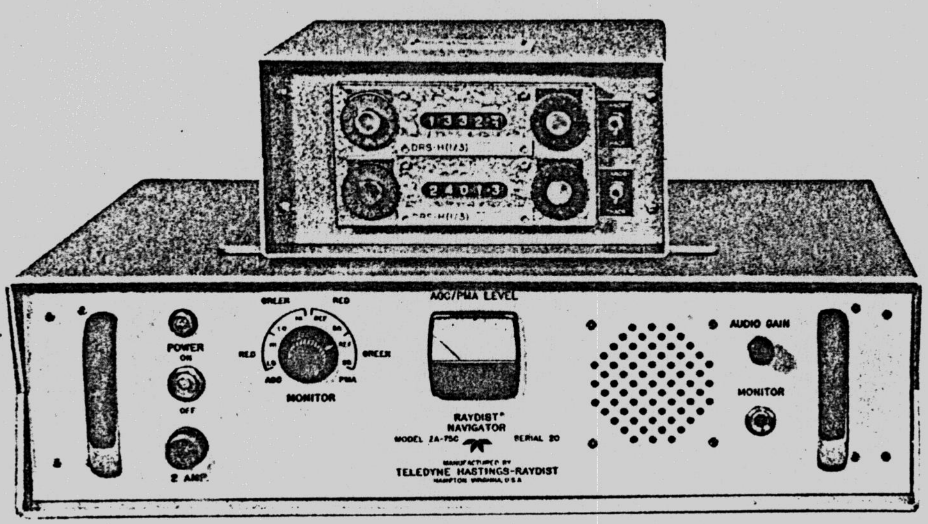
APPENDIX C

TELEDYNE
HASTINGS-RAYDIST

Hampton, Virginia 23661 (804) 723-6531

RAYDIST DRS-H SYSTEM

Range-range and/or hyperbolic-hyperbolic operation with only two frequency allocations.



The Raydist Navigator and Position Indicator furnishes automatic position data in terms of direct distance to each of two fixed base stations when the system is operated in the range-range configuration. Or, automatic position data is furnished in terms of hyperbolic coordinates when the mobile transmitter is placed in operation ashore.

THE ONLY PRECISION RADIOLOCATION SYSTEM AVAILABLE TODAY WITH ALL THESE FEATURES:

- **Range-range/multi-party and/or hyperbolic-hyperbolic with unlimited user capability**
- **Beyond line-of-sight**
- **Completely automatic**
- **Digital output**
- **Highly portable**
- **Battery and/or AC operation**
- **Solid state silicon circuitry**
- **No transmission between base stations in range-range mode**

RAYDIST DRS-H SYSTEM

The new Raydist DRS-H System is a compact, lightweight, battery-powered radiolocation system which can be transported and installed in a matter of minutes in almost any location. This system has the same high accuracy and provides the same completely automatic operation as earlier Raydist Systems.

Virtually an all-weather system, the Long-Range DRS-H Raydist System operates over sea water at ranges in excess of 250 miles during daylight and 150 miles at night. The Medium-Range DRS-H Raydist System, utilizing the same electronic components as the Long-Range System, operates with a shorter antenna and lower transmitter output power to provide ranges up to 75 miles or more. Yet the entire system, complete with antennas* and batteries, can be carried easily in an automobile, aircraft, helicopter or small boat. Both systems are powered by two ordinary automobile batteries or other convenient 24-volt dc source. Solid-state inverters to provide 24-volt dc power from 115-volt ac power are available.

Raydist DRS-H provides a choice of two forms of position information; either range-range (circular) or hyperbolic coordinates. Both the range-range mode and the hyperbolic mode (along the base lines) provide sensitivities of 1/3 meter and over-all accuracies of a few meters. The choice of the type of operation depends on the user's specific application.

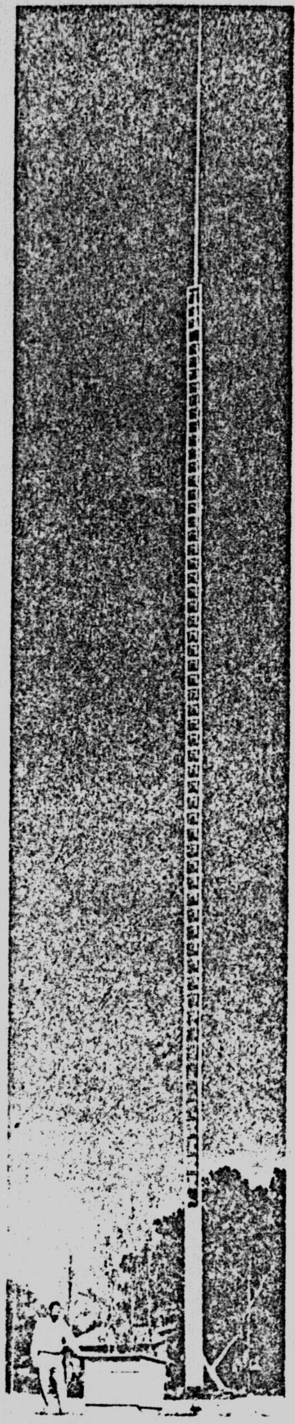
In the range-range mode, up to four users can operate simultaneously in the DRS-H System. Further, employing simple circular patterns, better intersections are obtained with a greater coverage area in the range-range mode. The range-range mode provides longer ranges seaward utilizing only two shore based stations. Transmissions occur only between the mobile stations and each base station. Therefore, the base station sites can be selected without concern for terrain or intervening coastline. To plot a position, one has only to swing two arcs, using the base stations as centers, and the two Raydist ranges as radii. The intersection of these two arcs provides an accurate position fix.

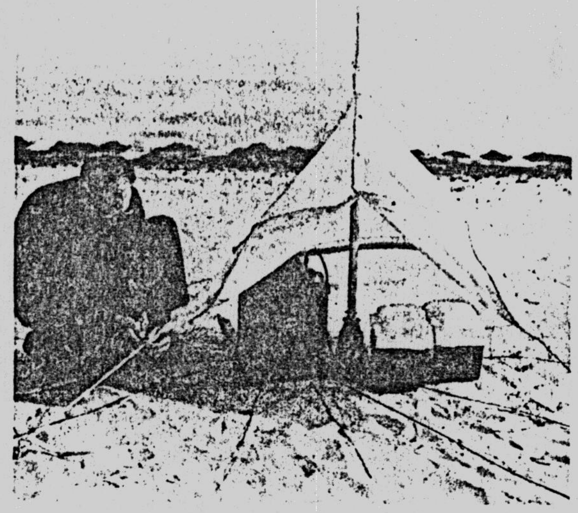
In the Hyperbolic mode, precision position data is available to an unlimited number of users simply by installing the mobile transmitter at a shore location. This provides two hyperbolic base lines, one between the shore based mobile transmitter and each of the two base stations. In this mode, a 22-inch "voltage probe" antenna can be employed on marine vessels or aircraft, eliminating many of the installation problems of larger antennas on small boats and aircraft. Since no transmission is required from the user vessel, the chance of interference with other user equipment is minimized.

The change from range-range to hyperbolic operation requires no equipment modification inside the base stations or the mobile equipment. The Raydist Position Indicator automatically provides either range or hyperbolic position data depending on the mode used. Thus, the user can change operational modes rapidly and economically depending upon specific work requirements.

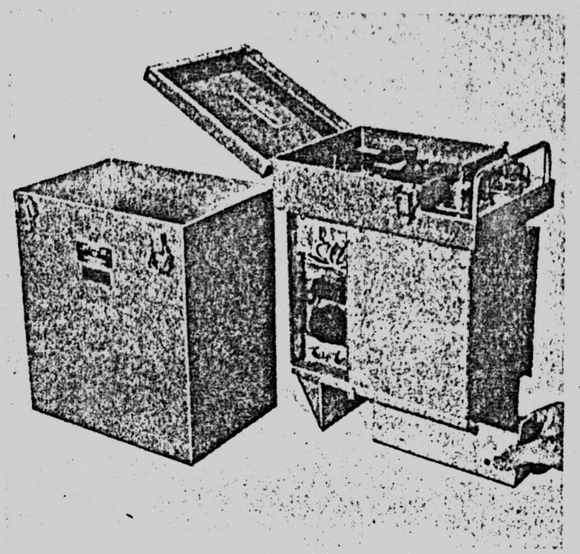
By using single-sideband techniques, only two frequencies are needed. This feature conserves the radio frequency spectrum and also makes the system much less susceptible to interference.

