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MARINE WEATHER DISSEMINATION SYSTEMS STUDY

Prepared for
UNITED STATES COAST GUARD
400 7th Street, S.W.
Washington, D.C. 20590

by

COMPUTER SCIENCES CORPORATION
16 August 1971

DEPARTMENT OF TRANSPORTATION ● UNITED STATES COAST GUARD

VOLUME IV - RECOMMENDATIONS FOR CHANGE

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6565 Arlington Boulevard
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16. Abstract <p>Potential improvements in existing and proposed weather dissemination systems are examined. Recommendations are made for changes in the policies, facilities and procedures of the U.S. Coast Guard and other government and non-government agencies aimed at effecting realistic improvements in system service. Service to coastal, off-shore and high seas areas is discussed.</p> <p>The work described was performed in the third phase of a study aimed at improving the dissemination of weather information to marine users and at establishing guidelines for future Coast Guard research and development efforts in this field.</p>			
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FOREWORD

This is the third of four reports prepared by Computer Sciences Corporation for the U.S. Coast Guard during the course of a Study of How Best to Utilize Coast Guard Communication Facilities for Weather Dissemination to Marine Users. The study was performed under Contract DOT-CG-00,579-A, which was awarded to CSC on August 31, 1970 and completed August 16, 1971.

The study was divided into four phases:

- Task 1 - Familiarization of the study team with existing marine weather dissemination systems, and the characterization of these systems in terms of their facilities, policies and procedures.
- Task 2 - Measurement of effectiveness of existing and planned weather dissemination systems, following the development of standards and criteria against which to measure this effectiveness.
- Task 3 - Formulation of recommendations for changes in the facilities, policies and procedures of the U.S. Coast Guard and other government and nongovernment agencies considered necessary to improve the dissemination of weather information to marine users.
- Task 4 - Generation of guidelines for future USCG research and development effort in the area of weather dissemination and alerting techniques in terms of operational constraints, performance requirements and cost data.

CSC wishes to acknowledge the assistance of CDR B. F. Hollingsworth, USCG, as Technical Representative to this study and also of LCDR E. Jones and CWO R. J. Williams in making data available for the study. CSC would also like to take this opportunity to thank Mr. Max Mull, Mr. William J. McKee, Jr., and

Mr. Warren Hight of the National Weather Service, NOAA, Mr. B. Hawkins of radio station WPTX, Mr. H. Hayes of radio station WPIK, and Mr. C. Monk of radio station WYRE for their valuable assistance.

It should be noted that the conclusions presented in this report are solely those of CSC and do not necessarily reflect the views of the Coast Guard or the National Weather Service.

TABLE OF CONTENTS

Section	Page
FOREWORD	ii
SUMMARY	vii
1 COASTAL DISSEMINATION	1-1
1.1 Introduction	1-1
1.1.1 The Changing Environment	1-1
1.1.2 The Approach - An Overall Systems Rationale	1-1
1.2 Improvement in Existing Systems	1-2
1.2.1 General	1-2
1.2.2 National Weather Service VHF Radio	1-3
1.2.3 Coast Guard 2 MHz and VHF Operations	1-7
1.2.4 Public Coast Station Operations	1-14
1.2.5 Commercial Broadcast System	1-14
1.3 A User-Oriented System	1-17
1.3.1 General	1-17
1.3.2 The Non-Equipped Boatman	1-17
1.3.3 The VHF Radiotelephone User	1-19
1.3.4 Users of VHF Receivers	1-22
1.3.5 MF Radiotelephone Users	1-22
1.3.6 Pre-Excursion Information	1-23
1.4 System Operational Limitations	1-24
1.4.1 General	1-24
1.4.2 Commercial Radio Dissemination	1-24
1.4.3 Coast Guard Operations	1-27
1.4.4 National Weather Service Operations	1-29
1.4.5 Public Coast Station Operations	1-31
1.4.6 Overview of the Proposed System	1-32
1.5 Recommendations for Change	1-33
1.5.1 Introduction	1-33
1.5.2 Coast Guard Action	1-34
1.5.3 National Weather Service Action	1-37
1.5.4 Commercial Broadcasters	1-40

TABLE OF CONTENTS (Continued)

Section	Page
1.5.5 Public Coast Stations	1-40
1.5.6 Implementation of a Commercial Broadcast Marine Weather Dissemination System	1-41
2 OFF-SHORE AND HIGH SEAS DISSEMINATION	2-1
2.1 Introduction	2-1
2.2 Information Transfer	2-2
2.2.1 Timeliness to User	2-2
2.2.2 Information Content	2-3
2.2.3 Format of Presentation	2-4
2.2.4 Special Needs	2-5
2.3 Technical Transmission	2-6
2.3.1 Coverage	2-6
2.3.2 Reliability of Transmission	2-8
2.3.3 Equipment for Improved Services	2-8
2.4 Management	2-9
3 SUMMARY OF RECOMMENDATIONS	3-1
3.1 Introduction	3-1
3.2 Recommendations for Changes in Coast Guard Policy, Facilities, and Procedures	3-1
3.3 Recommendations Addressed to the National Weather Service	3-3
3.4 Recommendations Addressed to Commercial Radio Operations	3-5
3.5 Recommendations Directed to Public Coast and Limited Coast Stations	3-5

LIST OF ILLUSTRATIONS

Figure		Page
1-1	Rate of Increase in Marine Mobile License Applications	1-8
1-2	Projected Growth in Total Marine Mobile Licenses	1-10
1-3	Growth in Number of Boats Projected from Coast Guard Statistics	1-11
2-1	Predicted Coverage Contour of 8205 kHz from Boston, 0000Z, July 1971, Reliability of 95% or Better, CW Telegraph	2-7
2-2	Proposed Questionnaire to Determine User Service Parameters for Off-Shore and High Seas Weather Dissemination	2-11

LIST OF TABLES

Table		Page
1-1	National Weather Service VHF Radio Transmission Sites to be Operational by 1976 in Scenario Areas of Study	1-5
1-2	Estimated 1976 Performance of NWS VHF Weather Radio System	1-6
1-3	Estimated 1977 Performance of VHF and MF Radiotelephone Systems	1-13
1-4	Estimated Potential Performance of Commercial Radio Weather Dissemination System	1-16

SUMMARY

This report describes work performed under Task 3 of the Marine Weather Dissemination Systems Study and includes recommendations for change aimed at improving weather dissemination services to marine users.

The analyses leading to the recommendations were based primarily on the results of the systems characterizations made under Task 1 and the systems effectiveness measurements of Task 2 of this study. Existing systems were examined to determine their potential performance based on realistic improvements in the next 5 to 6 years. Comparing the potential of these systems to the projected requirements of the user, deficiencies in service were identified and solutions sought. By considering multiple-use solutions and avoiding duplication of effort, an overall systems rationale was developed to serve the total marine community. The implications for each agency in meeting the requirements of this service were then examined individually to evaluate their technical, economic and political feasibility. Where the proposed changes were shown to be impractical, alternate proposals were examined for the role of that agency and the impact of the revision on the total system was determined. The requirements for implementing this system led to the formulation of recommendations for changes in the facilities, policies and procedures of the U.S. Coast Guard and other government and non-government agencies considered necessary improve the dissemination of weather information to marine users.

The salient recommendations made in this report call for the Coast Guard to institute a supervisory body concerned solely with the dissemination of weather and other environmental information to the marine user, and for this body to work actively with the National Weather Service toward the establishment of a network of commercial broadcast stations providing frequent, scheduled weather transmissions.

The report examines service to the coastal areas (and to predominantly recreational boatmen) in Section 1, and covers off-shore and high seas dissemination services in Section 2. The recommendations resulting from these analyses are summarized in Section 3.

SECTION I

COASTAL DISSEMINATION

1.1 INTRODUCTION

1.1.1 The Changing Environment

The most predictable changes to take place in the marine environment in future years are the steady growth in the number of recreational boats and the increasing use of radio communication and broadcasting. Overlying these general trends, however, are specific changes which are planned to take place during the next five or six years; the swing towards VHF usage in coastal areas, and the implementation of the National Weather Service VHF Weather Radio System. The impact which these two factors will almost certainly have on the marine environment makes an examination of this time period particularly appropriate.

In projecting the growth and change of the systems examined, therefore, emphasis was given to the 1971 to 1977 time period and the changes in users' requirements which will take place in this era.

1.1.2 The Approach - An Overall Systems Rationale

To establish the basis upon which recommendations for change are to be made, it is necessary to consider not only the requirements of the user but also the nature of the system to be changed and the economic and political implications of such changes on the controlling agency or authority.

Moreover, if the changes to be made are to contribute efficiently to an overall improvement in marine weather dissemination, they must be conceived in relation to each other and not as unilateral changes for each agency or organization involved.

In order to achieve this homogeneity in effort, CSC adopted

the following procedure: Existing systems were examined to determine their potential performance based on realistic improvements in the next 5 to 6 years. Comparing the potential of these systems to the projected requirements of the user, deficiencies in service were identified and solutions sought. By considering multiple-use solutions and avoiding duplication of effort, an overall systems rationale was developed to serve the total marine community. The implications for each agency in meeting the requirements of this service were then examined individually to evaluate their technical, economic and political feasibility. Where the proposed changes were shown to be impractical, alternate proposals were examined for the role of that agency and the impact of the revision on the total system was determined.

In this manner a set of changes was developed which, in CSC's opinion, would make the maximum contribution to improvement in marine weather dissemination within realistic and practical constraints. These changes form the basis for the set of recommendations made in this report. The procedure leading to the generation of these recommendations is outlined in the sections which follow.

1.2 IMPROVEMENT IN EXISTING SYSTEMS

1.2.1 General

Because the measurement of systems effectiveness conducted in Task 2 of this study was based on parametric analyses, it is possible to modify the values of certain parameters contributing to the effectiveness measurement and to determine the resulting improvement or degradation. If the modified values are objectively related to growth, technical improvement or other time-dependent changes then the resulting change in measured effectiveness is a valid estimate of the future performance of that system.

During this evaluation, primary emphasis was placed on the assessment of the Accessibility (Coverage x Audience) figure of effectiveness. This figure is of predominant importance since it reflects the percentage of the user audience served, and may be used as a basis from which to compute further service degradations due to less easily identified parameters such as message content, timeliness, etc.

Moreover, the model used to determine the reduction in effectiveness due to system schedule in Task 2 was based on the assumption of random access by the user. In order to make a valid comparison between systems, the model assumed that the user had no knowledge of the schedule of broadcasts made by the system. The analyses in Task 2 showed that this factor severely degraded the effectiveness of most systems and emphasized the value of an educational program familiarizing users with the broadcast schedule of any weather dissemination system. In proposing improvements to these systems, therefore, this familiarization is assumed to be an integral part of the changes made.

1.2.2 National Weather Service VHF Radio

Measurements of coverage area made for this system in Task 2 did not completely represent the ultimate service coverage for two reasons. In the first place, the system is in an early stage of implementation and will grow to increase its coverage significantly by 1976 if planned funding is approved. The system will have expanded its facilities from the current 29 stations to about 160, many of them being coastally located. Plans for the system are constantly under revision, but if the current schedule is maintained a further 14 stations will be added which will provide coverage in the scenario areas selected for study.

Second, the boundaries of several scenario areas upon which coverage was based happened to be located quite close to transmitting sites, with the result that much of the coverage provided by those sites was lost to the scenario area. The addition of a

single station in such areas, therefore, represents a significant increase in computed coverage.

Since precise station locations are not available (sites not yet having been selected), the increase in coverage area computed for each new transmitter represents an estimate. The estimate is based on similar criteria to those used in Task 2 (average quality receivers with a range of about 25 miles) and on the assumption that the station will be optimally located, i.e., at a coastal point chosen to maximize over-water coverage. This represents an ideal not likely to be achieved in practice for all stations but provides a criterion for the maximum coverage which may be expected to be achieved in the scenario areas. The increase in coverage is based on the list of stations given in Table 1-1.

As can be seen from Table 1-2, coverage values range from 15 to 38 percent, a distinct improvement over the 4 to 8 percent figures for the existing system in scenario areas 1 through 4 and 6. In particular, the addition of a station at Astoria, Oregon, increases the area 5 coverage from 0 to 18 percent.

