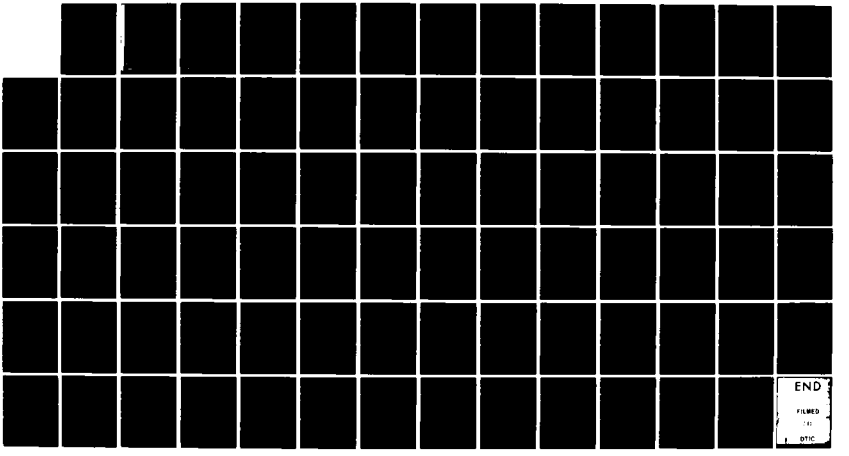
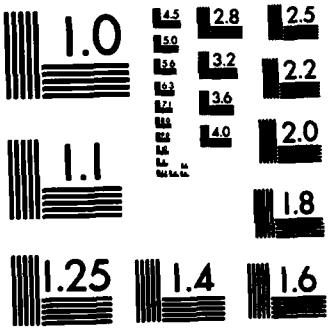
AD-A122 764 AN ANALYSIS OF NAVAL PERSONNEL RESOURCE ALLOCATIONS TO LOGISTICS VOLUME I.. (U) SRI INTERNATIONAL MENLO PARK CA R H MONAHAN AUG 82 N00167-80-C-0068 1/1

UNCLASSIFIED F/G 15/5 NL





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Final Report *August 1982*

AN ANALYSIS OF NAVAL PERSONNEL RESOURCE ALLOCATIONS TO LOGISTICS

Volume II — Methodology for Examining Effects of Personnel Shortfalls on Navy Logistics Personnel Readiness

By: RICHARD H. MONAHAN

Prepared for:

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CONTRACT N00167-80-C-0068

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SRI International

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SRI Project 1665

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REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
	AD-A122764	

4. TITLE (and Subtitle)
AN ANALYSIS OF NAVAL PERSONNEL RESOURCE ALLOCATIONS TO LOGISTICS: Volume II - Methodology for Examining Effects of Personnel Shortfalls on Navy Logistics Personnel Readiness

5. TYPE OF REPORT & PERIOD COVERED
Final Report covering the period May 1980 through May 1982

6. PERFORMING ORG. REPORT NUMBER
SRI Project 1665

7. AUTHOR(s)
Richard H. Monahan

8. CONTRACT OR GRANT NUMBER(s)
Contract N00167-80-C-0068

9. PERFORMING ORGANIZATION NAME AND ADDRESS
SRI International
333 Ravenswood Avenue
Menlo Park, California 94025

10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS

11. CONTROLLING OFFICE NAME AND ADDRESS
David W. Taylor Naval Ship Research and Development Center, Code 187
Bethesda, Maryland 20084

12. REPORT DATE
August 1982

13. NO. OF PAGES
87

14. MONITORING AGENCY NAME & ADDRESS (if diff. from Controlling Office)

15. SECURITY CLASS. (of this report)
UNCLASSIFIED

15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this report)
Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)
Logistics Support/Logistics Planning
Resource Allocations
Manpower Requirements
Personnel Data Bases
Personnel Readiness

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)
The report is published in two volumes: Volume I - Navy Sea-Based Personnel Resource Allocations to Logistics Functions, and Volume II - Methodology for Examining Effects of Personnel Shortfalls on Navy Personnel Readiness.

The objective of the research described in this Volume (Volume II) was to develop and demonstrate the use of a methodology that would be useful in examining the effects of personnel shortfalls on Navy personnel readiness

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19. KEY WORDS (Continued)

20 ABSTRACT (Continued)

relative to the broad area of logistics support and also to selected subareas of logistics such as maintenance, own-unit support, and supply. Following an introductory chapter, Chapter II presents a summary of the methodology developed and the results of an illustrative example used to demonstrate the use of this methodology in examining personnel shortfall effects on Navy Logistics personnel readiness. In Chapter III, the basic data bases that were available for use in this analysis are described. The methodology that was developed to satisfy the objective of this analysis is then described in Chapter IV, including a summary description of the computer program UALLOC designed to optimize Navy-wide logistics personnel readiness for various levels of personnel shortfalls. Chapter V then presents an illustrative example of the use of this methodology in examining the effects of personnel shortfalls on Naval logistics personnel readiness. This chapter also includes a brief critique of the methodology and indicates additional steps that could be implemented to improve on the usefulness of this type of approach to personnel readiness evaluation.

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PREFACE

This report documents the analysis and findings of a research project conducted for the David W. Taylor Naval Ship Research and Development Center (DTNSRDC), Bethesda, Maryland. The sponsor and technical monitor was M.J. Zubkoff, Code 187, of DTNSRDC. The work was performed under Contract N00167-80-C-0068.

The research was performed in the Center for Defense Analysis (CDA) of the Research and Analysis Division (RAD) of SRI International. J. Naar is Director of CDA, and D.D. Elliott is Executive Director of RAD.

R.H. Monahan was project leader and principal investigator. He was assisted by W. Schubert.

SRI extends its appreciation to personnel at the Navy Manpower and Material Analysis Center, Pacific, Captain S.J. Watlington, Commanding Officer, for their assistance in the data base development phase of this research project.

I INTRODUCTION

The objective of the research described in this report was to develop and demonstrate the use of a methodology that would be useful in examining the effects of personnel shortfalls on Navy personnel readiness relative to the broad area of logistics support and also to selected subareas of logistics such as maintenance, own-unit support, and supply.

In previous research conducted for the David W. Taylor Naval Ship Research and Development Center, SRI International analyzed the allocation of Navy shore-based personnel resources[*1] and Navy sea-based personnel resources (Volume I of this report) to logistics functions. These analyses indicated that considerable portions of Navy personnel resources, both ashore and afloat, are allocated to the various logistics functions. This implies that broad-based personnel shortfalls within the Naval manpower structure would significantly affect Naval readiness, not only from the standpoint of providing sufficient forces to conduct combat operations, but also from the standpoint of providing logistical support to these forces, without which they could not maintain and sustain an adequate level of operational capability. The research described in this volume supplements the previous research by providing an approach to evaluating the ramifications of personnel shortfalls on Naval logistics personnel readiness.

Chapter II presents a summary of the methodology developed and the results of an illustrative example used to demonstrate the use of this methodology in examining personnel shortfall effects

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* References are listed at the end of this report

on Navy Logistics personnel readiness. In Chapter III, the basic data bases that were available for use in this analysis are described. The methodology that was developed to satisfy the objective of this analysis is then described in Chapter IV, including a summary description of the computer program UALLOC designed to optimize Navy-wide logistics personnel readiness for various levels of personnel shortfalls. Chapter V then presents an illustrative example of the use of this methodology in examining the effects of personnel shortfalls on Naval logistics personnel readiness. This chapter also includes a brief critique of the methodology and indicates additional steps that could be implemented to improve on the usefulness of this type of approach to personnel readiness evaluation.

II SUMMARY

A. Personnel Readiness

Personnel readiness is a factor that addresses the availability of sufficient, qualified personnel to perform the required objectives of a Naval activity to perform its assigned mission responsibilities. For this research effort, a Naval activity is defined to include specific Naval organization units (ships or aircraft squadrons) and the shore-based mission areas as specified for the SHORSTAMPS/SHOROC manpower planning program (aircraft maintenance, automatic data processing, communications, etc.). A measure of personnel readiness must consider not only the availability of the required numbers of orficers, petty officers, other enlisted personnel, and civilians within an organizational unit or activity, but also the maintenance of a proper balance of these personnel with respect to mission essential skills, training, and Naval experience. The personnel authorizations contained in the ship and aircraft squadron manpower documents, and the SHORSTAMPS/SHOROC manpower planning program provide the standards for measuring personnel readiness strictly on a numerical basis. That is, if a unit or activity is staffed strictly in accordance with its authorization, then that unit or activity can be considered to possess a 100% rating for personnel readiness. Deviations from these authorizations, especially in the sense of shortfalls, will degrade personnel readiness, although the amount of degradation will be highly dependent upon the specific areas where the shortfalls occur. Thus, the procedure used to determine personnel readiness degradations from the standard must consider the full spectrum of the established personnel authorizations.

The approach used in this research effort is based on the assignment of utility values to the various personnel billets authorized to an activity. The personnel readiness standard for an activity is its authorized utility and is computed as the sum of the utilities of each authorized billet for that activity. In the event of deviations from an activity's authorized billet structure, personnel readiness is then defined as the ratio of achieved utility to authorized utility, where achieved utility is computed as the sum of the utilities of the assigned personnel to that activity. This definition of personnel readiness can be used for a single activity, a group of activities (such as all surface ships), or the entire Navy. It also can apply to specific functional segments of the Navy such as maintenance operations or supply operations.

B. Data Bases

The development of the methodology in support of this research effort was constrained by the availability of useful input data. The primary data sources for the data bases established under this research effort were the Ship Manpower Documents and tne Aircraft Squadron Manpower Documents contained in OPNAV Instructions, the Standards Implementation Document System (SIDS) data base tapes, and an outside contractor report on the accrued utility of Navy enlisted personnel. Five basic data bases were generated from these data sources. Four of these basic data bases represent personnel authorizations to surface ships, subsurface ships, aircraft squadrons, and shore mission areas. These basic personnel data bases specify the numbers of officers, enlisted personnel, and civilians allocated to each activity within the above specified subgroupings, broken down in terms of officer designators/EP ratings/civilian occupational codes and pay grades, where civilian pay grades were identified separately for four civilian pay plans (General Schedule, Federal Wage System-Supervisory, Federal Wage System-Leader, and Federal Wage System-Nonsupervisory). The fifth basic data base consists of

utility values associated with various EP ratings, assembled into seven distinct utility skill groups and varying by pay grade.

The basic data bases were then combined and transformed into five utility structured data bases, each representing one functional segment of the Navy (entire Navy, designated logistics, maintenance, own-unit support, and supply). These transformations first involved an expansion of the basic utility data base to include officers and civilians, as well as enlisted personnel. This step resulted in the establishment of 18 utility pay grades to represent the full spectrum of officer, enlisted, and civilian pay grades. This utility data base was then combined with the basic personnel data bases to generate the five utilility structured data bases.

C. Methodology

The methodology developed for this research effort, which represents an initial approach toward evaluating the effects of personnel shortfalls on Navy logistics personnel readiness, is based on the application of a modified utility evaluation concept to the definition of personnel readiness as the ratio of achieved utility to authorized utility. Initially, personnel within a given utility skill group/pay grade combination are assigned a constant utility value, regardless of the activity to which assigned. These utility values are then modified to reflect the relative utility of a person in relation to the authorized strength of an activity for each skill group/pay grade combination. That is, the utility value associated with the x^{th} person in a particular skill group/pay grade combination assigned to a given activity depends on the number of personnel of that skill group/pay grade combination authorized to that activity and this utility value varies inversely (in a linear manner) with the value of x. Thus the utility loss associated with losing one person when an activity is at its authorized strength with respect to a skill group/pay grade combination is much less than the utility loss associated with losing one person when the activity is at, say, one-half its authorized strength for that skill

group/pay grade combination. Also, if one activity is assigned, say, twice as many personnel of a particular skill group/pay grade combination than is another activity, then the utility loss associated with the loss of one person from the first activity will be much less than the utility loss associated with the loss of one person from the second activity.

A computer program, designated by the acronym UALLOC, was developed to implement this approach. This program is designed to optimize Navy-wide personnel readiness for various levels of shortfalls among the six different pay categories (officers, enlisted personnel, and the four civilian pay plans) under minimum manning level restrictions specified for the four different force groups (surface ships, subsurface ships, aircraft squadrons, shore mission areas). The program was designed to operate with any one of the five utility structured personnel data bases established for this analysis. Thus, the program can provide optimal allocations for the entire Navy, as well as for the restricted segments representing designated logistics, maintenance, own-unit support, and supply. The program utilizes as input one of the utility structured data bases and a force structure data base, which specifies the number of activities of each type within the Navy force structure subjected to analysis. In addition, specific case inputs are also prescribed which specify the minimum required manning levels for the four force groups and the percentages of shortfall for each pay scale (officers, enlisted personnel, and the four civilian pay plans). Having read in all the inputs, the program then performs its major function of determining the activity allocations, under the shortfall and minimum manning level conditions prescribed, that optimize achieved Navy-wide utility, or equivalently, Navy-wide personnel readiness. This is accomplished through repeated use of the subroutine OPUTIL. This subroutine operates on a specific pay scale/skill group/pay grade combination and minimizes its Navy-wide utility degradation for the specified personnel shortfall, under the restricted minimum manning level requirements. The subroutine uses an iterated Lagrange Multiplier procedure to accomplish the utility

minimizations. When the optimal allocations have been completed, the program then computes the summary outputs. These include the resulting personnel allocations and achieved utilities for each activity, in addition to the ratios of assigned personnel to authorized personnel (personnel availability) and achieved utility to authorized utility (personnel readiness) for each activity. The outputs also include the same as the above for the four force groups (surface ships, subsurface ships, aircraft squadrons and shore mission areas), in addition to the entire Navy.

D. Sample Application

The sample application of the use of the methodology developed is based on a set of 60 computer runs of the Utility Optimization Computer Program (UALLOC). For each of the five utility structured data bases, representing respectively the entire Navy and the four logistics functional areas (designated logistics, maintenance, own-unit support, and supply), four levels of shortfalls (5%, 10%, 15%, 20%) were assumed under three different manning level restriction assumptions (no minimum manning level requirements; 80% minimum manning level requirements for afloat forces with 70% minimum manning level requirements for ashore forces; and 90% minimum manning level requirements for afloat forces with 70% minimum manning level requirements for ashore forces).

The results obtained indicated that there were relatively insignificant differences among the personnel avilability and personnel readiness values obtained for the five different base populations (entire Navy, designated logistics, etc.). The personnel readiness values obtained for the four force groups (surface ships, subsurface ships, aircraft squadrons, and shore mission areas) generally adhere to those that could be theoretically predicted. This is shown in the table below where the results are those obtained under no minimum manning level requirements.

Shortfall Percentage	Computed Personnel Readiness		Theoretical Prediction
	Minimum	Maximum	
5	.996	1.000	.997
10	.986	1.000	.986
15	.971	.995	.976
20	.948	.978	.958

The theoretical predictions are based on the shortfalls being assessed against a single utility skill group/pay grade combination with an authorized strength of 100 personnel. For the most part, the personnel readiness values obtained under no minimum manning level requirements do not significantly differ across the four force groups for a given shortfall level. This reflects the intent of the modified utility approach where shortfalls in individual categories are applied to activities where the least degradation in utility would be achieved so that personnel readiness tends to remain on even levels, especially when applied to large subgroups of activities such as the force groups assumed in this research effort.