*47-foot antenna





Raydist base station (shown with medium-range antenna and reflecting weather shield).



Typical Raydist base station unit with silicon solid-state circuitry and interchangeable plug-in modules.

MOBILE EQUIPMENT

Lightweight Raydist mobile equipment consists of the Navigator, a CW transmitter and a small strip chart recorder. The Navigator measures 16″ x 5″ x 16″ and weighs 19 pounds and its associated Position Indicator is 8″ x 4″ x 10″ and weighs approximately 9 pounds. The CW transmitter, usually located close to the antenna, measures 11″ x 9″ x 14″ and weighs 23 pounds. The strip chart recorder measures 7″ x 8″ x 17″ and weighs approximately 15 pounds. Total power required is less than 7 amperes at 24-volts DC.

Modular construction permits immediate replacement of a faulty component in the field by relatively unskilled personnel. All solid-state electronic design and encapsulation techniques provide the highest degree of reliability.

Further important savings result from reduced transportation costs, reduced installation and maintenance time, and the elimination of complex data reduction.

Raydist long-range (100 feet) antenna installation with equipment shelter.

RAYDIST BASE STATIONS

Each base station is a single unit which needs only to be connected to the batteries and antenna. The lightweight, weatherproof unit measures 9″ x 12″ x 17″ high and weighs only 29 pounds. The range of the system depends on antenna height and power output levels. Depending on the antenna installation, the system provides a medium-range operation up to about 75 miles or a long-range operation up to 250 miles or more.

The 47-foot antenna for medium-range operations consists of a 35-foot telescopic aluminum whip with two 6-foot extensions weighing 25 pounds. The guys and ground system weigh 5 pounds. For long-range operations, a 100-foot aluminum tower and whip weighing 120 pounds are used. The guys and ground system weigh 85 pounds.

Power is supplied by two conventional automotive type storage batteries or other suitable 24-volt source. Long-range operation requires approximately 2½ amperes battery drain. For short ranges, the equipment may be operated at reduced output to conserve battery life.

DIGITAL & OPTIONAL ACCESSORIES

The Raydist Navigator is supplied with incremental digital output for use by a variety of peripheral equipment such as the Automatic Track Plotter, Data Printer, Remote Indicators, Line Follower, electronic computers, etc. Pure binary, BCD or ASC II outputs are available at extra cost. Information on Raydist accessories is available on request.

Raydist is available for immediate lease for use anywhere in the world.
For information, write, phone, or cable:

TELEDYNE
HASTINGS-RAYDIST

P. O. Box 1275, Hampton, Va. 23661 USA
Telephone: (804) 723-6531
TWX: (710) 882-0085 CABLE: HASTRAY

Printed in U.S.A.

POSITION FINDING SYSTEMS & EQUIPMENT DATA

NAME AND MODEL	The Raydist DRS-H System
MANUFACTURER	Teledyne Hastings-Raydist Hampton, Virginia, U.S.A.

OPERATING CHARACTERISTICS

NORMAL APPLICATION	Oceanographic, Hydrographic, Geophysical surveys, Dredging.
OTHER USES	Buoy tending, check/implant aids to navigation, search & rescue, ship trials, performance testing of other navigation systems.
NORMAL PLOTTING TYPE(S)	Range-Range or Hyperbolic.
OPTIONAL PLOTTING TYPES	Halop and hyperbolic-elliptical.
TRANSMISSION TYPE	CW (AO) and single sideband heterodyne beats.
MEASUREMENT TYPE	Phase measurement. Distance in lanes with resolution of one-hundredth of a lane.
FREQUENCY	1500 to 4500 kHz.
SPECTRUM USAGE	Typical system requires only two frequency allocations.
EQUIVALENT SPECTRUM USAGE	Continuous operation of CW and SSB stations. Maximum bandwidth for SSB stations with multi-party operation requires an allocation of less than 0.5 kHz.
APPROXIMATE RANGE	DAY: 250 nautical miles; NIGHT: 150 nautical miles. Over sea water.
RESOLUTION	Measured perpendicular to a line of position is 0.01 lane or approximately ½ meter at normal operating frequencies.
TYPICAL ACCURACY	Repeatable positioning accuracy ± 0.02 lanes (approximately ± 1 meter) within the operational range of the system. Total geographic accuracy 2 meters RMS. Accuracy maintained at all vehicle speeds.

USERS PER SYSTEM	Up to 4 users in Range-Range Mode. Unlimited number of users in hyperbolic mode.
SUSCEPTIBLE TO STATIC OR SKYWAVE	Low susceptibility to static & skywave due to continuous availability of phase information and SSB type of equipment and narrow band width. Skywave fluctuates very rapidly at 3 mHz and most is filtered out.
PRESENTATION	(1) digital counters; (2) printed paper tape; (3) punched tape; (4) magnetic tape; (5) track plotter display; (6) lane follower (left/right); (7) strip chart lane recording.
MANUAL/AUTO	Automatic tracking.
AUTO-STEERING ETC.	Manual or automatic navigation to any desired position in the system operating area can be provided through a properly programmed computer. Pre-programmed search pattern can be undertaken with automatic control of the vessel through an auto-pilot.
AMBIGUITIES	One per lane.
HOW RESOLVED	1) Continuous operation from known starting point 2) Use of second Raydist system or multiple frequencies 3) Use of Loran, Satellite, or Shoran for lane identification 4) Use of redundant Raydist data & suitable computer programs.
TIME TO TAKE FIX	(1) Manually recorded - less than 10 seconds. (2) Continuous & instantaneous presentation on digital counters, track plotter, print-out, magnetic tape, tape punch, lane follower, and strip chart lane recorder.
SPECIAL CHARTS	Circular grid charts for range-range operations or hyperbolic charts for hyperbolic operations can be drawn by hand or by suitably programmed digital plotters.
AVAILABILITY	Full time except for short periods of precipitation static in some areas of thunder storms.

SPECIAL FEATURES	Electronics housed in lightweight aluminum cases; easily transported by one man in rugged padded shipping cases. All powered from 24 VDC or commercial power with suitable DC converters. Long range with low input power.
COUNTRIES/CONTINENTS	Extensive use on all continents.
SPECIFICATIONS	Designed to withstand environmental extremes of temperature, humidity and vibration using latest encapsulation techniques. Only silicon solid-state & integrated circuit construction employed. Circuitry & components of proven performance provide virtually maintenance-free system with world-wide operational capabilities. No relays or vacuum tubes.

PHYSICAL CHARACTERISTICS OF LAND BASED EQUIPMENT

NO. OF STATIONS TRANSMITTING	2 stations per system (Range-Range or 3 stations per system hyperbolic). Additional stations may be used to provide additional coverage or redundant data.
OUTPUT POWER TO ANTENNA	CW 50 watts (average); SSB 50 watts (peak)
TRANSMITTER PRIMARY POWER	CW transmitter 5 amps at 24 volts DC; SSB transmitter 2.75 amps at 24 volts DC.
NO. OF OPERATORS FULL TIME	None. Entire operation (mobile and base stations) completely automatic.
RADIO PATH BETWEEN LAND BASED STATIONS	None in range-range mode. Baseline transmissions required in hyperbolic mode only.
WEIGHT OF EQUIPMENT PER CHAIN (including Power Supplies)	Complete Long-Range system (2 ranges) packed for air shipment (including antenna towers) 1192 lbs (540 kg). 3-station hyperbolic system 1556 lbs (708 kg) including additional towers.
POWER REQUIRED	Thermo-electric generators (when required) 182 lbs (80 kg) packed for air shipment (excluding gas bottle).

RAYDIST "T" SYSTEM SPECIFICATIONS

NAME AND MODEL	The Raydist "T" System
MANUFACTURER	Teledyne Hastings-Raydist, Hampton, Virginia U.S.A. 23661

OPERATING CHARACTERISTICS

NORMAL APPLICATION	Hydrographic and Geophysical Surveys, Dredging, Precision Position Control, Navigation
OTHER USES	Buoy tending, checking and implanting aids to navigation, ship trials, performance testing of other navigational systems, search and rescue
NORMAL PLOTTING TYPE(S)	Hyperbolic and HALOP
OPTIONAL PLOTTING TYPES	-------------------------
TRANSMISSION TYPE	CW (AØ) and SSB (A2h)
MEASUREMENT TYPE	Phase measurement. Distance in lanes with resolution of one-hundredth of a lane.
FREQUENCY	1500 to 4500 kHz
SPECTRUM USAGE	Typical system requires only two frequency allocations for station networks using up to 6 stations
EQUIVALENT SPECTRUM: USAGE	Continuous operation of CW and SSB stations. Maximum band width for multi-network SSB station less than .7 kHz.
APPROXIMATE RANGE	Day: 250 nautical miles. Night: 150 nautical miles. Over seawater.
RESOLUTION	Measured perpendicular to a line of position is .01 lane.
TYPICAL ACCURACY	Repeatable positioning accuracy ±0.02 lanes.
LANE WIDTH	Approximately 45 meters (depends upon location within the system).