The increase in the number of NWS VHF receivers through 1976 is more difficult to estimate, depending as it does on the reaction of users to increased service coverage, availability of competing systems, and changes in the economy. However, the widespread introduction of NWS channels on marine radiotelephone and direction-finding equipment suggests that by 1976 most or all such equipments will include this facility. This would mean that at least five percent of all boatmen would have NWS reception capability by virtue of its inclusion on non-dedicated equipment, and the number might be as high as 10 percent in some areas. (See analysis of VHF radiotelephone growth in Paragraph 1.2.3). There will undoubtedly be a large number of dedicated NWS receivers in use in addition to the above. One might reasonably expect that this figure will increase at least in proportion to the increase in coverage or service area provided. Since coverage will increase by a factor of four according to CSC's estimates, then the

TABLE 1-1
 NATIONAL WEATHER SERVICE VHF RADIO TRANSMISSION
 SITES TO BE OPERATIONAL BY 1976 IN
 SCENARIO AREAS OF STUDY

<p>SCENARIO AREA #2 Salisbury, Md.</p> <p>SCENARIO AREA #3 West Palm Beach, Fla. Key West, Fla. Fort Myers, Fla.</p> <p>SCENARIO AREA #4 Port Lavaca, Texas*</p>	<p>SCENARIO AREA #5 Astoria, Oregon</p> <p>SCENARIO AREA #6 Green Bay, Wisc. Milwaukee, Wisc. South Bend, Ind. Traverse City, Mich. Alpena, Mich. Bay City, Mich. Erie, Penn.</p>
<p>*Remote Operation</p>	

TABLE 1-2

ESTIMATED 1976 PERFORMANCE OF NWS VHF WEATHER
RADIO SYSTEM

SCENARIO AREA #	1	2	3	4	5	6
Scenario Area (Sq. Mi.)	3314	3071	12262	9560	9560	31468
Present Coverage (Sq. Mi.)	265	258	773	440	--	1673
Present Coverage (Percent)	8	8.4	6.3	4.6	--	5.3
Estimated Coverage In-crease by 1976 (Sq. Mi.)	--	748	4703	1421	981	8540
1976 Coverage (Percent)	8	24.4	38.4	14.9	18.1	27.2
1976 Performance (Accessibility, Percent)	2.4	7.3	11.5	4.5	5.4	8.2

number of dedicated NWS receivers may grow from the 7.5 percent estimate made in Task 2 to as high as 30 percent by 1976.

The introduction of a second broadcast frequency (162.4 MHz) by the NWS may tend to reduce the above estimate, since to make full use of the increase in coverage many pieces of equipment would have to be capable of reception on both NWS channels. This means increased cost and decreased sales. However, the majority of boatmen habitually operate their boats close to home and would probably be able to utilize single-channel receivers. For the purposes of this analysis, CSC assumes that the reduction in the number of dedicated receivers will be off-set by the growth in the number of equipment-included receivers, and estimates the number of NWS receivers in use by 1976 to be approximately 30 percent.

By combining the projected coverage figures with this estimated audience factor, the potential accessibility of the NWS system may be computed. The results are given in Table 1-2, where projected accessibility is shown to range from 2½ to 11½ percent.

1.2.3 Coast Guard 2 MHz and VHF Operations

The most important factor affecting the future performance of these systems is the change in audience distribution between MF and VHF radiotelephones which must come about as a result of FCC regulatory changes. The tendency will be for the number of VHF transceivers to grow and for a corresponding reduction in the number of MF radiotelephones to take place.

An analysis of FCC marine mobile license data* for applications made since 1966 shows a linear growth in the total number of applications (MF and VHF) of about 8,500 per year. (Figure 1-1). A license, when granted, remains valid for five years so that the number of licensed operators in any year is the cumulative total

*Item 11, Appendix C, Task 2 Report

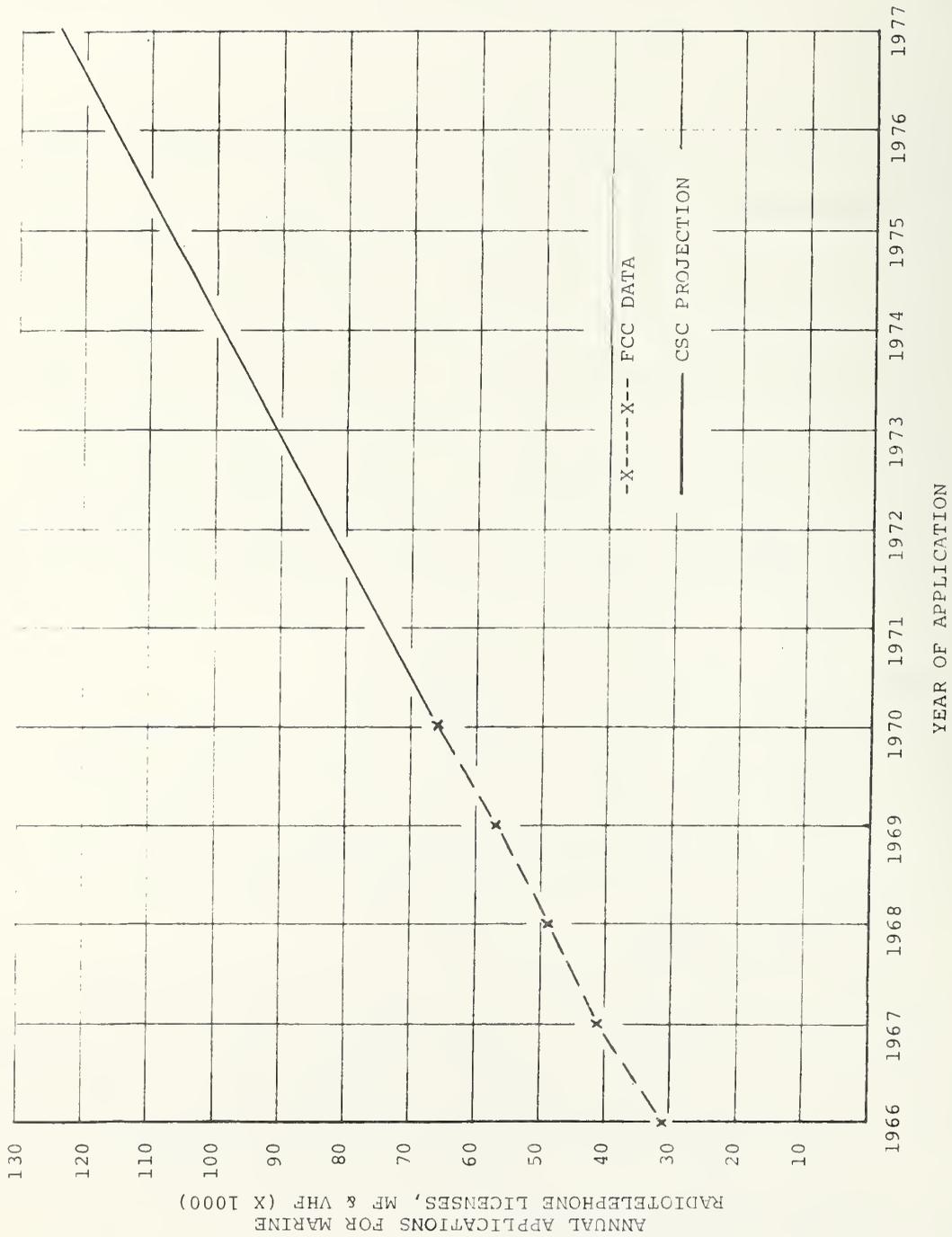


Figure 1-1. Rate of Increase in Marine Mobile License Applications.

of the number of applications for the previous five years. This means that the rate of growth of the number of licensed operators is five times the annual growth, or approximately 42,500 per year.

The projected growth in the total number of marine radio-telephone licenses is depicted in Figure 1-2, which shows an increase from the current figure of 245,432 to approximately 543,000 by 1977. Under the new FCC rules, all of these will be equipped with VHF.

The FCC estimates that approximately 10 percent of the currently licensed operators will continue to use MF (2MHz band) equipment after 1977 because their area of operation is generally outside the range of VHF stations. This puts the number of MF users at about 24,500. It is reasonable to suppose that this number will grow in proportion to the total growth in the intervening period; this means that by 1977 there may be as many as 49,000 MF users licensed for operation in the 2 MHz band.

In order to relate these figures to the analysis, it is necessary to know how the total boating population will change during the period of interest. Figure 1-3 depicts this growth as an extrapolation of Coast Guard statistics for the period 1965 to 1969. Since the graphic technique employed here is less accurate than rigorous numerical methods, upper, lower, and median growth rates have been estimated both for the number of registered boats and for the Boating Industries Association estimate of the total number of boats in the U.S. Superimposed on the extrapolated curves are the official figures for 1970. The close agreement with the predicted numbers lends confidence to the estimation technique.

From the curves it may be seen that the number of registered vessels in 1977 is projected as 6,700,000, and the total number of boats (based on BIA estimates) as 10,600,000. For the purposes of computing systems effectiveness it is the latter figure which is used since it is necessary to determine the percentage of all

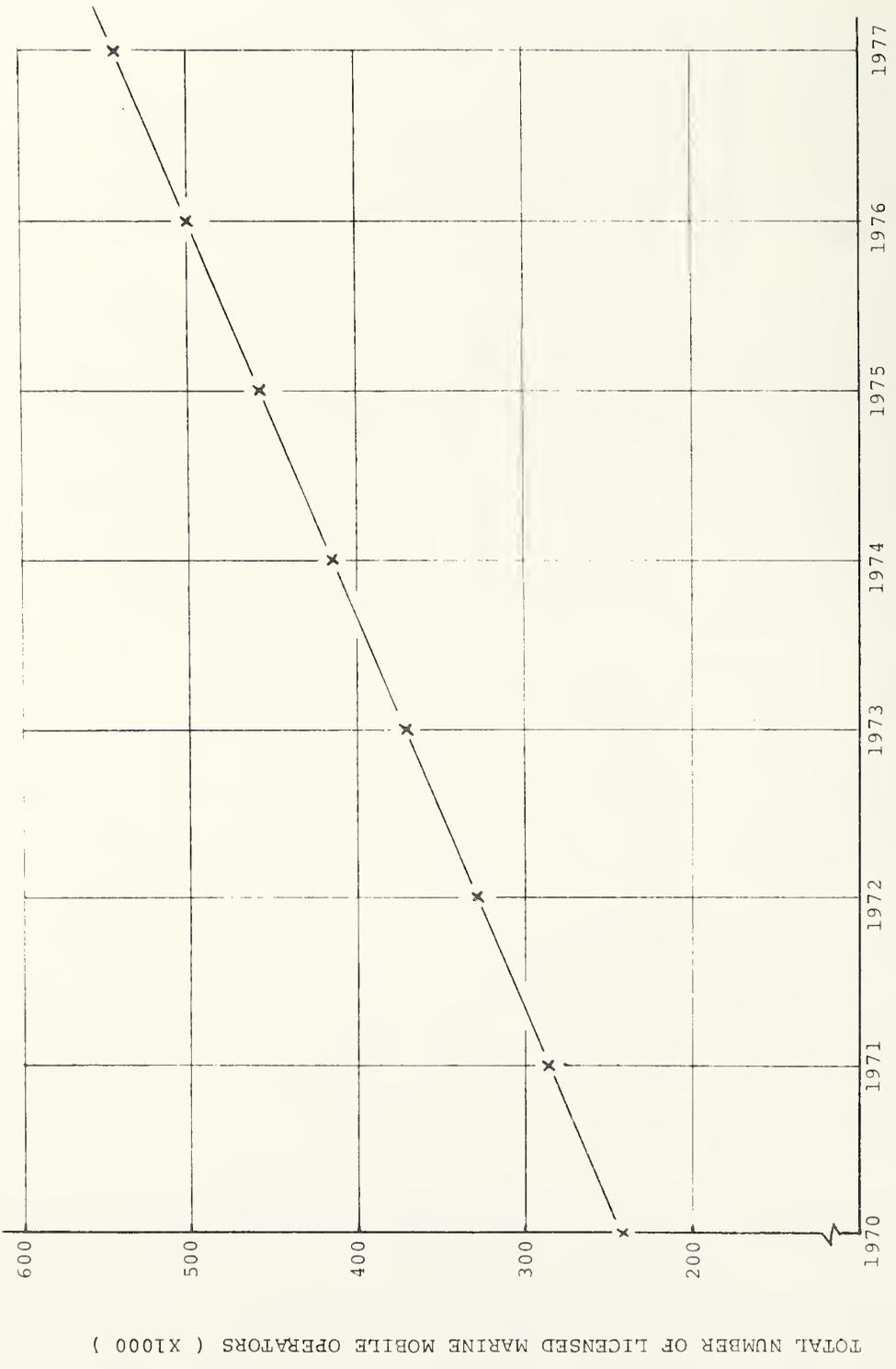


Figure 1-2. Projected Growth in Total Marine Mobile Licenses.