The personnel availability values obtained under no manning level restrictions show that the Subsurface Ship Force Group, with the smallest average activity personnel complements among the four force groups, exhibits the highest officer and enlisted availabilities, while the Shore Mission Area Force Group, with the highest average activity personnel complements, exhibits the lowest officer and enlisted availabilities. This is as would be expected since the modified utility approach applies the shortfalls proportionately more heavily on the larger activities than the smaller ones. The ranges in officer and enlisted availabilities obtained are given in the following table:

Shortfall Percentage	Officer Availability		Enlisted Availability	
	Minimum	Maximum	Maximum	Minimum
5	.931	1.000	.925	1.000
10	.868	1.000	.869	1.000
15	.811	1.000	.818	.987
20	.761	1.000	.770	.952

The civilian availabilities obtained are the direct unity complement of the shortfalls, as the Shore Mission Area Force Group is the only force group of the subgroups that contain civilian personnel. When the manning level restrictions are imposed, the general trend is a shifting of shortfalls from the afloat force groups with the higher minimum manning level requirements (80% or 90%) to the ashore force group with the lower minimum manning level requirement (70%). For the 80% requirement imposed on the afloat forces, some shifting of the shortfalls from the Surface Ship Force Group to the Subsurface Ship and Aircraft Squadron Force Groups, in addition to the ashore force group, also takes place. However, at the 90% minimum manning level requirement, the shifting is totally from the afloat force groups to the ashore force group.

E. Critique of Proposed Approach

The modified utility evaluation concept developed under this research effort represents an initial approach toward evaluating the effects of personnel shortfalls on Navy personnel readiness relative to logistics support functions. This type of approach has two significant features useful for evaluating personnel readiness.

The first useful feature is the relating of personnel readiness to the utility associated with assigned personnel to an activity. This provides a logical basis for assessing personnel readiness in terms of the relative worth of specific personnel billets to the performance of an activity's mission requirements. Although each billet authorized to an activity is necessary to the full performance of the activity's prescribed missions, these billets have differing criticalities with regards to mission performance and the loss of a person in a non-mission essential skill area would have much less of an effect on the activity's mission performance than the loss of a person in a mission essential skill area, especially under combat conditions.

The second useful feature of the proposed type of approach is in the capability of optimizing personnel readiness over a group of activities in the presence of personnel shortfalls within specific skill group/pay grade combinations. That is, this approach provides a rational method for distributing personnel shortfalls among a group of activities so as to minimize the degradation of the overall personnel readiness of that group of activities.

One desirable feature that is not included in the proposed type of approach is the capability for personnel substitution either among pay grades within a specific skill category or among skill categories for a specific pay grade.

The actual implementation of the proposed type of approach consists of two components: data base consolidation and optimization computer program design. The data base consolidation embodies the transformation of the basic personnel data bases to utility structured data bases. This data base consolidation resulted in a considerable reduction in the number of data base factors. The principal advantage of this consolidation is a four-fold reduction in the maximum number of allocation optimizations required for a given computer run, which translates to a substantial reduction in computer running time. A disadvantage of the data base consolidation is the loss of identity of actual billets, where officers, enlisted personnel, and civilians are identified as members of utility skill groups and not by officer designators, EP ratings, or civilian occupational code groups. This could be offset somewhat by increasing the number of utility skill groups so that each skill group would contain fewer officer designators, EP ratings, and civilian occupational codes and the skill group definitions themselves could be revised to be more related to specific Naval functions. Another area where improvement is required is in the componentization of shore based activities where the nature of these activities should be more compatible with that of the afloat activities (ships and aircraft squadrons) than are the Shore Mission Areas. One such option would be to use the actual shore

activities, such as Naval bases, supply centers, air stations, and so on. This revision, as well as the skill group redefinition, would obviously increase the number of data base factors and thus increase computer running time requirements. On the other hand, it should also add credibility to the results obtained through the use of the approach.

The Utility Optimization Computer Program (UALLOC) represents a convenient and efficient tool for evaluating personnel readiness in the presence of personnel shortfalls. The principle drawback of the program is that it generates abnormally high values for personnel readiness in relationship to the personnel availabilities obtained, as can be seen through perusal of the tables presented in the preceding section. The high readiness values generated by the program imply that the linearly variant utility assumption, used to establish the relative utility values of personnel authorized to an activity within a specific utility skill group/pay grade combination, places too little utility value at the end of the personnel scale. One possible option to correct this problem would be to establish a critical manning level, say 80%, where relative utility would be constant up to this critical level and then decrease linearly up to the 100% level. Another option would be to use a concave function instead of a linear function to represent relative utility. Another drawback of the program is the assumption that shortfalls are uniform over utility skill groups and pay grades. That is, if a shortfall of, say, 80% is assumed, then each utility skill group/pay grade combination is assumed to have an 80% shortfall. One possible remedy to this problem would be to allow non-uniform shortfall distributions over the utility skill groups and pay grades. This would allow evaluation of personnel readiness in such cases where there is a higher shortfall among, say, personnel in the highly critical skill areas or with higher pay grades than among those in less critical skill areas or with lower pay grades. Implementation of the above two proposed improvements would result in a more useful and credible computer program as a tool for evaluating personnel readiness in the presence of personnel shortfalls.

III BASIC PERSONNEL DATA BASES

The development of the methodology, in support of this analysis, was constrained by the availability of useful input data. This chapter describes the available data bases that were obtained to satisfy the objective of this analysis. The basic personnel data bases, described in Section B, were those used in the previous analyses of Navy personnel resource allocations to logistics support functions as documented in Volume I of this report and in the previous report on shore-based personnel resource allocations.[1] Personnel readiness, as defined for this analysis, was based on the assignment of relative utility values to the various authorized billets within the Navy manpower structure. The basic data used for these utility assignments are described in Section C. Section A of this chapter identifies the data sources that were used to establish the data bases discussed in Sections B and C of this chapter.

A. Data Sources

The data contained in the Basic Personnel Data Bases used in this analysis were obtained from several sources. The primary sources were the Ship Manpower Documents and the Aircraft Squadron Manpower Documents, contained in the 5320 Series of the OPNAV Instructions,[2] and the Standards Implementation Document System (SIDS) data base tapes.[3] The documents and the data base tapes were used to determine the numbers of officers, enlisted personnel (EP), and civilians allocated to each ship class, aircraft squadron type, and shore mission area in the Navy. These data were broken down in terms of officer designators and pay grades,

EP ratings and pay grades, and civilian occupational code groupings and pay grades for four different civilian pay plans: General Schedule (GS), Federal Wage System-Supervisory (WS), Federal Wage System-Leader (WL) and Federal Wage System-Nonsupervisory (WG)(other civilian pay plans were equivalenced to one of these four pay plans). The manner by which the personnel data bases were derived from the data sources is discussed in the next section of this chapter.

The utility data used in this analysis are based on utility curves derived from tables contained in a Decisions and Designs, Inc. report on accrued utility of Navy enlisted personnel.[4] The basic utility data used are discussed in Section C of this chapter.

B. Personnel Data Bases

Four distinct basic personnel data bases were generated for the purposes of this analysis: Surface Ship Personnel Data Base, Subsurface Ship Personnel Data Base, Aircraft Squadron Personnel Data Base, and Shore Mission Area Personnel Data Base. This categorization of personnel allocations is compatible with the companion analyses documented in Volume I of this report and Reference 1. The first three data bases are identical with the sea-based personnel data bases used in the analysis documented in Volume I of this report. They are briefly discussed in the following subsection. The Shore Mission Area Personnel Data Base was generated specifically for this analysis. The details of this data base generation are described in Subsection 2 of this section.

1. Basic Sea-Based Personnel Data Bases

Three basic sea-based personnel data bases were established for this analysis. These data bases represent personnel that are allocated to active ships and aircraft squadrons within the Navy, regardless of whether or not a ship is in port or an aircraft squadron is actually land-based. For the purposes of this analysis, it was convenient to separate the

sea-based Naval forces into three groups: surface ships, subsurface ships, and aircraft squadrons. Thus, a separate data base was established for each of these groupings.

The primary data sources for these data bases were the Ship Manpower Documents and the Aircraft Squadron Manpower Documents, contained in the OPNAV Instructions. These documents were used to determine the numbers of officers and enlisted personnel allocated to each ship class and each aircraft squadron type in the Navy, broken down in terms of officer designators/EP ratings and pay grades (civilians are not allocated to the sea-based forces). In a few cases where manpower documents were unavailable, manpower allocations were synthesized from analogous manpower documents by application of ratios of known officer and EP complements. Since the manpower document data had to be manually converted to computerized data bases, several reduction assumptions were imposed which reduced data reduction time, but would not induce any significant errors in light of the level of aggregation required for this analysis. These data reduction assumptions included: the selection of a typical ship within a ship class as representative of that ship class; assuming small classes of ships to be members of a larger analogous class; and the selection of a typical aircraft squadron type to be representative of a variety of numbered squadrons of a similar nature. A more detailed description of these data reduction measures is contained in Volume I of this report, where the same sea-based data bases were utilized.

Figures III-1 to III-3 present excerpts respectively of the Surface Ship Personnel Data Base (MDFILE), the Subsurface Ship Personnel Data Base (SSFILE), and the Aircraft Squadron Personnel Data Base (SQFILE). In respective order, these figures portray the officer and enlisted manpower allocations for the Surface Ship Class CGN-25(USS Bainbridge), the Subsurface Ship Class SSN-594(USS Permit), and the Aircraft Squadron Type VX-4(Air Test and Evaluation Squadron Four). The first record shown on each figure specifies the ship class or aircraft squadron type (Columns 1-9); the force class type (Column 10) where S = surface ship, U =

CGN	25S	737	0											
1110	0	0	0	0	1	1	3	7	7	3	0	0	0	0	22
2100	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
3100	0	0	0	0	0	0	1	0	0	2	0	0	0	0	3
4100	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
7430	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
7540	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
7660	0	0	0	0	0	0	0	0	0	0	0	1	1	0	2
0000	0	0	0	0	1	1	4	9	7	5	0	1	2	1	31

BM	0	1	0	1	3	4	0	8	0	0	17
DK	0	0	0	1	0	1	0	0	0	0	2
DS	0	0	1	2	2	4	0	0	0	0	9
EM	0	1	3	7	10	14	2	1	1	0	39
EN	0	0	0	1	1	2	0	1	1	0	6
ET	0	2	2	7	0	0	0	0	0	0	11
ETN	0	0	0	0	3	2	1	0	0	0	6
ETR	0	0	0	0	16	10	0	0	0	0	26
EW	0	0	1	1	2	3	2	0	0	0	9
FT	1	1	0	0	0	0	0	0	0	0	2
FTM	0	0	2	6	12	17	1	0	0	0	38
GM	0	1	0	0	0	0	0	0	0	0	1
GMG	0	0	0	0	1	1	0	1	0	0	3
GMM	0	0	1	2	4	4	2	1	1	0	15
GMT	0	0	0	1	2	3	0	0	0	0	6
HM	0	0	1	0	1	1	1	0	0	0	4
HT	0	0	1	2	2	3	3	2	1	0	14
IC	0	0	1	1	2	3	1	1	0	0	9
JO	0	0	0	0	0	1	0	0	0	0	1
MA	0	0	1	0	0	0	0	0	0	0	1
MM	0	1	6	16	23	30	1	9	2	0	88
MR	0	0	0	1	0	0	0	0	0	0	1
MS	0	1	1	3	4	6	7	0	0	0	22
OS	1	0	2	4	9	12	12	2	1	0	43
PC	0	0	0	0	1	0	0	0	0	0	1
PN	0	0	1	0	1	1	1	0	0	0	4
PO	1	0	0	0	0	0	0	0	0	0	1
QM	0	0	1	0	1	2	1	0	0	0	5
RM	0	1	1	3	4	7	3	0	1	0	20
SH	0	0	0	1	2	4	3	0	0	0	10
SK	0	1	0	1	1	2	3	1	1	0	10
SM	0	0	0	1	1	2	2	0	0	0	6
SN	0	0	0	0	0	0	0	37	18	0	55
ST	0	1	0	2	0	0	0	0	0	0	3
STG	0	0	0	0	4	6	3	0	0	0	13
TM	0	0	0	0	1	0	0	0	0	0	1
YN	0	1	0	1	0	3	2	0	0	0	7
EEEE	3	12	26	65	113	148	51	64	27	0	509

Figure III-1 SAMPLE SECTION-SURFACE SHIP PERSONNEL DATA BASE (MDFILE)

SSN	5940		317	0											
1120	0	0	0	0	0	1	2	3	4	0	0	0	0	0	10
1170	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
3100	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
0000	0	0	0	0	0	1	2	3	5	1	0	0	0	0	12
EM			0	1	0	4	2	2	0	0	0	0	9		
ET			0	0	2	3	0	0	0	0	0	0	5		
ETN			0	0	0	0	2	2	1	0	0	0	5		
ETR			0	0	0	0	3	2	0	0	0	0	5		
FTG			0	0	1	1	1	1	0	0	0	0	4		
HM			0	0	1	0	0	0	0	0	0	0	1		
IC			0	0	1	2	2	2	1	0	0	0	8		
MM			0	1	2	8	10	7	1	0	0	0	29		
MS			0	0	0	1	2	2	2	0	0	0	7		
PO			1	0	0	0	0	0	0	0	0	0	1		
QM			0	0	1	1	0	2	0	0	0	0	4		
RM			0	0	1	1	1	1	0	0	0	0	4		
SK			0	0	0	1	0	0	1	0	0	0	2		
SN			0	0	0	0	0	0	0	9	0	0	9		
STS			0	1	0	3	2	3	3	0	0	0	12		
TM			0	0	1	1	1	2	1	0	0	0	6		
YN			0	0	1	0	0	1	1	0	0	0	3		
EEEE			1	3	11	26	26	27	11	9	0	0	114		

Figure III-2 SAMPLE SECTION - SUBSURFACE SHIP PERSONNEL DATA BASE (SSFILE)

VX	4A1029 0														
1000	0	0	0	0	0	0	0	1	1	0	0	0	0	0	2
1301	0	0	0	0	1	1	0	0	0	0	0	0	0	0	2
1311	0	0	0	0	0	1	7	11	0	0	0	0	0	0	19
1321	0	0	0	0	0	0	5	8	0	0	0	0	0	0	13
1520	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
1630	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
2102	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
6330	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
6360	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
7380	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
OOOO	0	0	0	0	1	2	13	24	1	0	0	0	1	0	42
AD		0	1	2	5	8	8	9	0	0	0	33			
AE		0	2	1	3	6	9	6	0	0	0	27			
AF		1	0	0	0	0	0	0	0	0	0	1			
AK		0	0	0	1	3	2	1	0	0	0	7			
AM		0	1	0	0	0	0	0	0	0	0	1			
AME		0	0	0	3	2	4	4	0	0	0	13			
AMH		0	0	0	1	4	4	4	0	0	0	13			
AMS		0	0	2	4	7	10	10	0	0	0	33			
AN		0	0	0	0	0	0	0	48	0	0	48			
AO		0	0	1	3	3	5	4	0	0	0	16			
APO		1	0	0	1	5	0	0	0	0	0	7			
AQ		0	1	2	3	6	9	5	0	0	0	26			
ASE		0	0	0	0	0	0	2	0	0	0	2			
ASM		0	0	0	0	1	0	1	0	0	0	2			
AT		0	0	1	2	4	8	5	0	0	0	20			
AZ		0	0	0	2	2	2	2	0	0	0	8			
DK		0	0	0	0	1	0	0	0	0	0	1			
DM		0	0	0	0	0	1	0	0	0	0	1			
HM		0	0	0	1	0	0	0	0	0	0	1			
HN		0	0	0	0	0	0	0	2	0	0	2			
LI		0	0	0	0	0	1	0	0	0	0	1			
MS		0	0	0	0	1	1	2	0	0	0	4			
OS		0	0	1	0	0	0	0	0	0	0	1			
PH		0	0	0	0	1	0	0	0	0	0	1			
PN		0	0	0	1	1	2	2	0	0	0	6			
PO		0	0	0	2	5	1	0	0	0	0	8			
PR		0	0	0	1	1	2	2	0	0	0	6			
SN		0	0	0	0	0	0	0	2	0	0	2			
YN		0	0	1	2	1	3	6	0	0	0	13			
EEEE		2	5	11	35	62	72	65	52	0	0	304			

Figure III-3 SAMPLE SECTION-AIRCRAFT SQUADRON PERSONNEL DATA BASE (SQFILE)

subsurface ship, and A = aircraft squadron; the number of applicable officer designator entries (Columns 11-12); the number of applicable EP ratings (Columns 13-14); and the number of applicable civilian codes (Columns 15-16), which are always zero for sea-based forces. The next set of records each specify the officer designator, the numbers of officers per pay grade for that officer designator for Pay Grades 0-10 down to 0-1 and then W-4 down to W-1, and finally, the total number of officers for that officer designator. The officer designator set is terminated with an officer designator entry '0000', followed by the column total for each pay grade and finally the total number of officers. The next set of records applies in a similar manner to EP ratings, where the pay grades range from E-9 down to E-4, Designated Striker, and then E-3 down to E-1. This set is terminated with an EP rating entry 'EEEE', which contains the column totals.