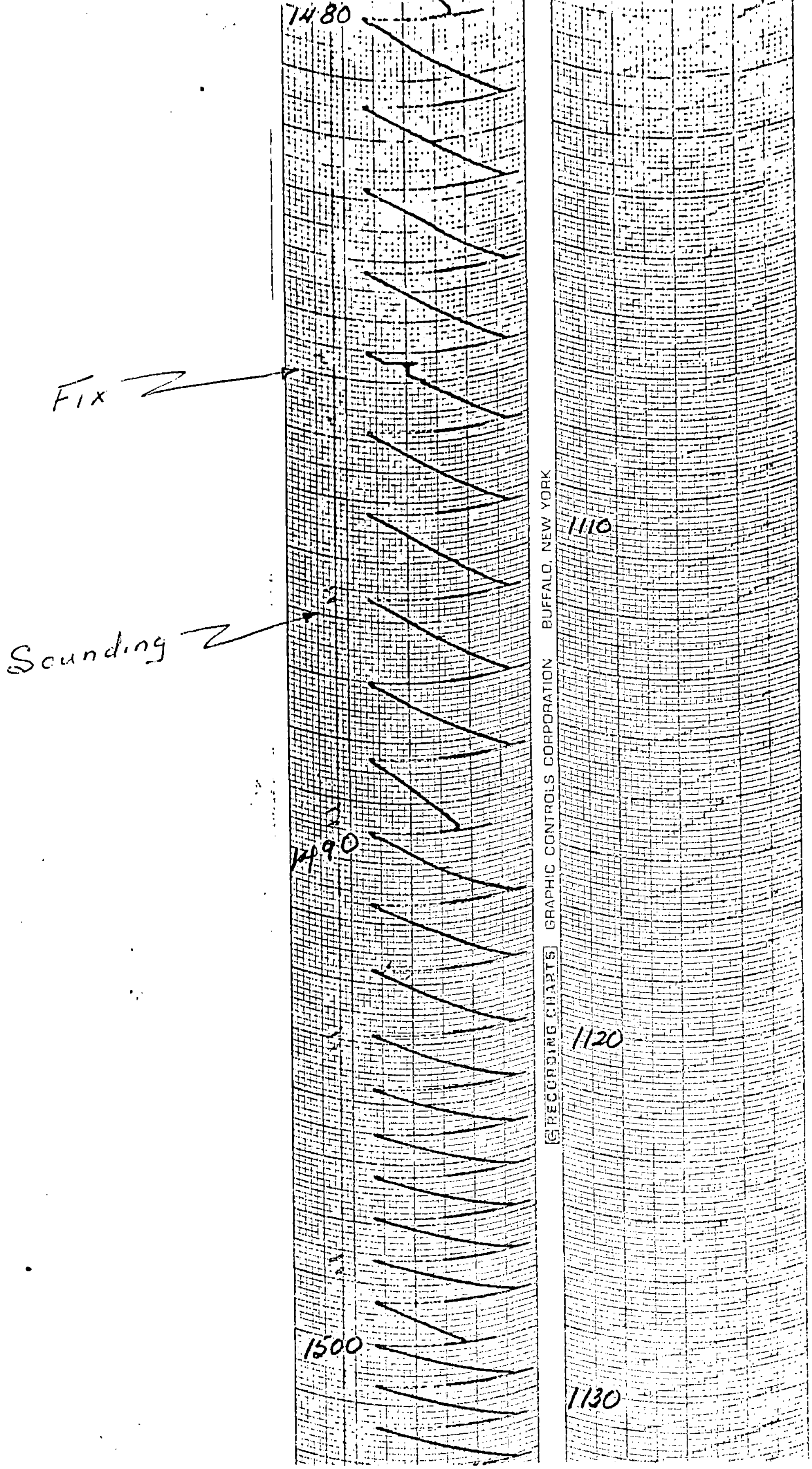
USERS FOR SYSTEM	Unlimited
SUSCEPTIBLE TO STATIC OR SKYWAVE	Low susceptibility to static and skywave due to continuous availability of phase (position) information and narrow band width SSB equipment. Skywave at normal operating frequencies fluctuates very rapidly and is readily filtered out.
PRESENTATION	(1) Digital Counters (2) Printed Paper Tape (3) Punched Tape (4) Magnetic Tape (5) Track Plotter (6) Lane Follower (left/right) (7) Strip Chart Lane Recording
MANUAL/AUTO	Automatic tracking
AUTO-STEERING, ETC.	Manual or automatic navigation to any location in the system operating area can be provided through a properly programmed computer so that a pre-plotted pattern can be undertaken with automatic control of the vessel through an auto-pilot.
AMBIGUITIES	One per lane
HOW RESOLVED	Use of redundant Raydist data and suitable computer program
TIME TO TAKE FIX	(1) Manually recorded - less than 10 seconds. (2) Continuous and instantaneous presentation on digital counters, track plotter, print-outs, magnetic tape, tape punch, lane follower and strip chart lane recorder.
SPECIAL CHARTS	Hyperbolic and Halop charts can be manually constructed or drawn by a digital plotter.
AVAILABILITY	Full time except for short periods of precipitation static in some areas of thunderstorms.
SPECIAL FEATURES	Light-weight base station electronic units (14 kilos) housed in rugged aluminum cases, easily transported by one man in rugged padded shipping case. All powered from 24 volt DC or commercial AC power using power supplies. Long range operation with low input power.

COUNTRIES/CONTINENTS	Raydist systems in extensive use in all continents. Use includes Arctic, Temperate and Tropical areas.
SPECIFICATIONS	Designed to withstand environmental extremes of temperature, humidity and vibrations using the latest encapsulation techniques. All electronic circuits use silicon semi-conductor or Integrated Circuit construction. Exclusive use of proven components provides high reliability and low maintenance. Base station equipment can be used for range-range operation without modification if desired. System provides specified accuracy at all speeds, including supersonic.

PHYSICAL CHARACTERISTICS OF LAND BASED EQUIPMENT

NUMBER OF STATIONS TRANSMITTING	4 stations - more stations may be added for extended area coverage.
OUTPUT POWER TO ANTENNA	CW: 50 watts average SSB: 10 watts average
TRANSMITTER PRIMARY POWER	CW transmitter 5 amps @ 24 volts DC SSB transmitter 2.75 amps @ 24 volts DC
NUMBER OF OPERATORS FULL TIME	All base stations operate unattended. No network synchronization required.
RADIO PATH BETWEEN LAND BASED STATIONS	Yes
WEIGHT OF EQUIPMENT PER CHAIN (including power supplies)	Complete 4-station network: 1700 lbs. (730 kg)
APPROXIMATE VOLUME OF EQUIPMENT	Complete 4 station network: 60 cubic feet
PORTABLE READILY	Yes
TIME TO SET UP CHAIN	½ day per station (3 men)

APPENDIX D



STRIP CHART RECORD OF RAYDIST LANES.