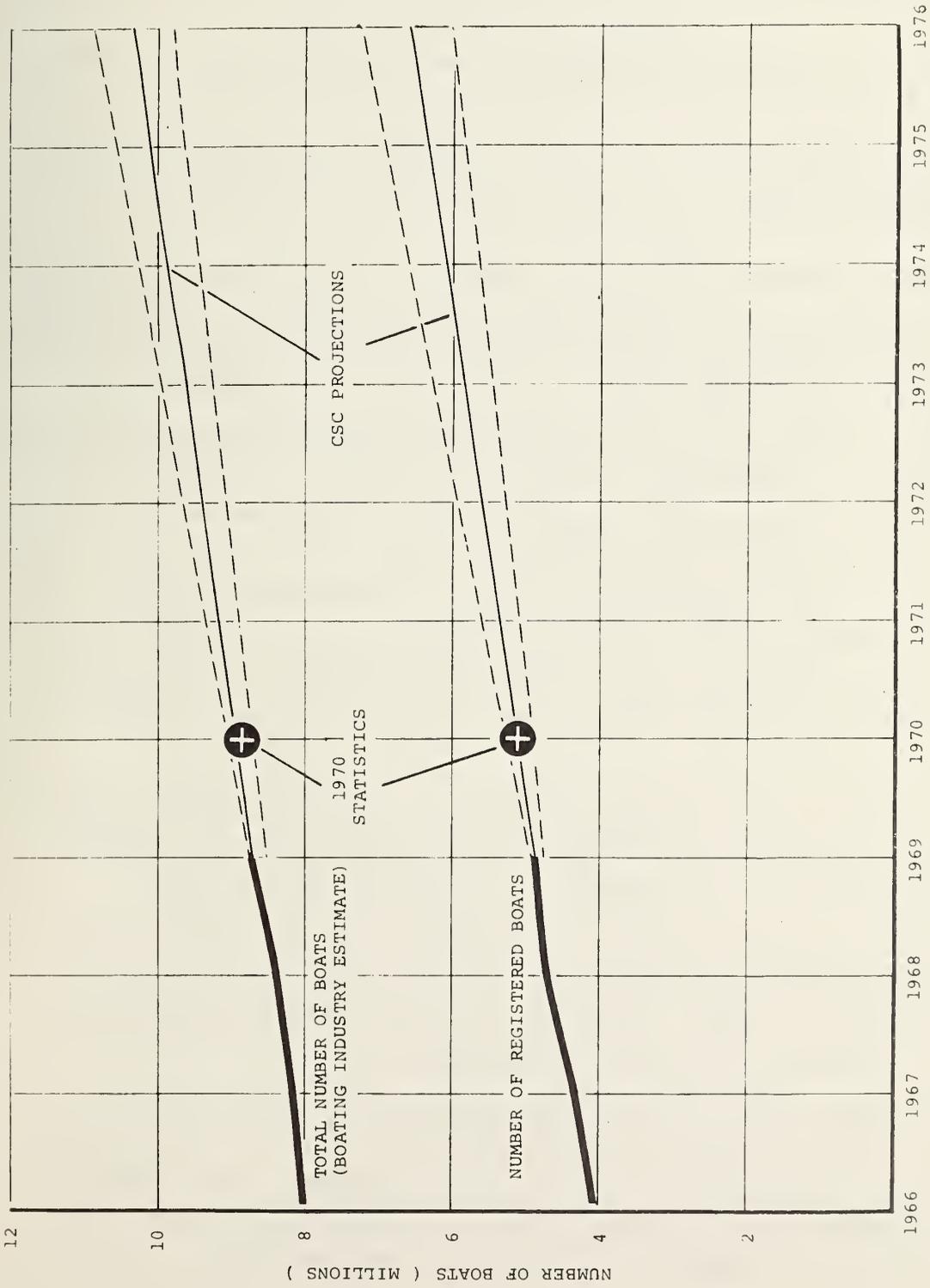


Figure 1-3. Growth in Number of Boats Projected
From Coast Guard Statistics.

users in a given area equipped to utilize each system's transmissions.

Based on the foregoing data, it can be seen that the number of VHF users will represent a little over 5 percent of the total boating population by 1976. The estimated number of MF users, on the other hand, will represent less than one half percent of all boatmen at most.

These audience figures are applied to the coverage estimates made in Task 2 and the results are shown in Table 1-3 where VHF system accessibility is seen to range from 2 to 5 percent. Two points should be noted here. First of all, the audience will vary from one scenario to another, which will make the effectiveness higher in some areas and lower in others. However, as the change-over to VHF nears completion it is to be expected that the differential in percentage audience figures will become less pronounced than those estimated in Task 2. As service becomes generally widespread and as the purchase price of equipment falls, the factors tending to cause uneven distribution are diminished. Growth figures from FCC data in several states clearly show this trend.

Secondly, the coverage provided by the Coast Guard at VHF frequencies is being increased in some areas, notably Florida. Any increase will be reflected in enhanced effectiveness.

Despite these factors, the accessibility in any area is unlikely to exceed 10 percent, and then only at the expense of effectiveness in other areas. The overall service capability for this system will be about 5 percent.

Coverage at MF is estimated to be 100 percent overall, so that the accessibility is audience-limited only. On this basis the figures are shown in Table 1-3 as $\frac{1}{2}$ percent. Once again, it is to be expected that there will be some variation from area to area, but this represents the general accessibility.

TABLE 1-3
 ESTIMATED 1977 PERFORMANCE
 OF VHF AND MF RADIOTELEPHONE SYSTEMS

SCENARIO AREA #	1	2	3	4	5	6
VHF Coverage (Factor)	0.778	0.759	0.370	0.452	0.967	0.769
VHF Accessibility (Percent)	3.9	3.8	1.9	2.3	4.8	3.8
MF Coverage Factor	————— 1.00 —————					
MF Accessibility (Percent)	————— 0.5 —————					

1.2.4 Public Coast Station Operations

The potential performance of the Public Coast Station system is dependent largely on the distribution of marine radiotelephone equipment. The analyses of Paragraph 1.2.3, therefore, apply here, indicating audience figures of 5 percent and $\frac{1}{2}$ percent for VHF and MF transmissions respectively.

Coverage of these systems, however, is likely to change somewhat in the next few years. The number of Class III-B stations is growing at a rapid rate, and the FCC indicates that the eventual limit to this number will be imposed by considerations of interference between adjacent stations. There appears to be sufficient demand to operate this type of service, in other words, that eventually all available geographic "slots" will be filled and coverage will be complete. Indeed, this situation has almost been reached in the East Coast regions already.

Since many of the existing MF stations are changing to VHF, there will be a decrease in their numbers during this same period. However, because of the greater range of MF transmissions, the reduction in coverage will not correspond necessarily to the reduction in numbers, many stations providing overlapping coverage patterns. It is not possible to compute the reduced coverage at this time since it is not known how many or which stations will convert; in any case, since the audience they will be serving is so small ($\frac{1}{2}$ percent, approximately) a change from 100 percent to, say, 80 percent coverage will make little difference to the overall effectiveness.

Accessibility of these two systems in future years is, therefore, computed as 5 percent for Class III-B (VHF) stations and $\frac{1}{2}$ percent or less for Class II-B (MF) stations.

1.2.5 Commercial Broadcast System

In Task 2 coverage figures were computed for two segments of the commercial broadcast system. One was for all stations broadcasting in the AM and FM bands, and the other just for those

stations making broadcasts directly from National Weather Service facilities. The distinction was necessary because it proved to be unfeasible to compute schedule weighting factors for an uncoordinated system of stations with unreliable schedules (see Task 2 analysis). However, in considering the potential effectiveness of the commercial system, it is valid to consider the coverage provided by the maximum number of stations, and it is this figure which is used in the projections made here. Coverage estimates (Table 1-4) range from approximately 70 percent to 100 percent.

Audience figures for the commercial system were estimated at 30 percent for current usage. In considering the potential of this system, the important factor is the degree of service provided. There are few people in the United States who do not own a portable commercial receiver of one kind or another. If the marine segment of the population was offered a meaningful weather information service via commercial radio, and if it was made aware that such a service was available, then certainly many more boatmen would take the receivers which they already own on board their boats.

It is difficult to determine with accuracy what percentage of the boating population would equip themselves in this way; it seems probable that the number would depend largely on the degree to which the service were advertised, as well as upon the quality of service in the user's immediate area. It is also probable that a certain percentage would not elect to use such a system if alternate and more sophisticated means of communication were available to them. The operator of a VHF marine radiotelephone might consider the use of so humble a piece of equipment as a "transistor radio" beneath his dignity or not worthy of consideration.

Nevertheless, in view of the high percentage of boatmen currently carrying portable commercial receivers, CSC believes that the figure could be expected to exceed 75 percent under the conditions outlined above.

TABLE 1-4
 ESTIMATED POTENTIAL PERFORMANCE OF COMMERCIAL
 RADIO WEATHER DISSEMINATION SYSTEM

SCENARIO #	1	2	3	4	5	6
Coverage Factor	0.681	1.00	0.981	0.701	0.899	0.727
Accessibility (Percent)	51.1	75.0	73.5	52.5	67.4	54.5

If this audience level is realized, then the accessibility of this system would rise to between 50 and 75 percent, as shown in Table 1-4. Ultimately, if all boatmen equipped themselves to use such a system, it would be accessible to between 70 percent and 100 percent of all users.

1.3 A USER-ORIENTED SYSTEM

1.3.1 General

From the results of the foregoing analyses it is possible to postulate an "idealized" system to serve the recreational boatman. The system is idealized in the sense that it is developed to serve the needs of the user with only minimal regard to operational considerations. However, it is realistic in the sense that it is developed from existing systems or logical growth forms of existing systems and is subject to the technical constraints of these systems.

The operational aspects of the system will be examined later from the disseminator's standpoint, taking into account political and economic aspects and the implications of such operations for the responsible agencies or organizations.

1.3.2 The Non-Equipped Boatman

A system of weather information dissemination via commercial radio has the greatest potential to serve the majority of recreational boatmen, not only because of the extensive coverage offered but because of the type of equipment required. Between 70 and 80 percent of all boatmen carry no communications or radio reception equipment on board their boats when they operate them on the water.

Although the reason for this must lie partly in a belief on the part of the boatmen that he has no need for such equipment, cost must also play an important part in his decision. The use of

commercial radio receivers, therefore, is attractive for three reasons: since most people own one or more such receivers, there may be no need for any expenditure on the part of the boatman; if he must buy a receiver, the boatman will generally pay less for such a receiver than for any other type; and the unit has the attractive aspect of being a general purpose device which the boatman can use a great deal of the time, not just on his boat.

The implementation of such a system would also have the important attribute of being available to the boatman on shore; that is, it would also operate as a pre-excursion mode information system. Of course, commercial radio is already widely used in this mode, but a formally organized system giving more frequent and precise information of the type needed by the boatman would be of considerably greater value (and deterrence) than the current broadcasts.

To provide the necessary information, the system should utilize the NWS Weather Wire System and/or the 162 MHz VHF Weather Radio System as its information source. Network weather information (such as that provided by United Press International and other agencies) lacks sufficient detail and timeliness.

The large number of commercial stations and their overlapping coverage suggests that almost continuous coverage could be provided by arrangement of a rota for broadcasts by stations serving the same area. For example, three stations with essentially similar coverage could provide marine weather broadcasts every 15 minutes but stagger their transmissions so that the user could intercept a broadcast every 5 minutes, giving him almost continuous coverage in that area. Alternatively, a regular schedule might be established on, say, the quarter hour, so that the boatman would be assured of weather information broadcasts this frequently at several different points on the tuning dial, thus increasing his "exposure."

A system operated in this manner would provide frequent,

relevant weather information with minimal investment cost to the user, and the information would be available to him at home and in his automobile as well as on his boat.

1.3.3 The VHF Radiotelephone User

Optimal service for that segment of the marine population using VHF radiotelephone equipment is less easily defined.

By 1977, it is estimated that this type of user will represent 5 percent of the recreational boating population - approximately 500,000 boatmen. His ranks will number many ex-AM radiotelephone users, boatmen privileged in earlier years to receive regular marine weather broadcasts via Coast Guard facilities at 2670 kHz.

