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VESSEL REQUIREMENTS (U) TRANSPORTATION SYSTEMS CENTER
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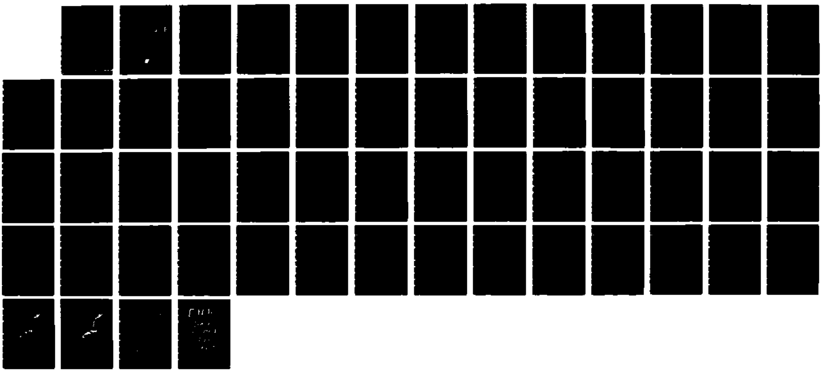

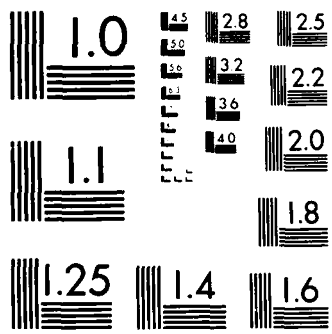

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SERVICE VESSEL ANALYSIS

VOL. I: SEAGOING AND COASTAL VESSEL REQUIREMENTS FOR SERVICING AIDS TO NAVIGATION

George J. Skaliotis, Ph.D.

Transportation Systems Center
Cambridge, MA 02142

Final Report
September 1987

This Document is available to the public through the National Technical Information Service, Springfield, Virginia 22161

U.S. Department of Transportation
United States Coast Guard

Office of Navigation
Washington, DC 20593

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT-CG-N-1-87, I		

4. Title and Subtitle

Service Vessel Analysis, Vol.I: Seagoing and Coastal Vessel Requirements for Servicing Aids to Navigation

5. Report Date

September 1987

6. Performing Organization Code

DTS-53

7. Author(s)

George J. Skaliotis, Ph.D.

8. Performing Organization Report No.

DOT-TSC-CG-87-2, I

9. Performing Organization Name and Address

U.S. Department of Transportation
Research and Special Programs Administration
Transportation Systems Center
Cambridge, MA 02142

10. Work Unit No. (TRAIS)

CG775/B7007

11. Contract or Grant No.

12. Sponsoring Agency Name and Address

U.S. Department of Transportation
United States Coast Guard
Office of Navigation
Washington, DC 20593

13. Type of Report and Period Covered

Final Report
Aug 1986 - Aug 1987

14. Sponsoring Agency Code

G-NSR-2

15. Supplementary Notes

16. Abstract

This analysis determines the number, mix, and home ports of vessels required to replace the aging fleet of WLB (seagoing) and WLM (coastal) buoy tenders currently servicing aids to navigation. A case study approach was used. Differing values of vessel speed, discrepancy response and other mission activity formed the cases. Using the Service Force Mix (SFM) model, the fleet to replace the WLB and WLM service capability was determined. The SFM model is a computer implemented simulation which models the activities of vessels servicing aids to navigation. Given a list of navigation aids which are assigned to available servicing vessels, the model simulates, for each vessel, the annual servicing of those aids and reports the resulting vessel performance.

Although this analysis makes no recommendations, a possible scenario of moderate discrepancy response, improved vessel speed, and single mission would suggest a replacement fleet of 31 vessels (17 seagoing, 14 coastal vessels). This reduces the current fleet by 9 vessels. In this case, four of the vessels saved were attributable to crossing district boundaries and saturating seagoing vessels with coastal aids. Determination of such savings might not have been obvious without the use of this modeling analysis technique.

A separate supplement to this document shows graphic plots of the aid to vessel assignments used for this study.

17. Key Words

Buoy Tenders, Navigation, Simulation, Vessel Replacement

18. Distribution Statement

DOCUMENT IS AVAILABLE TO THE PUBLIC THROUGH THE NATIONAL TECHNICAL INFORMATION SERVICE, SPRINGFIELD, VIRGINIA 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	64	

PREFACE

This study of the replacement vessel requirements for servicing aids to navigation was performed by the Transportation Systems Center (TSC) for the United States Coast Guard, Office of Navigation. It is delivered as part of Project Plan Agreement CG-775 to the Short Range Aids Division (G-NSR-2). The Coast Guard project managers have been LCDR H. H. Sharpe and LCDR A. R. Stiles Jr. The significant contributions of LCDR Stiles toward chapter 3 and for description of the acquisition process are appreciated. The intensive activity of obtaining and verifying accurate data describing thousands of aids to navigation throughout the Coast Guard as well as the need for a thoroughly coordinated study approach has provided the opportunity for an unusually close working relationship between TSC and the Coast Guard project managers. The author gratefully acknowledges the guidance, support, and pleasing nature of this relationship.

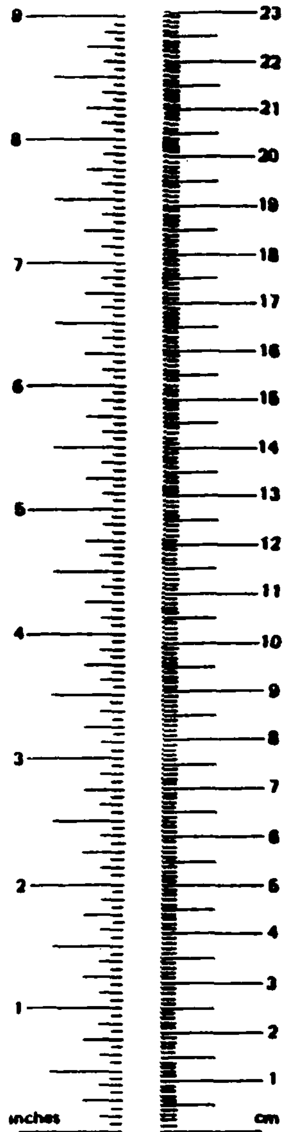
All of the TSC data entry, computer model runs and hand entry of data for and plotting of aid assignments shown in Volume II of this document were cheerfully and tirelessly performed by Kathleen Murphy.

METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

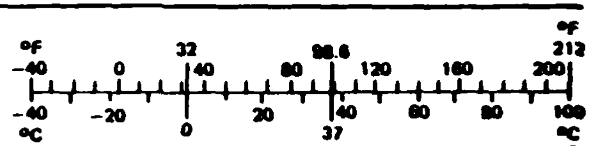
Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
	AREA			
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
	MASS (weight)			
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
	VOLUME			
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
	TEMPERATURE (exact)			
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in. = 2.54 cm (exactly). For other exact conversions and more detail tables see NBS Misc. Publ. 286. Units of Weight and Measures. Price $2.25 SD Catalog No. C13 10 286.



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
	AREA			
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
	MASS (weight)			
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
	VOLUME			
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
	TEMPERATURE (exact)			
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



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EXECUTIVE SUMMARY

This analysis identifies the number, mix, and home ports of vessels required to replace the aging fleet of WLB (seagoing) and WLM (coastal) buoy tenders currently servicing aids to navigation. A case study approach was used. Each case represented different assumptions about the performance and capabilities of the replacements. Differing values of three separate vessel parameters comprised the twelve cases studied. These were vessel speed, discrepancy response and other mission activity. Using the Service Force Mix (SFM) model, the fleet to replace the WLB and WLM service capability was identified.

The SFM model is a computer implemented simulation which models the activities of vessels servicing aids to navigation. Given a list of navigation aids which are assigned to available servicing vessels, the model simulates, for each vessel, the servicing of those aids and reports the resulting vessel performance. Once use of the SFM model identified the initial fleet, a three step process was used to exploit any additional savings. First, vessel home ports were adjusted to see if vessel use can be improved. Then, vessels crossed district boundaries attempting consolidate two underused vessels into one. Finally, attempts were made to saturate underused seagoing vessels with aids from coastal vessels.

To validate the model results, the present fleet size was compared to the results of the analysis case which was closest to current operations. The current fleet size was predicted by the analysis. However, the results suggested a shift in vessel mix, emphasizing the smaller WLM more than is currently being used. This is attributable to the current overlap of servicing capability between WLB and WLM class vessels. The aid assignment criteria set for this analysis eliminated this overlap.

Average vessel speed was a significant factor in the results. The increase from 9 to 13 knots accounted for savings of from 4 to 8 vessels depending on the case considered. The results were not highly sensitive to relocations of individual vessels to nearby home ports.

Although this analysis makes no recommendations, a possible scenario of moderate discrepancy response, improved vessel speed, and single mission would suggest a replacement fleet of 31 vessels (17 seagoing and 14 coastal). This reduces the current fleet by 9 vessels. In this case, four of the vessels saved were due to vessels crossing district lines and saturating seagoing vessels with coastal aids. Identification of such savings might not have been obvious without the use of this modeling analysis technique.

1. INTRODUCTION

1.1. BACKGROUND

One mission of the United States Coast Guard is to provide and service short range aids to navigation. These are the buoys, lights and other devices used by mariners for navigating the waterways. The Coast Guard currently is responsible for about 48,000 short range aids. These aids cover a wide geographical territory which not only includes the continental United States, but extends into the Caribbean, Alaska, Hawaii, and as far west as the Philippines. Each of these aids to navigation receives a routine inspection and servicing annually. In addition to this scheduled service, the Coast Guard responds to reports of outages, called discrepancies. To accomplish this, the Coast Guard maintains and staffs a diverse complement servicing vessels.

This study concerns itself with the largest two classes of servicing vessels, the WLB (seagoing) and WLM (coastal) buoy tenders. There are currently 28 WLB's and 12 WLM's in service throughout the Coast Guard. Most of these vessels were built in the 1940's and have undergone various facility improvements over the years. Improvements notwithstanding, the vessels are well beyond the end of their useful service life and the capability they provide requires replacement. One strong indication that the vessels need replacement is examination of the vessel employment standards. The employment standard for a vessel is a determination of number of days it can be expected to be productively employed in its mission activities. Although the WLB and WLM employment standard is at 170 days, they typically can only contribute about 125 days; the shortfall attributable to unscheduled maintenance.

Accordingly, the Coast Guard has initiated the process prescribed by The Office of Management and Budget (in Circular A-109) for major acquisitions. The first step was submission of a Mission Needs Statement for approval by the Secretary of Transportation. A formal review was then conducted by the Transportation Systems Acquisition Review Council (TSARC). On December 1, 1986, the Deputy Secretary approved the Mission Needs Statement as a result of this TSARC review. This allows the Coast Guard to proceed to the next step, which is development of the Acquisition Paper. In the Acquisition Paper, the capability replacement strategy is developed and issues raised in the TSARC review are addressed. These issues include alternative fleet mix possibilities, numbers of vessels for fleet mix possibilities, and fleet basing alternatives. The analyses presented in this study address these three issues in support of the Acquisition Paper now being developed by Coast Guard Headquarters.

Coincident to this activity, the Transportation Systems Center (TSC) was working with the Coast Guard Office of Navigation to develop a computer oriented aid to assist the Coast Guard District personnel to deal with the "service force mix" problem. The service force mix problem involves the assignment or reassignment of aids to navigation to servicing vessels which have competing demands on their availability. TSC had just completed development of a computer model which simulates the servicing of aids to navigation. The intent was to deliver the model to each Coast Guard District and install it for use on the district Standard Terminal microcomputer. By running the simulation a number of times for different assignments of aids to vessels, alternatives could be numerically evaluated on a consistent basis. The model was designed to provide assistance with such typical resource allocation problems as:

-Determination of which aids to reassign from a WLB to another servicing vessel to provide some additional time for other competing missions.

-Examination of options for decommissioning a servicing vessel.

-Identification of potential savings due to changing the home port of one or several vessels or Aids to Navigation Teams (ANT).

-Evaluation of the possible benefits of consolidating several nearby vessels or ANTs into a single home port.

After TSARC review identified question areas to be answered within the Acquisition Paper, the Office of Navigation and TSC determined that the TSC model could directly and quantitatively address the problem areas of fleet size, fleet mix, and home port alternatives on a consistent basis. TSC undertook the task to use the model to represent the entire Coast Guard on a district by district basis. The result would be to provide a range of answers based on a range of possible vessel designs and conditions of operation. Then, once fleet sizes were identified, a full costing study could help focus the Coast Guard's selection onto the most cost effective alternative. Several embellishments to the model logic were needed, primarily to represent a variety of discrepancy response policy alternatives. The prior TSC effort was redirected to provide this Service Vessel Analysis input to the Acquisition Paper. Upon completion of this current effort, TSC plans to resume work to complete documentation and delivery of the model to the individual Coast Guard districts.