APPENDIX E

HYDROTRAC™

A solid state single frequency over-the-horizon positioning system

THE HYDROTRAC SYSTEM

Introduction

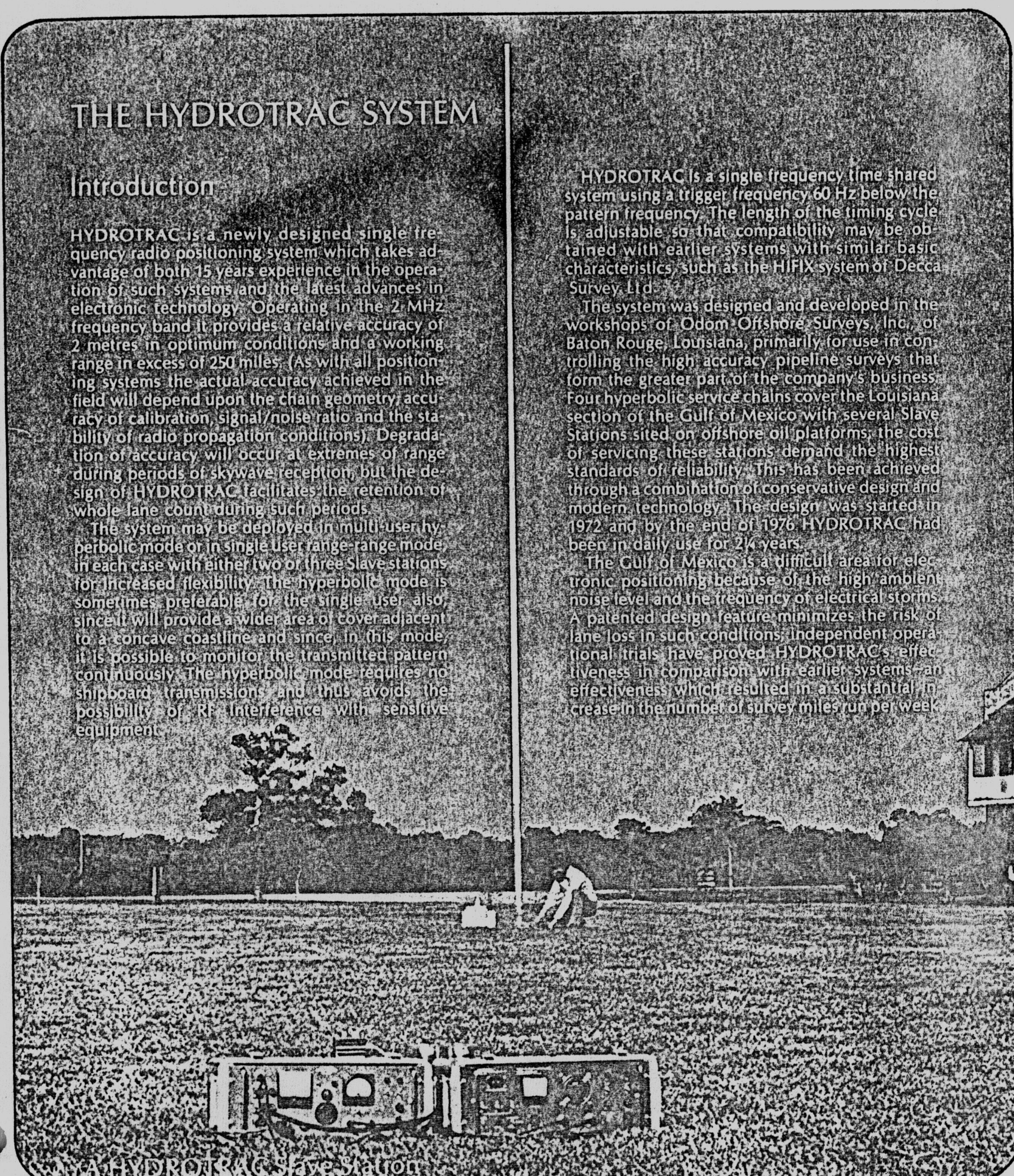
HYDROTRAC is a newly designed single frequency radio positioning system which takes advantage of both 15 years experience in the operation of such systems and the latest advances in electronic technology. Operating in the 2 MHz frequency band it provides a relative accuracy of 2 metres in optimum conditions and a working range in excess of 250 miles. (As with all positioning systems the actual accuracy achieved in the field will depend upon the chain geometry, accuracy of calibration, signal/noise ratio and the stability of radio propagation conditions). Degradation of accuracy will occur at extremes of range during periods of skywave reception, but the design of HYDROTRAC facilitates the retention of whole lane count during such periods.

The system may be deployed in multi-user hyperbolic mode or in single user range-range mode, in each case with either two or three Slave stations for increased flexibility. The hyperbolic mode is sometimes preferable for the single user also, since it will provide a wider area of cover adjacent to a concave coastline and since, in this mode, it is possible to monitor the transmitted pattern continuously. The hyperbolic mode requires no shipboard transmissions and thus avoids the possibility of RF interference with sensitive equipment.

HYDROTRAC is a single frequency time shared system using a trigger frequency 60 Hz below the pattern frequency. The length of the timing cycle is adjustable so that compatibility may be obtained with earlier systems with similar basic characteristics, such as the HIFIX system of Decca Survey Ltd.

The system was designed and developed in the workshops of Odom Offshore Surveys, Inc., of Baton Rouge, Louisiana, primarily for use in controlling the high accuracy pipeline surveys that form the greater part of the company's business. Four hyperbolic service chains cover the Louisiana section of the Gulf of Mexico with several Slave Stations sited on offshore oil platforms; the cost of servicing these stations demand the highest standards of reliability. This has been achieved through a combination of conservative design and modern technology. The design was started in 1972 and by the end of 1976 HYDROTRAC had been in daily use for 2¼ years.

The Gulf of Mexico is a difficult area for electronic positioning because of the high ambient noise level and the frequency of electrical storms. A patented design feature minimizes the risk of lane loss in such conditions; independent operational trials have proved HYDROTRAC's effectiveness in comparison with earlier systems—an effectiveness which resulted in a substantial increase in the number of survey miles run per week.

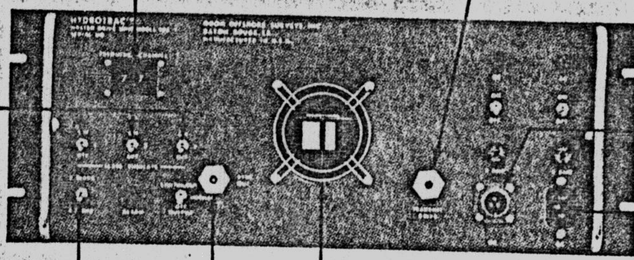


A HYDROTRAC Slave Station

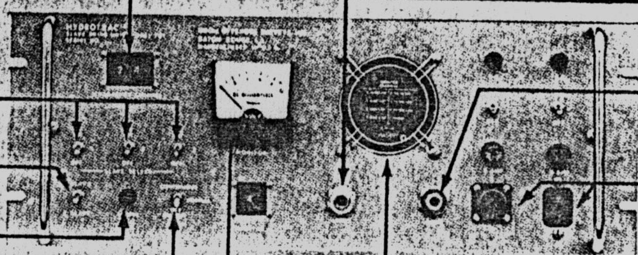
9730 Town Park Drive, Houston, Texas 77036, (713) 771-1263

THE HYDROCARTA CORPORATION

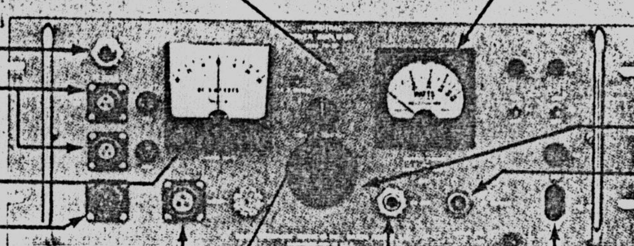
Master Drive Unit
Model No. 702



Slave Drive Unit
Model No. 701



Power Amplifier
Model No. 74-87



Additional Features of Power Amplifier

Harmonics are more than 70 dB down when used in conjunction with Antenna Coupler.

Lower Power Mode: Forty seconds after losing AC power the output power level is automatically reduced to a preset level in order to conserve battery capacity. For short planned outages, such as generator maintenance, an over-ride switch disables this circuit.

Output Power Monitoring: Sample and Hold circuits allow direct reading of output power, both forward and reflected, without fluctuations and without the necessity for continuous drive.

Circuit Protection: The possibility of damage to the output section, caused by antenna mismatch, has been greatly reduced by the combination of a voltage standing wave bridge and a sample and hold circuit, which attenuates the output to a safe level until the disorder has been corrected.