Such users may well feel that they are entitled to a similar service at VHF frequencies. Federal legislation, not choice (they may argue) is the reason for their abandonment of AM equipment and the consequent loss of weather service. On the basis of this argument it would seem to the deprived boatman that some Federal authority should be responsible for providing a similar service in the VHF band.

Unfortunately, this is not so. The service which they seek to have replaced was not federally required in the first place, and there is, therefore, no onus on any authority to replace it. Current scheduled marine weather broadcasts in the 2 MHz band are made by the Coast Guard in the interests of safety of life at sea, and because the Coast Guard has historically cooperated in disseminating National Weather Service products to the marine user. From a purely pragmatic standpoint, moreover, such broadcasts are cost-effective in that they tend to reduce the number of search-and-rescue missions which the Coast Guard undertakes.

It may be argued that these are excellent reasons for continuing that service in the VHF band. However, to do so would

impose severe manpower demands on the Coast Guard. Because of the inherently limited range of VHF transmissions, it will require the establishment of approximately 260 posts to provide VHF broadcast coverage comparable to that now achieved by less than 30 MF stations. Moreover, there is no assigned frequency in the VHF band comparable to the Coast Guard broadcast frequency of 2670 kHz in the MF band. This factor compounds the problem of making VHF weather broadcasts; on which frequency should they be made? The National Distress, Safety and Calling channel at 156.8 MHz is currently used to broadcast urgency signals and messages and short safety messages. Weather broadcasts to be made on working frequencies may also be announced on 156.8 MHz. However, the use of this frequency to broadcast frequent, scheduled weather transmissions would seriously interfere with the intended operation of the channel.

The recently authorized Environmental Channel at 156.75 MHz offers a possible alternative, but practical considerations preclude its effective use. The proximity of this channel to 156.8 MHz poses severe interference problems when operations on both frequencies are conducted at a single site. Transmissions, even at low power, at 156.75 MHz can cause unacceptable degradation in reception quality at 156.8 MHz unless considerable separation is provided between the transmit and receive antennas. The required separation cannot be achieved at many Coast Guard facilities. A further problem is the small number of receivers equipped to receive at 156.75 MHz. Recent Coast Guard trial broadcasts indicated little interest on the part of the user, probably as a result of this factor. Clearly, the provision of extensive VHF service by the Coast Guard entails much more than just changing broadcast bands.

What of the National Weather Service? Is it not the responsibility of this agency to provide the public with weather information? The public, yes; but the provision of marine weather

to VHF radiotelephone users represents an extremely specialized service, one which might logically be assigned a relatively low priority on a national scale.

Despite this, NWS plans ultimately will provide for such specialized service. In areas where marine users are considered to represent a significant segment of the public, NWS broadcasts on the VHF Weather Radio System contain a "marine segment". Moreover, many manufacturers are including NWS reception channels in their VHF radiotelephone equipment. Eventually, therefore, many owners of such equipment will have available continuous weather information in certain areas.

The problem, however, is that the coverage provided, though growing, is considerably less than that provided by MF services and is not likely to reach comparable values in the foreseeable future. In many areas, the VHF telephone user will find himself without any specific weather services.

An ideal solution would be for the Coast Guard to provide supplementary broadcasts at the VHF Weather Radio frequencies, 162.4/162.55 MHz. Two advantages accrue to such an arrangement. The user is provided with a uniform service (same content, same frequency) throughout his area of operation, and the selection of operating channels on his receiver becomes relatively straight forward; broadcasts made on a number of different frequencies in the same area pose a problem since the number of channels which the user can dedicate to weather reception is severely limited. Second, the Coast Guard manpower problem may be eased since the weather transcripts are readily available in format, and may be copied and revocalized, recorded and replayed, or simply relayed.

The arrangement also would have a long-term benefit in that users would be motivated to purchase and install a 162.55 or 162.4 MHz crystal in their equipment (if not already included). This would increase the audience at this frequency and enhance the ultimate effectiveness of the NWS system as coverage becomes more extensive, and

would preclude the necessity of rechanneling when NWS service became available in the user's area.

1.3.4 Users of VHF Receivers

The requirements of users equipped with VHF receivers (as opposed to transceivers) are essentially the same as for radiotelephone users, and the above proposals would provide the service needed by this type of user. In practice, such users will be predominantly NWS system users, because although VHF monitors operating in the marine band are available they appear to be used by very few boatmen. This is to be expected, since there are few services available in the marine band and monitors, of course, do not permit two-way communications. Users wishing to receive marine information would probably choose the generally less expensive 162 MHz monitor.

1.3.5 MF Radiotelephone Users

The service provided the MF radiotelephone user by Coast Guard and Public Coast stations is probably the best currently available to the marine user. The introduction in recent years of frequent (sometimes hourly) weather broadcasts by the Coast Guard at 2670 kHz have been well received and documentation shows that they provide a service which is highly valued by boatmen equipped to receive them.

However, in the light of FCC rule changes the number of boatmen so equipped will diminish rapidly in the next 5 years, and the requirements of the remainder will be different from those of the majority of current users. The use of MF radiotelephones in a two-way mode will be restricted to areas beyond range of VHF stations. The weather information required by such users will, therefore, include both coastal and off-shore forecasts and observations.

Although off-shore weather will be the major requirement at

MF frequencies (all MF users will also be equipped with VHF after 1977) there are two reasons for providing coastal weather also on these frequencies. A boatman operating off-shore needs to know the coastal weather conditions before attempting to enter the coastal zone; and second, the provision of this information at MF means that he may use his MF equipment as a backup to his VHF gear. Ideally then, weather broadcasts should continue to be made at 2 MHz on a frequent schedule and should contain both coastal and off-shore weather information.

1.3.6 Pre-Excursion Information

Boatmen frequently require weather information pertaining to their habitual area of operation before they leave shore and, in many cases, even before they leave home. Besides providing a valuable service to the user, such "pre-excursion" systems are useful in reducing the weather-susceptible boating population.

An ideal system would be immediately and easily accessible to every boatman and would provide him with up-to-date information for his immediate area of interest. It would inform him of prevailing conditions in the terms of the parameters of interest and would provide short-term forecasts of expected conditions. This information may be disseminated in three ways; by radio, television and newspaper; by telephone, on demand; and by display signals or messages at his point of departure.

Television and newspaper dissemination does not permit sufficiently up-to-date or frequent information content. Radio broadcasts, if used, should be made frequently (at least twice each hour) and should be updated at least hourly. Telephone sources should provide marine weather only and be updated at least hourly; sufficient discrimination should be available to provide local information relating to the user's area of interest. Display signals or messages should be available to all boatmen and provide sufficiently detailed information to permit the user to interpret the relevance of the warning to his own circumstances.

1.4 SYSTEM OPERATIONAL LIMITATIONS

1.4.1 General

The system proposed in Section 1.3 was developed with the needs of the user in mind. In this section, the proposals are examined from the operator's viewpoint to discover what demands are made on each operating authority and to determine the economic and political feasibility of implementing the system.

1.4.2 Commercial Radio Dissemination

From an overall service standpoint, there is no question that the commercial broadcast network is the only organization with the capability to provide the required service. CSC believes that the implementation of frequent scheduled marine weather broadcasts by selected commercial disseminators could satisfy the requirements of the vast majority of recreational boatmen and strongly recommends that measures be taken at the earliest possible time to initiate such a service.

The problem, of course, is what form these measures should take. The commercial broadcast industry is not a "system" in the true sense of the word, although it was considered as such for the purposes of this study and within the meaning of the term as defined in Task 2. The industry is formally united through national and state associations, such as the National Association of Broadcasters, the Virginia Association of Broadcasters, etc. There are, however, two other ties which may be more important. The first is the common interest shared by all commercial broadcasters as public service organizations; the second is the commercial nature of the industry itself. These common interests must form the basis for any cooperative agreement between commercial broadcasters and other agencies to provide marine weather services.

The role as a public-service organization predisposes each broadcaster to provide services considered valuable to the public,

and the possibility of obtaining a sponsor for that service makes it commercially attractive. Discussions with representatives of the industry have indicated that both these factors pertain and suggest that the organization of coastally-located broadcasters with a view to providing a structured marine weather dissemination service is a practical proposition. However, there are limitations to the degree of commercial support which can be maintained. The necessary communication links and organization for such a system are in existence in some areas and have already been used. Many commercial stations cooperate with the National Weather Service, which makes weather products available to participating stations via the Weather Wire teletypewriter system. What is needed is a leadership effort to determine areas in which broadcasts are needed, locate appropriate stations, educate these stations as to available sources of information, and to encourage their participation. These, then, are the operational limitations in providing the type of service proposed in Section 1.3.

Because of the lack of an appropriate leadership or supervisory organization, and because of the limits imposed in a commercially competitive market, the concepts of rotating broadcast schedule, and even of a universally similar schedule, are probably impractical. Although it is possible for a commercial station to obtain a sponsor to support the provision of marine weather information, stations in close proximity are in competition for his support and are unlikely to cooperate in "sharing" his custom. The desirability of certain time slots (e.g. on the hour) would make a cooperative agreement to broadcast according to rota difficult to achieve both from the station's point of view and from the sponsor's. The same general considerations make it improbable that commercial broadcasters could be persuaded to provide broadcasts at similar times and with similar regularity.

Nor is such a system likely to become operative without a determined leadership effort from outside the industry. While

generally willing to cooperate, individual stations not already making marine weather broadcasts may not be sufficiently motivated to explore the market for solely commercial reasons. The public service aspect of the system and the associated need plus the potential saleability of the service must be brought to their attention. Moreover, if the necessary coverage (station-spacing) and frequency of schedule is to be achieved, then the overview of an objective and concerned authority is required.

It is clear from these considerations that the idealized commercial system offering maximum coverage and almost continuous service is unlikely to be attainable. Despite this, CSC believes that sufficient number of commercial disseminators can be organized to provide frequent (at least once each hour) weather information broadcasts to the majority of recreational boatmen. To be successful, the implementation of such a system must be widely advertised to the boatman to insure that he equips himself with a suitable receiver.

The feasibility of such a service is evidenced by a program initiated in the New England area during the course of this study. The First Coast Guard District Office is coordinating the operation of a marine information service through the cooperation of a number of New England commercial broadcasting stations. The service began on Memorial Day, 1971 and will continue through the boating season. As of 1 June there were 28 radio stations participating in the program. The service consists of regularly updated on-scene weather reports as observed by the Coast Guard station in the area, selected local aids to navigation information, boating safety advisory information and notice of events of interest to local boatmen.

1.4.3 Coast Guard Operations

In examining the role of the Coast Guard in the postulated system of Section 1.3, two problems are immediately evident. The first of these is the limitation in available manpower for other than essential duties (search-and-rescue operations, watch duty, observations, etc.) The second is an equipment limitation.

The manpower problem was recognized in Section 1.3 and the relay or rebroadcast of available transmissions suggested as a solution. However, even this type of role would occupy a significant portion of a watch-stander's time if frequent broadcasts were to be made.

The major problem in providing such a service, however, lies in the incompatibility of existing Coast Guard transmission equipment with the requirements of the proposed broadcasts. Although designed to operate throughout the required range of frequencies (152 to 174 MHz), the most commonly used equipment, AN/URC-45, is constrained by an operational bandwidth of 1.5 MHz, although the band may be selected to lie anywhere between 152 MHz and 174 MHz.

Since Coast Guard operations require that the National Distress, Safety and Calling channel on 156.8 MHz be monitored, and since existing equipment and operations are centered around 156.5 MHz, it is clear that broadcasts in the region of 162 MHz are not possible under existing circumstances. Though the equipment could be retuned to operate at this frequency, the alternation would preclude the use of the equipment for normal operations. The purchase of additional equipment to facilitate the proposed service is not feasible within current budgetary limitations.

There remains the possibility of utilizing Coast Guard facilities for remote, automated transmission of NWS VHF Weather Radio broadcasts. This will be discussed in the following section.

Coast Guard transmissions in the MF band make lesser demands in terms of manpower. The number of users equipped to benefit from these broadcasts will diminish, however, in coming years; by 1977 it is estimated that they will represent less than half of one percent of the boat population.

Those using this type of equipment will be mariners whose operations regularly take them considerable distances from shore, and it may be assumed that they will be more experienced sailors and often small commercial operators. Their area of operation and their experience makes them less susceptible to weather hazards than the occasional boatman; their requirements, therefore, tend toward less frequent but more detailed weather information, probably covering a longer forecast period.

On this basis, Coast Guard operations at 2 MHz might be reduced without significant loss of service to the user. Such a reduction would be particularly appropriate if it permitted an increase in service to the less experienced boatman operating closer to shore.