1.2. SCOPE

This study limits itself to the population of short range aids to navigation which are currently serviced by the WLB and WLM class buoy tenders. The entire Coast Guard was considered. Using the Service Force Mix (SFM) model as the evaluation tool, the requirements for replacing the WLB and WLM service capability were identified. This was done separately for twelve different cases which represent a range of design and operational alternatives. The result of this study was to identify the fleet size, fleet mix, and home port basing for the replacement vessels in each of the cases. Beyond the expectation of reasonable planning results within each district, the potential fleet size was further reduced by consideration of alternative home ports, vessels crossing district boundaries, and saturating underused vessels with aids from other vessels. The reorganization of District boundaries arising from the Gilbert study were fully considered. In all, more than 225 separate situations were simulated representing several thousand individual vessel runs of the model. The task required less than one year and represented about 1.5 labor years of effort.

The remaining chapters of this report will provide an overview of the Service Force Mix model, describe the conditions and assumptions of the study, and provide the results of the study. The Appendixes provide additional detailed information. Of particular note is Appendix A which contains the detailed results of fleet size, mix, and home port on an vessel by vessel basis for each of the twelve different cases which were considered. Volume II of this report shows detailed graphical plots of the assignments of aids to vessels used for this study.

2. SERVICE FORCE MIX MODEL (SFM) DESCRIPTION

The Service Force Mix (SFM) Model is a computer implemented simulation which presents an overview of the annual vessel activities in servicing aids to navigation. Given a list of navigation aids which are assigned to any number of servicing vessels, the model simulates the servicing of those aids and reports the resulting vessel performance. By running the model for several alternatives and comparing the results, the effectiveness of several differing aid assignments may be evaluated. This chapter provides a brief description of the SFM model operation. The following sections will describe the data structure, model logic, and reports of results.

2.1. DATA STRUCTURE

2.1.1. Data files. To operate correctly, the SFM model requires three separate files of data. One to describe the aids to navigation, one for the servicing **vessels**, and one to describe the **district** level environment of operation. Figure 2-1 shows these three file structures and enumerates their more important elements.

2.1.1.1. Aids file. The **AIDS** file is used to describe each aid to navigation to be serviced. There is one entry in the file for each aid to be serviced. In special cases where aids are routinely visited by the servicing vessel more than once in a servicing cycle, the aid is shown in the file more than once. The most prevalent example of aids serviced more than once are seasonal aids which are placed in the spring and removed before winter. Others include the Mississippi River aids in the Eighth District which are visited as a group during a trip up the river as many as ten times a year. The fifteen specific characteristics used by the SFM model include: identifying data (number, name, type, authorized hull), location data (waterway, latitude, longitude, depth, exposed or protected environment), servicing vessel, and servicing schedule (next inspection, mooring check, recharge, relief, and any special service).

The order of placement of aids within the file is important. The model acts as a sequential list processor. That is, it will service aids for any particular vessel in the order of placement within the file. Thus, the entries need to be somewhat geographically contiguous. District aid files are often ordered in this way and are entered either by waterway, which is a small geographic area, or by light list order, which essentially follows

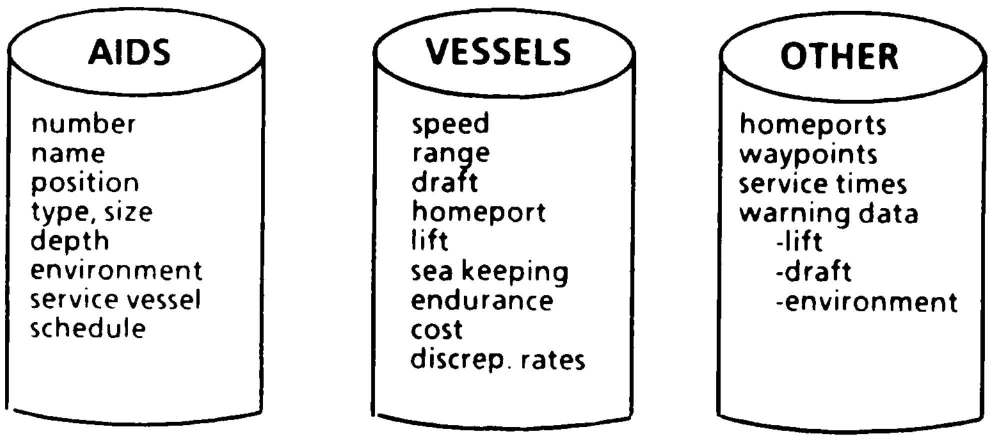

FIGURE 2-1 SFM DATA FILE STRUCTURE

a coastline. If aids within a file are not found to be close to one another, the file must be sorted by an appropriate combination of latitude, longitude and waterway.

2.1.1.2. Vessel file. The SFM model derives all vessel performance information from the **VESSEL** file. Thus, any new vessel designs are completely described by the data fields within this file. This file contains one entry for each servicing vessel. There are 22 fields of information describing each vessel. They include: identifying data (name, class), descriptive data (home port, length of day, draft, service radius, lift, seakeeping, overnight endurance), performance data (economical speed and range, maximum speed and range, fraction of time at economical speed), environmental tolerance (probability of aborting missions due to exposure or visibility), servicing data (discrepancy policy, probability of aids becoming discrepant), hourly cost, and availability (total operational hours, other mission time, additional discrepancy time).

For this study, two generic vessels were defined. The "big" vessel was the replacement vessel to service the seagoing aids and the "small" vessel would service the coastal aids. Specification of the parameters for these replacement vessels were provided by Coast Guard Headquarters. Since vessel costs are highly dependent upon the number of vessels acquired, vessel costs were deliberately omitted from this study. It is presumed that a naval engineering study will separately determine the cost parameters after a fleet size has been identified. Values for specific vessel parameters used for this study are given in Chapter 3.

2.1.1.3. **District file.** In addition to the files describing aids and vessels, there is one which provides a description of miscellaneous district data required to run the model. There are three important categories of district level data required. These are home port descriptions, aid service times, and vessel-buoy environment compatibility.

Each home port is described by a name, a latitude/longitude, and a latitude/longitude of a waypoint. The home port name is matched with the port given in the vessel file for each vessel. This file provides the port location so that travel may be simulated. When ever a vessel leaves its home port, the SFM model requires that it travel to a waypoint before going to the first aid to service. This is because all travel within the model is with straight lines between two points. The provision of a waypoint allows simulation of navigation through a channel before reaching open waters. If no waypoint is necessary, the waypoint location is set equal to the port location.

A prior TSC study [1] examined the service records for ten percent of the aids to navigation in the First Coast Guard District (Boston) dating back through the past ten years for factors which might determine aid service times. Factors examined included, servicing vessel type, year of service, buoy type, buoy exposure, water depth, buoy diameter, and type of service. The only factors shown to be significant in affecting service times were type of service, and exposed vs. non-exposed environment. Accordingly, the SFM model requires separate service times by the categories of service and exposure. A separate TSC examination of

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[1] Factors Affecting Aid Service Times in the First Coast Guard District, Report Number DOT-TSC-CG-569-TM3, Transportation Systems Center, January 11, 1985

the same data [2] provided the service times used in this study. They are given below in Figure 2-2.

TYPE OF SERVICE	EXPOSED	NON-EXPOSED
inspection	0.7	0.4
mooring	1.1	0.5
recharge	2.3	1.1
relief, or relief and recharge	0.9	0.4
relief and mooring	1.2	0.6
recharge and mooring	2.8	1.4

FIGURE 2-2 TIME ON STATION BY TYPE OF SERVICE (HOURS)

The Coast Guard Districts are in the process of converting local aid files into a common format database, ATONIS (Aids to Navigation Information System). This database provides for full descriptions of each aid in the district. One of the fields of information maintained in ATONIS describes the environment of the aid (exposed, semi-protected, or protected). Since the SFM model selects appropriate service times by exposed vs. non-exposed environment, it is essential that this data be provided. Thus, the third category of district data within the model is a default matrix of values which can be used to assign an appropriate environment for each aid in the ATONIS system which does not already have an entry for environment. This assignment is based on buoy size.

2.1.2. Data Sources. The primary source of data for the aids to navigation consisted of the District level ATONIS files. The data fields specifically required by the SFM model were requested from the individual districts for aids now serviced by WLB (seagoing) and WLM (coastal) buoy tenders. These data were supplemented for known unusual conditions which would cause an aid to be serviced more often than annually. One such condition is the placement and subsequent removal of seasonal aids.

Discrepancy data were also derived from district data and were calculated separately for WLB and WLM vessel types. In most cases, these numbers represent data for the most recent four quarters.

Other sources of SFM model data included district level abstracts of operation, vessel records, commandant instruction and

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[2] Service Times for Short Range Aids to Navigation in the First Coast Guard District, Report Number TSC-CG-569-TM-5, Transportation Systems Center, June 5, 1985.

prior service force mix studies conducted by TSC. The subjects covered by these studies included: service times, types of service, vessel availability, vessel performance, aid servicing requirements, allowable assignments of aids to vessels, wind and wave conditions, and visibility conditions.

2.2. MODEL LOGIC

The Service Force Mix Model is an event oriented, deterministic, computer simulation of vessels servicing aids to navigation. It is written in Pascal and consists of approximately 6,000 lines of code. The code is divided into six major modules: an executive, text editor, aid file processor, vessel file processor, calculation/display processor, and random access file processor. These modules are compiled and linked together and operate on the Coast Guard Standard Terminal microcomputer.

The model is menu driven. It can be operated with no specific knowledge of the internal workings of the program. Rather, a person knowledgeable in servicing aids to navigation can operate the model by making several simple menu selections offered to him or her on several successive computer screens. In addition to running the simulation, the operator can edit the vessel and district files, and can change the assignment of aids to vessels in a variety of ways. The data for the model, described above, are provided in the form of text files which are read and converted by the model in appropriate formats for SFM model consumption.

The model logic is centered on the operation of a single vessel. Aids from the ordered assignment list are provided to the vessel one at a time for servicing. The vessel's operations are simulated and its performance is recorded. Each vessel is processed until the district's operations are complete. Since the aids on the list are serviced annually by the vessel, the simulation represents the annual vessel activities. The primary measure resulting from the simulation is a vessel use factor which is a measure of the time each vessel is used compared with its adjusted available time.

Vessel activities which are represented include steaming from home port to an aid through a waypoint, servicing that aid then steaming to the next aid and servicing it. The process is repeated until the day is done. Then, depending upon the vessel parameters, the vessel will either set anchor and rest overnight, or return to home port and begin the next and successive days until all of its aids are serviced. Associated with each vessel are some additional parameters which allow for a more realistic simulation of its activities. For example, the effects of bad weather are represented by indicating the percentage of aids for which the servicing vessel must return to home port before completing the sortie (aid servicing trip).

Also associated with each vessel is a discrepancy percentage and servicing policy. The discrepancy percentage represents the percent of aids which must be visited a second time. The discrepancy aid list is generated by selecting the appropriate number of aids from throughout the original aid list and merging the discrepancy list back into the regular list. The policy for servicing these discrepancies can be set to three levels of response. Level "A" (immediate response) requires each discrepancy to be serviced as it occurs. The order of the discrepancies is scrambled so as not to replicate the order in the original list. Upon completion of the current aid's service, the vessel proceeds to the discrepancy, services it, and then returns to the regularly scheduled list. Level "B" (moderate response) allows for the vessel to complete it's sortie before servicing discrepancies. When the vessel returns to home port, all accumulated discrepancies are serviced, and then service on the regular list is resumed. Level "C" (deferred response) is the least restrictive. It presumes that the discrepancies will be serviced when the vessel is next in the area. Thus, no steaming time is allowed for discrepancy response other than 30 minutes for positioning.

The specific sequence of operations used to service a single aid for a single vessel is shown in the flow chart on Figure 2-3. The process begins on the upper left corner of the diagram where the model attempts to fetch the next aid from the list to be serviced. If there are no more aids left in the list, then the vessel steams home (only if it has left home) and the results are tabulated and stored. If an unserviced aid was found in the list, the model first checks the weather. If the weather is found not to be ok, then the servicing vessel is sent back to home port before steaming to the aid. If the weather is acceptable, then a check is made to see if there is enough daylight to steam to the aid and service it. If there is not enough daylight, a check is made to see if it is possible to rest overnight. If so, the anchor is set and the aid is serviced the next day. If not, the vessel is sent to home port and steams to the aid the next day. From whichever situation, the aid is finally reached by the vessel and is serviced. The entire process is then repeated as an attempt is made to fetch the next aid to be serviced from the list.