SHIP RECE

WHOLE LANE SWITCHES AND SLEW CONTROL
Set Mode: Initial Lane Count is set by slewing the patterns in the direction selected by the switches at a speed controlled by the Slew Control.
Operate Mode: Slew Rate is disabled. Whole lane value may be increased or decreased by 1 on each actuation of the switch

VISUAL ALARM
5 Flashing decimal points in one or both displays indicate an alarm Actuated by lack of signal, interference or the presence of excessive skywave

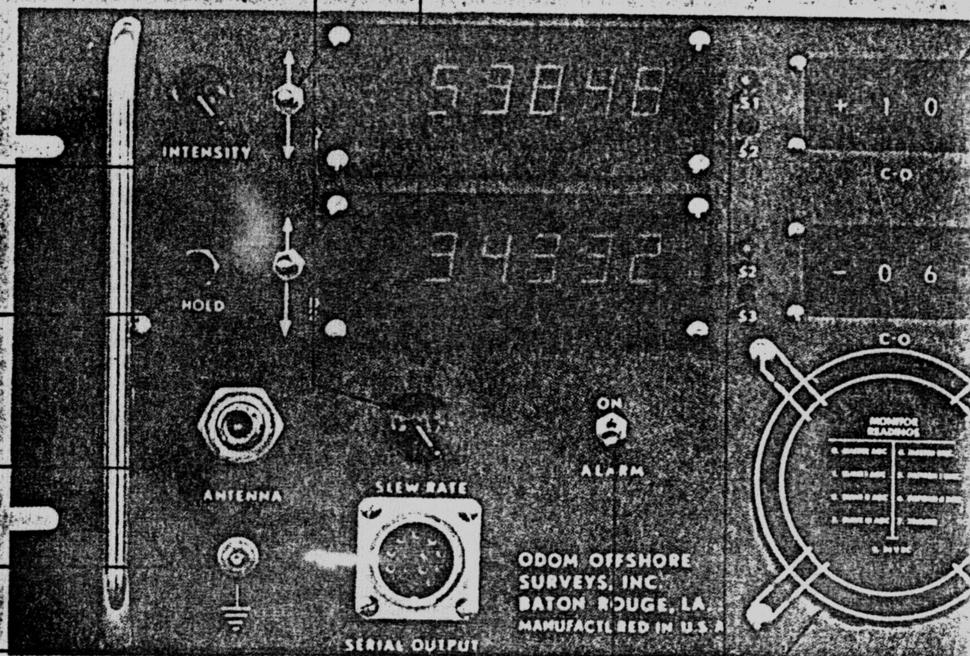
DIMMER CONTROL
At full intensity the displays may be read in bright sunlight at 5 metres.

DISPLAY HOLD
Display is frozen when depressed, updates on release. Does not affect data output.

ANTENNA INPUT
BNC connector for RF input

GROUND LUG

OUTPUT CONNECTOR



AUDIO ALARM SWITCH
Disables audible tone which is in parallel with visual alarm. Switch is overridden by overheating or by incorrect operation of Whole Lane Switches when in Operate mode.

AC BLOWER

SLAVE SELECTIC
Indicate the Slav

Change of Frequency

The pattern frequency may be selected in steps of 10 Hz within the band 1.6-2.0 MHz by programming a synthesizer with switches and tuning some RF stages. Retuning is not required if frequency changes are kept within a 10 KHz band.

System Synchronization

The HYDROTRAC receiver and Slave Drive Units are self locking so that no manual manipulation is required to synchronize either with the Master. This feature eliminates the risk of locking in one cycle off, and the consequent 1/3 lane errors.

Error Correction

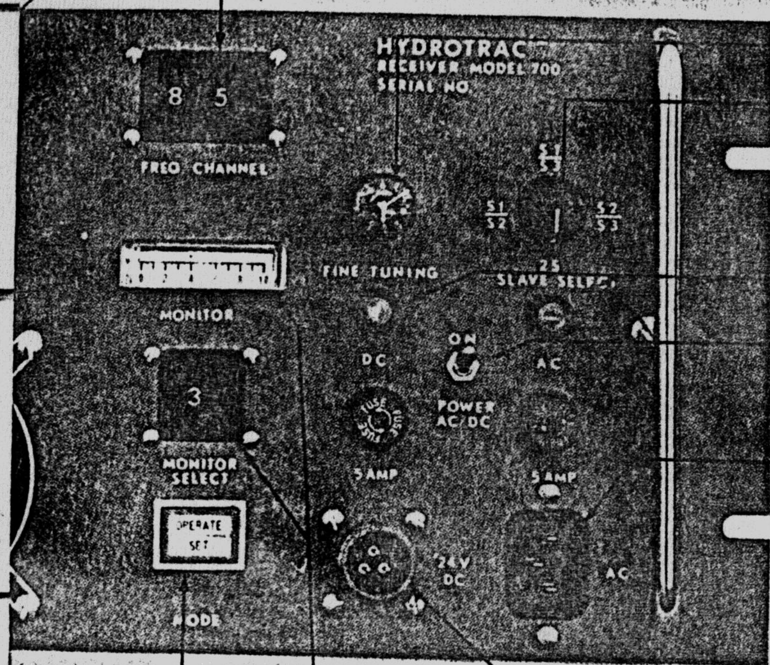
The receiver is self-referencing, so that two received signals, in phase, will give a pattern reading of .00, without operator adjustment. The random errors of the receiver are less than .01 lane.

Fluctuation in propagation conditions and the incidence of skywave will increase the random error of the difference signal. This is reduced by an analogue filter which limits pattern excursions without reducing accuracy.

The so-called fixed errors of 2 MHz positioning systems are rarely constant in either time or position. It is therefore convenient to be able to correct these at the receiver, to allow for changes in monitor readings or for the movement of the vessel into a different correction zone. This is accomplished by digital arithmetic circuits controlled by thumbwheel switches. Thus the correction may be entered or changed at any time, without risk of losing lanes or reference, and the correction in use is continuously displayed.

/ER, Model No. 700

ndition,



PATTERN CORRECTION THUMBWHEELS
For easy correction of propagation variations

FREQUENCY SLECTION THUMBWHEELS
Disabled in Operate Mode

FINE TUNE CONTROL

PATTERN SELECT SWITCH
Selects 2 or 3 Slave operation and, if 3 Slave, which Slaves should be displayed. Disabled in Operate mode.

POWER INDICATOR LIGHTS (DC and AC)

POWER ON/OFF
Controls both DC and AC inputs.

AC POWER INPUT
Only required for cooling fan. If AC power fails, operation may be continued by removing the receiver from its case.

DC POWER INPUT
24 VDC

MONITOR METER AND MONITOR SELECT CONTROL
Provides an indication of received signal strength from each station, the presence of skywave, the absence of trigger, and input D.C. power level.

LIGHTS
in use

MODE SELECT
Set Mode required during initialization. Normal tracking begins on selecting Operate.

Retention of Lane Count

HYDROTRAC receivers will maintain correct lane count for longer periods in high atmospheric noise conditions than earlier equipment, because of the improved design of the triggering system. All single frequency time shared systems require synchronization between the various transmitters and the receivers; this synchronization is normally provided by a trigger signal from the Master. If synchronization should be lost, due perhaps to a flash of lightning being read as a trigger, the receiver may attempt to compare the Slave 1 transmission with Slave 2, for example, rather than with the Master. It is this that is the most frequent cause of the spinning dials that lose numbers of lanes at one time.

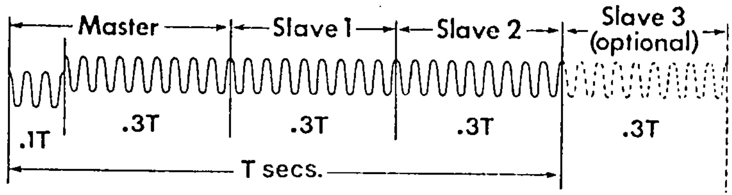
The HYDROTRAC receiver, however, contains its own internal precision timing source from which receiver timing is derived. This internal source is periodically updated by the Master trigger, but only after 256 correctly spaced signals have been received. False triggering is thus virtually impossible.

The next most frequent causes of lane loss are skywave, which will degrade the received signal and in some circumstances cancel it completely, and prolonged electrical disturbances lasting for several seconds. Either occurrence could result in the elimination of one value from the difference equation which drives the display, and the display would attempt to move at high speed. In HYDROTRAC the maximum rate of the display is limited to correspond with the vessel's expected maximum speed over the ground; it has been found that this restriction greatly reduces the incidence of lane loss during high atmospheric noise conditions.

THEORY OF OPERATION

The Master and Slave Stations each transmit a continuous wave signal in sequence on the selected frequency, each cycle commencing with a trigger signal, 60 Hz below that frequency, transmitted by the Master (see Figure 1).