The requirement for pre-excursion information by the user has its impact on Coast Guard operations in the form of requests for weather information by telephone. In an attempt to satisfy this demand, consideration has been given to the provision of automatic answering equipment to offset the workload caused by personally answering calls (see Task 1 report).

The operation of this type of service is extremely expensive, and it does not appear feasible for Coast Guard operations to include telephone dissemination. On the other hand, answering requests by telephone manually interferes with essential operations and is even less desirable.

Coast Guard involvement in pre-excursion information systems is more effectively utilized in the area of display signals. Almost one third of the Coastal Warning Display Stations currently

in use is operated by the Coast Guard. This service is valuable to the boatman, but lacks sufficient information about the warning in effect. The nature of the system makes any significant improvement difficult.

1.4.4 National Weather Service Operations

The development of weather information products and the dissemination of these products to the public is the primary responsibility of the National Weather Service (NWS). The discharge of this responsibility is effected in part through the VHF Weather Radio System and the telephone weather information systems operated by the NWS.

The provision of specialized services, such as those to the marine user, must fall within the framework of a service to the public at large. This may limit the services provided to the marine user who has more urgent need of weather information than the casual public listener, and prevent implementation of the "ideal" system of Section 1.3.

The difficulties lie in the message content of the broadcast and in the geographic coverage provided. Marine information, though included in broadcasts from coastally located stations, is brief and represents only a small portion of the message transcript. The priority for station implementation and the actual siting of stations is based on factors other than marine user requirements. Consequently, there may be significant bodies of water carrying heavy boating activity which are not covered by the NWS VHF system until full area coverage of U.S. coastal waters is achieved.

The Weather Service is not unaware of these conflicting factors, however, a fact which is reflected in the number of coastally located stations already in service and NWS priorities for future sites. It is clear, though, that because the marine user is

merely a subset of the majority user class, the system does not realize its full potential in serving the boatman. Several stations which are "coastally" located are actually sited several miles inland, with a resulting significant loss in over-water coverage. Admittedly, the siting is often predicated on the location of an existing antenna mount or mast; but the result, nevertheless, is a loss to the marine user in favor of the general listening public.

Similarly, the provision of a marine weather segment in appropriate areas indicates that the Weather Service is aware of the need for such information by the boating public. Once again, however, the marine user plays "second fiddle" to the general public in the type of information provided, general weather being the main segment and marine weather only a secondary addition.

Though the NWS VHF Weather Radio Service is potentially an ideal system for providing marine weather information to the boatman on a continuous basis, the limitations discussed above preclude full realization of this service by the marine user.

The NWS also disseminates weather information by telephone, operating single-line recordings and multi-line automatic telephone answering systems. Under present policy, the NWS will implement specific marine services at many populous locations. To provide the level of service outlined in Section 1.3, however, more such locations would have to be implemented and the content of the message transcript expanded somewhat to include observed local conditions.

Budgetary and equipment limitations prevent the accomplishment of the above steps in a total effort, and the competing needs of other classes of user dilute the effort which the NWS can expend in this direction. The provisions currently being made for this type of service by the NWS represent a considerable effort and probably the maximum which can reasonably be supported for such specialized services.

1.4.5 Public Coast Station Operations

At the present time, many public coast stations operating in the 2 MHz band broadcast marine weather information on a scheduled basis. These broadcasts are also made in the VHF band from stations in the Florida and Great Lakes regions. The broadcasts are limited in number, however, and generally occur in the early morning or late afternoon time periods.

In discussions with telephone company personnel, the possibility of more frequent weather broadcasts was explored. The general reaction was that the provision of more than four scheduled broadcasts per day would interfere with normal operations, requiring the operator to interrupt or queue radiotelephone calls in order to maintain the schedule. Economic and manpower limitations were also cited as blocks to more frequent transmissions.

Since the basis for operation of these facilities lies in the provision of two-way telephone communications to marine users on demand, any significant interference with this service is clearly unacceptable; and since the provision of broadcast weather information is not a statutory requirement of their operation, Public Coast Stations are understandably reluctant to foot the bill for such services.

The economic aspect of the problem is made more acute by the fact that current VHF operations by many concerns are not financially successful, but are either supported by complementary land-mobile communications traffic or subsidised by the parent telephone company. This state of affairs will not continue indefinitely, and VHF Public Coast operations are expected to become financially attractive as the audience grows.

Nevertheless, recognizing the situation which currently pertains, CSC examined the possibility of some agency purchasing broadcast time from Public Coast concerns for the express purpose of making scheduled weather broadcasts. Representatives inter-

viewed on this proposal considered it a novel idea, but doubted that it was practical. It was pointed out that a tariff would have to be filed by any individual company wishing to provide marine weather broadcasts on a paid basis. As a result, the companies operating under such an agreement could be requested to sell "commercial time" to other interested parties, with the result that they would be hampered in their primary function of supplying "demand access" to ship-to-shore telephone subscribers.

Assuming that these potential difficulties could be dealt with effectively, the time required for filing and approving tariff documents could preclude scheduled frequent marine weather broadcasts sooner than the 1973-1974 boating season.

Because of the demand-access nature of the system, it appears as though frequent scheduled broadcasts of marine weather information by Public Coast stations is not a practical proposition. However, the extensive coverage which will eventually be provided by the VHF segment of this system, and the ready accessibility of the system to its subscribers on demand, together offer a significant potential as a weather information source on request. These facilities could provide a valuable service to their subscribers by making the latest marine weather information available on demand, a service which would require each station to install a NOAA Weather Wire teleprinter terminal or a VHF Weather Radio Monitor.

1.4.6 Overview of the Proposed System

Having examined the proposals for marine weather dissemination to coastal users from the aspect of operational limitations, it is now possible to overview the system as it appears after modifications resulting from these limitations.

In the revised system concept, service to the majority of recreational boatmen is provided by way of frequent broadcasts from commercial radio stations made on an announced, regularly

scheduled basis. The initiative for the implementation of these broadcasts and the supervision and monitoring role necessary to their continued availability comes from an objective outside agency.

Continuous marine weather information for users who require such services and are prepared to equip to receive them is made available by the NWS VHF Weather Radio System. Improved message format and increased coverage are required to maximize this service.

Marine weather services to VHF radiotelephone users is restricted to the above category in recognition of the difficulties encountered in providing dedicated broadcasts for this class of user. The above services may also be utilized by boatmen using suitable monitor (receive-only) equipment.

Users of MF marine radiotelephone equipment are served by Coast Guard transmissions at 2670 kHz as before. However, the schedule is less frequent and the emphasis has changed to off-shore weather information.

All users have access to relevant marine weather information before they take to the water (pre-excursion mode) by virtue of the commercial radio broadcasts and telephone weather systems operated by the NWS and telephone companies, supplemented by the Coastal Warning Display System.

1.5 RECOMMENDATIONS FOR CHANGE

1.5.1 Introduction

Based on the consideration of potential improvement, user requirements and operational limitations in the previous sections, recommendations for changes in the policies, procedures, and facilities of the Coast Guard and other organizations to improve the dissemination of marine weather information to coastal operators may be made. Recommendations for each individual agency are described in the following paragraphs with a discussion of the

reasons for each recommendation in detail. For convenience, the recommendations are summarized in brief in Section 3.

1.5.2 Coast Guard Action

a. General

Although the U.S. Coast Guard has statutory authority (USC 147) for the dissemination of weather information to mariners, this is not considered to be among its primary responsibilities, and such services should not, and must not, interfere with the discharge of other essential and unique responsibilities conducted in the interests of safety of life at sea.

Nevertheless, the Coast Guard, as the only agency having the interests of the boatman as its predominant concern, must bear the responsibility of assuring that essential services are made available to the boatman, either through its own auspices or through those of other agencies and organizations. The recognition of this responsibility is evidenced by the procurement under which this study was conducted.

In view of this situation, CSC recommends that the Coast Guard does not undertake to provide extensive weather dissemination services which may degrade the performance of other essential operations and which may be provided in a more cost-effective manner by other organizations. Instead, CSC recommends that the Coast Guard assume the role of moderator, establishing in detail the needs of the marine user and providing the coordination necessary to the effective and efficient implementation of services to satisfy these needs.

b. Policy

To ensure that the marine user, and in particular the susceptible recreational boatman, is provided with essential weather information services, CSC recommends that the Coast Guard institute within its ranks a body of persons concerned solely with the provision and coordination of such services. This body

should monitor the availability of services in each District and recommend and initiate corrective action where needed. It should also maintain an awareness of changing user requirements and suggest appropriate modification of service to the sponsoring agency or organization.

It is not within the scope of this study to determine the exact organizational make-up of this body, nor to specify the staffing level required. The recommendation is made on the basis that this proposal will lead to an improvement in weather dissemination significantly greater than that which could be attained through an equivalent expenditure in funds in support of Coast Guard operated dissemination programs.

It is further recommended that this body establish intimate working liaison with representatives of the marine services division of the National Weather Service. This liaison might best take the form of a specially convened, permanent committee on marine weather dissemination. Other organizations having as their concern the welfare of the recreational boatman should also be actively involved in the business of this committee.

The first business of this committee should be the implementation of a network of commercial radio stations making frequent broadcasts of marine weather information. A suggested approach to achieve this end is given in Paragraph 1.5.6.

c. Procedures

It is recommended that current Coast Guard procedures for radio dissemination of weather warnings and information remain substantially unchanged. Broadcasts of scheduled marine weather at 2670 kHz should be continued in the interests of users equipped with MF radiotelephones, although the frequency of schedule could be reduced as the change-over to VHF usage becomes pronounced. CSC further recommends that the information content of these broadcasts be reevaluated periodically during the change-over to ensure compliance with the changing needs of the user.

The procedures currently adopted for use of VHF frequencies should be maintained, limiting the use of this band to transmissions at 156.8 MHz of urgency signals and messages, safety signals, and announcements of special broadcasts to be made on other frequencies. CSC recommends that the Coast Guard does not make regularly scheduled broadcasts in this band in view of manpower restrictions and the possible degradation of essential operations which might result.

Dissemination of weather forecasts by telephone is properly the role of the National Weather Service in conjunction with the local telephone company. It is recommended that the appropriate NWS telephone number for marine or general weather be listed in the telephone book under local Coast Guard listings under the heading "Weather." Telephone inquiries to Coast Guard facilities should be referred to this number and the caller informed of Coast Guard policy in this respect.

The Coast Guard is in a unique position to make local observations of sea and wind conditions, and currently supplies this information to the NWS for inclusion in certain broadcasts. It is recommended that this role be continued, but that careful consideration be given to more timely means of disseminating this type of information to the boating public. Rigorous procedures should be adopted and maintained to ensure that timely observations are included in the NWS VHF Weather Radio broadcasts and, where applicable, in regular marine weather broadcasts made by commercial radio disseminators. Where such dissemination techniques prove to be inadequate to meet public demand, consideration should be given to automatic telephone systems dissemination, with the cost for such services being shared by the Coast Guard and the National Weather Service.

d. Facilities

It is recommended that current Coast Guard coverage at VHF frequencies be extended to include all areas of jurisdictional responsibility to permit the monitoring of national safety channels and the coordination of search and rescue operations through communications in this band. It is further recommended that the Coast Guard procure and install VHF monitor receivers equipped with a tone alerting capability at all rescue coordination centers and subordinate commands within the service area of NWS VHF broadcast stations. CSC recommends that the use of the Environmental Channel (156.75 MHz) be excluded from consideration in view of the limited service capability and potential interference with operations on the adjacent National Distress, Safety, and Calling Channel (156.8 MHz).

To facilitate voice broadcasts in the 2 MHz band, CSC recommends the installation of recording equipment for the regular transmission of weather information.

No expansion of facilities for telephone weather information is recommended other than that dictated by considerations of disseminating on-scene observations in the absence of a suitable alternative dissemination method (see 1.5.2.c above).

1.5.3 National Weather Service Action

a. General

Although dissemination of weather information is a statutory responsibility of the National Weather Service (NWS), service to special groups (such as marine users) must necessarily be provided within the framework of a service to the general public. However, the marine user in particular has a more urgent need of this type of information than does the public at large, since the safety of his property and even his life may depend upon it.

The changes currently taking place in the marine communications environment make it economically unfeasible for the U.S. Coast Guard

to maintain the level of service which has been provided in prior years in the medium frequency band. The NWS VHF Weather Radio System, when completed, will provide part of the service lost to MF radiotelephone users, but will not have equivalent coverage. Moreover, the vast majority of recreational boatmen will still have no means of obtaining timely weather information while operating their boats on the water.