This process is completed for each vessel until all the specified vessels, which may include all within the district, have been simulated. The results are then summarized and reported as the operator may select and print.

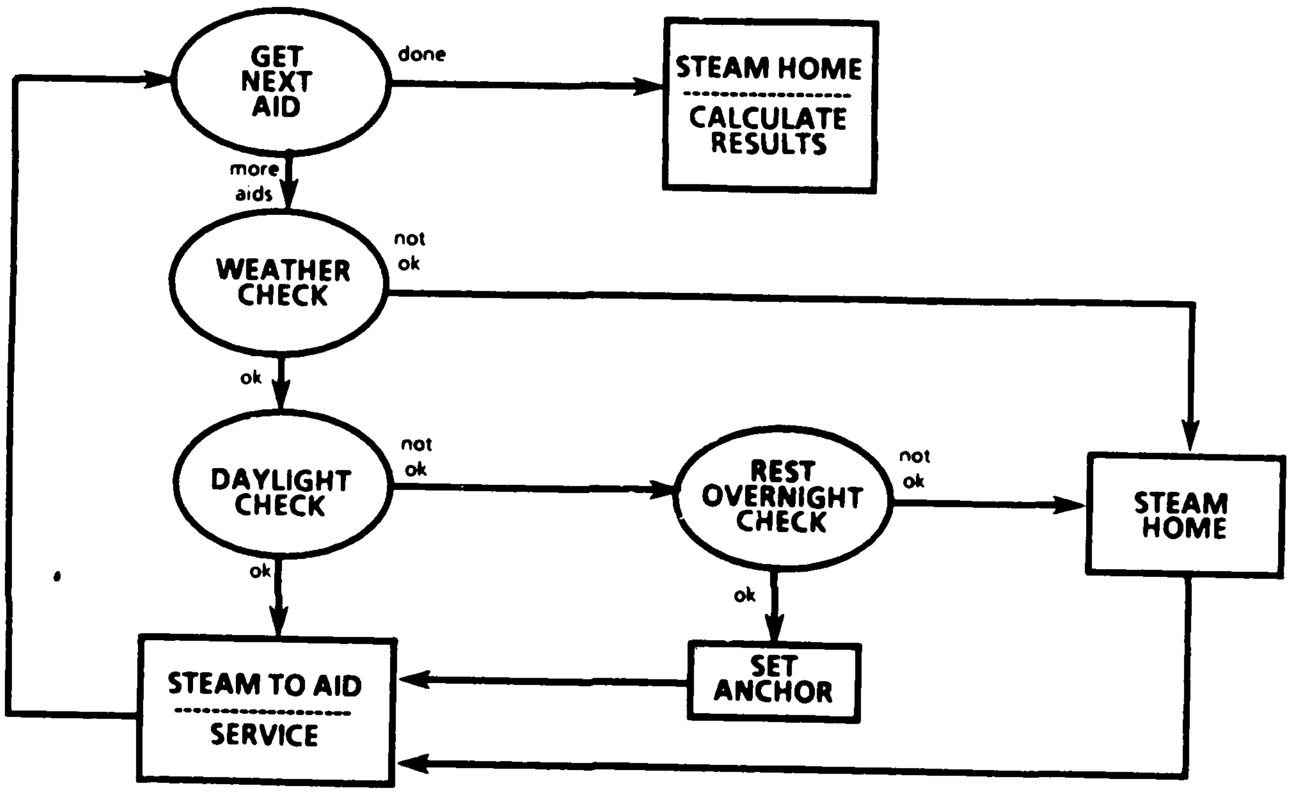

FIGURE 2-3 SFM MODEL LOGIC DIAGRAM

2.3. MODEL OUTPUT

The Service Force Mix Model provides the results of its calculation on a single screen. This screen may also be printed. Each output screen may represent either a single vessel, a class of vessel (such as seagoing or coastal), or may summarize results for the entire district. Figure 2-4 shows a sample output screen from the model.

The results are divided horizontally into three sections. The first is a header section which identifies the conditions, dates, files, and district of the run. The middle section describes the input parameters of the run. The last section shows the resultant model calculations. The portion marked "AIDS" shows the number of scheduled aids and discrepancies which were serviced. If an aid is outside of the radius of service (as measured from the vessel's home port), then it is skipped. The "TIME" section shows hours spent within each category. The "TRIP RESULTS" section shows various categories of sorties and the days elapsed in performing the service.

Finally, the "PRODUCTIVITY" section gives the measures of interest to this study. The primary performance measure is "USE %". This measures a vessel's use rate. If a vessel is fully employed, its use percentage will be 100. Since the higher the use percentage, the less the need for additional vessels, the goal of assigning aids to vessels is to use the vessels as fully as possible. By combining results for all of the vessels in a district, different assignments can be compared so that the best may be favored. The next section will discuss strategies used to minimize the required replacement fleet size.

```
Aids: RUN2-2                         SERVICE FORCE MIX         aids created: 01/30/87
Plat: RUN2-2                              648 aids             aids altered: 02/17/87
                                     8th DISTRICT  2/19/87

BIG-2  BIG                           CALCULATION RESULT      RUNID:

speed  9.0 kn (9-9)              PORT: GALVESTON                         AVAILABILITY
range 99.9 K-nm(99.9-99.9)                                      employment  2380 hr
 time  100 % economical speed                                   other miss   595 hr
  ron    5 days          max sea E (Exp,Semi,Prot)             adl discrep     0 hr
  day   14 hr            exposed abort    0.0 %                  net AtoN   1785 hr
 lift   20 tn               other abort   8.0 %
draft   13 ft          aids descrepant   84.0 %         500 nm service radius
 cost    1 $/hr    POLICY A - discrepancies done after current aid is done

     AIDS                            TIME (hrs)              TRIP RESULTS
   179 scheduled                 694 sched steamtime       29 total sorties
   150 discrepancy               542 discr steamtime        0 exposed aborted sorties
   329 TOTAL DONE                243 sched worktime        27 other aborted sorties
     0 skipped                   204 discr worktime        98 total days  59 days away

PRODUCTIVITY          cost:        5 dollars per aid     TOTAL COST OF $1684
                      trip:      3.0 calculated days per sortie
                      time:      27 % u/way time working aids
                       use:      94 % available time used
```

FIGURE 2-4   SAMPLE OF SFM MODEL OUTPUT

3. STUDY STRUCTURE

3.1. OBJECTIVE

The objective of this study is to identify the number, mix, and home ports of vessels required to replace the aging fleet of WLB and WLM buoy tenders currently servicing aids to navigation. A case study approach was developed whereby each case represented a different set of assumptions regarding the performance capabilities and expectations for the replacement vessels. Twelve cases were defined and analyzed. These cases represent the range of consideration for vessel design parameters. Once fleet sizes for each of the cases has been identified, a separate naval engineering study can estimate the costs for the differing sets of assumptions.

The Transportation Systems Center has recently completed development of a computer model which simulates the servicing of aids to navigation. Through extensive use of this simulation, this study identifies the minimum fleet size and mix (of seagoing vs. coastal vessels) for each of the twelve defined cases. Consideration of different home ports for the vessels provided an opportunity to further reduce the required fleet sizes. Through adjustment of home ports, assigning aids to vessels across district boundaries, and saturating underused seagoing vessels with the aids assigned to some of the coastal vessels, the fleet size was minimized.

3.2. APPROACH

3.2.1. **Case study structure.** Three separate vessel parameters were identified to define the different cases to be studied. They were vessel speed, discrepancy response policy and, for seagoing vessels, whether they were single mission or multi-mission. The range of cases is formed by each of the possible combinations of values for these three parameters. Each of the parameters is explained below. The twelve cases are as defined as given in Figure 3-1.

3.2.1.1. **Vessel speed.** The two speeds selected were 9 knots and 13 knots. These speeds do not represent maximum vessel speeds. Rather, they stand for average operating speeds. The 9 knot case was selected by Coast Guard Headquarters as most representative of current operations where the top vessel speeds range from 12 to 13 knots. To represent a newer, more capable

CASE	SPEED	SEAGOING MISSION	DISCREPANCY RESPONSE POLICY
A	9 knots	single	A
B	9 knots	single	B
C	9 knots	single	C
D	13 knots	single	A
E	13 knots	single	B
F	13 knots	single	C
G	9 knots	multi	A
H	9 knots	multi	B
I	9 knots	multi	C
J	13 knots	multi	A
K	13 knots	multi	B
L	13 knots	multi	C

FIGURE 3-1 DEFINITION OF TWELVE STUDY CASES

vessel with a top speed of 15 to 16 knots, a 13 knot speed was selected. The decision was made to not examine a case where the new vessels were less capable than today's fleet.

3.2.1.2. **Discrepancy policy.** A discrepancy is a defect in an aid to navigation which requires a buoy tender visit for correction. An example would be if a buoy's light were reported to be unlit. A vessel may exhibit a range of discrepancy response behavior, from immediate response to a deferred response. Because the level of responsiveness affects a vessel's availability for scheduled service, it also has a direct effect on the number of vessels required to perform the mission. Thus, discrepancy response policy is an important variable in the case study structure.

The Service Force Mix Model provides for analysis of three different levels of vessel discrepancy response: the responsive extreme of immediate response, a moderate midpoint, and the unresponsive extreme of deferred response. In terms of the SFM model's operation, discrepancies arise evenly spaced in time throughout the servicing period of one year, although their occurrence is in no particular geographic order within the servicing area.

Immediate response **(policy A)** dictates that when a discrepancy arises the vessel will travel to it and provide service immediately after completion of the aid currently being serviced. This is true regardless of how far away the discrepancy might be. Upon completion of the discrepancy service, service on the regularly scheduled list of aids is resumed.

The moderate response (policy B) allows discrepancies to accumulate until the servicing vessel returns to home port. Then, all unserviced discrepancies are serviced in a reasonable geographic order. Upon completion of all outstanding discrepancies, service on the regularly scheduled list of aids resumes. The discrepancy list is so checked and serviced upon each return to home port.

Deferred discrepancy response (policy C) assumes that each discrepancy will be serviced only when the vessel is in the area. Therefore, the only vessel travel time allowed under this option is 30 minutes which presumes the vessel is nearby but needs a bit of positioning to service the aid and place it on-station (into the proper location).

Policy B was selected to approximate current Coast Guard policy. Policies A and C were chosen to determine the sensitivity of discrepancy response policies on fleet size. We found that Policy B did, in fact, approximate current practice. The current fleet size is replicated by the SFM model at a point one quarter the distance from B toward C.

3.2.1.3. Single vs. multi-mission. The coastal vessels have consistently remained single mission. That is, they only perform aids to navigation functions. Alternatively, the seagoing vessels have traditionally performed multi-mission activities. Thus, they not only service aids to navigation, but also assist in such mission areas as search and rescue, enforcement of laws and treaties, military operations, and in some cases, ice breaking.

The third case study parameter, then, allows for two possibilities as regards single vs. multi-mission. The seagoing vessels can be either multi-mission, as is current practice, or they can be single mission which would represent an increased vessel availability and, thus, a requirement for fewer replacement vessels. The effects of single mission seagoing aids to navigation vessels on the other Coast Guard mission areas was addressed in a recent internal Office of Navigation study. [3]

Figure 3-2 below shows the percent of the available vessel time which is presumed by the SFM model to be dedicated to the Aids to Navigation (AtoN) Mission. In the single mission cases, the other time is considered to be Coast Guard "overhead" time and would include operational training and emerging activities such as search and rescue. The difference between seagoing and coastal

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[3] WLB Multi-Mission Utilization and Replacement of WLB Capability; internal document; U.S. Coast Guard Office of Navigation, Short Range Aids Division; June 1987

availability for single mission is attributable to the nature of seagoing vessels which, because of their greater endurance and capability are in greater demand for diverted activities.

VESSEL CATEGORY	AtoN MISSION DEDICATION
Seagoing - single mission	75%
Seagoing - multi-mission	55%
Coastal - single mission	85%

FIGURE 3-2 PERCENT AVAILABLE TIME DEDICATED TO ATON MISSION

3.2.2. **Assigning aids to vessels.** The aids to navigation considered by this study were restricted to those which are currently assigned to the WLB (seagoing), and WLM (coastal) class buoy tenders, since these are the candidate vessels for replacement. The study area was comprised of the entire Coast Guard, although there were no aids currently serviced by WLB's or WLM's in the Second District (St Louis).

Currently, there is an overlap of servicing capability between WLB and WLM class vessels. The WLB, when convenient, will service aids which could be serviced by a WLM. The aid assignment criteria set by Coast Guard Headquarters for this study obviates this overlap, unless it results in a reduction in the overall vessel count. Since this will have the effect of offloading some aids from the seagoing to the coastal tenders, the net result of this tightening of assignment policy will be to reduce the number of the larger, more expensive vessels in favor the smaller ones.