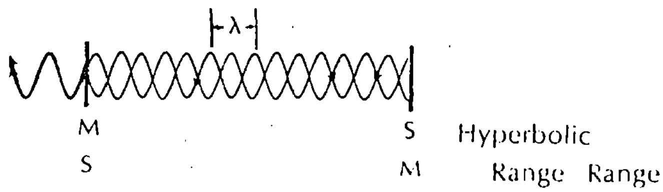
Figure 1



Within the Ship Receiver three phase locked loops generate internal signals with the same frequency and phase as the received signals from the Master and the selected Slaves. These internal signals are continuous, being updated during each transmission cycle, to give the same effect as if the transmissions from the shore stations were continuous.

Taking the hyperbolic mode first, the standard convention in preparing the charts on which the positions are to be plotted is to give the baseline extension at the Master station a value of 0.00 lanes, from which it follows that the Master and Slave signals must be in phase along that line (see Figure 2)

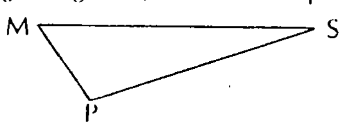
Figure 2



and that, to achieve this, the Slave signal must be considered to have been transmitted before the Master signal with which it is in phase. The actual change of phase along MS is $\frac{MS}{\lambda} \times 360°$, where λ is the wavelength, and it can be seen that, before any Master and Slave signals may be compared, this value must be subtracted from the phase of the Slave signal in order to bring the two signals into their correct phase relationship.

The Hydrotrac receiver displays a phase difference for each pattern, obtained by subtracting the Slave signal from that of the Master. Looking at Figure 3, when the ship receiving antenna is at point P,

Figure 3



the difference of phase along MP will be $\frac{MP}{\lambda} \times 360°$ and that along PS will be $\frac{PS}{\lambda} \times 360°$, from which the constant value $\frac{MS}{\lambda} \times 360°$ must be subtracted. The value shown by the receiver, R, is the difference of phase expressed in whole cycles and hundredths, thus

$$R \times 360° = \frac{MP}{\lambda} \times 360° - \left(\frac{PS}{\lambda} \times 360° - \frac{MS}{\lambda} \times 360°\right)$$

$$\text{whence } R = \frac{1}{\lambda}(MS + MP - PS) \ldots (1) \qquad \text{or } R = \frac{F}{V}(MS + MP - PS) \ldots (2)$$

since $V = F \times \lambda$, where V is the velocity of propagation of radio waves and F is the frequency.

Formula 2 is the fundamental formula from which the pattern values may be calculated for any point whose position is known. If the receiver is then adjusted to display those values at that point, all values displayed subsequently, as the ship moves, will be based on the same convention of the master base line extension being zero, and may be plotted on charts drawn to that convention.

There are two qualifications that must be made; first of all the distances MP, MS, etc., are measured over the earth's surface and plane values must be corrected to the spheroid before use of the above formula. Secondly, the velocity of propagation is not a constant, although it must be treated as one for computational purposes. The procedures for reducing the magnitude of, and measuring the variation in, the resultant error, are fully described in the Hydrotrac Operating Manual.

In Range Range mode the Master station is installed on the ship and the direction of movement of the Receiver displays is reversed, since in this mode it is convenient to make the value at the Slave station zero, and values increase as the ship moves away from the Slave. Figure 2 still applies but the positions of Master and Slave are reversed, and it can be seen that the Slave signal is transmitted in phase with the received Master signal, so that the difference in phase aboard the ship, between the Master and the Slave, is equal to that caused by travelling a distance 2 x MS. MS may be replaced by PS since the transmitting and receiving antennas are coincident, so that

$$R \times 360° = 2\frac{PS}{\lambda} \times 360°$$

$$\text{whence } R = \frac{2\,PS}{\lambda} \ldots\ldots (3) \quad \text{or} \quad R = \frac{2\,F\,PS}{V} \ldots (4)$$

SPECIFICATIONS

Common to All Units Except Antenna Coupler

Operating frequency: 1.6-2 MHz (higher frequencies on request)
Trigger frequency: Operating frequency less 60 Hz.
Timing cycle (Two Slave): 2 per second
(1 or 5 per second on request)
I.F. bandwidth: 120 Hz (approx) between 3 dB points
R.F. Sensitivity: 1μV (measured at antenna input from 50 ohm source)
Power supply: 22-30 VDC (negative ground) and 115 VAC or 230 VAC ± 10%, 47/63 Hz
Temperature Limits: 0-50° C (operating)
-55° to +75° C (storage)
Relative Humidity: 20-98% (w/o condensation)
Dimensions: 48.3 x 17.8 x 31.5 cm, 19.0 x 7.0 x 12.4 in
Transit case (also used for operation when units are not rack mounted) weight: 6.8 kg., 15 lbs.
Dimensions: 55.9 x 23.6 x 41.3 cm, 22.0 x 9.3 x 16.26 in.

Slave Drive Unit

Model No. 701
Power consumption: DC, 50 VA (72 during warm up)
AC, 20 VA
Weight: 11.6 kg, 25.5 lbs.

Power Amplifier

Model No. 74-87
Power Output: 0-150 watts Peak Envelope Power, continuously variable.
Power consumption: DC, 384 VA at 150 watts
RF output
Low power mode, 72 VA
(20 watts RF)
Standby mode, 24 VA
AC, 20 VA
Weight: 10.2 kg, 22.5 lbs.

Antenna Coupler

Model No. 610
Input: 50 ohms unbalanced
Tuning: continuously variable
Maximum power output: 200 watts
Minimum Antenna Capacitance: 130 picofarad
Maximum distance from antenna: 2 feet
Provision made for use of voltage standing wave bridge for tuning
Temperature limits: -55° to +75° C
Overall Dimensions: 35 x 18 x 41 cm., 15 x 7 x 16 in.
Weight: 9.1 kg., 20 lbs.

Receiver

Model No. 700
Power consumption: DC, 72 VA (108 during warm up)
AC, 20 VA
Maximum speed: 38 knots (approx.) (with 80 metre lane width)
Weight: 13.2 kg, 29 lbs.

Master Drive Unit

Model No. 702
Power consumption: DC, 35 VA (48 during warm up)
AC, 20 VA
Weight: 8.2 kg, 18 lbs.

Power Supply (Optional)

Model No. 620
Input: 100-130 VAC, 57-63 Hz or 220-240 VAC, 47-53 Hz
Output: 26.5 VDC,
AC similar to input
Charge Rate: 15 amp nominal, 25 amp maximum
Weight: 65 lbs.
Should AC power input fail the AC output will be supplied from an integral inverter.

Receiver Outputs

A. INTERNAL

A1. Serial BCD (standard)—compatible with all HYDROCARTA systems

METHOD: Serial, asynchronous, 8-bit data bytes transmitted via 20 ma. neutral current loop at 1200 baud

FORMAT:

		Pattern 1			Pattern 2		
377_8	Control Byte	LSD		MSD	LSD		MSD

One start and two stop bits plus one odd parity bit frame each 8 bit byte. The first is a synchronization byte of octal 377 and the second is a control byte in which bits 0-6 form a device code, settable by the user, and bit 7 is an error bit. The data follows in six bytes, each containing two BCD digits, Pattern 1 first and least significant digit first. The repetition rate may be set internally at 12, 6, 4, 3, 2 or once per second.

A2. Analogue (standard)—for strip chart recorder. Each pattern is represented by an analogue voltage in which OV = .00 and 10V = .99. The output impedence is 100 ohms.

A3. Serial ASCII (optional)—compatible with Hewlett Packard 9800 series calculators, using HP 11205A Serial I/O Interface. Available simultaneously with the standard serial BCD.

Pattern 1						Pattern 2						
MSD					LSD	MSD					LSD	Line Feed

Standard 8-bit serial ASCII code with one start bit, one stop bit and no parity. Control levels conform to EIA RS 232-C specifications and data is transmitted most significant digit first, Pattern 1 first. The ASCII board is supplied set at 1200 baud with the Line Feed character (Octal 12) delimiting the data set. Variations are programmable on the board to provide Carriage Return followed by a variable delay and Line Feed, and to provide other standard baud rates up to 4800 baud.

B. EXTERNAL (all optional)

These optional outputs are all provided through an interface box, which may be placed adjacent to the user's equipment, and which receives its input from the serial BCD socket. In each case the data is updated at the rate selected for the serial output. The box requires an input of 24VDC, 115VAC or 230VAC as specified

B1. Parallel BCD. 48 data lines at standard TTL levels and two control lines, Data Ready and Data Request.