2. Basic Shore Mission Area Personnel Data Base

The Basic Shore Mission Area Personnel Data Base established for this analysis represents personnel that are allocated to various activities within the Navy shore establishment. For purposes of this analysis it was convenient to group personnel in terms of their allocations to one of the mission areas established under the Shore Requirements, Standards, and Manpower Planning System/Shore Requirements Operational Capabilities (SHORSTAMPS/SHOROC) Program as defined in the SHOROC Dictionary.[5] A total of 25 such mission areas are identified in this document. In addition, three additional categories are used in the SIDS data base, representing the Department of the Navy and Command Headquarters and Staff, students, and uncoded personnel (personnel billets that are not, as yet, allocated to any specific mission area). Table III-1 identifies these groupings together with the code used in the data base structure. For this analysis, these mission area groupings are used in an analogous manner as the ship classes and aircraft squadron types included in the sea-based personnel data bases.

Table III-1

SHOROC MISSION AREAS

Code	Mission Area
UN	Uncoded Personnel
HQ	Headquarters and Staff Personnel
ST	Students
ACM	Aircraft Maintenance
ADP	Automatic Data Processing
COM	Communications
CON	Construction of Shore Facilities
CPY	Cryptology
DEN	Dental
ELX	Electronics Material Support
ENV	Environmental Support
FAC	Facilities Support
FIR	Firefighting
FIN	Financial Services
FSS	Flight Support Services
ICS	Internal and Inter-Command Support
INT	Intelligence
MED	Medical
PER	Personnel Support
PSO	Port Service Operations
RCT	Recruiting
R&D	Research, Development, Test and Evaluation
SEC	Security
SFP	Shore Facilities Planning
SHP	Ship Repair
SUP	Supply
TRA	Training
WEP	Weapons

The data sources for this data base were the two SIDS data base tapes.[3] These tapes contain slightly over 300,000 data records, where a record identifies a Naval activity, an officer or enlisted component within an activity, or an officer, enlisted, or civilian position (set of positions) within an activity. Each data base record is 163 characters in length and contains a variety of coded information relative to that activity, component, or position. In this analysis, the activity and component records were not required. For the position records, only selected data were required from a record. These were the mission area code; designator and pay grade for officers; rating and pay grade for enlisted personnel; pay plan, occupational code, and pay grade for civilians; and the number of current billets represented by the position record.

The selected data entries in a position record, when decoded, were for the most part directly applicable to the requirements of the shore-based data base used in this analysis. The one major exception occurs in the area of civilian pay plans. In the SIDS record descriptions, there are a total of 31 different civilian pay plans. For this analysis, it was convenient to consider the four prevalent pay plans and equivalence the remainder to these pay plans as much as possible. The pay plans used are the General Schedule (GS), Federal Wage System-Supervisory (WS), Federal Wage System-Leader (WL) and Federal Wage System-Nonsupervisory (WG). The other pay plans such as Canal Zone GS Type Positions (CZ), Maritime (WM), Foreign Defense Schedule (FD), and so on were equivalenced, for the most part, to these four pay plans as indicated in Table III-2. Except for the few exceptions noted in the table, pay grades for these pay plans were assumed the same as their equivalenced pay plan. Since pay grades were used to represent skill levels, and not for monetary value, these equivalencing relationships were assumed sufficiently representative for the purpose of this analysis.

Table III-2

CIVILIAN PAY PLAN EQUIVALENCIES

	Primary Pay Plan			
	General Schedule (GS)	Federal Wage System Supervisory (WS)	Federal Wage System Nonsupervisory (WG)	Federal Wage System Leader (WL)
Equivalenced Pay Plans	AD - Administratively Determined Rates, Not Elsewhere Specified AG - Foreign National, Similar to GS Positions CZ - Canal Zone GS Type Positions EC - Experts and Consultants EX - Executive Pay FD - Foreign Defense Schedule GW - Employment Under Schedule A213.3102 Classified and Paid at GS Rate NM - Canal Zone Nonmanual ST - Scientific and Professional SZ - Canal Zone Special Category Type Positions ZZ - Employees Serving Without Compensation	MS - Canal Zone Manual, Supervisory NU - Foreign National, Similar to Ungraded Wage Service Positions (Grades 16-20)* WD - Nonsupervisory Wage Grade Production Facilitating Positions† WN - Supervisory Wage Grade Production Facilitating Positions** WY - Inspection Service, Supervisory	MO - Canal Zone Manual, Nonsupervisory NU - Foreign National, Similar to Ungraded Wage Service Positions (Grades 1-15) WB - All Wage Positions Not Paid Under Coordinated Federal Wage System Pay Schedule or Not Otherwise Designated WI - Printing and Lithographic Pay Schedules (WDC)†† WM - Maritime Pay Schedules WP - Printing and Lithographic Pay Schedules (Not WDC)†† WT - Federal Wage System-Training WW - Employment Under Schedule A213.3102 Classified and Paid at a Regularly Established Rate Under a Wage System WX - Inspection Service, Nonsupervisory WZ - Canal Zone Wage System Type Positions YV - Summer Aid Employment YW - Student Aid Employment	None

* For NU pay grades 16-20, pay grade equivalencing formula WS = NU - 10 (Derived from Ref. 10)

† For all WD pay grades, pay grade equivalencing formula WS = WD + 2 (Derived from Ref. 10)

** For all WN pay grades, pay grade equivalencing formula WS = WN + 6 (Derived from Ref. 10)

†† For WI and WP pay grades 1-19, pay grade equivalencing formulas WG = INT (WI/2) + 3 and WG = INT (WP/2) + 3 (Derived from Refs. 11 and 12). Higher pay grades were omitted for lack of equivalencing information - 127 billets).

In order to accumulate the personnel allocation data in a format compatible with the sea-based personnel data bases, a computer program, designated by the acronym SHRFIL, was designed to accomplish this purpose. This program is basically a bookkeeping program that reads selected portions of a data record, determines if that record is a position record, and, if so, translates the coded entries to be data-base compatible, and then accumulates and stores the number of billets into the appropriate data base file location. This file is actually a four-dimensional array with the first dimension the mission area; the second dimension being the pay plan such as officer, enlisted, general schedule, and so on; the third dimension being the designator, rating, or occupational code group respectively for officers, enlisted personnel, and civilians; and the fourth dimension being the pay grade, including an extra position for row totals. The value of an element in the array represents the total number of billets allocated to the shore-based Navy matching the four dimensional identifiers for that array element. If, in reading a data record, the program encounters an inconsistency in one or more of the selected data elements, it prints out, on a separate file, the data elements that were read for subsequent error analysis. The outputs of the program then are the Shore Mission Area Personnel Data Base (SHFILE) and an error listing of data records (SHFERR).

Several runs of SHRFIL were required to generate the shore-based data base. The first several runs, through analysis of the SHFERR output, identified a few cases where SHRFIL could be expanded to accommodate a number of the data base reading errors. The final run resulted in the generation of the Shore Mission Area Personnel Data Base. This run still identified a number of data record inconsistencies. The majority of these were enlisted personnel without specified pay grades, mainly musicians and enlisted students, primarily recruits. Although a fairly large number of billets were included in these two categories, their

exclusion from the data base was not considered significant for the purposes of this analysis as musician ratings would be given low priority in times of personnel shortfalls and the recruits would eventually be spread out among the enlisted ratings in the same proportions as those already included in the data base.

Figure III-4 presents an excerpt of the Shore Mission Area Personnel Data Base. This figure portrays the officer, enlisted, and civilian manpower allocations to the Environmental Support Mission Area (ENV). The first record shown on the figure specifies the mission area (Columns 1-4); the number of applicable officer designator entries (Columns 5-6); the number of applicable EP ratings (Columns 7-9); and the number of applicable civilian occupational code groups, broken down in terms of the GS pay plan (Columns 10-11), the WS pay plan (Columns 12-13), the WG pay plan (Columns 14-15), and the WL pay plan (Columns 16-17). Note that the WL entry for the sample excerpt is zero, indicating that there are no personnel under the Federal Wage System-Leader Pay Plan allocated to the Environmental Support Mission Area. The next set of records each specify the aggregated officer designator, the number of officers per pay grade for that designator for Pay Grades O-11 down to O-1, and then W-4 down to W-1, including a Commodore Pay Grade between Pay Grades O-7 and O-6, and finally the total number of officers for the aggregated officer designator. The aggregated officer designators, as defined in NPRDC Report SR80-18[6], were assumed sufficient for the purposes of this analysis. The level of aggregation is identified by the inclusion of Xs in the officer designator entry. For example, all Submarine Warfare Officers with a designator in the 1120 series would be assigned the aggregated officer designator 112X. A complete list of the aggregated officer designators used in this analysis is presented in Table III-3. The officer designator set is terminated with an officer designator entry '0000', followed by the column totals for each pay grade and finally the total number of officers allocated to the mission area. The next set of records applies in a similar manner to EP ratings, where the EP

ENV10	1217	1	1	0														
100X	0	0	0	0	0	0	0	1	4	10	7	4	0	0	0	0	26	
105X	0	0	0	0	0	0	0	0	1	3	0	0	0	0	0	0	4	
111X	0	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0	3	
112X	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	
163X	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	
180X	0	0	0	0	0	0	3	18	55	39	11	19	0	0	0	0	145	
310X	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	
510X	0	0	0	0	0	0	1	3	1	1	0	0	0	0	0	0	6	
6XXX	0	0	0	0	0	0	0	0	8	15	7	8	0	0	0	0	38	
7XXX	0	0	0	0	0	0	0	0	0	0	0	0	2	14	8	0	24	
0000	0	0	0	0	0	0	4	24	71	70	25	31	2	14	8	0	249	
AG	5	27	109	250	255	284	45	0	0	975								
AO	0	0	0	0	1	0	0	0	0	1								
BM	0	0	1	1	0	0	0	0	0	2								
DP	0	0	0	2	0	0	0	0	0	2								
DS	0	0	2	1	8	5	0	0	0	16								
EN	0	0	0	0	0	1	0	0	0	1								
ET	0	1	3	20	26	28	1	0	0	79								
OT	0	4	16	30	45	27	10	0	0	132								
PN	0	0	0	1	0	0	1	0	0	2								
SN	0	0	0	0	0	0	9	0	0	9								
TD	0	0	0	0	0	2	3	0	0	5								
YN	0	0	1	1	1	1	0	0	0	4								
EEEE	5	32	132	306	336	348	69	0	0	1228								
0	0	0	0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	3
1	0	0	0	0	1	10	6	5	0	0	0	0	0	0	0	0	0	22
3	0	0	0	3	4	6	16	31	0	13	1	14	12	36	35	15	8	0	0	194
4	0	0	0	0	3	1	7	6	3	6	1	5	2	4	0	0	0	1	0	39
5	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	3
6	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
7	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
8	0	0	2	16	28	79	154	105	20	43	3	34	6	4	1	1	0	0	1	497
10	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	3
11	0	0	0	0	0	0	0	5	1	0	0	1	0	1	0	0	0	0	0	8
13	0	0	6	26	46	94	121	51	3	17	7	11	14	29	1	0	0	0	2	428
14	0	0	0	0	2	2	2	0	0	1	0	0	0	0	0	0	0	0	0	7
15	0	0	0	1	16	56	44	15	0	4	1	2	0	1	0	0	0	0	0	140
16	0	0	0	0	0	0	4	1	0	4	0	2	0	2	0	0	0	0	0	13
19	0	0	0	0	0	0	2	1	0	4	0	0	0	0	0	0	0	0	0	7
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	2
21	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
GSGS	0	0	8	47	100	250	358	221	27	93	13	70	36	79	39	16	8	1	3	1369
67	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
WSWS	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
26	0	0	0	0	9	0	0	0	0	0	0	0	0	0	0	9				
WGWG	0	0	0	0	9	0	0	0	0	0	0	0	0	0	0	9				

Figure III-4 SAMPLE SECTION-SHORE MISSION AREA PERSONNEL DATA BASE (SHFILE)

Table III-3

AGGREGATED OFFICER DESIGNATORS

Designator		Designator	
100X	Command Staff Officer	165X	Special Duty Officer (SDO) --Public Affairs
105X	Command Staff Officer	167X	Special Duty Officer (SDO) --Merchant Marine, Engr.
110X	Other Line Officer	168X	Special Duty Officer (SDO) --General Administration
111X	Surface Warfare Officer	169X	Special Duty Officer (SDO) --Merchant Marine, Comm.
112X	Submarine Warfare Officer	180X	Special Duty Officer (SDO) --Geophysics
113X	Special Warfare Officer	191X	Medical Corps Officer
114X	Special Operations Officer	192X	Dental Corps Officer
116X	Surface Warfare Officer	193X	Medical Service Corps Officer
117X	Submarine Warfare Officer	194X	Chaplain Corps
118X	Special Warfare Officer	195X	Judge Advocate General's Corps Officer
119X	Special Operations Officer	196X	Medical Corps Officer
130X	Aviation Officer (Pilot)	197X	Medical Corps Officer
131X	Aviation Officer (Pilot)	210X	Medical Corps Officer
132X	Aviation Flight Officer	220X	Dental Corps Officer
137X	Aviation Flight Officer	230X	Medical Service Corps Officer
139X	Aviation Officer (Pilot)	250X	Judge Advocate General's Corps Officer
140X	Engineering Duty Officer	290X	Nurse Corps Officer
141X	Engineering Duty Officer	310X	Supply Corps Officer
144X	Engineering Duty Officer	410X	Chaplain Corps Officer
146X	Engineering Duty Officer	510X	Civil Engineer Corps Officer
150X	(Unknown)	6XXX	Line-Limited Duty Officer
151X	Aviation Engineering Duty Officer	7XXX	Warrant Officer
152X	Aviation Maintenance Duty Officer	8XXX	Warrant Officer
161X	Special Duty Officer (SDO) --Crypto		
163X	Special Duty Officer (SDO) --Intelligence/Photo		
164X	Special Duty Officer (SDO) --Intelligence /Photo		

ratings used in this analysis is presented in Table III-4 and were obtained, for the most part, from NPRDC Report SR80-7.[7] This set is terminated with an EP rating entry 'EEEE', which contains the column totals. The next set of records applies to General Schedule civilian employees (including equivalenced pay plans), where the GS levels range from GS-18 down to GS-0. The occupational code groupings are aggregated by one hundred series increments and have been abbreviated by deleting the two trailing zeros. For example, the occupation code group 15 appearing in the file represents the 1500 series of white-collar occupational codes (Mathematics and Statistics). A complete list of the white-collar occupational code groups used in this analysis is presented in Table III-5 and are as defined in US Office of Personnel Management Report SM-56-14.[8] This set is terminated with an occupational code group entry 'GSGS', which also contains the column totals. The next three sets of records apply to Federal Wage System employees (including equivalenced pay plans) in the order of Supervisory (WS), Nonsupervisory (WG), and Leader (WL). The WS pay grades range from WS-19 to WS-1, while the WG and WL pay grades range from WG-15 to WG-1 and WL-15 to WL-1. The occupational code groups are aggregated by one thousand series increments and have been abbreviated by deleting the trailing three zeros. For example, the occupational code group 67 in the file represents the 67000 series of blue-collar occupational codes (Manufacture and Repair Shop Operation). A complete list of the blue-collar occupational code groups used in this analysis is presented in Table III-6 and were obtained from US Office of Personnel Management Report SM59-12.[9] These three sets of records are terminated with occupational code group entries 'WSWS', 'WGWG', and 'WLWL', respectively, where these records contain the column totals for the respective set of records. Note in the sample excerpt of Figure III-4, there are no WL data records as previously mentioned.