Each aid in the list was assigned to either a seagoing aid or a coastal vessel. The conditions for seagoing vessel assignment are given in Figure 3-3. If one any of the conditions were met, then the aid was declared seagoing. All others were assigned to coastal vessels.

-all aids 8 feet or greater in diameter
-all first class buoys
-all aids in exposed waters

FIGURE 3-3 AID ASSIGNMENT CRITERIA

These assignments were the initial ones. To eliminate the service overlap, they provide for a coastal vessel which is less capable than the current WLM's. In some individual cases, the assignments were subject to change in the fleet optimization phase which is described below.

To assist in the assignment process and ensure that the assignments of aids to vessels was geographically reasonable, graphic plots were made of the significant assignments. These plots show the home ports, vessel track lines, and the aids assigned to these vessels. Volume II of this study contains the complete set of plots.

The assignment process is performed at the district level. The first step is to assign all aids to either a single seagoing or coastal vessel according to the above criteria. This single vessel is to be centrally located within the district. Then the SFM model is run and results usually show each vessel to be oversubscribed. The use percentages then give an indication of how many vessels of each type might be needed. The aids are accordingly reassigned to additional vessels placed within the district. The SFM model is rerun in this way until the proper number of vessels results. The end product of this activity is identification of the initial fleet. This initial finding is then subjected to an optimization procedure whereby, any opportunity for saving additional vessels is exploited.

3.2.3. **Optimizing fleet size.** The process of optimizing the fleet size for any individual case involves three separate sequential steps. First, vessel home ports are adjusted to see if vessel use can be reduced due to the particular geography of the situation. Then aids in an adjoining district are assigned to the vessel in the hope of sharing one vessel between two districts where there were previously two vessels. Finally, opportunities are explored to saturate an underused seagoing vessel with the aids from a coastal vessel to cause additional savings. At that point, the case is considered complete and the resultant fleet sizes are reported.

3.2.3.1. **Home port assignments.** Other than certain ports which cannot accommodate seagoing vessels, there were no restrictions placed on the use of current home ports for the replacement vessels. Thus, the analysis was able to assess different home ports to minimize the fleet size. Once the initial assignment of aids produced a fleet size, nearby home ports were tried for the replacement vessels to determine if any further reductions in vessel use percentages were attainable. If so, the home ports were changed to produce the lowest possible vessel use. This process does not, in itself, result in fewer vessels.

However, if the vessel use level can be lowered, there is a greater chance of vessel consolidation by either sharing or saturation as described below.

3.2.3.2. **Vessel sharing.** Similarly, the results were not to be constrained by geographical district boundaries. Thus, if two adjacent districts had underused vessels of like type, the opportunity for one of these vessels to service the aids previously assigned to both was examined. The procedure developed to perform this examination was called vessel sharing.

To describe the process, presume that two adjacent districts, A and B, each have a seagoing vessel home ported near the common district border. Additionally, A's vessel is 45% used and B's is 40% used. First, we check to see if either vessel can do the other's aids in addition to its own. To simulate A servicing B's aids, a run is made of B's aids from A's home port. If the resulting use percentage, when added to A's regular use percentage is less than 100% then A is assigned B's aids and B is eliminated. If not, then B is similarly checked with A's aids.

If the vessel use percentages are still too high, as many aids as possible are reassigned from A and B to other vessels within their district. This is done until the others' use percentages are as close to 100% as possible. The result is to release some servicing capacity for the vessels under consideration for sharing. The attempt at sharing is then retried and at that point, the attempt is either deemed successful or not. Appendix C enumerates all attempts which were made at vessel sharing.

The Gilbert study [4] is an internal Coast Guard examination of administrative and operational structure. One set of results from this study which have been implemented include two cases of consolidation of districts. In one of the cases a district was split in two and made a part of the adjacent two districts. In the other case, two districts were made into one. As regards this Service Vessel Analysis study, the Gilbert study presents a special case of vessel sharing. This study accounts for the Gilbert consolidations.

3.2.3.3. **Vessel saturation.** When all potential savings due to home port assignments and vessel sharing have been exhausted, attempts at vessel saturation are tried. Vessel saturation can occur within any district with an underused seagoing and coastal vessel in nearby home ports. The attempt is

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[4] Realignment of Support and Management Function for the United States Coast Guard; RADM Gilbert; February 1987

successful when the seagoing vessel has sufficient excess capacity to offload all of the coastal vessel's aids, thus obviating the need for the coastal vessel. Appendix D shows all attempts at vessel saturation.

The concept of vessel saturation can confound a strict interpretation the objectives of this study. This is because the rules of aid assignment to vessels are not being totally followed. However, since vessel saturation contributes to the overall goal of minimizing the fleet, it was used.

3.3. DATA

3.3.1. **New vessel parameters.** The values for the parameters of operation used by the SFM model for the seagoing and coastal tenders are shown below in Figure 3-4.

The range was set to an arbitrarily high value within the SFM model. In current operations operating range is not a limiting factor and was set so it wouldn't be a model constraint. The range on existing cutters is from 13,500 to 23,000 nautical miles for the WLB and from 3,000 to 8,700 for WLM, depending on particular vessel design. Determination of appropriate range is a good topic for the subsequent naval engineering study, since reducing excess range in a vessel could well reduce its final purchase and operating costs. This is because a reduction of a vessel's range could reduce it's volume and weight.

PARAMETER	UNIT	SEAGOING	COASTAL
range	n-mile	99900	99900
rest overnight (RON)	days	5	2.5
length of day	hours	14	10
lift	tons	20	10
draft	feet	13	7
max sea		exposed	semi-protected
service radius	n-mile	500	500
employment	hours	2380	1700
other missions (single)	hours	595	255
other missions (multi)	hours	1071	n/a

FIGURE 3-4 VESSEL PARAMETER VALUES

Rest overnight endurance (RON) was derived from Coast Guard data in the Abstract of Operations for FY86. The days away from home port compared to the number of trips supported the values of 5.0 and 2.5 days as the approximate average current experience. Actual endurance is longer but based on experience, trips are practically limited by other considerations such as deck load, daylight, and crew considerations including crew endurance. The

RON design for the new vessel was kept the same since the nature of operations would be unchanged.

The length of day was determined based on analysis of the Abstract of Operations for the Fiscal Years 1981 through 1985. Lift, draft, and max sea were set based on the criteria established for which aids would be serviced by each vessel class.

Service radius is an internal SFM model check on the aid position data. It is meant to call attention to an aid which has an erroneous latitude or longitude associated with it. Service radius is measured from the vessel's home port.

Current employment standards are at 170 days for the vessels considered. The employment values are derived by multiplying 170 days by the appropriate number of hours per day. It should be noted that although the standards show 170 days, historically the WLB's and WLM's are only achieving about 125 days per year. The fact that most of the fleet is about 45 years old accounts for the additional maintenance which keeps these vessels operating below their standard. A new ship should operate at the design specifications. Times set aside for other missions are derived from the values given in Figure 3-2 above.

3.3.2. Data collection. Each district provided to TSC a diskette containing the appropriately formatted data. These data included a file describing the selected aids to navigation, a vessel file describing the current fleet, and a home port file containing all potential home ports for both seagoing and coastal vessels. Once received, these data were verified for correctness of format. They were then loaded into the SFM model for preliminary analysis. Often the existing vessels and conditions were run to verify that the aid files provided were correct. The list of aids was then plotted with vessel track lines shown to verify that the sorting of the aids list was also correctly done. In many cases, several rounds of revisions were necessary before the data were certified correct for use. All data collection and revision requests to the districts were coordinated through Coast Guard Headquarters.

3.3.3. Special district conditions. The Mississippi River aids in the 8th District were treated separately to better simulate actual servicing conditions. Currently, these aids are serviced as a group ten times per year because of significant fluctuations in river levels. To simulate this activity, a single trip up the river was simulated. The results were multiplied by ten and then folded by hand into the results for the appropriate coastal vessel. The remaining capacity for that vessel was then available for other servicing functions.

Throughout the study, the 11th District San Pedro seagoing vessel has been assigned both seagoing and coastal aids. This is due to the combination of a sparse density of aids with distance of coastline. This difference in assignment practice was preferred to the alternative of assigning a seagoing and a coastal vessel, both of which would be highly underused. Currently, a single WLB (seagoing buoy tender) serves the area.

Because of ice conditions, several districts, such as the 5th (Portsmouth) and the 9th (Cleveland), service some of their aids on a seasonal basis. That is, two trips to the aid are made instead of the normal single trip. One trip to set in the aid in the spring, and one to relieve it before winter. In these cases, the aid list has two separate entries for each aid to simulate these activities.

The following home ports were restricted to coastal vessels either because they could not physically accommodate a seagoing vessel or they were not suitable as a base for seagoing operations:

-Crisfield
-Alexandria
-Ft Pierce
-Oak Island
-Kennewick
-Bangor
-Sand Point

The status of the conversion to the standardized ATONIS (Aids to Navigation Information System) database varied from district to district. Accordingly the 9th district database did not yet contain usable latitudes and longitudes. These were entered for use by the SFM model by hand. The positions were derived and estimated based on a comparison with the light list database.

Because the unusually long steaming distances in the 14th District (Hawaii) require vessels of great endurance, only seagoing vessels were used. This matches current practice.

Although not a consideration within this study, some of the locations in the 17th District (Alaska) require transit across extreme environments. The program manager may wish to consider substitution of seagoing vessels for some of the coastal tenders.

The data in this study fully consider the two changes in districts boundaries mandated by the Gilbert study. These changes include dividing the 3rd District (New York) and merging its pieces into the 1st (Boston) and the 5th (Portsmouth) Districts; and consolidating the 11th District (Long Beach) with the 12th (Alameda).

4. RESULTS

4.1. SUMMARY OF RESULTS

The end product of this study is the identification of the number of vessels of each size which would be required to replace the current fleet of WLB and WLM class buoy tender for each of the twelve defined study cases. Appendix A gives these detailed results along with the list of home ports which provide these fleet sizes. Those results are summarized here in Figure 4-1. Note that although only seagoing vessels are allowed to operate in a multi-mission mode, the number of coastal vessels differs with the single and multi-mission cases. This is because the opportunities for sharing vessels differs with each of the cases, so the end result can be different. The results are shown regrouped by the operational parameters of discrepancy response policy and seagoing mission, then the design parameter of speed is given.

CASE	DISCREPANCY RESPONSE POLICY	SEAGOING MISSION	SPEED	REPLACEMENT VESSELS NEEDED SEAGOING	COASTAL	TOTAL
A	immediate	single	9 kts	23	16	39
D	response		13 kts	19	14	33
G		multi	9 kts	28	19	47
J			13 kts	22	18	40
B	moderate	single	9 kts	19	16	35
E	response		13 kts	17	14	31
H		multi	9 kts	25	17	42
K			13 kts	20	14	34
C	deferred	single	9 kts	17	15	32
F	response		13 kts	16	10	26
I		multi	9 kts	22	14	36
L			13 kts	17	13	30

FIGURE 4-1 SUMMARY OF STUDY RESULTS

Several observations can help place the results in perspective. First, this chart represents a compilation of a great deal of information. Each line of the chart is a separate case study and has its own set of special conditions which make it uniquely different from the others. Appendix A should be consulted for interpretation of any individual case results. By summarizing here, the results achieved in any one case may be compared with the others.

The discrepancy policy differences used by the SFM model represent two extremes and a mid-point. It is unlikely that the extremes would ever be sought as a goal or achieved. The immediate response policy (policy A) is probably too costly to achieve. Since, in policy A, there is no planning of discrepancy response activity, it represents a situation where less time is available for routine servicing. So either a greater number of vessels must be committed to the mission, as the analysis results suggest, or the state of repair of the aids will worsen causing an increasing number of discrepancies and exacerbating the problem. The opposite extreme of deferred response (policy C) begins to suggest problems with overall system safety. However, one can think of the different policies as being on a line and the number of vessels for each of theses policies as points on the line. One could then select a fleet level representing a discrepancy response somewhat less than the extremes.

Multi-mission is represented within the SFM model by subtracting multi-mission time from available vessel time, unlike different discrepancy policies which cause different vessel traffic patterns. Thus, the effects of differing availabilities is most directly measured by looking at multi vs. single mission operations.

Speed is a significant factor. The increase of average speed from 9 to 13 knots accounts for savings of from four to eight vessels depending on the case considered.