B2. Incremental—for Houston Instrument Plotter, Models 6650 or 6655. Two wire forward and reverse control, TTL compatible, for each pattern, with 100 pulses generated by a movement of one lane. Each pulse has an amplitude greater than 3 volts and a rise time of less than 10 μsec.

APPENDIX F

RECEIVED DATE: __________

PRE-VERIFICATION CRITIQUE CHECKLIST

The following items are to be considered in the preparation of a critique of incoming hydrographic surveys prior to their entry into the verification process. In preparing the critique, only items which are either exceptionally well done or deficient need be addressed.

RESPONSIBILITY FOR APPRAISAL:

Item (1) CAM 3, CAM 3x1,* or CAM 31

Item (2) CAM 3 or CAM 3x1*

Item (3) Verifier

Item (4) Verifier

Item (5) CAM 3, CAM 3x1,* or CAM 31

Item (6) CAM 3 CAM 3x1,* or CAM 31

Item (7) CAM 3

*CAM 3X1 is to be bypassed until position is established.

PRE-VERIFICATION CRITIQUE CHECKLIST

Registry No.________
Field No.____________
Date Commenced__________

(1) Final Field Sheet

Legibility
Reproducibility
Adequacy of depth curves
Sounding line orientation and spacing
Adequacy of developments
Marginal notes
Position spacing
Crossline comparisons

(2) Descriptive Report

Completeness
Disposition of Pre-survey Review Items

(3) Fathogram

Labeling
Annotation (positions, scale changes, line ID)
Quality
Scanning
Bar checks

(4) Raw Printout and Sounding Volumes

Labeling
Annotation and notes
- Legibility
- Line identification (LB, LE, etc.)
- Speed
- Course
- Unusual conditions
- D.P. descriptions
- Relative position of Rks or other features

(5) Calibration Data

Documentation
Consistency
Overall quality

(6) General Compliance With:

Project Instructions
Hydrographic Manual
OPORDER
Other pertinent instructions

(7) Survey Accepted:

If returned to field unit explain reasons.

H- OPR- FIELD-

Verifier's Check List

CONTROL OVERLAY

1. Read Descriptive Report and make necessary changes in pencil.
2. Signals which fall outside the high-water line have been described.
3. List source of signals.
4. Check plotting of all triangulation, topo and hydro stations.
5. List all signals that were in error.

Verifier: ______________________

POSITION OVERLAY

1. Read Descriptive Report and make all necessary changes in pencil.
2. List source of shoreline.
   a. Give earliest and latest date of photographs
   b. Field inspection date
   c. Field edit date
   d. Reviewed - Unreviewed
3. Transfer all topographic information and reconcile with hydro as far as possible.
4. All items effecting the plotting of the survey which are in the remarks columns of sounding volumes or field printouts were noted and checked.
5. All D.P.'s locating critical soundings, rocks, buoys, etc.

were verified.

6. All position numbers are legible.

7. The protractor has been checked within the last three months.

   Date__________________ Type____________________

8. All fixed aids located, together with those on the contemporary topographic sheets have been shown on the survey.

9. The position overlay was constantly compared with the boat sheet.

10. Degree, minute values and symbols have been checked, also electronic distance arcs have been properly idenified and checked.

11. The position of bottom samples have been shown and checked with boat sheet.

12. The position overlay was satisfactory except as follows:

Verifier:_________________________

<u>SOUNDING OVERLAY</u>

1. Read Descriptive Report and make necessary notes in pencil.

2. Soundings mentioned in Descriptive Report have been verified and checked in pencil, including Lat. and Long. and position numbers.

3. Transfer all topographic information and reconcile with hydro.

4. All signal numbers and trianglation names are correctly transfered from control overlay.

5. All junctions have been made in proper color, depth curves made identical and necessary soundings transfered.

6. All notes in the sounding volumes and printouts have been checked and appropriate action taken.

7. Crosslines have been verified.

8. All soundings are clear and critical soundings are a little larger and inked.

9. The scanning, reduction, spacing, plotting of questionable soundings have been verified. List in item 10.

10. The sounding overlay was satisfactory except as follows:

11. The low-water and delineation of shoal areas have been properly shown.

12. Depth curves were satisfactory except as follows:

13. All fixed aids have been properly shown.

14. All floating aids listed in the Descriptive Report and Light List have been verified.

15. The sounding overlay was constantly compared with the boat boat sheet.

16. Heights of rocks awash were correctly reduced and compared with topographic information.

17. All information on the sheet is shown in accordance with

figures 82 and 83 in the Hydro Manual.

18. Degree, minute values and symbols have been checked.

Verifier: ______________________

NOAA FORM 77-27
(9-72)
(PRESC. BY HYDROGRAPHIC MANUAL 20-2, 6-94, 7-13)

U. S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

HYDROGRAPHIC SURVEY STATISTICS

HYDROGRAPHIC SURVEY NO. ____________

RECORDS ACCOMPANYING SURVEY: To be completed when survey is registered.

RECORD DESCRIPTION	AMOUNT	RECORD DESCRIPTION	AMOUNT
SMOOTH SHEET		BOAT SHEETS	
DESCRIPTIVE REPORT		OVERLAYS	

DESCRIPTION	DEPTH RECORDS	HORIZ. CONT. RECORDS	PRINTOUTS	TAPE ROLLS	PUNCHED CARDS	ABSTRACTS/ SOURCE DOCUMENTS
ENVELOPES						
CAHIERS						
VOLUMES						
BOXES						

T-SHEET PRINTS *(List)*

SPECIAL REPORTS *(List)*

OFFICE PROCESSING ACTIVITIES

The following statistics will be submitted with the cartographer's report on the survey

PROCESSING ACTIVITY	AMOUNTS			
	PRE-VERIFICATION	VERIFICATION	REVIEW	TOTALS
POSITIONS ON SHEET				
POSITIONS CHECKED				
POSITIONS REVISED				
DEPTH SOUNDINGS REVISED				
DEPTH SOUNDINGS ERRONEOUSLY SPACED				
SIGNALS ERRONEOUSLY PLOTTED OR TRANSFERRED				
	TIME (MANHOURS)			
TOPOGRAPHIC DETAILS				
JUNCTIONS				
VERIFICATION OF SOUNDINGS FROM GRAPHIC RECORDS				
SPECIAL ADJUSTMENTS				
ALL OTHER WORK				
TOTALS				

PRE-VERIFICATION BY	BEGINNING DATE	ENDING DATE
VERIFICATION BY	BEGINNING DATE	ENDING DATE
REVIEW BY	BEGINNING DATE	ENDING DATE

VERIFICATION NOTE TO EDP-AMC

Survey H-______ Field No. ____________

OPR-______

The following overlays and printouts (with additional changes) are requested by the Verification Branch:

______ Positions to be changed
______ Soundings to be corrected
______ Soundings to be excessed

______ Control Overlay to Position Overlay and Printout
______ Position to Sounding Overlay and Printout
______ Soundings Corrector Printout
______ Sounding Overlay to Smooth Sheet
______ Overlay Verified
______ Change Point of Origin
______ Change Signal No. Origin
______ Plot Sub-plans ______ Cards Punched
______ Plot Smooth Sheet ______ Mylar
______ Plot Soundings in fms tenths to 31 and half fms to 101
______ Plot Sounding Overlay in Color
______ Request Corrector Printout
______ Change Tide Correctors
______ Proj. Blue Ball Point Pen and 10mm Black Ticks
______ Plot Revised Excess Overlay Level 1, 2, 3
______ Plot Soundings at Regular Rotation
______ Plot Distortion Points Lat. ___° ___' ___" Long. ___° ___' ___"
______ Plot Stamp No. 42 Lat. ___° ___' ___" Long. ___° ___' ___"

______ Plot Overlay and Printout
______ Change Signals
______ Enlarge congested area
______ Plot Electronic Arcs
______ Paper
______ Black Ink
______ Change Velocity Correctors
______ TRA Correctors
______ Rotation

Cards have been keypunched for all changes and accompany this note.

After all corrections have been applied, please plot the smooth sheet with plotter origin Lat. ___° ___' ___" Long. ___° ___' ___" size __________.

Verifier: ____________________

No. 42 HYDROGRAPHIC SURVEY

Field No. .... Reg. No ....

Scale 1: .... Plotted: Verified

Projection ....

Tri. Sta. ....

Topo Sta. ....

Hydro. Sta. ....

Datum. ....