Table III-4

ENLISTED PERSONNEL RATINGS

Rating	Description
AF	Aviation Boatswain's Mate
ABE	Aviation Boatswain's Mate (Launching & Recovery Eqpmt.)
ABF	Aviation Boatswain's Mate (Fuels)
ABH	Aviation Boatswain's Mate (Aircraft Handling)
AC	Air Controlman
AD	Aviation Machinist's Mate
ADJ	Aviation Machinist's Mate (Jet Engine Mechanic)
ADR	Aviation Machinist's Mate (Reciprocating Mechanic)
AE	Aviation Electrician's Mate
AF	Aircraft Maintenance Man (E-9 only)
AG	Aerographer's Mate
AK	Aviation Storekeeper
AM	Aviation Structural Mechanic
AME	Aviation Structural Mechanic (Safety Equipment)
AMH	Aviation Structural Mechanic (Hydraulics)
AMS	Aviation Structural Mechanic (Structures)
AN	Airman
AO	Aviation Ordnanceman
APO	Aviation Petty Officer
AQ	Aviation Fire Control Technician
AS	Aviation Support Equipment Tech.
ASE	Aviation Support Equipment Technician (Electrical)
ASH	Aviation Support Equipment Technician (Hydraulics & Structures)
ASM	Aviation Support Equipment Technician (Mechanical)
AT	Aviation Electronics Technician
AV	Avionics Technician (E-9 only)
AW	Aviation Antisubmarine Warfare Operator
AX	Aviation Antisubmarine Warfare Technician
AZ	Aviation Maintenance Administrationman
BM	Boatswain's Mate
BR	Boilermaker
BT	Boiler Technician
BU	Builder
CE	Construction Electrician
CM	Construction Mechanic
CT	Communications Technician
CTA	Communications Technician (Administration Branch)
CTI	Communications Technician (Interpretive Branch)
CTM	Communications Technician (Maintenance Branch)
CTO	Communications Technician (Communications Branch)
CTR	Communications Technician (Collection Branch)
CTT	Communications Technician (Technical Branch)
CU	Constructionman (E-9 only)
DK	Disbursing Clerk
DM	Illustrator Draftsman
DN	Dentalman
DP	Data Processing Technician
DS	Data Systems Technician
DT	Dental Technician
EA	Engineering Aid
EM	Electrician's Mate
EN	Engineman
EO	Equipment Operator
EQ	Equipmentman (E-9 only)
ET	Electronics Technician
ETN	Electronics Technician (Unknown)
ETR	Electronics Technician (Unknown)
EW	Electronics Warfare Technician
FN	Fireman
FT	Fire Control Technician
FTB	Fire Control Technician (Ballistic Missile Fire Control
FTG	Fire Control Technician (Gun Fire Control)
FTM	Fire Control Technician (Surface Missile Fire Control

Table III-4 (Concluded)

Rating	Description	Rating	Description
GM	Gunner's Mate	STG	Sonar Technician (Surface)
GMG	Gunner's Mate (Guns)	STS	Sonar Technician (Submarine)
GMM	Gunner's Mate (Missiles)	SW	Steelworker (includes CUCM)
GMT	Gunner's Mate (Technician)	TD	Tradesman
GS	Gas Turbine System Technician	TM	Torpedoman's Mate
GSE	Gas Turbine System Technician (Electrical)	UT	Utilitiesman
GSM	Gas Turbine System Technician (Mechanical)	YN	Yeoman
HM	Hospital Corpsman		
HN	Hospitalman		
HT	Hull Maintenance Technician		
IC	Interior Communications Eletrician (includes EMCM)		
IM	Instrumentman (includes PICM)		
IS	Intelligence Specialist		
JO	Journalist		
LI	Lithographer		
LN	Legalman		
MA	Master-At-Arms		
ML	Molder		
MM	Machinist's Mate		
MN	Mineman		
MR	Machinery Repairman		
MS	Mess Management Specialist		
MT	Missile Technician		
MU	Musician		
NC	Navy Counselor		
OM	Opticalman (includes PICM)		
OS	Operations Specialist		
OT	Ocean Systems Technician		
PC	Postal Clerk		
PH	Photographer's Mate		
PI	Precision Instrumentman (E-9 only)		
PM	Patternmaker (includes MLCM)		
PN	Personnelman		
PO	Petty Officer		
PR	Aircrew Survival Equipmentman		
PT	Photo Intelligence Technician		
QM	Quartermaster		
RM	Radioman		
RP	Religious Program Specialist		
SD	Steward		
SH	Ship's Serviceman		
SK	Storekeeper		
SM	Signalman		
SN	Seaman		
ST	Sonar Technician		

Table III-5

CIVILIAN WHITE-COLLAR OCCUPATIONAL CODE GROUPS

Occupational Code Group*	Description
0	Miscellaneous Occupations
1	Social Science, Psychology and Welfare
2	Personnel Management and Industrial Relations
3	General Administrative, Clerical, and Office Services
4	Biological Sciences
5	Accounting and Budget
6	Medical, Hospital, Dental, and Public Health
7	Veterinary Medical Science
8	Engineering Architecture
9	Legal and Kindred
10	Information and Arts
11	Business and Industry
12	Copyright, Patent, and Trade-Mark
13	Physical Sciences
14	Library and Archives
15	Mathematics and Statistics
16	Equipment, Facilities, and Service
17	Education
18	Investigation
19	Quality Assurance, Inspection, and Grading
20	Supply
21	Transportation
22	Unspecified
23	Postal Operations

* Group members should be multiplied by 100 to correspond with group numbers in Reference 8.

Table III-6

CIVILIAN BLUE-COLLAR OCCUPATIONAL CODE GROUPS

Occupational Code Group*	Description
25	Wire Communication Equipment Installation and Maintenance
26	Electronic Equipment Installation and Maintenance
27	Quartz Crystal Work
28	Electrical Installation and Maintenance
29	Electronic Equipment Operation
31	Fabric and Leather Work
32	Glass Work
33	Instrument Maintenance
34	Machine Tool Work
35	Manual Labor
36	Masonry, Plastering, and Roofing
37	Metal Processing
38	Metal Work
39	Motion Picture, Radio, Television, and Sound Recording Equipment Work
40	Optical Work
41	Painting and Paperhanging
42	Pipefitting
43	Plastic Work
44	Printing and Reproduction
45	Rubber Work
46	Woodwork
47	General Maintenance and Operations
48	General Equipment Maintenance
50	Agriculture, Forestry and Kindred
52	Miscellaneous Occupations
53	Fixed Industrial Maintenance
54	Fixed Industrial Equipment Operation
55	Quarry Work
56	Currency, Securities, Coin, and Medal Making
57	Mobile Industrial Equipment Operations
58	Mobile Industrial Equipment Maintenance
59	Marine Operations
60	Railroad Operations
61	Railroad Maintenance
62	Marine Maintenance
65	Ammunition and Explosives
66	Armament Work
67	Manufacture and Repair Shop Operations
69	Warehousing

Table III-6 (Concluded)

Occupational Code Group*	Description
70	Packing and Processing
73	Laundry and Dry Cleaning
74	Food Preparation and Serving
75	Medical Services
76	Merchandising and Personal Services
77	Animal Caretaking
82	Fluid Systems
83	Instrumentation
84	Reclamation Work
85	Aircraft Propeller Overhaul
86	Aircraft Engine Overhaul
87	Manufacturing, Repair and Industrial Support Supervision
88	Aircraft Overhaul
90	Film Processing
99	Blue-Collar Unspecified

* Group members should be multiplied by 1000 to correspond with group numbers in Reference 9.

C. Basic Personnel Utility Data Base

The basic personnel utility data base was derived from utility tables contained in the Decisions and Design, Inc. report on accrued utility of Navy enlisted personnel.[4] This report presents the results of a study conducted to determine the relative contribution to navy missions of the accrued experience of enlisted personnel. The report identifies seven groupings of EP ratings from which relative utility data were generated. The utility groupings and numbers obtained were derived from analysis of interviews conducted with several experienced officers and petty officers, representing a fairly broad spectrum of duty types and service experience. Although these utility data were considered as being approximate in nature and not intended to be used for comparisons among EP ratings, it was felt that they did provide a sufficient and useful data base for the purposes of this analysis.

The utility groupings established in that report are as follows, where the EP ratings used are as defined previously in Table III-4:

Group A - FT, ST

Group B - AD, AQ, AT, AX, CTT, ES, ET, EW, GM, MT

Group C - ABE, AE, AM, AO, AW, BM, BT, CTM, EN, GS, HT, MM, MN, TD, TM

Group D - ABF, ABH, AS, CTI, CTO, CTR, IS, OS, OT, PR, QM, RM

Group E - CTA, HM, IM, ML, MR, OM, PM, SM, YN

Group F - AG, AK, AZ, BU, CE, CM, DK, DP, DT, EA, EO, LN, MA, MS, NC, PN, SK, SW, UT

Group G - DM, JO, LI, MU, PC, PH, SH

Utility values were established in a range from 0 to 100, and were tabulated for each utility group in arrays representing pay grade and length of service. For this analysis, the length of service variable was eliminated by choosing the maximum utility value for a pay grade over the various years of service. The resulting Personnel Utility Data Base obtained in this manner is presented in Table III-7.

Table III-7

BASIC PERSONNEL UTILITY DATA BASE

Pay Grade	Utility Group						
	A	B	C	D	E	F	G
E-1	11	11	11	11	11	10	8
E-2	19	20	20	20	20	14	10
E-3	29	29	29	29	29	19	14
E-4	52	52	52	43	38	22	14
E-5	67	67	67	52	48	31	17
E-6	81	81	81	62	52	31	17
E-7	95	90	81	67	57	38	21
E-8	100	95	86	73	63	42	21
E-9	100	95	86	73	63	42	21

IV METHODOLOGY

This chapter describes the methodology that was developed to provide a basis for examining the effects of personnel shortfalls on Navy personnel readiness relative to logistics support functions. This methodology is constrained by the availability of the input data bases as discussed in the previous chapter. The methodology is based on the establishment of a definition of personnel readiness in terms of the relative utility of personnel assigned to specific billets within the Navy manpower structure. Section A of this chapter provides the details of this definition of personnel readiness. Sections B and C describe the transformations and expansions of the basic data bases (as described in Sections III.B and C) that were required to satisfy the needs of the methodology. Section D then develops a modified utility evaluation concept that provides a basis for optimizing Navy-wide personnel readiness across the various Naval activities under different levels of personnel shortfalls among officers, enlisted personnel, and civilians. Section E describes a computer program designed to optimize Navy-wide personnel readiness under specific levels of personnel shortfall through the implementation of the modified utility evaluation concept.

A. Personnel Readiness

Personnel readiness is a factor that addresses the availability of sufficient, qualified personnel to perform the required objectives of a Naval organizational unit or activity to perform its assigned mission responsibilities. A measure of personnel readiness must consider not only the availability of the required numbers of officers, petty officers, other enlisted personnel, and civilians within an organizational unit or

activity, but also the maintenance of a proper balance of these personnel with respect to mission essential skills, training, and Naval experience. The personnel authorizations contained in the ship and aircraft squadron manpower documents, and the SHORSTAMPS/SHOROC manpower planning program provide the standards for measuring personnel readiness strictly on a numerical basis. That is, if a unit or activity is staffed strictly in accordance with its authorization, then that unit or activity can be considered to possess a 100% rating for personnel readiness. Deviations from these authorizations, especially in the sense of shortfalls, will degrade personnel readiness, although the amount of degradation will be highly dependent upon the specific areas where the shortfalls occur. That is, the loss of one storekeeper from a total of ten authorized may have a lower degradation effect than the loss of one sonar technician from a total of only four. Thus, the procedure used to determine personnel readiness degradations from the standard must consider the full spectrum of the established personnel authorizations.

The approach used in this analysis is based on the assignment of utility values to the various personnel billets authorized to an activity.* The personnel readiness standard for an activity is its authorized utility and is computed as the sum of the utilities of each authorized billet for that activity. In the event of deviations from an activity's authorized billet structure, personnel readiness is then defined as the ratio of achieved utility to authorized utility. That is,

$$\text{Personnel Readiness} = \frac{\text{Achieved Utility}}{\text{Authorized Utility}} \qquad \text{(IV-1)}$$

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* For the remainder of this report, the term 'activity' will be used to refer to either an organizational unit (ship or aircraft squadron) or a shore activity (shore mission area).

where achieved utility is computed as the sum of the utilities of the assigned personnel to that activity. In the unlikely cases of overstaffing or overqualified personnel filling some billets, the achieved utility could exceed the authorized utility. In such cases, personnel readiness would be assigned a value of unity. However, this analysis is concerned solely with the effects of shortfalls on personnel readiness and thus achieved utility will always be less than authorized utility. Personnel readiness, as defined by Eq. IV-1, can be used for a single activity, a group of activities (such as all surface ships), or the entire Navy. It also can apply to specific functional segments of the Navy such as maintenance operations or supply operations.

B. Personnel Utility Data Base Expansion

The expansion of the Personnel Utility Data Base for use in this analysis first required assigning each officer designator, EP rating, and civilian occupational code group to one of the seven utility skill groups identified in the basic utility data base, described previously in Section III.C. These utility skill group assignments were based on our knowledge of the functions required of the various designators, ratings and occupational codes and the manner in which they relate to the utility skill group's primary characteristics as given by the following:

Group A: Operate complex weapons systems, make quick decisions, requires extensive formal and on-the-job training.

Group B: Operate or maintain complex equipment, requires extensive formal and on-the-job training.

Group C: Operate or maintain equipment of intermediate level of complexity, requires some formal training and much on-the-job training.

Group D: Operate or maintain less complex support equipment and perform less technical tasks than ratings in Groups A, B and C, requires some formal and on-the-job training.

Group E: Perform administrative and support functions with some combat role requirements.

Group F: Perform administrative and support functions with little combat role requirements.

Group G: Perform useful support functions with no combat role requirements.

The resulting assignments are presented in Table IV-1.

The next step in the expansion of the data base required the establishment of utility pay grades that include representation of the full spectrum of officer, EP and civilian pay grades. This equivalencing of pay grades was based on the equivalent grade schedules used by the Naval Facilities Engineering Command in planning quarters and messing facilities for officers, enlisted personnel, and civilians.[13] Table IV-2 presents a listing of the utility pay grades and the equivalency relationships with officer, EP, and the the four civilian pay grades.

The final step in expanding the Personnel Utility Data Base was to expand and normalize the utility tables contained in the Basic Personnel Utility Data Base (Table III-7) which only consider the nine EP pay grades. This was accomplished by fitting least-squares lines to the basic data for utility pay grades 1 to 9 (E-1 to E-9) for each utility skill group and then normalizing the values to equal unity for the highest utility obtained for the least-squares extrapolation (Pay Grade 18 for Skill Group A).

The resulting normalized utility values used in this analysis for the various utility skill groups and pay grades are presented in Table IV-3.

C. Personnel Data Base Transformations

The personnel data base transformations were accomplished in two stages. First, the basic personnel data bases were transformed into equivalent formats, and then all four data bases were combined into a single utility structured personnel data base, one for each of the logistics functional areas addressed in this analysis, in addition to one addressing the full spectrum of Naval operations. These transformations are discussed, in turn, in the remainder of this section.