This report does not recommend any case over another. Rather, it's purpose was to provide a range of values so that costing factors may be applied and an overall cost effective solution will be achieved. However, if one's criteria were to avoid the discrepancy policy extremes and then try to minimize the fleet size by selecting the faster speed and the single mission option for seagoing vessels. The resulting selection would be case E where a total of 31 vessels would be required. This represents a substantial savings over the current fleet of 40.

An examination of case E in Appendix A shows that this minimum fleet size was due in part to vessels crossing district boundaries in the Fifth, Eighth, and the Thirteenth Districts. In the Ninth District, the seagoing vessel ported in Detroit was also given Detroit's coastal aids, thus saving one coastal vessel.

These practices of vessel sharing and saturation accounted for similar savings throughout the case studies. One might argue that conventional wisdom within the districts would properly identify each district's minimum fleet. One possible contribution of this modeling technique is to identify those opportunities for saving vessels by sharing between districts which might be more difficult to determine in a less structured analysis.

4.2. VALIDATION OF MODEL OPERATION

One check on the validity of the SFM model, it's logic and the appropriateness of the data used would be to select that case which is closest to current operations and compare the results with the current fleet size. By definition of the cases, the current case is modeled by the 9 knot and multi-mission option. The current discrepancy response policy is closest to the moderate policy B. As indicated earlier in this report, discussions with Headquarters personnel established the current case to be between policies B and C, closest to B. This would make the closest comparison with case H, or part of the way between case H and case I.

Currently there are 28 WLB's and 12 WLM's in service for a total of 40 vessels. The SFM model analysis yielded 42 vessels for case H and 36 vessels for case I. Thus, for total vessels, the SFM model technique replicates current operations.

If one were to interpolate between the two cases to arrive at the 40 current vessels, the result would suggest 24 WLB's and 16 WLM's are needed. Thus, the analysis suggests that the current fleet mix could well shift to more emphasize the WLM contribution to the effort. Since these numbers are not far from the existing fleet, we may be measuring here the current overlap in servicing capability. Removing this overlap has the effect of downsizing the overall fleet.

4.3. COST CONSIDERATIONS

This analysis is predicated upon the notion that a complete life cycle costing study will be performed based upon the fleet sizes identified herein. This would entail a naval engineering study of the implications of the specific vessel parameters used. Therefore, this analysis cannot result in any recommendations based on cost.

However, one cost observation is offered for consideration. WLB's and WLM's are large vessels requiring large crews for proper operation. Thus, one driving cost factor is crew costs. A significant factor affecting crew cost will be single vs multi-mission. This is because multi-mission operations reduce a vessel's availability for Aids to Navigation service. Also, one factor affecting current WLB crew size is the requirement for multi-mission capability, that is, the need for long endurance, sustained twenty four hour watch, etc. If the seagoing vessel's mission could be redefined to single, some of the endurance and watch provisions would be obviated and a double savings could result. First, a saving of the number of vessels would ensue due to more available time for AtoN mission; also, the cost per vessel would be reduced due to the reduced crew size requirement.

4.4. CONCLUSIONS

Although recommendations can be developed only after the costing implications of the different possible minimum fleet sizes are fully considered, an obtainable scenario of improved vessel speed and dedication to single mission would suggest a replacement fleet of 31 vessels (17 seagoing and 14 coastal). This is a reduction by 9 over the current fleet of 40 WLB and WLM class vessels.

The home ports selected were reasonable choices but are by no means to be thought of as the only choices. They represent one solution which caused the minimum fleet size to be identified. However, choosing others in many cases would provide similar results. The results were not highly sensitive to relocations of individual vessels to nearby home ports. Thus, other factors could mitigate the choices made within this analysis. For example, the optimized home port locations do not address the availability of housing or required shore support facilities. Examination of the individual case results in Appendix A would determine how critical any individual home port would be to the results.

The reorganization of district boundaries arising from the Gilbert study were fully considered. Since the analysis considered the crossing of district lines in minimizing the fleet, the results were not affected by this reorganization other than in the format of presentation of the results.

The results for any particular district are subject to redirection dictated by local conditions. For example, in the Ninth District (Cleveland), ice conditions might cause separate consideration of the use of all seagoing vessels within the district. The same might be true for parts of the Seventeenth District (Alaska) where the environment might be particularly harsh. Such changes would not likely affect the fleet size (31 vessels) but could alter the fleet mix to, for example, 21 seagoing and 10 coastal tenders. Such considerations are beyond the scope of this analysis.

This was an analysis of aids serviced by the Coast Guard's WLB and WLM class buoy tenders. Using the Service Force Mix (SFM) model as the evaluation tool, the requirements for replacing the WLB and WLM service capability were identified. This was done separately for twelve different cases which represent a range of design and operational alternatives. The result of this study was to identify the fleet size, fleet mix, and home port basing for the replacement vessels in each of the cases. These are summarized in Figure 4-1 above, and presented in detail in Appendix A. Beyond what might be expected to result from a similar planning effort from the individual districts, the potential fleet size was further reduced by consideration of alternative home ports, vessels crossing district lines, and saturating underused vessels with aids from other vessels.

APPENDIX A. DETAILED CASE RESULTS

This section provides the detailed results which were summarized in the main text of the study. Each of the twelve cases considered are presented on a separate sheet. The conditions defining each case are identified along the top of the page. The results are then given by district for both seagoing and coastal buoy tenders. The information given for each vessel includes home port, the number of aids assigned to the vessel, and the percentage of vessel capacity which was used to service the aids, including discrepancy response. The column marked RUNID is given only to catalog the physical location of the computer results sheets so they may be found if any question arises. Thus the RUNID column should not be of interest to most readers.

The vessel column is also occasionally marked with a "*" or a "#" character. Vessels marked with a "*" have aid assignments across district boundaries. They represent a situation where the aid assignments to two underused vessels in adjacent districts were consolidated onto a single vessel. The end result was to lower the required number of vessels so that inconvenient district boundaries did not arbitrarily increase the recommended number of required vessels. Similarly, vessels marked with a "#" involve aid assignments for seagoing vessels which include aids properly assigned to coastal buoy tenders. In cases where this reassignment was possible, the need for coastal vessels was reduced.

Certain entries on particular case results sheets are marked with footnotes which further describe unusual individual situations. The following comments apply to all results sheets:

-Aid counts shown throughout the results sheets reflect the numbers of aids assigned to the vessel. The number of aids serviced is higher due to discrepancy service. The use percentages reflect all service, including discrepancy response.

-The aid counts shown for the "coastal-2" vessel in New Orleans does not reflect the Mississippi River aids, which are included in the use percentages. This is because these aids were treated separately and then added into the results. Current practice is simulated by servicing these aids as a group ten times per year. Thus the port of New Orleans is critical to this coastal tender.

-Note that throughout the study, the San Pedro vessel has been assigned both seagoing and coastal aids. Since this was done at the outset, no vessel savings have been attributed to this policy, and thus the "#" saturation sign does not appear.

CASE A   single mission   9 knots   policy A

Required vessels: 23 seagoing, 16 coastal, 39 total

DETAILED RESULTS SHEET   * - crossing district lines

- seagoing vessel with coastal aids

DIST	VESSEL	HOME PORT	AIDS	USE%	RUNID
1	*seagoing-1	New York	293	87	99
	seagoing-2	New London	249	98	W17
	seagoing-3	Boston	323	97	
	seagoing-4	Rockland	355	100	
	coastal-1	New York	204	56	72
	coastal-2	Bristol	381	88	
	coastal-3	Rockland	309	69	
5	seagoing-2	Yorktown	223	88	120
	seagoing-3	Portsmouth	221	95	
	coastal-1	Cape May	305	96	158
	coastal-2	Crisfield	287	99	
	coastal-3	Portsmouth	250	97	
7	#seagoing-1	Savannah	284	86	129,S2,14
	#seagoing-2	Key West	197	86	S1
	seagoing-3	Canaveral	75	68	
	seagoing-4	San Juan	167	50	
8	seagoing-2	Galveston	179	94	2
	seagoing-3	Mobile	191	94	
	coastal-2	New Orleans	26	99	159
	coastal-3	Mobile	188	104	
[illegible]	#seagoing-1	Duluth	415	99	95,S43
	seagoing-2	Charlevoix	245	93	
	seagoing-3	Detroit	179	60	
	coastal-2	Charlevoix	275	100	162
	coastal-3	Port Huron	341	96	
	coastal-4	Detroit	251	83	
11	seagoing-1	San Pedro	150	97	111
	*coastal-2	San Francisco	75	49	78,w27b
13	*seagoing-2	Astoria	107	73	33
	seagoing-3	Anacortes	121	49	W21
	coastal-3	Anacortes	111	97	173
[illegible]	seagoing-1	Petersburg	128	68	137
	#seagoing-2	Seward	165	89	S3
	seagoing-3	Kodiak	75	82	
	coastal-1	Petersburg	320	85	133
	[illegible]	Sitka	221	64	
	[illegible]	Sand Point	84	83	
[illegible]	[illegible]	Guam	192	83	55
	[illegible]	Honolulu	280	90	

CASE B SINGLE mission 9 knots policy B
Required vessels: 19 seagoing, 16 coastal, 35 total

DETAILED RESULTS SHEET * - crossing district lines
- seagoing vessel with coastal aids

DIST	VESSEL	HOME PORT	AIDS	USE %	RUNID
1	seagoing-1	New York	332	98	123
	seagoing-2	Bristol	371	100	
	seagoing-3	Rockland	365	97	
	*coastal-1	New York	200	43	110,W20b
	coastal-2	Bristol	401	98	
	coastal-3	Rockland	372	97	
5	seagoing-2	Cape May	308	94	135
	seagoing-3	Yorktown	273	97	
	coastal-3	Yorktown	356	98	108
	coastal-2	Alexandria	407	98	
7	#seagoing-2	Key West	237	104	16,S8
	#seagoing-3	Savannah	303	78	S9,14
	seagoing-4	San Juan	183	73	
8	seagoing-2	Galveston	179	82	2
	seagoing-3	Mobile	191	86	
	coastal-2	New Orleans	44	80	2
	coastal-3	Mobile	170	78	
9	seagoing-1	Charlevoix	249	100	136
	seagoing-2	Detroit	223	72	
	coastal-1	Duluth	367	84	163
	coastal-2	Charlevoix	275	92	
	coastal-3	Port Huron	341	75	
	coastal-4	Detroit	251	81	
11	seagoing-1	San Pedro	136	62	78
	#seagoing-2	San Francisco	136	62	S10,78
13	seagoing-1	Astoria	177	87	32
	coastal-1	Portland	115	72	32
17	seagoing-1	Petersburg	154	88	131
	seagoing-2	Kodiak	101	91	
	coastal-1	Petersburg	320	72	133
	coastal-2	Sitka	221	58	
	coastal-3	Kodiak	113	56	
	coastal-4	Sand Point	84	64	
14	seagoing-1	Guam	192	83	55
	seagoing-2	Honolulu	280	90	

CASE C SINGLE mission 9 knots policy C
Required vessels: 17 seagoing, 15 coastal, 32 total

DETAILED RESULTS SHEET

* - crossing district lines
\# - seagoing vessel with coastal aids

DIST	VESSEL	HOME PORT	AIDS	USE %	RUNID
1	#seagoing-1	New York	507	102	72,S13
	seagoing-2	Bristol	417	100	
	seagoing-3	Rockland	348	76	
	coastal-2	Bristol	381	65	72
	coastal-3	Rockland	309	54	
5	seagoing-2	Cape May	360	89	138
	*seagoing-3	Wilmington	275	94	W3b
	coastal-2	Cape May	430	102	165
	coastal-3	Yorktown	426	99	
7	seagoing-2	Key West	240	99	172
	seagoing-4	San Juan	190	69	
	coastal-3	Savannah	134	31	14
8	seagoing-2	Galveston	179	60	7
	seagoing-3	Mobile	191	66	
	coastal-2	New Orleans	121	100	87
	*coastal-3	Mobile	200	114 [1]	W14
9	seagoing-1	Charlevoix	282	93	94
	#seagoing-2	Detroit	441	90	S15
	coastal-1	Duluth	367	65	164
	coastal-2	Charlevoix	275	86	
	coastal-3	Port Huron	341	73	
11	seagoing-1	San Pedro	187	97	114
	coastal-2	San Francisco	71	23	78
13	*seagoing-1	Astoria	191	80	32,W22
	coastal-1	Portland	115	53	32
17	seagoing-1	Petersburg	154	70	131
	#seagoing-2	Kodiak	214	87	S17
	coastal-1	Petersburg	320	65	133
	coastal-2	Sitka	221	48	
	coastal-4	Sand Point	84	57	
14	seagoing-1	Guam	192	83	55
	seagoing-2	Honolulu	280	90	

[1] The use percentage here exceeds the allowable 105% by 9%. Note that the seagoing vessel, also ported in Mobile, is underutilized and has more than sufficient capacity to help out the coastal vessel.