Recognizing these factors, CSC proposes a system of marine weather dissemination by commercial radio stations, similar to that already in existence but more formally organized, more extensive, better publicized and providing more frequent broadcasts. The feasibility of such a system has been established during this study, but cannot become a reality without the close cooperation of the Coast Guard and the NWS and a determined effort by both parties.

b. Policy

National Weather Service policy in assigning priorities to certain services serving the needs of the marine user should be reexamined with respect to the needs of the recreational boatman. Although representing a relatively small percentage of the total population, this class of user has a more urgent requirement for timely weather information than members of the general public.

This factor should be given careful consideration in choosing locations and assigning funds for VHF Weather Radio sites and automatic telephone answering systems. The relative proportion of general weather messages dealing with marine conditions should also be considered in this light, and the tailoring of message content to the marine user's needs carefully examined.

NWS policy on dissemination of its products by commercial radio stations should be maintained, but the procedures for encouraging station participation and for providing weather products to each station need to be revised (see 1.5.3.c).

c. Procedures

CSC recommends that the content of marine weather information transcripts for radio and telephone dissemination be revised in accordance with the modifications suggested by many users during the course of this study. These changes include:

(i) Updating of information at least once every two hours; where forecasts and conditions have not changed since the last update, the transcript should be repeated but the time of issuance changed to reflect the evaluation.

(ii) Including wave heights and lengths in the transcript.

(iii) Giving greater emphasis to observed local conditions.

It is recognized that (ii) above poses problems in terms of obtaining the information. Procedures for eliciting available observations by Coast Guard personnel should be examined and improved where possible, and as much information of this type given where feasible.

d. Facilities

Where a need for VHF Weather Radio Service is identified, and where coverage is not available under the NWS Plan for VHF Radio Service, consideration should be given to supplementary, low-powered remote transmitters operated from Coast Guard facilities.

Such sites are often ideally located from the standpoint of service to the marine user, and existing antenna masts could be utilized providing careful consideration is given to interference problems (solved by antenna spacing and/or filtering).

It is not recommended that this type of supplementary site be introduced as a temporary expedient prior to the commissioning of future planned permanent facilities. Only in locations where ultimate service will not provide coverage, and where a significant need can be shown to exist, should these procedures be considered.

1.5.4 Commercial Broadcasters

There are many commercial broadcast stations making frequent marine weather broadcasts in the United States, often more frequently than once each hour. These stations provide a much-appreciated service to the recreational and small commercial boatmen in their areas.

Representatives of these stations to whom CSC talked during the course of this study indicated that the provision of marine weather information is regarded by most as a public service among coastally-located stations. However, those making frequent (half-hourly) broadcasts clearly stated that their operations in this field are financially attractive, time spots adjacent to the marine broadcasts being sold to manufacturers and distributors of marine equipment and sometimes to non-marine oriented interests.

CSC strongly recommends that all coastally located commercial broadcast stations consider the requirement for this type of service in their immediate area and examine the sales potential of such broadcasts. Those already making infrequent broadcasts are recommended to consider the significant increase in service which they are uniquely capable of providing by making more frequent broadcasts.

Contact with Coast Guard and National Weather Service personnel is recommended to establish local need for such services and to identify available weather information sources and procedures. Acquisition of the NOAA Weather Wire teleprinter service and/or the NWS VHF Weather Radio monitor equipment (preferably with the Tone-Alert feature) is recommended.

1.5.5 Public Coast Stations

The acquisition of weather information source equipment (see 1.5.4, above) by Public Coast Stations is strongly recommended by CSC as an essential part of the service offered by such operations

to their subscribers. In this manner, fee-paying subscribers may, on demand, receive the latest weather information for their area via the nearest Public Coast Station.

It is also recommended that Public Coast Stations broadcast the latest information as frequently as normal operation permits, but in any case no less than three times each day. Recommended times for these broadcasts are 0800, 1200, and 1600 hours, unless local conditions and user requirements dictate otherwise.

1.5.6 Implementation of a Commercial Broadcast Marine Weather Dissemination System

The following recommendations are offered as guidelines for the implementation of a weather dissemination system based on broadcasts by commercial radio stations.

a. Identification of currently participating stations: Identify in each District commercial broadcast stations providing any marine weather services, characterizing them in terms of regularity of schedule, message content and information source. NWS listings (given on Marine Weather Services Charts) may serve as a baseline but should not be regarded as exhaustive or necessarily up to date.

b. Determination of additional service requirements: Identify areas in which additional stations are required to make broadcasts to provide the necessary coverage, or where existing broadcasts must be made more frequently. Coverage analysis techniques developed in Task 2 of this study could be used for this purpose.

c. Education of commercial disseminators: The need for service should be brought to the attention of the selected stations by the Coast Guard, acquainting them with the findings of this Weather Dissemination Study and suggesting an examination of the commercial prospects of such a service. The availability of weather products should be explained to the station by participating NWS personnel, and an explanation of the means of obtaining these

products made. Cost and performance data on the NOAA Weather Wire and VHF Tone-Alert Weather Radio systems should be made available.

d. Preparation of potential sponsors: The participation of commercial enterprises as sponsors should be solicited from a service desirability standpoint. The Coast Guard should acquaint manufacturers of boats, engines, marine accessories and communications equipment with the findings of this Weather Dissemination Study and indicate the value of their support to the program. They should be encouraged to seek advertising outlets in conjunction with marine weather dissemination broadcasts in preference to other advertising modes of similar effectiveness.

e. Education of the user: When the program is under way, the boating public should be encouraged by every means available to carry on board boats a portable AM, FM or AM/FM receiver. The initial effort would best take the form of brief television announcements similar to those currently being made in the interests of boating safety. Following introduction of the service to the public, specific details on participating stations, broadcast frequencies and times of transmissions should be publicized in all available media. Wherever possible these should be general public media (newspaper, etc.) rather than special interest outlets such as boating magazines, notices to mariners, etc.

SECTION 2

OFF-SHORE AND HIGH SEAS DISSEMINATION

2.1 INTRODUCTION

Recommendations to improve the dissemination of weather information to marine users in the off-shore and high seas areas involve three aspects. These are:

- a. Information Transfer
- b. Technical Transmission
- c. Management

All are complementary to the end objective of providing satisfactory weather information. Although the above considerations are not unique to the off-shore and high seas areas, they are of increased significance because of the greatly expanded area of weather interest and the extended transmission paths involved. The off-shore and high seas users, however, possess a favorable characteristic which assists in the dissemination solution. As professional and serious mariners, they respect the need for weather information and initiate considerable effort to obtain available information. The probability of intercept, therefore, is not appropriate in evaluating dissemination in this case.

Consideration for improvement addresses the following essential measures:

- a. Information Transfer
 - (1) Timeliness to user
 - (2) Contents of information provided
 - (3) Format of presentation
 - (4) Special needs

b. Technical Transmission

- (1) Coverage of geographical areas
- (2) Reliability of transmission
- (3) Equipment for improved services

c. Management

- (1) Recognition of existing procedures for information gathering and exchange
- (2) Improved systems integration
- (3) Implementation of timely corrections

2.2 INFORMATION TRANSFER

2.2.1 Timeliness to User

The perishability of weather information, and the importance of warnings in time to permit reaction, dictate prompt handling from processing centers through disseminators to users. An evaluation of an optimum frequency of dissemination against users desires has not been performed. However, means exist by which sampling could compare frequency of forecasts against needs. The frequency of forecasts desired is related to the pattern of weather change for the area, and the proximity of the vessel to coasts, islands or shoals. Weather information upon departure is a specialized requirement discussed in subsection 2.2.4 Further examination of scheduled forecasts and broadcast schedules is recommended.

The provision of weather information to the station serving as a disseminator must be timely to his published broadcasts. Commercial stations at Chatham and Tuckerton have indicated that material failed to reach them by broadcast time on several occasions in March and April 1971. The delay creates inefficiencies in station operations by requiring extra and separate handling which impacts upon traffic schedules. In sampling ship's radio officers,

ten percent commented upon late broadcasts. It is recommended that processing and transmitting times to disseminators be controlled by firm schedules.

The transmission by commercial stations tends to "bunch" broadcasts by forecast release times. Although such dissemination is a public service by the station and without charge to the National Weather Service, there is an indirect pecuniary potential to each station's operation. By being the first to broadcast the new forecast, a station attracts listening vessels which then hear the list of ships for which traffic is held by that station. Further, the ships having weather observer messages may be influenced to transmit their reports through that station. In 1970, 109,821 weather observer messages were transmitted from ships to United States commercial stations. Each message handled by the commercial station contributes to that station's earnings. An equitable balance is needed to encourage a spread of broadcast times by coastal stations, and also avoid implied disadvantages to a disseminator scheduled for a later time slot. In comparison, Coast Guard radio stations received 160,638 METEO observations from ships in 1970. The commercial stations view the weather messages sent through commercial means as highly competitive, and, of course, seek feasible means of increasing the potential commercial share.

Sampling of ship's comments suggest that forecasts be increased from two to four times daily in the Gulf of Mexico and Florida straits.

2.2.2 Information Content

The forecast areas for marine weather are not equitably treated with respect to geographical areas. For example, the Southwest North Atlantic and Pacific Coast encompass extensive areas in comparison to other defined forecast areas. The SW North Atlantic also includes the Bahama passages and eastern approaches to the Florida Straits which are of detailed interest to vessels

in these waters. The weather forecast areas should be subdivided geographically with relative uniformity as may be feasible considering meteorological and shipping routes. Additional reporting areas by selected local stations should be considered which expressly address conditions in the approaches to major ports such as Boston, New York, New Orleans, Galveston-Port Arthur, Los Angeles, San Francisco, and Seattle.

The organization of broadcasts merits review so as to provide immediate summary of changes and highlights. Detailed report should then follow. Broadcasts for off-shore areas by any one station should include all forecast areas adjacent to the area of the disseminating station. The need to monitor several stations to cover common routes results in a disjointed effort by the user. Although most stations broadcast weather for all three reporting areas of the Gulf of Mexico, a major coastal station at Port Arthur transmits weather for only the Middle and West Gulf of Mexico (Weather for Merchant Shipping, page 24). Ships departing that area easterly bound for the Florida Straits are, therefore, required to monitor an additional station to receive weather for the East Gulf area.

Sampling indicates the need for fog reports and forecasts, wave heights, centers of storms as well as the fronts, direction of movements, and more information of localized conditions in approaches to major ports.

Longer range weather forecasts (e.g., 5-day forecasts) are needed for major tracks. This is discussed further in Subsection 2.2.4.

2.2.3 Format of Presentation

Formats of Morse code telegraphy broadcasts are considered satisfactory. Sampling as reported by the Port Meteorological Officer, New Orleans, indicated that some radio officers felt that information was redundant in transmission. Their view was that

similar forecast material for an adjacent area might be shortened in terms of transmission. However, the labor saved by radio operators may jeopardize receipt of complete forecasts since the forecast message distributed to all coastal stations cannot anticipate individual similarities in weather in adjacent areas, nor the combination of areas that each station may actually broadcast.

The advantages of teleprinter, facsimile, and VHF where available, in weather dissemination merits continued emphasis. Existing pilot programs should be continued and expanded. Program objectives should demonstrate meaningful advantages, create an awareness, stimulate economical and simple terminal devices, and show cost advantages to the ship operator.

Facsimile has unique values in presentation, and the means to address specific conditions of interest. Sampling of ships with facsimile indicates an outstanding acceptance and support. The only complaints addressed the need for more information, and poor reception in many areas. The possibility of local facsimile transmissions for sea approaches to major ports should be investigated (see subsection 2.3.1).

2.2.4 Special Needs

Sampling of user requirements in port, for the category of vessels normally making off-shore and high seas passages, indicates 72 percent desired a weather chart or facsimile copy prior to departure. Suggestions included providing daily charts to ship agents, customs officers, or pilots for delivery to the ship. Comments stressed the difficulty in not receiving timely weather conditions and forecasts prior to departing the sea buoy. Delays up to eight hours were experienced after departure before a scheduled broadcast could be received. Reprints of appropriate charts should be arranged locally and distributed to ships expecting departure.

Too many ship masters and officers are unaware of weather services available. Weather services available should be listed and disseminated to foreign ships in ports, and monthly to U.S. ships. Changes in broadcast details should also be included since routine publications are often outdated by change.