Table IV-1

UTILITY SKILL GROUP ASSIGNMENTS

Utility Skill Group	Aggregated Officer Designators *	EP Ratings †	Civilian White Collar Occupational Code Groups **	Civilian Blue-Collar Occupational Code Groups ††
A	111X, 112X, 116X, 117X 130X, 131X, 139X	FT, FTB, FTG, FTM, ST, STG, STS	None	None
B	100X, 105X, 110X, 113X, 114X, 118X, 119X, 132X, 137X, 152X, 7XXX, 8XXX	AC, AD, ADJ, ADR, AF, AN, AQ, AT, AV, AX, CTT, ET, ETN, ETR, EW, GM, GMG, GMM, GMT, MT, SN	None	None
C	140X, 141X, 144X, 146X, 150X, 151X	AB, ABE, AE, AM, AME, AMH, AMS, AO, AW, BM, BT, CT, CTM, EN, GS, GSE, GSM, HT, MM, MN, TD, TM	None	None
D	161X, 163X, 164X, 6XXX	ABF, ABH, AS, ASE, ASH, ASM, CTI, CTO, CTR, EM, IC, IS, OS, OT, PI, PR, PT, QM, RM	None	25, 26, 33, 40, 65, 66, 82, 83, 85, 86, 88
E	191X, 192X, 210X, 220X	APO, BR, CTA, DN, FN, HM, HN, IM, ML, MR, OM, PM, SM, YN	8, 11, 15	27, 28, 29, 57, 58, 59, 62, 67
F	180X, 193X, 230X, 290X, 310X, 510X	AG, AK, AZ, BU, CE, CM, CU, DK, DP, DT, EA, EO, EQ, LN, MA, MS, NC, PN, PO, SK, SW, UT	2,3,4,5,6,16,17, 19, 20, 21	34, 37, 38, 43, 45, 47, 48, 53, 54, 60, 61, 69, 87, 90
G	165X, 167X, 168X, 169X, 194X, 195X, 196X, 197X, 250X, 410X	DM, JO, LI, MU, PC, PH RP, SD, SH	0, 1, 7, 9, 10, 12, 14, 18, 22, 23	31, 32, 35, 36, 39, 41, 42, 44, 46, 50, 52, 55, 56, 70, 73, 74, 75, 76, 77, 84, 99

* Aggregated Officer Designators are defined in Table III-3

† EP Ratings are defined in Table III-4

** Civilian White-Collar Occupational Code Groups are defined in Table III-5

†† Civilian Blue-Collar Occupational Code Groups are defined in Table III-6

Table IV-2

UTILITY PAY GRADE EQUIVALENCIES

Utility Pay Grade	Officer Pay Grades	EP Pay Grades	Civilian Pay Grades *			
			GS	WS	WL	WG
1		E-1	GS-0, GS-1			WG-1, WG-2
2		E-2	GS-2			WG-3, WG-4
3		E-3	GS-3			WG-5, WG-6
4		E-4	GS-4			WG-7, WG-8
5		E-5	GS-5	WS-1	WL-1	WG-9
6		E-6		WS-2, WS-3	WL-2	
7		E-7		WS-4	WL-3	WG-10
8		E-8	GS-6	WS-5, WS-6	WL-4	
9		E-9		WS-7	WL-5	WG-11
10	O-1, W-1, W-2		GS-7	WS-8, WS-9	WL-6, WL-7, WL-8	WG-12, WG-13
11	O-2, W-3, W-4		GS-8, GS-9	WS-10, WS-11	WL-9, WL-410, WL-11	WG-14
12	O-3		GS-10, GS-11	WS-12, WS-13	WL-12, WL-13, WL-14	WG-15
13	O-4		GS-12	WS-14, WS-15, WS-16	WL-15	
14	O-5		GS-13, GS-14	WS-17, WS-18, WS-19		
15	O-6		GS-15			
16			GS-16			
17	O-7 thru O-11		GS-17			
18			GS-18			

* GS - General Schedule; WS-Federal Wage System, Supervisory; WL- Federal Wage System Leader; WG- Federal Wage System, Non-Supervisory

Table IV-3

NORMALIZED UTILITY VALUES

Utility Pay Grade	Utility Skill Group						
	A	B	C	D	E	F	G
1	.049	.049	.049	.049	.049	.044	.035
2	.088	.088	.088	.088	.088	.062	.044
3	.128	.128	.128	.128	.128	.084	.053
4	.230	.230	.230	.190	.168	.097	.062
5	.296	.296	.296	.230	.212	.122	.069
6	.358	.358	.327	.274	.230	.137	.075
7	.420	.398	.358	.296	.252	.168	.084
8	.442	.420	.380	.323	.278	.186	.093
9	.496	.475	.438	.359	.307	.199	.100
10	.552	.526	.484	.396	.337	.218	.108
11	.608	.580	.531	.433	.367	.237	.115
12	.664	.632	.577	.470	.397	.256	.123
13	.720	.684	.624	.507	.427	.275	.130
14	.776	.737	.670	.544	.457	.294	.138
15	.832	.790	.717	.581	.487	.313	.145
16	.888	.842	.763	.618	.517	.332	.153
17	.944	.895	.810	.655	.574	.351	.160
18	1.000	.947	.856	.692	.577	.370	.168

The basic personnel data bases established for use in this analysis, as described in the preceding chapter, were formatted in terms of the basic data sources and thus were not consistent with one another. For example, on one hand, the three sea-based personnel data bases listed officers only up through grade O-10, while the shore-based personnel data base listed officers on up through grade O-11 and included a space for Commodores between grades O-6 and O-7. On the other hand, the sea-based personnel data bases listed designated strikers, with their associated NICs, separately from other E-3 pay grade personnel, while the shore-based personnel data base did not consider this distinction. The required data base transformations to rectify these and other inconsistencies were accomplished by the use of two computer programs: AFLALT for the afloat forces and SHALT for the shore-based personnel. These programs also expanded the data bases to include a utility skill group and functional area identification for each officer, EP and civilian position record in the respective data base. The applicable utility skill groups were identified in the previous subsection. The functional area identifications were established on a judgmental basis, considering the relationships between the associated job titles and the functional area designations. The resulting identifications are presented in Table IV-4.

The results of the AFLALT and SHALT runs produced the revised personnel data bases MDNEW, SSNEW, SQNEW and SHNEW derived respectively from the data bases MDFILE, SSFILE, SQFILE and SHFILE, which were described in Section III.B. Figure IV-1 presents an excerpt from the revised Shore Mission Area Personnel Data Base (SHNEW). This figure portrays the officer, enlisted and civilian manpower allocations to the Environmental Support Mission Area (ENV). The format shown in the figures is the same for all four new data bases. The differences in the data base format as compared with the old data base format shown in Figure III-4 for the same mission area are as follows:

Table IV-4

FUNCTIONAL AREA IDENTIFICATIONS

Functional Area	Aggregated Officer Designators*	EP Ratings†	Civilian White-Collar Occupational Code Groups**	Civilian Blue-Collar Occupational Code Groups††
Operations	110X, 111X, 112X, 113X, 114X, 116X, 117X, 118X, 119X, 130X, 131X, 132X, 137X, 139X, 7XXX, 8XXX	AB, ABE, ABF, ABH, AC, AN, AO APO, BM, CT, CTA, CTI, CTO, CTR, CTT, EM, EN, EO, GM, GMG, GMM, GMT, IS, OS, QM, RM, SM, SN	None	None
Maintenance	140X, 141X, 144X, 146X, 150X, 151X, 152X, 6XXX	AD, ADJ, ADR, AE, AF, AM, AME, AMH, AMS, AQ, AS, ASE, ASH, ASM AT, AV, AX, AZ, BR, BT, BU, CE, CM, CTM, CU, DM, DS, EA, EQ, ET, ETN, ETR, EW, FN, FT, FTB, FTG, FTM, GS, GSE, GSM, HT, IC, IM, ML, MM, MN, MR, MT, OM, OT, PI, PM, PR, PT, ST, STG, STS, TM, UT	0, 16, 22	25, 26, 27, 28, 31, 32, 33, 34, 36, 37, 38, 40, 41, 42, 43, 45, 46, 47, 48, 53, 54, 61, 62, 66, 67, 82, 83, 84, 85, 86, 88
Own-Unit Support	100X, 105X, 161X, 163X, 164X, 165X, 167X, 168X, 169X, 180X, 191X, 192X, 193X, 194X, 195X, 196X, 197X, 210X, 220X, 230X, 250X, 290X, 410X, 510X	AG, DK, DN, DP, DT, HM HN, JO, LI, LN, MA, MU, NC, PC, PH, PN, PO, RP, YN	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 17, 18, 23	29, 35, 39, 44, 50, 52, 56, 73, 74, 75, 76, 77, 90, 99
Supply	310X	AK, AW, MS, SD, SH, SK TD	19, 20, 21	55, 57, 58, 59, 60, 65, 69, 70, 87

* Aggregated Officer Designators are defined in Table III-3

† EP Ratings are defined in Table III-4

** Civilian White-Collar Occupational Code Groups are defined in Table III-5

†† Civilian Blue-Collar Occupational Code Groups are defined in Table III-6

ENV			L10	1217	1	1	0															
100X	2	3	0	0	1	4	10	7	4	0	0	0	0	26								
105X	2	3	0	0	0	1	3	0	0	0	0	0	0	4								
111X	1	1	0	0	0	2	1	0	0	0	0	0	0	3								
112X	1	1	0	0	1	0	0	0	0	0	0	0	0	1								
163X	4	3	0	0	1	0	0	0	0	0	0	0	0	1								
180X	6	3	0	3	18	55	39	11	19	0	0	0	0	145								
310X	6	4	0	0	0	0	1	0	0	0	0	0	0	1								
510X	6	3	0	1	3	1	1	0	0	0	0	0	0	6								
6XXX	4	2	0	0	0	8	15	7	8	0	0	0	0	38								
7XXX	2	1	0	0	0	0	0	0	0	2	14	8	0	24								
OOOO			0	4	24	71	76	25	31	2	14	8	0	249								
AG	6	3	5	27	109	250	255	284	45	0	0	975										
AO	3	1	0	0	0	0	1	0	0	0	0	1										
BM	3	1	0	0	1	1	0	0	0	0	0	2										
DP	6	3	0	0	0	2	0	0	0	0	0	2										
DS	2	2	0	0	2	1	8	5	0	0	0	16										
EN	3	1	0	0	0	0	0	1	0	0	0	1										
ET	2	2	0	1	3	20	26	28	1	0	0	79										
OT	4	2	0	4	16	30	45	27	10	0	0	132										
PN	6	3	0	0	0	1	0	0	1	0	0	2										
SN	2	1	0	0	0	0	0	0	9	0	0	9										
TD	3	4	0	0	0	0	0	2	3	0	0	5										
YN	5	3	0	0	1	1	1	1	0	0	0	4										
EEEE			5	32	132	306	336	348	69	0	0	1228										
0	7	2	0	0	0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	3
1	7	3	0	0	0	0	1	10	6	5	0	0	0	0	0	0	0	0	0	0	0	22
3	6	3	0	0	0	3	4	6	16	31	0	13	1	14	12	36	35	15	8	0	0	194
4	6	3	0	0	0	0	3	1	7	6	3	6	1	5	2	4	0	0	0	1	0	39
5	6	3	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	3
6	6	3	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
7	7	3	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
8	5	3	0	0	2	16	28	79	154	105	20	43	3	34	6	4	1	1	0	0	1	497
10	7	3	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	3
11	5	3	0	0	0	0	0	0	0	5	1	0	0	1	0	1	0	0	0	0	0	8
13	5	3	0	0	6	26	46	94	121	51	3	17	7	11	14	29	1	0	0	0	2	428
14	7	3	0	0	0	0	2	2	2	0	0	1	0	0	0	0	0	0	0	0	0	7
15	5	3	0	0	0	1	16	56	44	15	0	4	1	2	0	1	0	0	0	0	0	140
16	6	2	0	0	0	0	0	0	4	1	0	4	0	2	0	2	0	0	0	0	0	13
19	6	4	0	0	0	0	0	0	2	1	0	4	0	0	0	0	0	0	0	0	0	7
20	6	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	2
21	6	4	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
GSGS			0	0	8	47	100	250	358	221	27	93	13	70	36	79	39	16	8	1	3	1369
67	5	2	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
#S#S			0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
26	4	2	0	0	0	0	9	0	0	0	0	0	0	0	0	0	0	9				
#G#G			0	0	0	0	9	0	0	0	0	0	0	0	0	0	0	9				

Figure IV-1 SAMPLE SECTION - NEW SHORE MISSION AREA PERSONNEL DATA BASE (SHNEW)

- For all position records, column 6 denotes the utility skill group and column 8 the functional area identified with the job code identifier in columns 1-4. The numerical equivalencies for the utility skill groups are; 1 = A, 2 = B, 3 = C, 4 = D, 5 = E, 6 = F, and 7 = G: and for the functional areas, these are 1 = Operations, 2 = Maintenance, 3 = Own-Unit Support, and 4 = Supply.

- All officer pay grades in the Admiral and Commodore category (Commodore and O-7 through O-11) are combined into a single Admiral category, denoted as O-7 and these combined allocations appear in columns 10-13. Thus the officer allocation columns begin with Pay Grade O-7 and proceed downward to Pay Grade O-1, followed by Pay Grades W-4 down to W-1, with the final column denoting the total number of officer billets for that position record.

For the sea-based personnel data bases, the changes made were as follows:

- Added the utility skill group and functional area identifiers to each position record.

- Combined officer designators in terms of the aggregate officer designators as defined in Table III-3.

- Combined all Admiral pay grades (O-7 through O-10) into a single Admiral category (O-7).

- Combined designated strikers and E-3s into a single category (E-3).

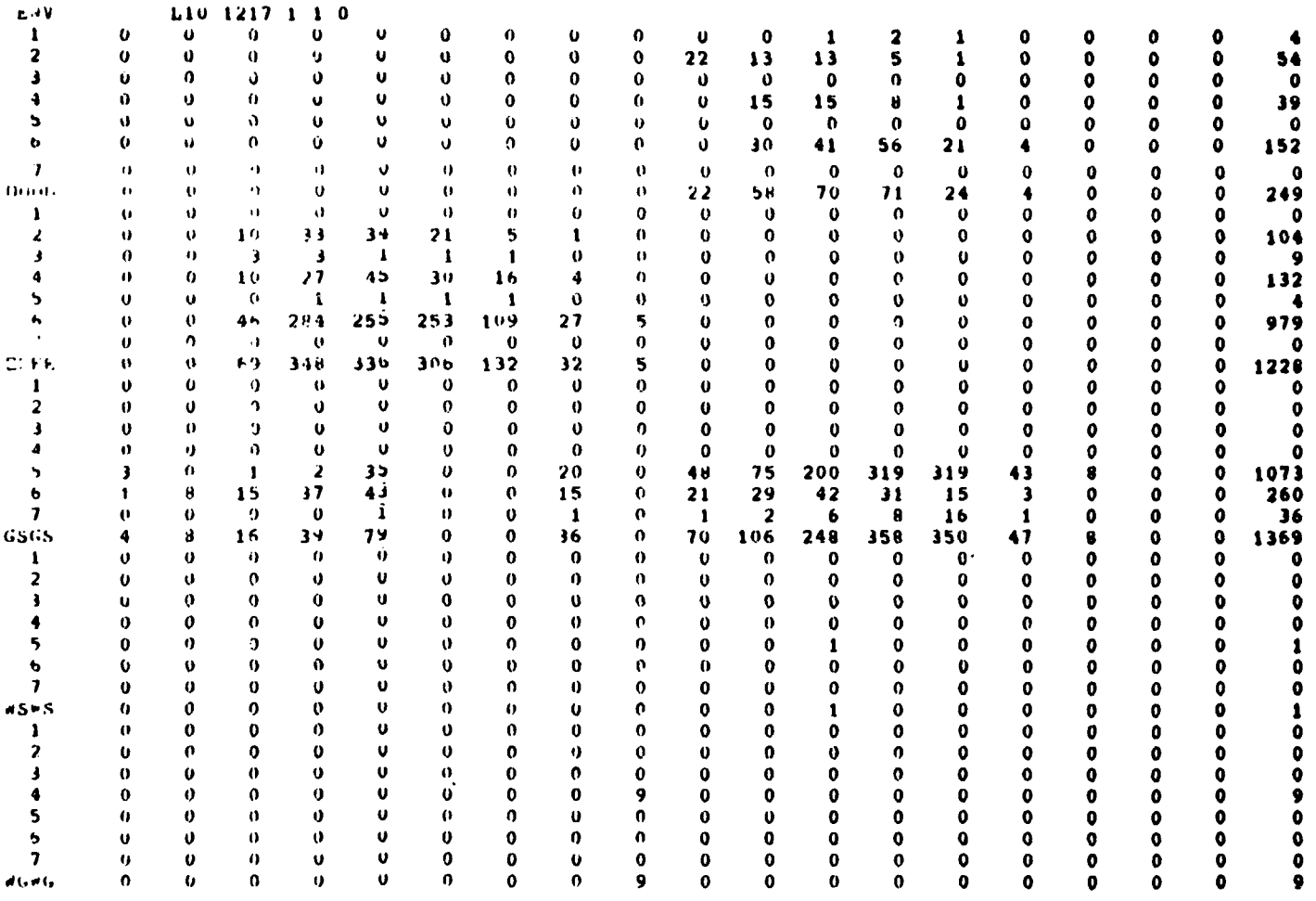
- Combined all airman (AN), fireman (FN), and seaman (SN) allocations into the respective categories, eliminating the specification of NICs.