CASE D SINGLE mission 13 knots policy A
Required vessels: 19 seagoing, 14 coastal, 33 total

DETAILED RESULTS SHEET

* - crossing district lines
# - seagoing vessel with coastal aids

DIST	VESSEL	HOME PORT	AIDS	USE %		RUNID
1	#seagoing-1	New York	507	103		72,S25
	seagoing-2	Bristol	417	100		
	seagoing-3	Rockland	348	74		
	coastal-2	Bristol	381	66		72
	coastal-3	Rockland	309	56		
5	seagoing-2	Cape May	338	94		139
	seagoing-3	Yorktown	243	88		
	coastal-1	Baltimore	421	109	[2]	160
	coastal-2	Yorktown	391	97		
	*coastal-3	Oak Island	164	64		W2
7	#seagoing-2	Key West	237	101		16,S27,14
	seagoing-3	Savannah	169	56		
	seagoing-4	San Juan	183	90		
8	seagoing-2	Galveston	179	72		2
	#seagoing-3	Mobile	361	110	[3]	S28
	coastal-2	New Orleans	44	64		2
9	seagoing-1	Charlevoix	282	92		94
	#seagoing-2	Detroit	441	93		S29
	coastal-1	Duluth	350	55		95
	coastal-2	Charlevoix	312	97		
	coastal-3	Port Huron	321	59		
11	seagoing-1	San Pedro	136	54		78
	#seagoing-2	San Francisco	136	76		S30
13	seagoing-1	Astoria	177	94		32
	coastal-1	Portland	115	77		32
17	seagoing-1	Petersburg	154	85		131
	seagoing-2	Kodiak	101	81		
	coastal-1	Petersburg	320	66		133
	coastal-2	Sitka	221	46		
	coastal-3	Kodiak	113	49		
	coastal-4	Sand Point	84	57		
14	seagoing-1	Guam	192	61		55
	seagoing-2	Honolulu	280	71		

[2] The coastal tender ported in Baltimore is used slightly greater than capacity in the current representation. Given the level of excess capacity among the remaining coastal tenders in the district, a judgement was made that an appropriate aid assignment could be made that kept all tenders below 100%. Thus the 109% was allowed to stand.

[3] Notice that this seagoing tender also services some of the coastal district aids. The use percentage of 110% shown could be reduced to acceptable limits by allowing the underutilized New Orleans coastal tender to take on some of Mobile's coastal aids.

CASE E   SINGLE mission   13 knots   policy B
Required vessels: 17 seagoing, 14 coastal, 31 total

DETAILED RESULTS SHEET   * - crossing district lines
- seagoing vessel with coastal aids

DIST	VESSEL	HOME PORT	AIDS	USE %	RUNID
1	seagoing-1	New York	303	67	72
	seagoing-2	Bristol	417	92	
	seagoing-3	Rockland	348	70	
	coastal-1	New London	453	90	71
	coastal-2	S Portland	440	93	
5	seagoing-2	Cape May	360	92	140
	*seagoing-3	Wilmington	276	96	W4c
	coastal-2	Cape May	430	93	166
	coastal-3	Yorktown	426	96	
7	seagoing-2	Key West	239	100	124
	seagoing-4	San Juan	190	82	
	coastal-3	Savannah	134	30	14
8	seagoing-2	Galveston	179	66	2
	seagoing-3	Mobile	191	69	
	coastal-2	New Orleans	120	100	89
	*coastal-3	Mobile	201	104	W16
9	seagoing-1	Charlevoix	282	81	94
	#seagoing-2	Detroit	631	97	S34
	coastal-1	Duluth	432	90	167
	coastal-2	Charlevoix	361	92	
11	seagoing-1	San Pedro	187	98	115
	coastal-2	San Francisco	71	18 [4]	78
13	*seagoing-1	Astoria	191	83	32,W23
	coastal-1	Portland	115	47	32
17	seagoing-1	Petersburg	154	68	131
	seagoing-2	Kodiak	101	65	
	coastal-1	Petersburg	511	100	169
	coastal-2	Cordova	65	101	
	coastal-3	Sand Point	162	99	
14	seagoing-1	Guam	192	61	55
	seagoing-2	Honolulu	280	71	

[4] The specifics in considering the 11th and 13th districts suggest that a program manager could convert the 2 seagoing and 2 coastal tenders to 3 seagoing tenders, but only careful consideration of costs would determine if this would be beneficial.

CASE F SINGLE mission 13 knots policy C
Required vessels: 16 seagoing, 10 coastal, 26 total

DETAILED RESULTS SHEET
* - crossing district lines
# - seagoing vessel with coastal aids

DIST	VESSEL	HOME PORT	AIDS	USE %	RUNID
1	*seagoing-1	New York	503	109	[5]105,W18
	seagoing-2	New London	460	100	
	seagoing-3	Rockland	443	98	
	coastal-1	New London	453	81	71
	coastal-2	S Portland	440	83	
5	#seagoing-3	Yorktown	588	94	43,S36
	coastal-2	Cape May	511	97	43
7	seagoing-2	Key West	207	100	155
	seagoing-3	Port Royal	275	104	
	coastal-2	Miami	241	90	21
8	seagoing-2	Galveston	179	51	7
	#seagoing-3	Mobile	361	82	S37
	coastal-2	New Orleans	44	36	7
9	seagoing-1	Charlevoix	282	71	94
	#seagoing-2	Detroit	631	52	S38
	coastal-1	Duluth	432	87	168
	coastal-2	Charlevoix	361	77	
11	seagoing-1	San Pedro	132	78	68
13	seagoing-1	Astoria	177	48	32
	*coastal-1	Portland	186	100	78,W32
17	seagoing-1	Petersburg	154	52	131
	#seagoing-2	Kodiak	242	87	S40
	coastal-1	Petersburg	538	95	132
	coastal-2	Cordova	59	69	
14	seagoing-1	Guam	192	61	55
	seagoing-2	Honolulu	280	71	

[5] Here adjustments can be made within the 1st district, and if necessary, with the 5th district to allow the unacceptable 109% to be reduced by at least 4% to the acceptable 105% level.

CASE G MULTI mission 9 knots policy A
Required vessels: 28 seagoing, 19 coastal, 47 total

DETAILED RESULTS SHEET * - crossing district lines
- seagoing vessel with coastal aids

DIST	VESSEL	HOME PORT	AIDS	USE %	RUNID
1	seagoing-1	New York	268	97	142
	seagoing-2	New London	229	94	
	seagoing-3	Boston	278	100	
	seagoing-4	Rockland	293	100	
	coastal-1	New York	204	56	72
	coastal-2	Bristol	381	88	
	coastal-3	Rockland	309	69	
5	seagoing-1	Cape May	235	99	157
	seagoing-2	Yorktown	178	100	
	seagoing-3	Portsmouth	180	99	
	coastal-1	Cape May	305	96	158
	coastal-2	Crisfield	287	99	
	coastal-3	Portsmouth	250	97	
7	*seagoing-1	Savannah	152	79	121
	seagoing-2	Key West	90	69	W31
	seagoing-3	Canaveral	75	93	
	seagoing-4	San Juan	167	68	
	coastal-2	Miami	107	50	14
	coastal-3	Savannah	134	50	
8	seagoing-1	Galveston	156	98	146
	seagoing-2	New Orleans	156	86	
	seagoing-3	Mobile	58	47	
	coastal-2	New Orleans	26	99	159
	coastal-3	Mobile	188	104	
9	seagoing-1	Sault Ste Marie	110	74	147
	seagoing-2	Charlevoix	173	98	
	seagoing-3	Detroit	189	90	
	coastal-1	Duluth	367	99	162
	coastal-2	Charlevoix	275	100	
	coastal-3	Port Huron	341	96	
	coastal-4	Detroit	251	83	
11	seagoing-1	San Pedro	136	100	78
	seagoing-2	San Francisco	65	98	
	*coastal-2	San Francisco	75	49	78,W27b
13	seagoing-2	Astoria	56	67	33
	seagoing-3	Anacortes	121	67	
	coastal-3	Anacortes	111	97	173

-case G continued on next page-

-case G continued-

17	seagoing-1	Petersburg	128	92	133
	seagoing-2	Cordova	38	99	
	#seagoing-3	Kodiak	153	103	S6
	seagoing-4	Cold Bay	49	32 [6]	
	coastal-1	Petersburg	320	85	133
	coastal-2	Sitka	221	64	
	coastal-4	Sand Point	84	83	
14	seagoing-1	Guam	186	80	141
	seagoing-2	Honolulu	68	95	
	seagoing-3	Honolulu	218	53	

[6] The attempt to saturate this low-use vessel with the aids of one of the coastal tenders and thus reduce the fleet was not successful.

CASE H MULTI mission 9 knots policy B
Required vessels: 25 seagoing, 17 coastal, 42 total

DETAILED RESULTS SHEET * - crossing district lines
- seagoing vessel with coastal aids

DIST	VESSEL	HOME PORT	AIDS	USE %	RUNID
1	seagoing-1	New York	268	89	143
	seagoing-2	New London	229	89	
	seagoing-3	Boston	278	92	
	seagoing-4	Rockland	293	92	
	*coastal-1	New York	200	43	110
	coastal-2	Bristol	401	98	W20b
	coastal-3	Rockland	372	97	
5	seagoing-1	Cape May	235	85	145
	seagoing-2	Yorktown	202	93	
	seagoing-3	Portsmouth	158	78	
	coastal-3	Yorktown	356	98	108
	coastal-2	Alexandria	407	98	
7	seagoing-2	Key West	111	96	149
	seagoing-3	Savannah	194	100	
	seagoing-4	San Juan	177	77	
	coastal-2	Miami	107	49	14
	coastal-3	Savannah	134	40	
8	seagoing-1	Galveston	161	94	6
	seagoing-2	New Orleans	151	86	
	#seagoing-3	Mobile	228	98	S11
	coastal-2	New Orleans	44	80	2
9	seagoing-1	Duluth	76	78	161
	seagoing-2	Charlevoix	207	88	
	seagoing-3	Detroit	189	75	
	coastal-1	Duluth	367	84	163
	coastal-2	Charlevoix	275	92	
	coastal-3	Port Huron	341	75	
	coastal-4	Detroit	251	81	
11	seagoing-1	San Pedro	147	98	112
	coastal-2	San Francisco	71	23	78
13	*seagoing-2	Astoria	110	75	33
	seagoing-3	Anacortes	121	57	W24
	coastal-1	Portland	115	72	32
17	seagoing-1	Petersburg	128	79	137
	#seagoing-2	Seward	165	81	S12
	seagoing-3	Kodiak	75	96	
	coastal-1	Petersburg	320	72	133
	coastal-2	Sitka	221	58	
	coastal-4	Sand Point	84	64	
14	seagoing-1	Guam	186	80	141
	seagoing-2	Honolulu	68	95	
	seagoing-3	Honolulu	218	53	

CASE I MULTI mission 9 knots policy C
Required vessels: 22 seagoing, 14 coastal, 36 total

DETAILED RESULTS SHEET * - crossing district lines
- seagoing vessel with coastal aids

DIST	VESSEL	HOME PORT	AIDS	USE %	RUNID
1	#seagoing-1	New York	390	85	193,S18
	seagoing-2	New London	260	96	
	seagoing-3	Boston	329	97	
	seagoing-4	Rockland	293	79	
	coastal-2	Bristol	381	65	72
	coastal-3	Rockland	309	54	
5	seagoing-2	Cape May	308	97	150
	seagoing-3	Yorktown	273	98	
	coastal-2	Cape May	430	102	165
	coastal-3	Yorktown	426	99	
7	seagoing-2	Key West	130	78	16
	#seagoing-3	Savannah	303	76	S20,14
	seagoing-4	San Juan	183	50	
8	seagoing-2	Galveston	179	82	7
	seagoing-3	Mobile	191	90	
	coastal-2	New Orleans	121	100	87
	*coastal-3	Mobile	200	114 [7]	W14
9	#seagoing-1	Duluth	415	95	95,S21
	seagoing-2	Charlevoix	245	95	
	seagoing-3	Detroit	179	61	
	coastal-2	Charlevoix	275	86	164
	coastal-3	Port Huron	341	73	
	coastal-4	Detroit	251	62	
11	seagoing-1	San Pedro	136	63	78,S23
	#seagoing-2	San Francisco [8]	136	70	
13	seagoing-1	Astoria	177	83	32
	coastal-1	Portland	115	53	32

-case I continued on next page-

[7] This 114% could easily be brought down to 105% or less by having the Galveston seagoing tender reduce the Mobile seagoing vessel's usage. Then the Mobile seagoing could help out the Mobile coastal vessel.