Ref. Sta. ....

Lat .... m. Adj.

Long .... m Unadj.

NOAA FORM 76-97 (2-72) (PRES. BY HYDROGRAPHIC MANUAL, 6-94)

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMIN.

VERIFIER'S REPORT
HYDROGRAPHIC SURVEY, H________

INSTRUCTIONS - This form serves to identify items of a check list in verification together with items which are separately reported to the Reviewer. The form is not to be forwarded to the Reviewer. A report, which is prepared for the Reviewer, should identify items by number and letter and will be filed in the Descriptive Report until the survey is reviewed.

CL - Check List Items: should be checked as having been completed during the verification processes.

R - Report Item: This column refers to those items reported to the reviewer and is used to indicate the items discussed.

Part I - DESCRIPTIVE REPORT	CL	R
Note: The verifier should first read the Descriptive Report for general information and problems.		
1. The Descriptive Report was consulted, paragraphs checked if found satisfactory, and notations were made in soft black pencil regarding action taken. Remarks Required: -- None		
2. Soundings originating with the survey and mentioned in the Descriptive Report have been verified and checked in soft black pencil, including latitude and longitude, together with position identification. Remarks Required: -- None		
3. All reference to survey sheets mentioned in the Descriptive Report should include registry number and year. Remarks Required: -- None		
Part II - SHORELINE AND SIGNALS		
4. Source of shoreline signals. Remarks Required: -- List all surveys a. Give earliest and latest dates of photographs b. Field inspection date c. Field Edit date d. Reviewed-Unreviewed		
5. The transfer of contemporary topographic information was carefully examined and reconciled with the hydrography. Remarks Required: -- Discuss remaining differences.		
6. The plotting of all triangulation stations, topographic stations and hydrographic signals has been checked and noted in processing stamp No. 42 on the smooth sheet. Remarks Required: -- None		
7. Objects on which signals are located and which fall outside of the high-water line have been described on the sheet. Remarks Required: -- List those signals still unidentified.		
Part III - JUNCTIONS		
Note: Make a cursory comparison preliminary to inking soundings in area of overlap.		
8. All junctions of contemporary or overlapping sheets were compared and overlapping curves were made identical. Remarks Required: -- None		
9. The notation in slanted lettering "JOINS H---- (19)" was added in colored ink for all verified contemporary adjoining or overlapping sheets. Those not verified are shown in pencil. Remarks Required: -- None		

Part III - JUNCTIONS (Continued)	CL	R
10. Junctions with contemporary surveys were satisfactory except as follows: Remarks Required: -- Consider conditions after adjustments have been made; note adjustments made. Make special notes of **Butt** junctions and areas which are **SUPERSEDED.**		
Part IV - VOLUMES		
11. All items affecting the plotting of the survey which are entered in the remarks columns of the sounding records were noted and check marked. In all cases appropriate action was taken and exceptions noted in the volumes. Remarks Required: -- None		
12. Condition of sounding records was satisfactory except as follows: Remarks Required: -- Mention deficiencies in completeness of notes or actions for the following: (a) rocks (b) line turns (c) position values of beginning and ending of lines (d) bar check or velocity correctors (e) time recording (f) notes or markings on fathograms (g) was reduction of soundings accurately done? (h) was scanning accurate? (i) were peaks at uneven intervals missed? (j) were stamps completed? (k) references to adjacent features		
Part V - MACHINE PLOTTING		
13. All positions verified instrumentally were check marked in color in the sounding records, and verifier initialed the processing stamp. Remarks Required: -- None		
14. The plotting of all unsatisfactory crossings was verified. Remarks Required: -- None		
15. All detached positions locating **critical** soundings, rocks, buoys, breakers, obstructions, kelp, etc., were verified and the position numbers are legible. Remarks Required: -- None		

Part V - PROTRACTING (Continued)	CL	R
16. The protracting was satisfactory except as follows: Remarks Required: -- Refers to protracting in general except for specific faults repeated often, or faults in control information, which required considerable replotting or adjustments.		
17. The protractor has been checked within the last three months. Remarks Required: -- Date of check, type of protractor and number.		
Part VI - SOUNDINGS 18. All soundings are clear and legible, and critical soundings are a little larger than adjacent soundings. Remarks Required: -- None		
19. Sounding line crossings were satisfactory except as follows: Remarks Required: -- Discuss adjustments.		
20. The spacing of soundings as recorded in the records was closely followed; Remarks Required: -- None		
21. The scanning, reduction, spacing, plotting of questionable soundings have been verified. Remarks Required: -- None		
22. The smooth plotting of soundings was satisfactory except as follows: Remarks Required: -- Refer to legibility, errors in spacing, and errors in numbers - but not to errors in scanning.		
Part VII - CURVES 23. The depth curves have been inspected before inking. Remarks Required: -- By whom was the penciled curves inspected.		
24. The low-water line and delineation of shoal areas have been properly shown in accordance with the following: a. From T-Sheet in dotted black lines b. From soundings in orange c. Approximate position of sketched curve is dashed orange d. Approximate position of shoal area not sounded in black dashed Remarks Required: -- None		
25. Depth curves were satisfactory except as follows: (This statement should not refer to the manner in which the curves were drawn). Remarks Required: -- Indicate areas where curves could not be drawn completely because of lack of soundings. For some inshore areas a general statement is sufficient.		

Part VIII - AIDS TO NAVIGATION	CL	R
26. All fixed aids located together with those on the contemporary topographic sheets, have been shown on the survey. Remarks Required: -- Conflicts of any nature listed.		-
27. All floating aids listed in the Descriptive Report should be verified and checked in soft black pencil, including latitude and longitude and position identification. Remarks Required: -- None		
Part IX - BOATSHEET 28. The boat sheet was constantly compared with the smooth sheet with reference to notes, position of sounding lines and supplemental information. Remarks Required: -- None		
29. Heights of rocks awash were correctly reduced and compared with topographic information. Remarks Required: -- Note excessive conflicts with topographic information.		
Part X GENERAL 30. All information on the sheet is shown in accordance with figures 82 and 83 in the Hydrographic Manual (Pub. 20-2). Remarks Required: -- None		
31. Unnecessary pencil notes have been removed from the sheet. Remarks Required: -- None		
32. Degree, minute values and symbols have been checked; also electronic distance arcs have been properly identified and checked on the smooth sheet. Remarks Required: -- None		
33. The bottom characteristics are adequately shown. Remarks Required: -- None		
Part XI - NOTES TO THE REVIEWER 34. Unresolved discrepancies and questionable soundings.		
35. Notation of discrepancies with photogrammetric survey inserted in report of unreviewed photogrammetric survey or on copy.		
36. Supplemental information.		

Verified by

Date

CAM 312
3/30/76

HYDROGRAPHIC INSPECTION TEAM

ATLANTIC MARINE CENTER

HYDROGRAPHIC SURVEY REVIEW

DATE:

REGISTRY NO.: H-

FIELD NO.:

GENERAL LOCALITY and SPECIFIC LOCATION:

SURVEYED:

PROJECT NO.:

SCALE: 1:________

SOUNDINGS BY:

CONTROL:

Chief of Party ....
Surveyed by ....
....
....
....
....
....
....
Automated Plot by .... Calcomp Plotter #618 (AMC)
Verified and Inked by ....

1. Description of the Area

2. <u>Control and Shoreline</u>
Type-Source-Origin

3. <u>Hydrography</u>

A. Crossings:

B. Depth Curves:

C. Low-water Line:

D. Developments:

4. <u>Condition of the Survey</u>

The sounding records, automated plotting and the Descriptive Report are/are not adequate and conform to the requirements of the Hydrographic Manual, supplemented by the Atlantic Marine Center Manual, with the following exceptions:

5. <u>Junctions</u>

6. <u>Comparisons</u>

A. Prior Surveys:

(a) Recommend:

B. Contemporary Surveys:

(a) Recommend:

C. Wire Drag:

(a) Recommend:

D. Published Chart # ______________________________

______ Edition

Dated: ______

(a) Hydrography:

(b) Attention is directed to the following:

(c) Aids to Navigation:

7. Compliance With Instructions

This survey does/does not comply with the Project Instructions.

8. Additional Field Work

This is an ______ basic survey. Additional field work is/is not recommended.

9. Hydrographic Inspection Team Comments

Hydrographic Inspection Team comments are included within this report and Verification deficiencies found, if any, have been corrected on the Smooth Sheet.

Additional Notes for H- ______