- Revised the number of officer designators and EP rating entry specifications and expanded the civilian entry specifications to include the four civilian pay grades, with all civilian entry specifications being set to zero.

The second stage in the data transformation procedure involved combining the four personnel data bases into a single utility structured personnel data base, generating one such data base for each of the logistics functional areas (designated logistics, maintenance, own-unit support, and supply) and also one

covering the entire Navy. These transformations were accomplished by use of the computer programs UTIALL, UTILOG, UTIMAI, UTIOUS, and UTISUP, where the latter five programs were simple modifications of the primary program UTIALL. The use of these programs resulted in the generation of five utility structured personnel data bases, designated by the same acronyms as their respective generating program.

Figure IV-2 presents an excerpt of the utility structured data base UTIALL. This figure portrays the officer, enlisted, and civilian manpower allocations to the Environmental Support Mission Area (ENV), broken down into utility skill groups and pay grades, for the shore-based Navy population. The first record shown on the figure specifies the mission area (Columns 1-9); the force class type (Column 14); the number of applicable aggregated officer designator entries (Columns 15-16); the number of applicable EP ratings (Columns 17-19); and the number of applicable civilian occupational code groups, broken down in terms of the GS pay plan (Columns 20-21), the WS pay plan (Columns 22-23), the WG pay plan (Columns 24-25), and the WL pay plan (Columns 26-27). The next set of records each specify the utility skill group for officers, the number of officers per utility pay grade for that utility skill group (18 pay grades), and finally the total number of officers for that utility skill group. The officer set of entries is terminated with a skill group entry '0000', followed by the column totals for each utility pay grade and finally the total number of officers allocated to the activity. The remaining sets of entries provide similar information with respect to enlisted personnel and the four civilian pay plans, with the terminating records for each set being given the respective skill group entries of 'EEEE', 'GSGS', 'WSWS', 'WGWG', and 'WLWL'. For the activity (ENV) shown in the figure, there are no WL civilian pay plan personnel allocated, as indicated by the zero entry in the first record for that pay plan (Columns 26-27), so that there is no set of records for the WL pay plan.



E-4V		L10	1217	1	1	0														
1	0	0	0	0	0	0	0	0	0	0	0	1	2	1	0	0	0	0	4
2	0	0	0	0	0	0	0	0	0	22	13	13	5	1	0	0	0	0	54
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	15	15	8	1	0	0	0	0	39
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	30	41	56	21	4	0	0	0	152
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
[illegible]	0	0	0	0	0	0	0	0	0	22	58	70	71	24	4	0	0	0	249
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	10	33	34	21	5	1	0	0	0	0	0	0	0	0	0	0	104
3	0	0	3	3	1	1	1	0	0	0	0	0	0	0	0	0	0	0	9
4	0	0	10	27	45	30	16	4	0	0	0	0	0	0	0	0	0	0	132
5	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	4
6	0	0	45	284	255	253	109	27	5	0	0	0	0	0	0	0	0	0	979
[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
[illegible]	0	0	69	348	336	306	132	32	5	0	0	0	0	0	0	0	0	0	1228
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	3	0	1	2	35	0	0	20	0	48	75	200	319	319	43	8	0	0	1073
6	1	8	15	37	43	0	0	15	0	21	29	42	31	15	3	0	0	0	260
7	0	0	0	0	1	0	0	1	0	1	2	6	8	16	1	0	0	0	36
GSGS	4	8	16	34	79	0	0	36	0	70	106	248	358	350	47	8	0	0	1369
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
#S#S	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	9
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
#G#G	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	9

Figure IV-2 SAMPLE SECTION - UTILITY STRUCTURED PERSONNEL DATA BASE - ENTIRE NAVY (UTIALL)

D. Modified Utility Evaluation Concept

The authorized utility for an activity is defined as the sum of the utilities of each authorized billet. If we let a denote the activity index, i the utility skill group index, and j the utility pay grade index, then activity a's authorized utility, denoted by AU_a is given as follows:

$$AU_a = \sum_{i=1}^{7} \sum_{j=1}^{18} u_{ij} n_{ija} \qquad \text{(IV-2)}$$

where u_{ij} = the utility value associated with skill group i and pay grade j

and n_{ija} = the number of personnel authorized to activity a in skill group i with pay grade j.

If A denotes the total number of activities in the Navy, then the Navy-wide authorized utility AU_{tot} is given by the following equation:

$$AU_{tot} = \sum_{a=1}^{A} AU_a \qquad \text{(IV-3)}$$

Substituting Eq. IV-2 for AU_a and rearranging the summation signs, Eq. IV-3 can be rewritten as follows:

$$AU_{tot} = \sum_{i=1}^{7} \sum_{j=1}^{18} u_{ij} \sum_{a=1}^{A} n_{ija} \qquad \text{(IV-4)}$$

If shortfalls exist with respect to Naval personnel, then the numbers of assigned personnel to the activities, denoted by x_{ija}, will in some cases be less than that authorized. That is, $x_{ija} < n_{ija}$ for some values of i and j. Eq. IV-4 could be used to compute achieved utility, with x_{ija} replacing n_{ija}. However, this representation would not reflect the relative value of the loss of specific personnel between different activities. That is, the loss of one person in skill group i and pay grade j from an activity authorized 100 persons in that skill group/pay grade

combination would have the same degrading effect on Navy-wide achieved utility as the loss of one such person from an activity that is authorized only two such persons. The modified utility evaluation concept used in this analysis presents an alternative approach that considers the relative utility of personnel of the same skill group/pay grade combination assigned to activities with different authorized strengths for that particular combination.

The modified concept assumes that the utility value associated with the loss of one person within a skill group/pay grade combination for an activity increases linearly with the number of such personnel losses, while the sum of these utilities remains the same as if each person were assigned the same utility value as that used in determining the authorized utility for that activity. If we let U_{ija} denote the authorized utility associated with the skill group i/pay grade j combination for activity a, then

$$U_{ija} = u_{ija} n_{ija} \qquad \text{(IV-5)}$$

where each person is assigned a utility value of u_{ija}. Under the modified concept, person x_{ija} would be assigned a utility value $u^*_{ija}(x_{ija})$ given by the following equation.

$$u^*_{ija}(x_{ija}) = \frac{2(n_{ija} - x_{ija} + 1)}{n_{ija} + 1} u_{ij} \qquad \text{(IV-6)}$$

For example, suppose that a certain activity is authorized 10 persons within a specific skill group/pay grade combination that has an associated utility per person value of 0.5. Then the total authorized utility for that activity's skill group/pay grade combination is 5.0, with each person being assigned a utility value of 0.5. Under the modified concept, the x^{th} person would be assigned the utility value as shown in the following table:

x	Utility
1	.909
2	.818
3	.727
4	.636
5	.545
6	.455
7	.364
8	.273
9	.182
10	.091
Total	5.000

Thus, losing the first person out of 10 (x=10) would result in utility loss of .091, whereas the loss of the last person (x=1) would result in an additional utility loss of .909. Note that the total sum of the utility values is 5.0, the same as the authorized utility for that activity.

The use of the modifed utility evaluation concept would result in the achieved utility of an activity, denoted by U_a, to be computed by the following equation:

$$U_a = \sum_{i=1}^{7} \sum_{j=1}^{18} \sum_{k=1}^{X_{ija}} u^*_{ija}(k) \qquad \text{(IV-7)}$$

where X_{ija} denotes the number of personnel in the utility skill group/pay grade combination (i,j) assigned to activity a and $u^*_{ija}(k)$ is as given in Eq. IV-6 with $k=x_{ija}$. Thus the personnel readiness for activity a, denoted by R_a, would be determined as follows:

$$R_a = \frac{U_a}{AU_a} \qquad \text{(IV-8)}$$

where U_a and AU_a are as given respectively in Eq. IV-7 and Eq. IV-2. Navy-wide personnel readiness, denoted by R_N, would then be determined by the following equation:

$$R_N = \frac{\sum_{a=1}^{A} U_a}{\sum_{a=1}^{A} AU_a} \qquad \text{(IV-9)}$$

E. Utility Optimization Computer Program

The Utility Optimization Computer Program, designated by the acronym UALLOC, was designed to optimize Navy-wide personnel readiness for various levels of shortfalls among the six different pay categories (officers, enlisted personnel, and the four civilian pay plans) under minimum manning level restrictions specified for the four different force groups (surface ships, subsurface ships, aircraft squadrons, shore mission areas). The program was designed to operate with any one of the five utility structured personnel data bases established for this analysis, as described previously in Section IV.C. Thus, the program can provide optimal allocations for the entire Navy, as well as for the restricted segments representing designated logistics, maintenance, own-unit support, and supply.

The expanded Personnel Utility Data Base, described previously in Section IV-B, is built into the program. The first function of the program then is to read in the Force Structure Data Base, which is the same as that described in Volume I of this report. This data base simply lists the number of active activities of each type within the Navy force structure. That is, the number of ships of each class, the number of aircraft squadrons of each type, and the number of shore mission areas of each type. The program then reads in the specific Utility Structured Personnel Data Base to be subjected to analysis and computes the authorized personnel allocations and utilities for each activity, as well as those for the larger subgroups of surface ships, subsurface ships, aircraft squadrons, shore mission

areas, and ultimately the entire Navy. The next step the program performs is to read in the specific case inputs which consist of the minimum required manning levels for the four force groups and the percentages of shortfall for each pay scale (officers, enlisted personnel, and the four civilian pay plans.)

Having read in all the inputs, the program then performs its major function of determining the activity allocations, under the shortfall and minimum manning level conditions prescribed, that optimize achieved Navy-wide utility, or equivalently, Navy-wide personnel readiness. This is accomplished through repeated use of the subroutine OPUTIL. This subroutine operates on a specific pay scale/skill group/pay grade combination and minimizes its Navy-wide utility degradation for the specified personnel shortfall, under the restricted minimum manning level requirements. The subroutine uses an iterated Lagrange Multiplier procedure to accomplish the utility minimizations. The essence of this procedure is as follows.

Consider a specific pay scale/skill group/pay grade combination. Let n_a denote the number of personnel authorized to activity a for that specific combination and u denote the assigned utility value for that combination. If we let x_a denote the shortfall for activity a, then the utility degradation $\Delta U_a(x_a)$ for that activity, under the modified utility evaluation concept described in the preceding section is given as follows:

$$\Delta U_a(x_a) = \sum_{i=1}^{x_a} \frac{2ui}{(n_a+1)} \qquad \text{(IV-10)}$$

This equation follows from Eq. IV-6, where $u = u_{ij}$, $n_a = n_{ija}$, and $i = n_{ija}-x_{ija}+1$ for each person up to the x_a^{th} person from the bottom. If we let S denote the shortfall specified for the pay scale group under consideration and m_a denote the minimum manning level specified for activity a, then the problem can be specified as follows:

$$\text{Minimize} \quad \sum_{a=1}^{A} \Delta U_a(x_a) \qquad \text{(IV-11)}$$

subject to

$$\sum_{a=1}^{A} x_a = S \tag{IV-12}$$

and

$$0 \leq x_a \leq n_a - m_a \tag{IV-13}$$

The solution procedure involved for this problem is based on an iterated Lagrange Multiplier solution to Eqs. IV-11 and IV-12. The Lagrange solution to this unrestricted problem is given as follows:

$$x_a = \frac{\lambda - c_a}{2c_a} \tag{IV-14}$$

where

$$c_a = \frac{u}{n_a + 1} \tag{IV-15}$$

and

$$\lambda = \frac{2S+A}{\sum_{a=1}^{A} c_a^{-1}} \tag{IV-16}$$

If the solution values of x_a given by Eq. IV-14, all meet the conditions specified by Eq. IV-13, then that represents the optimum solution. If the conditions of Eq. IV-13 are not satisfied for all a, then the following problem modifications are invoked:

(1) If $x_a < 0$, then x_a is set equal to zero and activity a is withdrawn from the problem, with A being reduced by one.

(2) If $x_a > n_a - m_a$, then x_a is set equal to $n_a - m_a$ and activity a is withdrawn from the problem, with A being reduced by one and S being reduced by x_a.

With the above problem modifications invoked, the solution procedure is then reapplied. This iteration procedure continues until all x_a satisfy the conditions of Eq. IV-13. In the event that all activities have been withdrawn in accordance with (1) or (2) above and Eq. IV-12 is not satisfied, then the manning level restrictions to the problem are too strict. In this case, the values of m_a are set equal to zero and the solution procedure is then initiated for this new problem, where all activities are reinstated into the problem.

When the optimal allocations have been completed, the program then computes the remaining summary outputs. These include the resulting personnel allocations and achieved utilities for each activity, in addition to the ratios of assigned personnel to authorized personnel (personnel availability) and achieved utility to authorized utility (personnel readiness) for each activity. The outputs also include the same as the above for the four force groups (surface ships, subsurface ships, aircraft squadrons and shore mission areas), in addition to the entire Navy.

A sample output table is presented in Figure IV-3. This table presents the results for a UALLOC run using the data base UTILOG (designated logistics) where the personnel shortfalls are assumed as 20% (SF=.20) for all pay scales and the minimum manning levels are assumed as 80% for the afloat forces and 70% for the shore mission areas (ML=.8, .7). The table headings are, for the most part, self-explanatory. The exceptions are NIF, which denotes the number of units of that activity in the force structure assumed, and T, which specifies the activity's force class type (S= surface ship, U=subsurface ship, A= aircraft squadron, and L = shore mission area).