[8] Note that in prior cases, there was not a need for a San Francisco seagoing tender. This tender also now takes over the small number of coastal aids which before, required the use of a coastal tender. The net effect has been to trade a coastal for a seagoing vessel, rather than add a new vessel.

-case I continued-

17	seagoing-1	Petersburg	154	96	131
	seagoing-2	Kodiak	101	84	
	coastal-1	Petersburg	320	65	133
	coastal-2	Sitka	221	48	
	coastal-3	Kodiak	113	51	
	coastal-4	Sand Point	84	57	
14	seagoing-1	Guam	186	80	141
	seagoing-2	Honolulu	68	95	
	seagoing-3	Honolulu	218	53	

CASE J   MULTI mission   13 knots   policy A

Required vessels: 22 seagoing, 18 coastal, 40 total

DETAILED RESULTS SHEET   * - crossing district lines
- seagoing vessel with coastal aids

DIST	VESSEL	HOME PORT	AIDS	USE %	RUNID
1	*seagoing-1	New York	310	95	102,W19
	seagoing-2	New London	263	97	
	seagoing-3	Boston	308	97	
	seagoing-4	Rockland	338	97	
	coastal-1	New York	204	40	72
	coastal-2	Bristol	381	66	
	coastal-3	Rockland	309	56	
5	seagoing-2	Baltimore	250	92	151
	seagoing-3	Portsmouth	194	81	
	coastal-1	Baltimore	421	109	160
	coastal-2	Yorktown	391	97	
	*coastal-3	Oak Island	164	64	W2
7	seagoing-2	Key West	111	100	126
	seagoing-3	St Simmons	194	107	
	seagoing-4	San Juan	177	98	
	coastal-2	Miami	107	37	14
8	seagoing-2	Galveston	184	98	152
	seagoing-3	Mobile	186	92	
	coastal-2	New Orleans	44	64	2
	coastal-3	Mobile	170	63	
9	#seagoing-1	Duluth	398	87	95,S32
	seagoing-2	Charlevoix	245	95	
	seagoing-3	Detroit	179	62	
	coastal-2	Charlevoix	312	97	95
	coastal-3	Port Huron	321	59	
	coastal-4	Detroit	251	55	
11	seagoing-1	San Pedro	152	100	113
	coastal-2	San Francisco	71	28 [9]	78
13	*seagoing-2	Astoria	105	72	33,W25
	seagoing-3	Anacortes	121	52	
	coastal-1	Portland	115	77	32
17	seagoing-1	Petersburg	128	72	132
	seagoing-2	Cordova	38	73	
	seagoing-3	Kodiak	89	97	
	coastal-1	Petersburg	320	66	133
	coastal-2	Sitka	221	46	
	coastal-3	Kodiak	113	49	
	coastal-4	Sand Point	84	57	
14	seagoing-1	Guam	192	84	55
	seagoing-2	Honolulu	280	97	

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[9] Here an unsuccessful attempt was made to free up the Astoria vessel as much as possible and then use it to relieve the San Francisco coastal tender.

CASE K MULTI mission 13 knots policy B
Required vessels: 20 seagoing, 14 coastal, 34 total

DETAILED RESULTS SHEET * - crossing district lines
- seagoing vessel with coastal aids

DIST	VESSEL	HOME PORT	AIDS	USE %	RUNID
1	seagoing-1	New York	249	63	73
	seagoing-2	New London	197	62	
	seagoing-3	Boston	329	90	
	seagoing-4	Rockland	293	72	
	coastal-1	New London	453	90	71
	coastal-2	S Portland	440	93	
5	seagoing-1	Baltimore	319	100	153
	seagoing-2	Portsmouth	270	99	
	*seagoing-3	Wilmington	175	74	W1b
	coastal-2	Cape May	430	93	166
	coastal-3	Yorktown	426	96	
7	seagoing-2	Key West	130	74	16
	seagoing-4	San Juan	183	65	
	coastal-3	Savannah	134	30	14
8	seagoing-2	Galveston	179	89	2
	seagoing-3	Mobile	191	94	
	coastal-2	New Orleans	120	100	89
	*coastal-3	Mobile	201	104	W16
9	seagoing-1	Charlevoix	244	100	154
	seagoing-2	Detroit	228	79	
	coastal-1	Duluth	432	90	167
	coastal-2	Charlevoix	361	92	
	coastal-3	Detroit	441	78	
11	seagoing-1	San Pedro	136	63	78
	#seagoing-2	San Francisco	136	64	S35,78
13	seagoing-1	Astoria	177	91	32
	coastal-1	Portland	115	47	32
17	seagoing-1	Petersburg	154	93	131
	seagoing-2	Kodiak	101	88	
	coastal-1	Petersburg	511	100	169
	coastal-2	Cordova	65	101	
	coastal-3	Sand Point	162	99	
14	seagoing-1	Guam	192	84	55
	seagoing-2	Honolulu	280	97	

CASE L MULTI mission 13 knots policy

Required vessels: 17 seagoing, 13 coastal,

DETAILED RESULTS SHEET

* - crossing district lines

\# - seagoing vessel with coastal aids

DIST	VESSEL	HOME PORT	AIDS	USE %	REMD
1	seagoing-1	New York	332	92	[illegible]
	seagoing-2	Bristol	371	96	
	seagoing-3	Rockland	365	91	
	coastal-1	New London	453	81	[illegible]
	coastal-2	S Portland	440	83	
5	seagoing-2	Cape May	338	91	[illegible]
	seagoing-3	Yorktown	243	72	
	coastal-2	Cape May	511	97	[illegible]
	coastal-3	Yorktown	345	59	
7	seagoing-3	Savannah	169	41	[illegible]
	seagoing-4	San Juan	190	72	
	coastal-2	Miami	241	90	21
8	seagoing-2	Galveston	241	100	[illegible]
	*#seagoing-3	Mobile	422	103	W1.b,S42
	coastal-2	New Orleans	44	36	
9	seagoing-1	Charlevoix	282	96	94
	seagoing-2	Detroit	631	105	174
	coastal-1	Duluth	432	87	168
	coastal-2	Charlevoix	361	77	
	coastal-3	Detroit	441	74	
11	seagoing-1	San Pedro	187	100	116
13	*seagoing-1	Astoria	191	85	32,W26
	*coastal-1	Portland	186	100	78,W32
17	seagoing-1	Petersburg	154	71	131
	seagoing-2	Kodiak	101	61	
	coastal-1	Petersburg	538	95	132
	coastal-2	Cordova	59	69	
	coastal-3	Sand Point	141	74	
14	seagoing-1	Guam	192	84	55
	seagoing-2	Honolulu	280	97	

APPENDIX B. DISCREPANCY AND VISIBILITY PERCENTAGES

	% DISCREPANCIES		% VISIBILITY ABORTS [1]	
	SEAGOING	COASTAL	SEAGOING	COASTAL
1(Gilbert) [2]	33	20	17	[illegible]
1 Boston	28	12	18	10
3 New York	44	36	15	11
5 Portsmouth	46	36	7	5
7 Miami	34	38	4	[illegible]
8 New Orleans	84	51 [3]	8	5
9 Cleveland	8	8	13	7
11(Gilbert)	44	34	18	12
11 Long Beach	8	8	14	9
12 Alameda	69	52	21	14
13 Seattle	69	44	7	4
17 Juneau	19	15 [4]	5	3
14 Honolulu	50	36	4	2

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[1] Visibility abort percentages were provided by the Office of Navigation and were derived from Headquarters transmissivity data. The numbers represent the percent of the time for which visibility drops below 4 miles for seagoing aids and 2 miles for coastal aids.

[2] in some of the districts redefined by the Gilbert Study, the percentages were obtained by combining the components of the old distric

[3] Note that there will be ten annual coastal vessel aid-servicing trips to the Mississippi River aids.

[4] The real percentages are large(121)-26%, small(261)-15%, shore(568)-18%. The large + shore combine to form 19%. The overall percentage is 18%

APPENDIX C. LOG OF VESSEL SHARING ATTEMPTS

WORKSHEET	DIST	DIST	CASE	Y/N
W27b	11	13	A Coastal	Y
W8	5	7	A Coastal	N
W6	5	7	B Coastal	N
W13	7	8	B Coastal	N
W30	11	13	B Coastal	N
W9	7	8	C Seagoing	N
W28	11	13	C Coastal	N
W10	7	8	D Seagoing	N
W15	7	8	D Coastal	N
W11	7	8	E Seagoing	N
W7	5	7	E Coastal	N
W29	11	13	E Coastal	N
W16	7	8	E Coastal	N
W5	5	7	L Seagoing	N
W21	11	13	A Seagoing	Y
W17	1	5	A Seagoing	Y
W20b	1	5	B Coastal	Y
W3	5	7	C Seagoing	Y
W22	11	13	C Seagoing	Y
W14	7	8	C Coastal	Y
W2	5	7	D Coastal	Y
W23	11	13	E Seagoing	Y
W4b	5	7	E Seagoing	Y
W18	1	5	F Seagoing	Y
W24	11	13	H Seagoing	Y
W25	11	13	J Seagoing	Y
W19	1	5	J Seagoing	Y
W1	5	7	K Seagoing	Y
W26	11	13	L Seagoing	Y
W12b	7	8	L Seagoing	Y
W31	5	7	G Seagoing	Y
W32	11	13	F Coastal	Y

APPENDIX D. LOGS OF VESSEL SATURATION ATTEMPTS

S#	CASE	DIST	SEA PORT	COASTAL PORT	SAT?
1	A	7	Key West	Miami	Y
2	A	7	Savannah	Savannah	Y
43	A	9	Duluth	Duluth	Y
44	A	13	Anacortes	Anacortes	N
3	A	17	Seward	Kodiak	Y
4	G	7	Savannah	Savannah	N
5	G	7	Key West	Miami	N
6	G	17	Kodiak	Kodiak	Y
7	G	17	Cold Bay	Sand Point	N
8	B	7	Key West	Miami	Y
9	B	7	Savannah	Savannah	Y
10	B	11	San Francisco	San Francisco	Y
11	H	8	Mobile	Mobile	Y
12	H	17	Seward	Kodiak	Y
13	C	1	New York	New York	Y
14	C	1	Rockland	Rockland	N
15	C	9	Detroit	Detroit	Y
45	C	1	Rockland	Rockland	N
16	C	17	Petersburg	Petersburg	N
17	C	17	Kodiak	Kodiak	Y
18	I	1	New York	New York	Y
19	I	1	Rockland	Rockland	N
20	I	7	Savannah	Savannah	Y
21	I	9	Duluth	Duluth	Y
22	I	9	Detroit	Detroit	N
23	I	11	San Francisco	San Francisco	Y
24	I	17	Kodiak	Kodiak	N
25	D	1	New York	New York	Y
26	D	1	Rockland	Rockland	N
27	D	7	Key West	Miami	Y
28	D	8	Mobile	Mobile	Y
29	D	9	Detroit	Detroit	Y
30	D	11	San Francisco	San Francisco	Y
31	D	17	Kodiak	Kodiak	N
32	J	9	Duluth	Duluth	Y
33	J	9	Detroit	Detroit	N
47	J	11-13	Astoria	San Francisco	N
34	E	9	Detroit	Detroit	Y
46	E	11-13	Astoria	San Francisco	N
35	K	11	San Francisco	San Francisco	Y
36	F	5	Yorktown	Yorktown	Y
37	F	8	Mobile	Mobile	Y

38	F	9	Detroit	Detroit	Y
39	F	17	Petersburg	Petersburg	N
40	F	17	Kodiak	Sand Point	Y
41	L	5	Yorktown	Yorktown	N
42	L	8	Mobile	Mobile	Y