Ships approaching or departing ports are interested in local weather conditions. Coastal stations should consider more frequent broadcasts which address local weather only. The possibility of facsimile charts for local approaches being broadcast on VHF FM several times daily should be considered.

2.3 TECHNICAL TRANSMISSION

2.3.1 Coverage

Morse telegraph coverage appears adequate except for minor temporary voids or interference. This primarily results from both high power medium frequency and high frequency simultaneous use of two or more frequencies common in the maritime service. The collective pattern of several frequencies permits selection of the strongest signal. The geographical area in the skip zone of high frequencies is covered by medium frequency transmission. Technical improvement programs for coastal stations should be continued by the Coast Guard. Optimum frequency planning for coverage should continue to utilize propagational analysis studies such as accomplished by the Institute for Telecommunication Sciences. Organic means should be considered for the Coast Guard to compare coverage by all participating stations on a monthly basis. An example of computed coverage for international Ice Patrol broadcast from Coast Guard Radio Station Boston for July 1971, is shown by Figure 2-1.

Sampling of users indicates difficulty in receiving high frequency weather broadcasts in the Pacific area between the Panama Canal Zone and off-shore Mexico. "Weather Service for Merchant Shipping" includes tasking for this area to commercial stations at Port Arthur (WPA), and Galveston (KLC). Antenna directivity and frequency choices should be reviewed to ascertain the problem

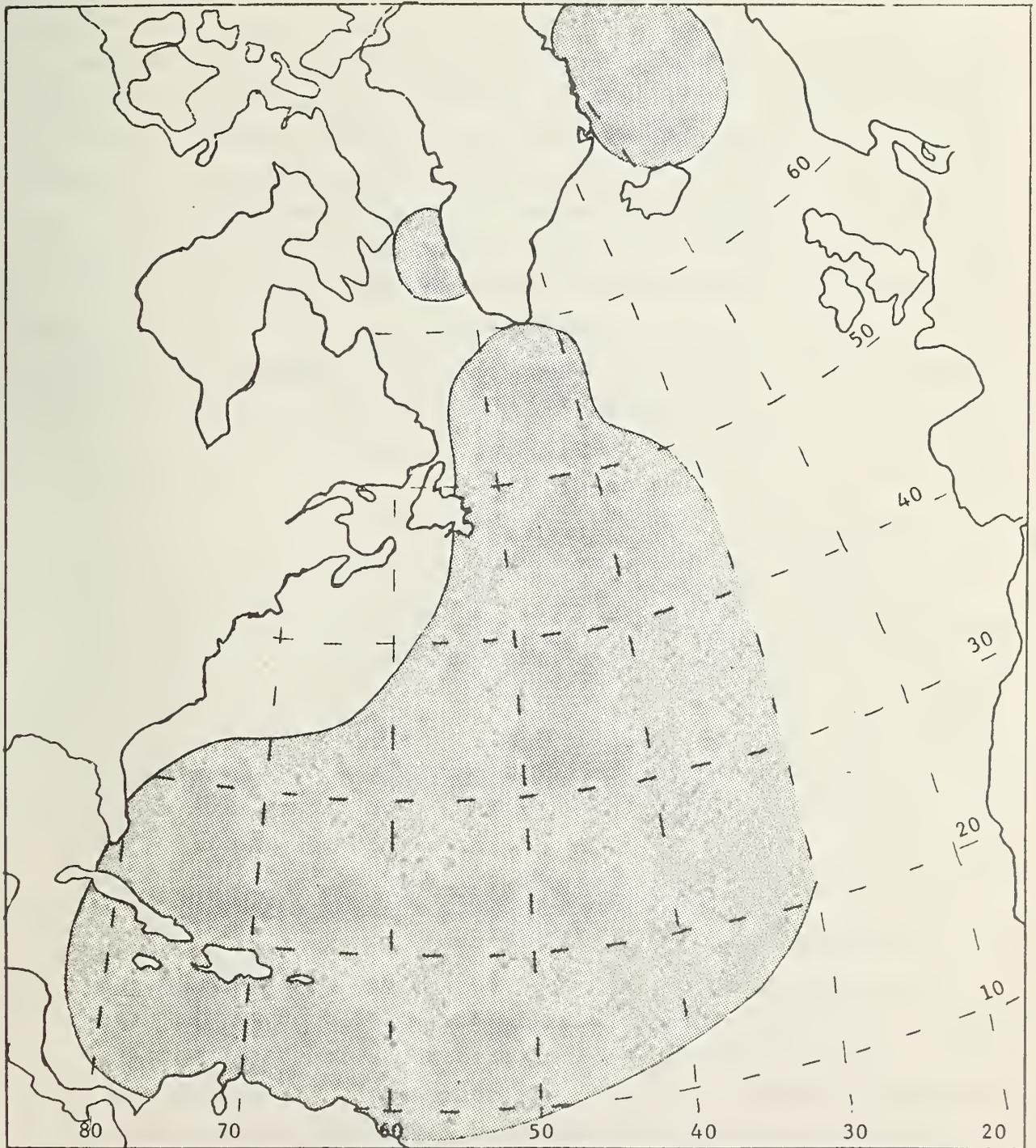


Figure 2-1. Predicted Coverage Contour of 8205 kHz
From Boston, 0000Z, July 1971, Reliability
of 95% or Better, CW Telegraph

Coverage of facsimile requires continuing improvement measures. This includes the use of propagational analysis, and appropriate antenna patterns. The southern orientation of antennas at Brentwood WFH and WFK are not suitable for general coverage. Further, possible transmission of regional facsimile charts by stations in local areas should be programmed. Possible scheduled use of selected VHF FM stations should be considered such as New York, Cape Hatteras, Florida Straits, and San Francisco.

The increased signal-to-noise ratio for voice and facsimile service suggests programs to expedite single sideband conversion and application of propagational studies. Results of the current pilot programs should be compared with computer predictions to refine coverage performance.

2.3.2 Reliability of Transmission

An analytical standard has not been established for weather dissemination. A reliability of 95 percent may be achieved for a designed coverage with reasonable equipment and good operator proficiency. An increase of reliability above this value becomes increasingly demanding of design and operating factors, and costs. Overall reliabilities may be increased by use of multifrequency techniques. The design standards should be determined for the geographical coverage, and techniques of maintaining high reliabilities applied to technical operations.

2.3.3 Equipment for Improved Services

The advantages possible through the use of facsimile, teleprinter, and voice for weather dissemination requires hardware programs commensurate with pilot programs. Equipment which is economical, compact, and reliable is required for the marine environment. Lightweight printers and facsimile terminals are available and should be modified and standardized for maritime operations.

Additional items which should be considered are simple voice frequency recorders for recording weather broadcasts, and possible selective calling devices to alert users to a weather warning broadcast.

VHF FM has been addressed as a coastal system. However, sampling indicates that off-shore shipping use the coastal system at any opportunity. The high masts of most ocean shipping greatly extends the ranges normally associated with the coastal weather area. Extended range designs should be considered for selected coastal sites (e.g., Dry Tortugas, Miami, Hatteras, Cape Cod, San Francisco, etc.) with additional heights, power, and antenna gains. Both sampling of users and reports of F.C.C. marine inspectors confirm the widespread use of VHF FM by off-shore shipping for areas where considerable range is attainable.

2.4 MANAGEMENT

Effective weather dissemination to the off-shore and high seas user requires development of a sound systems plan. The plan should consider requirements for operations and technical transmission. All users should be aware of the plan, services available, and how to secure the information. This includes both education and publication of participating disseminators. The system should be responsive to the user and provide continuing means of assessing the overall system performance. Deficits found by user feedback and self-diagnostic approaches should receive timely correction.

Basic managerial techniques are in being which serve the objectives described above, but some refinement is possible by a closer integration of forecasters, disseminators, and the users served. The Coast Guard has arranged radio propagation analyses for radio coverage of the off-shore and high seas areas by individual stations and specific frequencies. It has applied site engineering criteria to selection of sites and facilities. The Coast Guard has initiated pilot programs, particularly at Boston, which assist in operational evaluation of transmission modes and formats, and has maintained a close public relations program with the maritime community.

The National Weather Service has an existing structure that is capable of obtaining information on user service through its

Port Meteorological Officers. Although both the NWS and the Coast Guard coordinate their respective activities concerning marine weather, the evaluation process of the service provided needs strengthening. Means of including representatives of major ship operators as participants in planning mid-range objectives should be developed. This should include parallel efforts to solicit economical hardware designs to improve weather display and transmission. Questionnaires should be prepared and given to users at least annually. A sample form is shown by Figure 2-2. The Port Meteorological Officer should provide the resulting information on a scheduled basis to the National Weather Service. The National Weather Service should provide the Coast Guard with a summary of these views as well as its recommendations. Copies of the completed questionnaires also should be provided to the Coast Guard for reference.

In summary, the required managerial techniques are recognized and practiced through isolated procedures. By considering means to integrate and exchange expert knowledge in respective areas, further refinement of the product provided to the marine user may be achieved. The applications and uses of marine weather information in the off-shore and high seas areas are of a specialized nature. Its ultimate role involves both safety at sea and judgments in a maritime environment. The Coast Guard should, therefore, exercise the major role in transmission and dissemination as relates to these specialized users. The National Weather Service should continue to concentrate upon the elements required in information collection from off-shore and high seas stations, and the processing, preparation, and provision of maritime meteorological and surface information in an effective form which best serves the users. The total effort should be continuously coordinated at a national level.

PART I - INSTALLATION

SHIP'S NAME _____ CALL SIGN _____

TYPE:

RADIO FACILITIES:

Cargo _____ MF Radio Telegraph _____

Tanker _____ HF Radio Telegraph _____

Passenger _____ 2 MHz Telephone _____

Bulk Carrier _____ VHF Telephone _____

Fishing _____ HF SSB Telephone _____

Is Facsimile equipment installed? _____

Is Teleprinter equipment installed? _____

PART II - COVERAGE

How many weather messages are copied daily? _____

How frequent would you desire weather reports? Every _____ hours.

Is the information content and format satisfactory? _____

Are schedules for broadcasts timely for your needs? _____

For last 100 weather messages copied, indicate
approximate number received by:

MF Telegraph _____, HF Telegraph _____, HF SSB Voice _____, and
MF Voice _____.

Are broadcasts intended to be copied found to be receivable and
of sufficient signal level? _____.

Which coastal station weather broadcasts are copied normally on
routine schedules (by call sign)? _____, _____, _____, _____,

What transmission changes would most assist dissemination? _____.

PART III - PRESENTATION FORMATS

If facsimile is copied, what is reaction to formats provided?

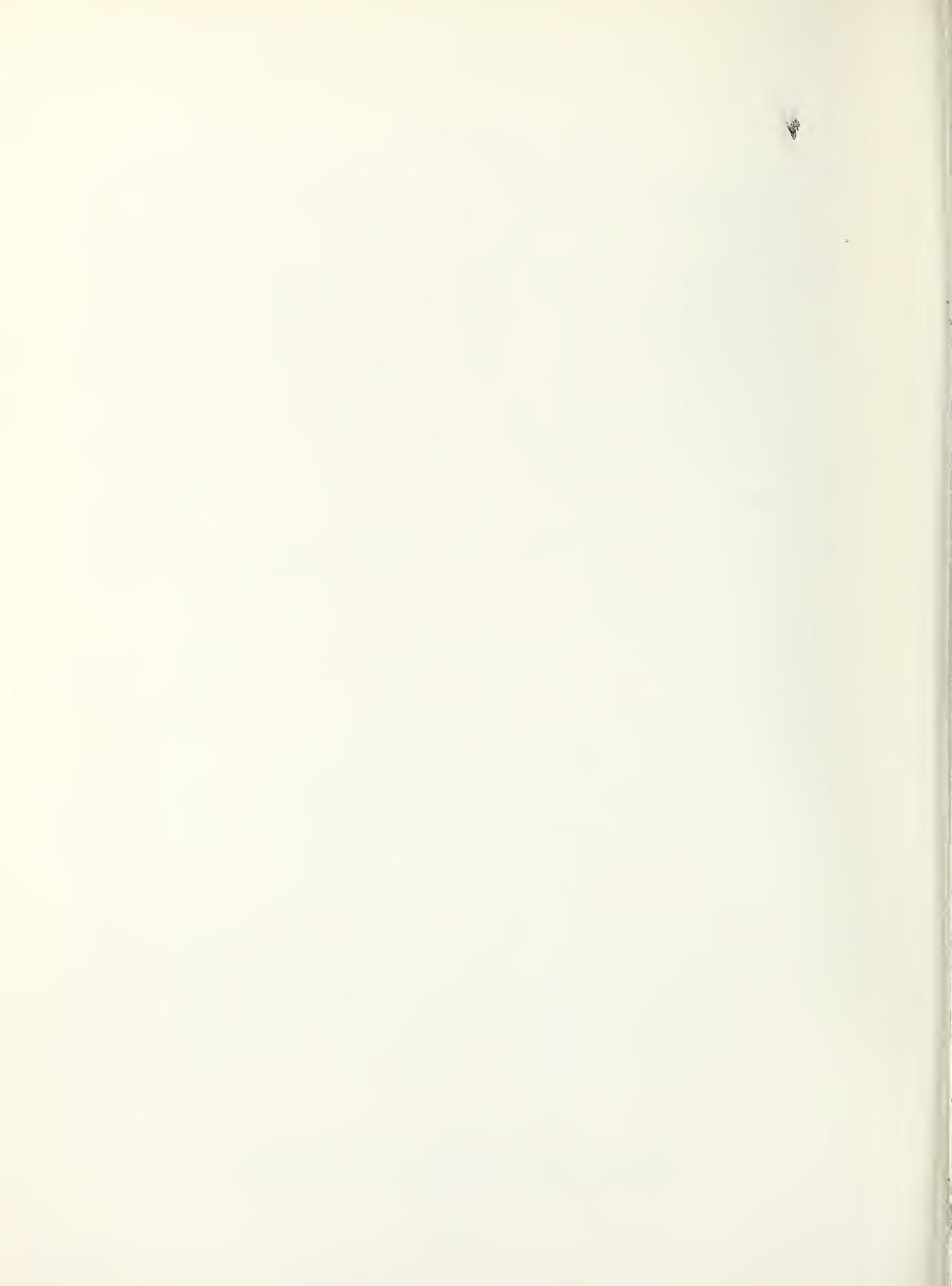
If facsimile received, which coastal stations are normally used?