PERSONNEL ALLOCATIONS SUMMARY

NL=,6,,7 - SF=,20

ACTIVITY CODE		NIF	I	S	I	OFF ALLOW	OFF MNG	OFF AVAIL	EP ALLOW	EP MNG	EP AVAIL	CIV ALLOW	CIV MNG	CIV AVAIL	MAXIMUM UTILIZN	ACHIEVED UTILITY	PERS MONS
AD	14	5	S		255	216	0.848	4215	3379	0.802	0	0	0.000	1025.6	978.3	0.954
AD	26	2	S		78	67	0.868	1214	975	0.803	0	0	0.000	297.6	283.5	0.953
AD	37	3	S		300	246	0.822	3591	2877	0.801	0	0	0.000	919.2	877.9	0.955
AE	25	3	S		12	12	1.000	411	340	0.829	0	0	0.000	81.1	77.6	0.957
AE	29	8	S		40	38	0.960	1176	973	0.828	0	0	0.000	237.0	226.5	0.956
AFS	4	7	S		84	77	0.928	1428	1168	0.818	0	0	0.000	269.8	256.0	0.956
AGF	3	1	S		8	7	0.934	223	182	0.820	0	0	0.000	55.1	43.0	0.956
AGFF	1	0	S		0	0	0.000	0	0	0.000	0	0	0.000	0.0	0.0	0.000
AGP	1176	0	S		0	0	0.000	0	0	0.000	0	0	0.000	0.0	0.0	0.000
AO	99	3	S		15	14	0.948	459	382	0.833	0	0	0.000	87.6	84.0	0.959
AO	148	0	S		0	0	0.000	0	0	0.000	0	0	0.000	0.0	0.0	0.000
AOE	3	4	S		36	34	0.949	1048	856	0.817	0	0	0.000	210.0	200.9	0.957
AOR	2	7	S		56	52	0.934	1260	1036	0.823	0	0	0.000	256.2	244.9	0.956
AR	5	4	S		192	163	0.852	3648	2956	0.802	0	0	0.000	886.4	846.0	0.954
ARS	41	8	S		0	0	0.000	184	174	0.950	0	0	0.000	37.4	36.5	0.980
AS	18	10	S		520	440	0.847	8960	7183	0.802	0	0	0.000	2177.9	2078.1	0.954
AS	31	2	S		208	170	0.821	3554	2844	0.800	0	0	0.000	864.0	826.1	0.956
ASR	7	4	S		8	6	0.844	108	103	0.957	0	0	0.000	25.1	24.5	0.975
ASR	21	2	S		6	5	0.896	178	154	0.866	0	0	0.000	32.9	31.7	0.963
ATF	162	0	S		0	0	0.000	0	0	0.000	0	0	0.000	0.0	0.0	0.000
ATS	2	3	S		6	5	0.844	114	106	0.935	0	0	0.000	23.1	22.6	0.975
AVM	1	1	S		40	16	0.822	409	330	0.807	0	0	0.000	96.3	91.5	0.950
CG	5	0	S		0	0	0.000	0	0	0.000	0	0	0.000	0.0	0.0	0.000
CG	10	0	S		0	0	0.000	0	0	0.000	0	0	0.000	0.0	0.0	0.000
CG	17	9	S		45	42	0.937	2286	1872	0.819	0	0	0.000	513.1	489.1	0.953
CG	34	9	S		45	42	0.937	2367	1936	0.818	0	0	0.000	530.7	505.7	0.953
CGN	9	1	S		20	16	0.846	634	508	0.803	0	0	0.000	150.7	143.6	0.953
CGN	25	1	S		5	4	0.956	293	238	0.814	0	0	0.000	70.1	66.7	0.952
CGN	36	3	S		21	19	0.948	945	766	0.811	0	0	0.000	220.7	210.0	0.952
CGN	38	3	S		24	22	0.934	894	725	0.812	0	0	0.000	214.7	204.3	0.952
CV	41	2	S		98	84	0.866	2584	2070	0.801	0	0	0.000	612.0	489.8	0.956
CV	62	3	S		165	141	0.856	4134	3312	0.801	0	0	0.000	834.8	797.8	0.956
CV	66	3	S		165	142	0.861	4272	3423	0.801	0	0	0.000	859.0	821.1	0.956
CV	67	1	S		52	45	0.867	1404	1125	0.801	0	0	0.000	281.0	268.7	0.956
CVN	68	3	S		150	129	0.863	4212	3376	0.802	0	0	0.000	864.4	826.1	0.956
DD	933	39	S		117	117	1.000	7644	6319	0.827	0	0	0.000	1672.6	1596.6	0.955
DDG	24	23	S		69	69	1.000	5290	4343	0.821	0	0	0.000	1171.1	1116.6	0.953
DDG	33	4	S		16	15	0.976	884	726	0.822	0	0	0.000	197.2	188.0	0.953
DDG	46	10	S		30	30	1.000	2500	2044	0.818	0	0	0.000	555.7	529.1	0.952
FF	1038	2	S		4	4	1.000	314	260	0.831	0	0	0.000	66.4	63.3	0.953
FF	1047	10	S		30	27	0.927	1730	1438	0.831	0	0	0.000	373.9	356.7	0.954
FF	1072	47	S		141	141	1.000	8037	6689	0.832	0	0	0.000	1696.4	1621.0	0.956
FFG	4	0	S		24	23	0.976	1110	920	0.829	0	0	0.000	244.5	233.5	0.955
FFG	7	3	S		6	5	0.979	270	233	0.866	0	0	0.000	61.4	58.6	0.957
LCC	20	2	S		38	33	0.880	808	653	0.809	0	0	0.000	152.3	145.1	0.953
LHA	1	4	S		112	96	0.865	1528	1237	0.810	0	0	0.000	315.9	301.0	0.953
LKA	117	3	S		15	15	1.000	420	368	0.880	0	0	0.000	82.5	79.1	0.958

Figure IV-3 SAMPLE UALLOC OUTPUT TABLE

ACTIVITY CODE		NIF	F	OFF ALLOW	OFF MNG	OFF AVAIL	EP ALLOW	EP MNG	EP AVAIL	CIV ALLOW	CIV MNG	CIV AVAIL	MAXIMUM UTILITY	ACHIEVED UTILITY	PERS MONS
LPD	1	2	S	42	20	0.914	390	320	0.822	0	0	0.000	80.7	77.1	0.955
LPD	6	12	S	120	111	0.932	2328	1914	0.822	0	0	0.000	478.8	457.7	0.956
LPH	7	7	S	98	91	0.939	2303	1870	0.812	0	0	0.000	491.1	470.5	0.956
LSD	29	8	S	32	31	0.990	1336	1102	0.825	0	0	0.000	259.7	248.5	0.957
LSD	37	5	S	15	15	1.000	890	733	0.824	0	0	0.000	172.0	164.5	0.956
LST	1193	20	S	20	20	1.000	1400	1215	0.868	0	0	0.000	232.9	226.5	0.964
MSO	422	3	S	0	0	0.000	84	79	0.941	0	0	0.000	16.4	16.1	0.984
PG	92	5	S	0	0	0.000	60	59	0.998	0	0	0.000	13.4	13.4	0.999
SS	580	7	U	0	0	0.000	266	245	0.923	0	0	0.000	68.9	62.8	0.960
SSBN	598	4	U	8	8	1.000	444	374	0.844	0	0	0.000	118.4	110.1	0.958
SSBN	608	5	U	10	10	1.000	555	468	0.844	0	0	0.000	148.1	138.4	0.954
SSBN	616	31	U	62	62	1.000	3441	2905	0.844	0	0	0.000	897.4	856.1	0.954
SSN	578	5	U	5	5	1.000	425	366	0.862	0	0	0.000	109.0	104.3	0.956
SSN	585	5	U	0	0	0.000	405	348	0.861	0	0	0.000	102.4	97.7	0.956
SSN	594	14	U	14	14	1.000	1232	1058	0.859	0	0	0.000	320.3	305.7	0.955
SSN	637	38	U	38	38	1.000	3344	2871	0.859	0	0	0.000	868.9	827.5	0.955
SSN	688	12	U	12	12	1.000	1104	942	0.854	0	0	0.000	285.6	272.7	0.954
MC		11	A	22	21	0.979	1353	1120	0.828	0	0	0.000	310.9	296.5	0.954
MH		1	A	21	17	0.835	238	192	0.810	0	0	0.000	65.6	62.3	0.951
MH	12	4	A	28	26	0.949	752	613	0.816	0	0	0.000	187.9	179.1	0.953
MS	1	2	A	20	18	0.917	394	321	0.816	0	0	0.000	102.9	97.9	0.952
MSL		8	A	0	0	0.000	880	711	0.808	0	0	0.000	220.9	210.0	0.951
RVAH		10	A	30	27	0.920	1560	1284	0.823	0	0	0.000	362.2	344.3	0.951
VAL		28	A	84	82	0.986	5208	4251	0.826	0	0	0.000	1226.9	1169.6	0.953
VAW		14	A	196	173	0.887	4270	3455	0.809	0	0	0.000	1037.7	989.0	0.953
VAQ		8	A	8	7	0.958	1080	891	0.825	0	0	0.000	253.9	241.8	0.953
VAW		14	A	42	41	0.986	1526	1268	0.831	0	0	0.000	378.2	367.9	0.956
VF	4	12	A	144	131	0.911	4200	3389	0.807	0	0	0.000	1006.6	960.3	0.954
VF	14	16	A	80	79	0.992	2960	2414	0.816	0	0	0.000	724.4	691.1	0.954
VFP	63	1	A	5	4	0.800	195	157	0.805	0	0	0.000	41.0	38.9	0.950
VP		26	A	130	128	0.992	6786	5493	0.810	0	0	0.000	1609.2	1534.4	0.954
VQ	2	2	A	18	16	0.899	742	598	0.807	0	0	0.000	167.7	160.0	0.954
VRC	30	2	A	6	5	0.931	344	282	0.821	0	0	0.000	80.7	76.9	0.953
VRH		4	A	20	19	0.992	980	794	0.810	0	0	0.000	231.7	220.8	0.953
VS		12	A	44	23	0.979	2532	2098	0.813	0	0	0.000	593.2	565.1	0.953
VT		4	A	4	4	1.000	120	103	0.860	0	0	0.000	21.0	20.3	0.967
VWH		2	A	40	17	0.692	1350	1081	0.801	0	0	0.000	317.9	303.6	0.955
VX	4	2	A	14	13	0.938	460	374	0.813	0	0	0.000	106.4	101.5	0.953
VXE	6	1	A	7	6	0.969	277	224	0.811	0	0	0.000	63.5	60.5	0.953
UN		1	L	4248	1747	0.784	8273	6420	0.776	26049	21295	0.800	7876.6	7525.8	0.955
HQ		1	L	3332	2616	0.785	2526	1957	0.775	9864	7887	0.800	5429.6	5184.1	0.955
SF		1	L	1756	1371	0.781	17539	13725	0.783	0	0	0.000	4446.9	4249.9	0.956
ACA		1	L	286	224	0.785	11222	8682	0.774	23994	19187	0.800	8935.2	8536.8	0.955
ADP		1	L	376	298	0.793	1339	1051	0.785	7071	5662	0.801	1890.9	1810.9	0.958
CON		1	L	278	214	0.788	2326	1812	0.779	2663	1982	0.805	1152.5	1098.3	0.953
CON		1	L	264	206	0.783	596	470	0.787	2930	2356	0.804	1100.5	1054.7	0.958
CPY		1	L	249	193	0.776	1186	935	0.789	230	191	0.834	899.1	870.7	0.954

Figure IV-3 SAMPLE UALLOC OUTPUT TABLE (Continued)

ACTIVITY CODE	NIF	T	OFF ALLOW	OFF MNG	OFF AVAIL	EP ALLOW	EP MNG	EP AVAIL	CIV ALLOW	CIV MNG	CIV AVAIL	MAXIMUM UTILIZ	ACHIEVED UTILIZ	PERS NUMB
DEN	1	L	1237	960	0.776	2017	1589	0.788	349	283	0.812	819.4	779.6	0.951
ELX	1	L	114	94	0.825	962	743	0.773	7549	6085	0.802	3101.4	2969.3	0.957
ENV	1	L	221	174	0.790	1215	969	0.782	1379	1110	0.805	760.8	726.8	0.956
FAC	1	L	530	416	0.785	2049	1607	0.784	33646	26894	0.799	6467.9	6200.3	0.959
FIR	1	L	7	6	0.912	89	73	0.821	3765	3023	0.790	313.3	300.4	0.959
FIN	1	L	391	278	0.793	1099	863	0.785	10302	8241	0.800	2131.3	2042.6	0.959
FSS	1	L	45	37	0.829	624	493	0.791	629	514	0.817	271.8	259.8	0.953
ICS	1	L	3115	2443	0.784	6039	4638	0.768	11894	9479	0.800	4170.8	3971.2	0.954
INT	1	L	608	475	0.783	2069	1571	0.760	2126	1703	0.801	1169.4	1095.4	0.948
MED	1	L	5987	4640	0.775	12757	9968	0.781	4396	3494	0.802	4942.8	4702.4	0.951
PER	1	L	702	552	0.786	8711	6818	0.777	9940	7954	0.800	4665.7	4429.1	0.954
PSD	1	L	41	33	0.829	648	547	0.796	375	309	0.827	206.6	197.3	0.955
RCI	1	L	290	230	0.794	4503	3494	0.776	267	217	0.818	1213.6	1161.5	0.949
RED	1	L	752	592	0.787	995	780	0.784	19106	15284	0.800	7539.1	7226.4	0.959
SEC	1	L	118	94	0.797	1951	1527	0.783	3570	2855	0.800	756.9	719.8	0.951
SFP	1	L	69	57	0.826	29	25	0.895	768	626	0.816	261.2	240.9	0.922
SHP	1	L	172	137	0.802	3608	2808	0.778	63485	50722	0.799	13596.0	13028.4	0.958
SUP	1	L	1635	1278	0.782	7305	5708	0.781	30933	24725	0.799	7109.3	6806.7	0.957
TRA	1	L	1809	1418	0.784	13780	10643	0.772	2959	2384	0.806	5980.8	5675.3	0.949
WEP	1	L	247	190	0.794	1905	1494	0.785	11060	8854	0.801	3894.6	3660.1	0.951
SURFACE	330	S	4543	3136	0.885	95571	77894	0.815	0	0	0.000	20917.8	19978.2	0.955
SUBSURFACE	121	U	149	149	1.000	11216	9582	0.854	0	0	0.000	2907.1	2775.2	0.955
AIR	184	A	943	867	0.940	38207	31082	0.814	0	0	0.000	9106.2	8682.0	0.953
SHORE	28	L	20799	20978	0.783	117464	91406	0.778	291659	233327	0.800	99888.2	94279.5	0.944
TOTAL NAVY	663		31414	25131	0.800	262458	209966	0.800	291659	233327	0.800	1131899.9	129712.0	0.955

Figure IV-3 SAMPLE UALLOC OUTPUT TABLE (Concluded)

V SAMPLE APPLICATION AND CRITIQUE OF METHODOLOGY

This chapter presents the results of an application of the methodology described in the preceding chapter to evaluating the ramifications of personnel shortfalls on Naval logistics personnel readiness. Section A presents the results and analysis of a number of computer runs of the Utility Optimization Computer Program (UALLOC) applied to several levels of personnel shortfalls across the broad spectrum of Navy manpower authorizations. This analysis illustrates the use of the methodology developed and also provides insights to the advantages and disadvantages of this type of approach to evaluating Navy logistics personnel readiness relative to the existence of personnel shortfalls. Section B then presents a critique of the proposed approach, indicating areas on which the methodology could be improved to provide a more useful tool to evaluating logistics personnel readiness under various levels of personnel shortfalls within the Navy manpower structure.

A. Sample Application of Methodology

The sample application of the use of the methodology developed is based on a set of 60 computer runs of the Utility Optimization Computer Program (UALLOC) described previously in Section IV.E. For each of the five utility structured data bases, representing respectively the entire Navy and the four logistics functional areas (designated logistics, maintenance, own-unit support, and supply), four different levels of shortfalls (5%, 10%, 15%, and 20%) were assumed under three different manning level restriction assumptions (no minimum manning level requirements; 80% minimum manning level requirements for afloat forces with 70% minimum manning level requirements for ashore forces; and 90% minimum manning level requirements for afloat

forces with 70% minimum manning level requirements for ashore forces). The results of the computer runs consisted of 60 tables similar in nature to that illustrated in Figure IV-2 of the previous chapter.