APPENDIX E. DESCRIPTION OF DETAILED DISTRICT PLOTS

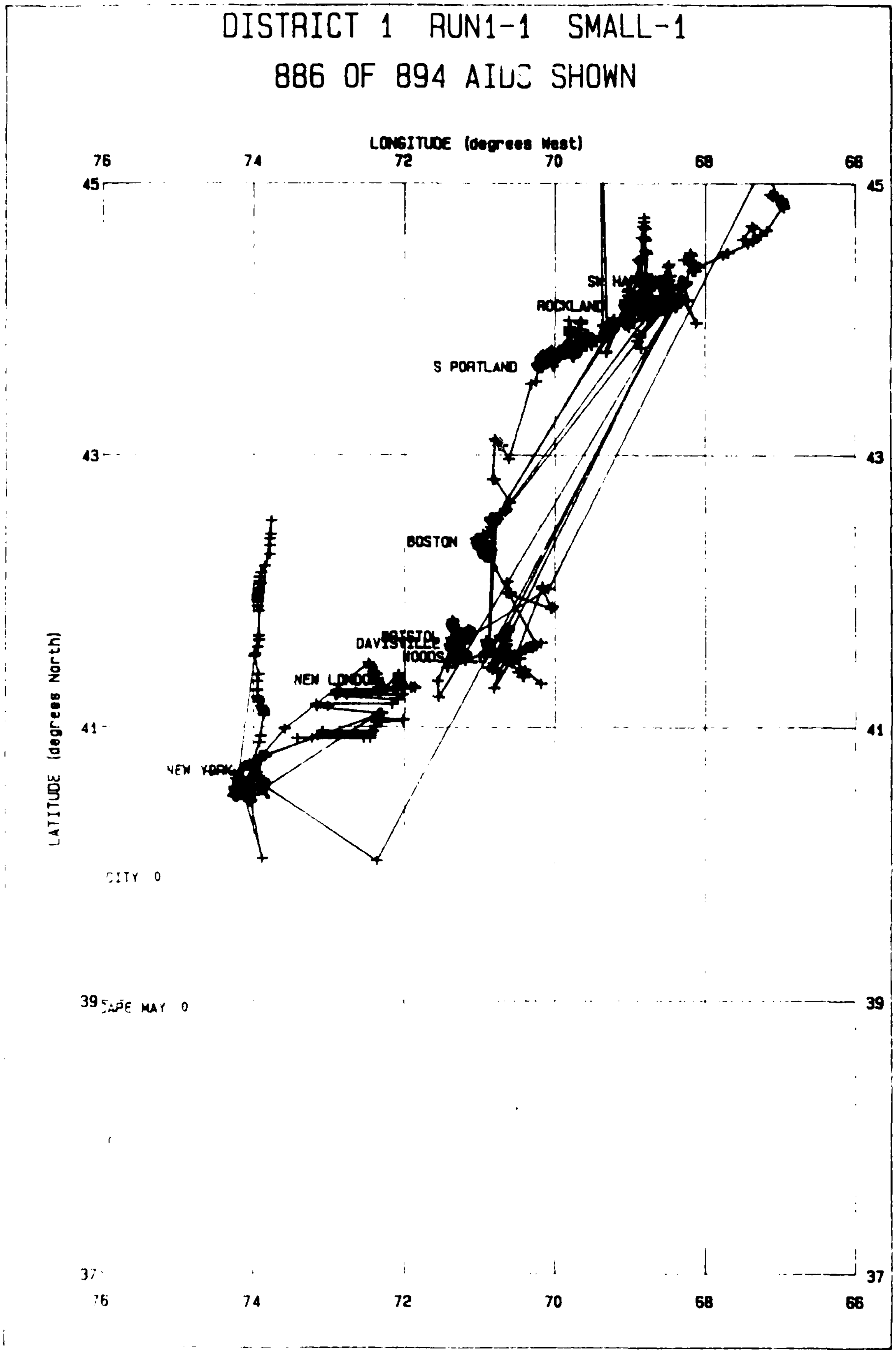
As part of the process of verifying that assignments of aids to servicing vessels was reasonable, plots were developed representing the aids assigned to vessels. This section contains those plots. They are given in District order and within each District, they are shown in order of increasing numbers of District vessels. Each plot has an identifying heading which shows the district, run number and vessel name. The run number may be interpreted as follows. The example of "RUN2a-1" means there were 2 seagoing vessels and 1 coastal vessel assigned to the District. The "a" next to the "2" indicates this is the case where an alternative setup "a" was run of the 2 seagoing vessels. The vessel name of "big-1" indicates that this plot is only for seagoing vessel "1" and "small-2" would indicates that this plot is only for coastal vessel "2".

In addition to the heading, the number of aids plotted and shown are given. In cases where these two numbers are different, the difference is attributable to those aids which, due to their location, were outside the boundaries of the given map.

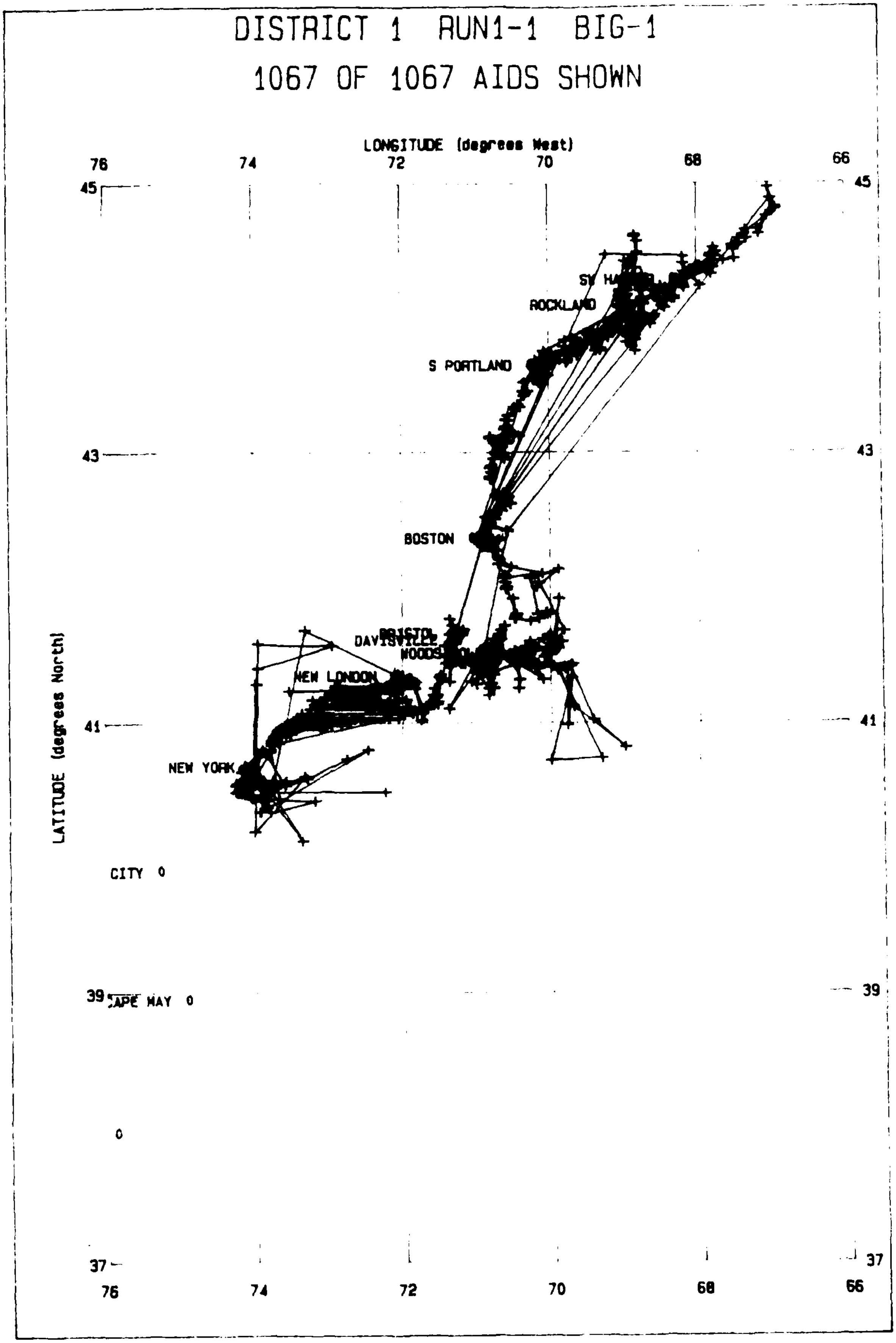
Each plot shows latitudes, longitudes, and all home ports within the boundaries (even if the ports are not in the same District). Each aid is plotted with a "+". The pen is left down between aids to that vessel track lines are also plotted. For each District, the first plot is "RUN1-1". This shows all the aids in the district for either the seagoing or coastal vessels on a single page. This helps to establish that the ordering on the aid list does not cause excessive zigzag vessel travel.

Other plots for the Districts show the cases run for other numbers of vessels. The runs shown are representative of each of the numbers of vessels run for the Districts. Not all of the minor changes which may have been run were plotted.

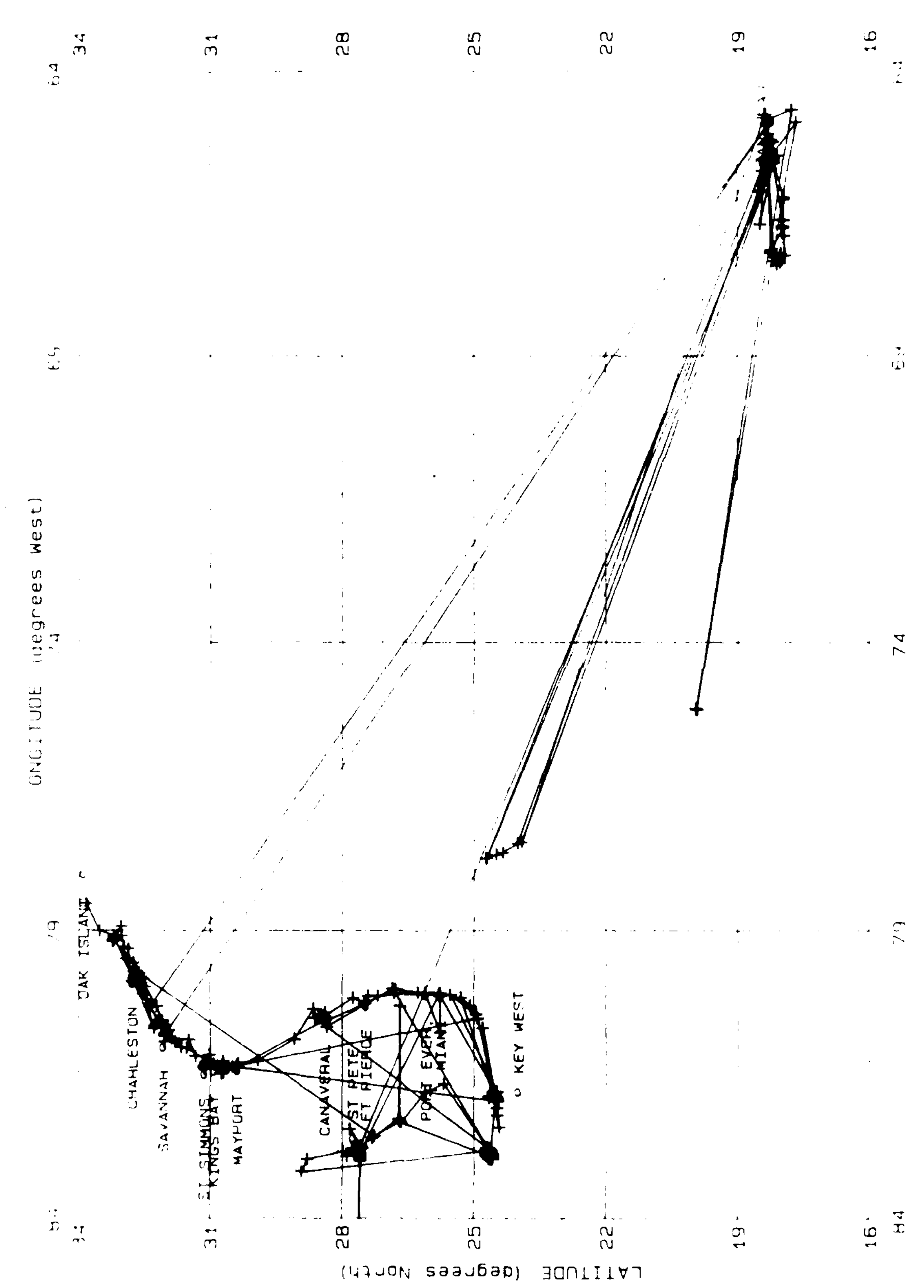
Several example plots follow. The complete set of plots which are too numerous to be included here comprise Volume II of this study.



DISTRICT 1 RUN1-1 SMALL-1
886 OF 894 AIDC SHOWN
LONGITUDE (degrees West)
76
74
72
70
68
66
45
43
41
39
37
LATITUDE (degrees North)
S PORTLAND
ROCKLAND
BOSTON
BRISTOL
DAVISVILLE
WOODS
NEW LONDO
NEW YORK
CITY 0
CAPE MAY 0


DISTRICT 1 RUN1-1 BIG-1
1067 OF 1067 AIDS SHOWN
LONGITUDE (degrees West)
LATITUDE (degrees North)
76
74
72
70
68
66
45
43
41
39
37
ROCKLAND
S PORTLAND
BOSTON
DAVISVILLE
NEW LONDON
NEW YORK
CITY 0
CAPE MAY 0
0

DISTRICT 7 RUN1-1 BIG-1
415 OF 416 AIDS SHOWN



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