Do you copy teleprinter weather broadcasts? _____

If so, which coastal stations are copied? _____

What improvements would be of assistance? _____

Figure 2-2. Proposed Questionnaire to Determine
User Service Parameters for Off-Shore
and High Seas Weather Dissemination



SECTION 3
SUMMARY OF RECOMMENDATIONS

3.1 INTRODUCTION

The recommendations for change resulting from this study have been presented and discussed in detail in Sections 1 and 2. For the convenience of the reader, and for reference purposes, the recommendations for both Coastal and Off-Shore/High Seas services are summarized briefly in the following paragraphs. The reader should note that the reasoning behind each of the recommendations, its relationship to overall systems service, and the justification for each individual proposal may be found in the preceding sections by reference to the Table of Contents.

3.2 RECOMMENDATIONS FOR CHANGES IN COAST GUARD POLICY, FACILITIES, AND PROCEDURES

CSC recommends that the Coast Guard

1. Institute within the Coast Guard a body concerned solely with the provision and coordination of marine weather services by the Coast Guard, National Weather Service, commercial broadcast stations, and other organizations.

2. Initiate as rapidly as possible a program of regularly scheduled broadcasts of marine weather information via commercial broadcast stations in accordance with the recommendations outlined in Paragraph 1.5.6.

3. Increase its efforts in the fields of boating education and public information to promote and advertise the availability and nature of existing and proposed services to the marine user, particularly through the mass media.

4. Extend the coverage of Coast Guard facilities at VHF frequencies in the interests of safety and in accordance with the currently planned expansion.

5. Continue current procedures for broadcast, at 156.8 MHz, of urgency signals and messages and announcements of special broadcasts.

6. Remove from consideration an extensive program of frequent, scheduled broadcasts of marine information at VHF frequencies at this time.

7. Remove from consideration use of the Environmental Channel at 156.75 MHz in view of limited service capability and potential interference with monitor operations on the National Distress, Safety, and Calling Channel at 156.8 MHz.

8. Procure and install VHF monitor receivers with a tone-operated alerting feature at rescue coordination centers (RCC) and subordinate commands located within the service area of NWS VHF broadcast stations.

9. Continue scheduled broadcasts of marine information at 2670 kHz, changing number of broadcasts and content as necessary to reflect the changing needs of the user.

10. Install broadcast tape-recording equipment at radio stations to facilitate voice broadcasts in the 2 MHz band.

11. Establish a policy of referral to NWS services for the dissemination of marine weather forecasts by land-line telephone, but give careful consideration to its own role in the dissemination of on-scene observations.

12. Continue with plans to implement a full HF broadcast service to high seas areas from new long-range stations at San Francisco, Honolulu, and Portsmouth.

13. Establish targets for receipt of dissemination products by both Coast Guard and commercial disseminators, and review the attainment of these targets on a continuing basis.

14. Establish a continuing, close, cooperative role with major organizations operating coastal stations, and seek means to

demonstrate mutual interests. The commercial radio disseminator makes a significant cost-free contribution to the weather dissemination program (and to Coast Guard Operations), and should be made to feel a team member.

15. Continue to evaluate coverage, transmission modes, and presentation techniques to off-shore and high seas users through pilot programs similar to those in operation at Radio Station Boston.

16. Formulate hardware development objectives for future ship-board communications equipment, incorporating industry views and encouraging standardization programs.

17. Continue technical support programs addressing coverage, propagation prediction, frequency selection, and site engineering, expanding these programs, if possible, to include computer prediction techniques and the definition of required signal levels for different transmission modes (telephone, facsimile, teleprinter, and manual CW telegraph).

18. Investigate means of transmission to the off-shore and high seas user while in transit of coastal and port approaches.

19. Integrate existing managerial procedures for service evaluation and user feedback to effect control and improvement of off-shore and high seas weather dissemination.

3.3 RECOMMENDATIONS ADDRESSED TO THE NATIONAL WEATHER SERVICE

CSC recommends that the National Weather Service

1. Continue its excellent cooperation with the Coast Guard in the provision and dissemination of marine information products.

2. Cooperate in particular in the establishment of a marine weather dissemination service via commercial broadcast stations, lending its considerable influence to encourage the participation of suitably located stations, and providing the required dissemination products and information on how they may be obtained.

3. Give careful consideration to the content of its products with reference to the needs of the recreational boatman, placing greater emphasis on the inclusion of existing conditions and surface phenomena.

4. Update marine information transcripts frequently in comparison with the rate of change of local weather phenomena, and include the time of the most recent update even though the message content may not have changed.

5. Reexamine the criteria for priority assignment to the establishment of VHF radio sites and land-based telephone services in view of the more serious requirements for weather information of marine users in comparison with the general public.

6. Consider the implementation of subsidiary VHF transmitting sites at existing Coast Guard facilities in areas of significant marine activity which will not be covered by the fully-implemented VHF Weather Radio service, evaluated under realistic transmission range assumptions.

7. Carefully examine the recently initiated weather broadcast and alerting service via time station WWV to ensure that the scheduled broadcast time (15 to 17 minutes after each hour) does not interfere with the internationally established silent period on 500 kHz in the time interval 15 to 18 minutes after the hour.

8. Continue the excellent cooperative pilot programs such as the facsimile transmissions via CG Radio Station Boston, and seek to include the evaluation of user feedback from such services into adaptive improvement procedures.

9. Examine the particular needs of off-shore and high seas users during transit of coastal and port approaches, and consider the provision of specialized services such as VHF transmitted facsimile information.

10. Reexamine the correlation between off-shore and high seas forecast areas in relation to traffic distribution and user needs as well as weather phenomena.

3.4 RECOMMENDATIONS ADDRESSED TO COMMERCIAL RADIO OPERATIONS

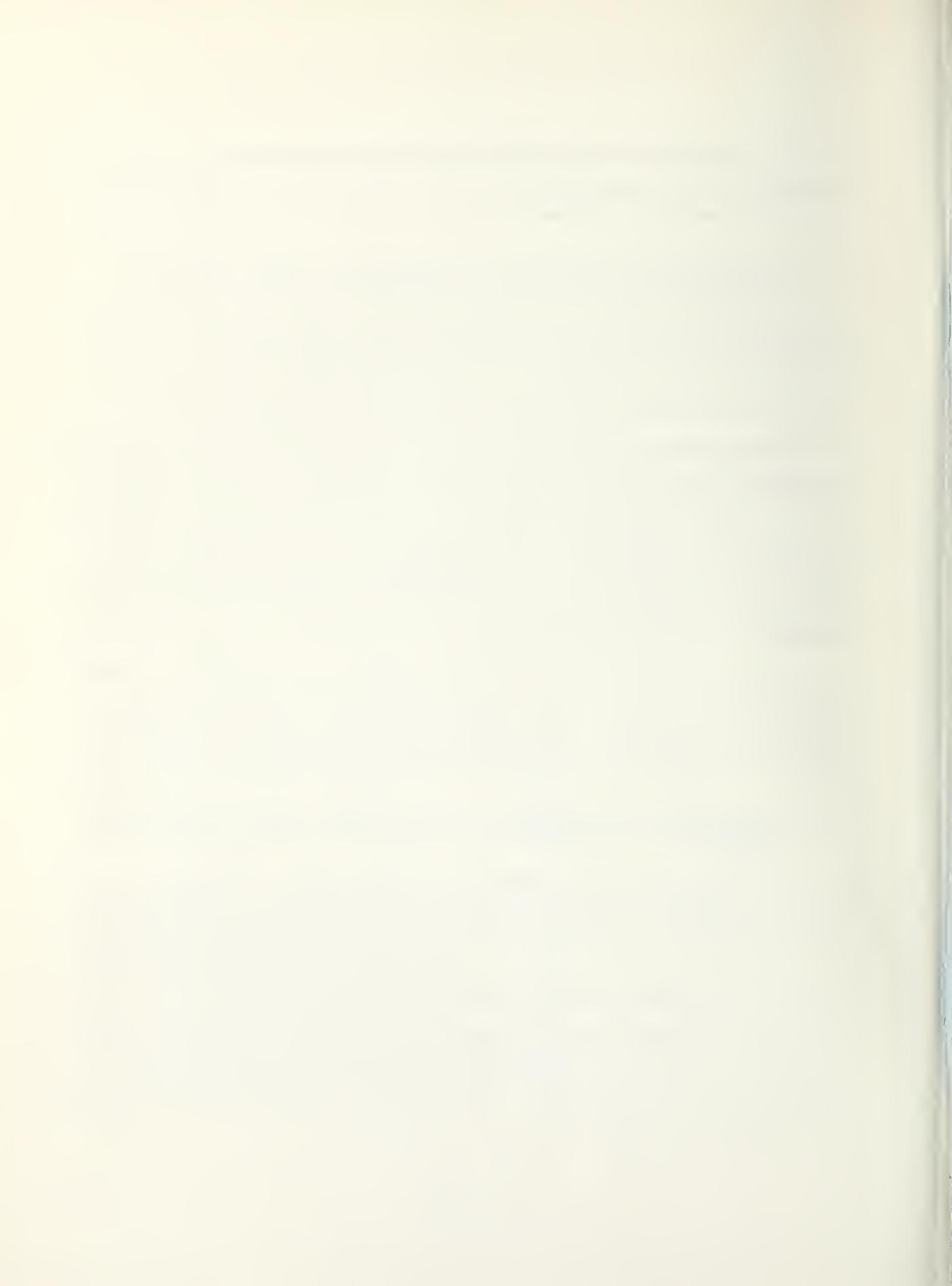
CSC suggests that commercial radio concerns give careful consideration to the unique capability which they possess by virtue of their universal audience to contribute significantly to the safety of more than 8 million recreational boatmen on U.S. waters.

CSC recommends that stations located within range of significant boating activity familiarize themselves with the essential conclusions of this study and recognize the important role they can play. It is further recommended that such stations examine the market potential and commercial gains associated with the dissemination of valuable marine weather and environmental information in areas of significant boating activity.

Interested operations are encouraged to seek further information from their local Coast Guard and National Weather Service offices as to the part which they can play in this essentially public service oriented, but potentially profitable, role.

3.5 RECOMMENDATIONS DIRECTED TO PUBLIC COAST AND LIMITED COAST STATIONS

CSC recommends that commercial marine radio telephone operations equip with effective means for receiving up-to-date marine weather information (such as the Weather Wire or VHF Weather Radio Services of the National Weather Service); that the availability of such information is made known to its subscribers so that they may seek self-protective information on request at normal tariff rates; and that such information is used to alert all suitably equipped users within range in the event of an emergency, according to accepted practice.



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