Tables V-1 to V-5 present summaries of the results obtained under no minimum manning level requirements where the basic populations assumed in the tables are respectively the entire Navy, the designated logistics functional area, the maintenance functional area, the own-unit support functional area, and the supply functional area. These summary results present the officer, enlisted, and civilian (where applicable) availabilities and the personnel readiness values for the five force groups (surface ships, subsurface ships, aircraft squadrons, shore mission areas, and total Navy) under the four different shortfall levels assumed.

The results shown in the summary tables indicate relatively insignificant differences among the values obtained for the five different base populations (entire Navy, designated logistics, etc.). The force group personnel readiness values generally adhere to those that could theoretically be predicted, as indicated in the table below. The theoretical predictions are based on the shortfalls being assessed against a single utility skill group/pay grade combination with an authorized strength of 100 personnel. The fact that these personnel readiness values are relatively high in comparison with the associated shortfalls is

Shortfall Percentage	Computed Personnel Readiness		Theoretical Prediction
	Minimum	Maximum	
5	.996	1.000	.997
10	.986	1.000	.986
15	.971	.995	.976
20	.948	.978	.958

Table V-1

SUMMARY OF PERSONNEL AVAILABILITY
AND READINESS WITH NO MANNING LEVEL RESTRICTIONS
BASIC POPULATION - ENTIRE NAVY

Force Group	Availability/Readiness Category	Percent Shortfall			
		5	10	15	20
Surface Ships	Officer Availability	.978	.940	.896	.848
	Enlisted Availability	.957	.907	.857	.806
	Personnel Readiness*	.997	.988	.974	.954
Subsurface Ships	Officer Availability	1.000	.977	.930	.879
	Enlisted Availability	.993	.955	.907	.852
	Personnel Readiness*	.999	.992	.978	.957
Aircraft Squadrons	Officer Availability	.967	.922	.872	.821
	Enlisted Availability	.964	.916	.866	.814
	Personnel Readiness*	.997	.988	.973	.953
Shore Mission Areas	Officer Availability	.937	.881	.830	.779
	Enlisted Availability	.936	.883	.834	.785
	Civilian Availability	.950	.900	.850	.800
	Personnel Readiness*	.996	.987	.974	.955
Total Navy	Officer Availability	.950	.900	.850	.800
	Enlisted Availability	.950	.900	.850	.800
	Civilian Availability	.950	.900	.850	.800
	Personnel Readiness*	.997	.988	.974	.955

* Personnel readiness computed in accordance with modified utility evaluation concept described in Section IV.D

Table V-2

SUMMARY OF PERSONNEL AVAILABILITY
AND READINESS WITH NO MANNING LEVEL RESTRICTIONS
BASIC POPULATION - DESIGNATED LOGISTICS

Force Group	Availability/Readiness Category	Percent Shortfall			
		5	10	15	20
Surface Ships	Officer Availability	.989	.963	.927	.882
	Enlisted Availability	.960	.912	.862	.811
	Personnel Readiness*	.997	.988	.973	.953
Subsurface Ships	Officer Availability	1.000	1.000	1.000	1.000
	Enlisted Availability	.992	.960	.914	.859
	Personnel Readiness*	.999	.992	.978	.956
Aircraft Squadrons	Officer Availability	1.000	.991	.974	.943
	Enlisted Availability	.965	.916	.865	.813
	Personnel Readiness*	.997	.988	.973	.954
Shore Mission Areas	Officer Availability	.943	.888	.835	.783
	Enlisted Availability	.933	.880	.829	.781
	Civilian Availability	.950	.900	.850	.800
	Personnel Readiness*	.997	.988	.974	.956
Total Navy	Officer Availability	.950	.900	.850	.800
	Enlisted Availability	.950	.900	.850	.800
	Civilian Availability	.950	.900	.850	.800
	Personnel Readiness*	.997	.988	.974	.955

* Personnel readiness computed in accordance with modified utility evaluation concept described in Section IV.D

Table V-3

SUMMARY OF PERSONNEL AVAILABILITY
AND READINESS WITH NO MANNING LEVEL RESTRICTIONS
BASIC POPULATION - MAINTENANCE

Force Group	Availability/Readiness Category	Percent Shortfall			
		5	10	15	20
Surface Ships	Officer Availability	.981	.943	.897	.846
	Enlisted Availability	.957	.908	.858	.808
	Personnel Readiness*	.996	.987	.972	.952
Subsurface Ships	Officer Availability	1.000	1.000	1.000	1.000
	Enlisted Availability	.990	.952	.901	.846
	Personnel Readiness*	.999	.991	.976	.954
Aircraft Squadrons	Officer Availability	.992	.966	.925	.878
	Enlisted Availability	.963	.914	.863	.812
	Personnel Readiness*	.997	.987	.971	.951
Shore Mission Areas	Officer Availability	.936	.879	.827	.776
	Enlisted Availability	.930	.876	.826	.778
	Civilian Availability	.950	.900	.850	.800
	Personnel Readiness*	.996	.986	.972	.953
Total Navy	Officer Availability	.950	.900	.850	.800
	Enlisted Availability	.950	.900	.850	.800
	Civilian Availability	.950	.900	.850	.800
	Personnel Readiness*	.996	.987	.972	.953

* Personnel readiness computed in accordance with modified utility evaluation concept described in Section IV.D

Table V-4

SUMMARY OF PERSONNEL AVAILABILITY
AND READINESS WITH NO MANNING LEVEL RESTRICTIONS
BASIC POPULATION - OWN UNIT SUPPORT

Force Group	Availability/Readiness Category	Percent Shortfall			
		5	10	15	20
Surface Ships	Officer Availability	.991	.964	.931	.887
	Enlisted Availability	.980	.943	.899	.849
	Personnel Readiness*	.999	.992	.980	.961
Subsurface Ships	Officer Availability	1.000	1.000	1.000	1.000
	Enlisted Availability	1.000	1.000	.987	.952
	Personnel Readiness*	1.000	1.000	.995	.978
Aircraft Squadrons	Officer Availability	.999	.987	.960	.921
	Enlisted Availability	.996	.970	.927	.872
	Personnel Readiness*	1.000	.995	.983	.962
Shore Mission Areas	Officer Availability	.946	.893	.841	.790
	Enlisted Availability	.936	.879	.826	.776
	Civilian Availability	.950	.900	.850	.800
	Personnel Readiness*	.997	.989	.975	.957
Total Navy	Officer Availability	.950	.900	.850	.800
	Enlisted Availability	.950	.900	.850	.800
	Civilian Availability	.950	.900	.850	.800
	Personnel Readiness*	.997	.989	.976	.957

* Personnel readiness computed in accordance with modified utility evaluation concept described in Section IV.D

Table V-5

SUMMARY OF PERSONNEL AVAILABILITY
AND READINESS WITH NO MANNING LEVEL RESTRICTIONS
BASIC POPULATION - SUPPLY

Force Group	Availability/Readiness Category	Percent Shortfall			
		5	10	15	20
Surface Ships	Officer Availability	.997	.976	.941	.894
	Enlisted Availability	.967	.919	.869	.818
	Personnel Readiness*	.997	.987	.971	.948
Subsurface Ships	Officer Availability	1.000	1.000	.994	.923
	Enlisted Availability	1.000	.994	.960	.897
	Personnel Readiness*	1.000	.999	.989	.961
Aircraft Squadrons	Officer Availability	1.000	1.000	.996	.938
	Enlisted Availability	.983	.938	.888	.836
	Personnel Readiness*	.998	.989	.973	.952
Shore Mission Areas	Officer Availability	.931	.868	.811	.761
	Enlisted Availability	.925	.869	.818	.770
	Civilian Availability	.950	.900	.850	.800
	Personnel Readiness*	.996	.987	.972	.953
Total Navy	Officer Availability	.950	.900	.850	.800
	Enlisted Availability	.950	.900	.850	.800
	Civilian Availability	.950	.900	.850	.800
	Personnel Readiness*	.996	.987	.972	.953

* Personnel Readiness computed in accordance with modified utility evaluation concept described in Section IV.D

addressed subsequently in the approach critique presented in the next section of this chapter. For the most part, the personnel readiness values do not significantly differ across the four force groups for a given shortfall level. This reflects the intent of the modified utility approach where shortfalls in individual categories are applied to activities where the least degradation in utility would be achieved, so that personnel readiness tends to remain on even levels especially when applied to large sub-groups of activities such as the force groups considered in this analysis.

The personnel availability values obtained show that the Subsurface Ship Force Group, with the smallest average activity personnel complements among the four force groups, exhibits the highest officer and enlisted availabilities, while the Shore Mission Area Force Group, with the highest average activity personnel complements, exhibits the lowest officer and enlisted availabilities. This is as would be expected since the modified utility approach applies the shortfalls proportionately more heavily on the larger activities then the smaller ones. The ranges in officer and enlisted availabilities portrayed in the total results presented in the five summary tables are as given in the following table.

Shortfall Percentage	Officer Availability		Enlisted Availability	
	Minimum	Maximum	Maximum	Minimum
5	.931	1.000	.925	1.000
10	.868	1.000	.869	1.000
15	.811	1.000	.818	.987
20	.761	1.000	.770	.952

The civilian availabilities obtained are the direct unity complement of the shortfalls, as the Shore Mission Area Force Group is the only force group of the subgroups that contain civilian personnel. It should be noted here that this holds for all three personnel categories for the Total Navy Force Group, since these availabilities reflect the total impact of the shortfalls.

The summary results presented in Table V-6 show the variations in force group average personnel availabilities and readiness for an assumed 20% shortfall under the three different minimum manning level requirements. These results indicate the general trend of shifting shortfalls from the afloat force groups with the higher minimum manning level requirements (80% or 90%) to the ashore force group with the lower minimum manning level requirement (70%). For the 80% requirement imposed on the afloat forces, some shifting of the shortfalls from the Surface Ship Force Group to the Subsurface Ship and Aircraft Squadron Force Groups, in addition to the ashore force group, also takes place. However, at the 90% minimum manning level requirement, the shifting is totally from the afloat force groups to the ashore force group. Under the 90% minimum manning level requirement on the afloat forces, the enlisted availabilities do not meet this requirement for each of the three force groups even though the enlisted availability for the ashore force group is above its 70% requirement. This implies that there are insufficient enlisted personnel in specific utility skill group/pay grade categories ashore to absorb the increased shortfalls imposed because of the higher afloat manning level requirements.

The summary results presented in Table V-7 show the variations in force group minimum (as opposed to average) personnel availabilities and readiness for the same cases used in Table V-6. These minimum values are the minimum of the individual activity values within each force group. These results generally mirror those presented in Table V-6, although the values are obviously lower in magnitude.

B. Critique of Proposed Approach

The modified utility evaluation concept, as described in Section IV.D, represents an initial approach toward evaluating the effects of personnel shortfalls on Navy personnel readiness relative to logistics support functions. This approach is based on defining personnel readiness as the ratio of the sum of the

Table V-6

SUMMARY OF AVERAGE PERSONNEL AVAILABILITY
AND READINESS WITH 20% SHORTFALLS
BASIC POPULATION - DESIGNATED LOGISTICS

Force Group	Availability/Readiness Category	% Manning Level Restrictions					
		AFL 0	ASH 0	AFL 80	ASH 70	AFL 90	ASH 70
Surface Ships	Officer Availability	.882		.885		.919	
	Enlisted Availability	.811		.815		.826	
	Personnel Readiness*	.953		.955		.959	
Subsurface Ships	Officer Availability	1.000		1.000		1.000	
	Enlisted Availability	.859		.854		.859	
	Personnel Readiness*	.956		.955		.957	
Aircraft Squadrons	Officer Availability	.943		.940		.950	
	Enlisted Availability	.813		.814		.825	
	Personnel Readiness*	.954		.953		.958	
Shore Mission Areas	Officer Availability	.783		.783		.778	
	Enlisted Availability	.781		.778		.765	
	Civilian Availability	.800		.800		.800	
	Personnel Readiness*	.956		.956		.954	
Total Navy	Officer Availability	.800		.800		.800	
	Enlisted Availability	.800		.800		.800	
	Civilian Availability	.800		.800		.800	
	Personnel Readiness*	.955		.955		.955	

AFL - Afloat Forces ASH - Ashore Forces

* Personnel readiness computed in accordance with modified utility evaluation concept described in Section IV.D

Table V-7

SUMMARY OF MINIMUM PERSONNEL AVAILABILITY
AND READINESS WITH 20% SHORTFALLS
BASIC POPULATION - DESIGNATED LOGISTICS

Force Group	Availability/Readiness Category	% Manning Level Restrictions					
		AFL 0	ASH 0	AFL 80	ASH 70	AFL 90	ASH 70
Surface Ships	Officer Availability	.810		.821		.847	
	Enlisted Availability	.787		.801		.809	
	Personnel Readiness*	.948		.950		.954	
Subsurface Ships	Officer Availability	1.000		1.000		1.000	
	Enlisted Availability	.848		.844		.851	
	Personnel Readiness*	.955		.954		.956	
Aircraft Squadrons	Officer Availability	.786		.800		.786	
	Enlisted Availability	.792		.801		.809	
	Personnel Readiness	.950		.950		.955	
Shore Mission Areas	Officer Availability	.775		.775		.769	
	Enlisted Availability	.765		.760		.750	
	Civilian Availability	.799		.799		.799	
	Personnel Readiness*	.949		.948		.940	

AFL - Afloat Forces ASH - Ashore Forces

* Personnel readiness computed in accordance with modified utility evaluation concept described in Section IV.D

utilities of personnel assigned to a given activity (group of activities) to the sum of the utilities of personnel authorized to the given activity (group of activities). Initially, personnel within a given utility skill group/pay grade combination are assigned a constant utility value, regardless of the activity to which assigned. These utility values are then modified to reflect the relative utility of a person in relation to the authorized strength of an activity for each skill group/pay grade combination. That is, the utility value associated with the x^{th} person in a particular skill group/pay grade combination assigned to a given activity depends on the number of personnel of that skill group/pay grade combination authorized to that activity and this utility value varies inversely (in a linear manner) with the value of x. Thus, the utility loss associated with losing one person when an activity is at its authorized strength with respect to a skill group/pay grade combination is much less than the utility loss associated with losing one person when the activity is at, say, one-half its authorized strength for that skill group/pay grade combination. Also, if one activity is assigned, say, twice as many personnel of a particular skill group/pay grade combination than is another activity, then the utility loss associated with the loss of one person from the first activity will be much less than the utility loss associated with the loss of one person from the second activity.

This type of approach has two significant features useful for evaluating personnel readiness in the presence of personnel shortfalls. The first useful feature is the relating of personnel readiness to the utility associated with assigned personnel to an activity. This provides a logical basis for assessing personnel readiness in terms of the relative worth of specific personnel billets to the performance of an activity's mission requirements. Although each billet authorized to an activity is necessary to the full performance of the activity's prescribed missions, these billets have differing criticalities with regard to mission performance. For example, a yeoman is certainly necessary for the

efficient conduct of administrative duties aboard a ship at sea. However, the loss of such a person would have much less of an effect on the ship's mission performance than the loss of a person, such as a fire control technician, possessing a high level of mission-essential skills, especially under combat conditions.

The second useful feature of the proposed approach is in the capability of optimizing personnel readiness over a group of activities in the presence of personnel shortfalls within specific skill group/pay grade combinations. That is, this approach provides a rational method for distributing personnel shortfalls among a group of activities so as to minimize the degradation of the overall personnel readiness of that group of activities. For example, if Ship A is authorized only two electronic technicians within a specific pay grade and Ship B is authorized ten such technicians, then the procedure would prescribe vacating an electronic technician billet aboard Ship B before vacating such a billet aboard Ship A if a shortfall of electronic technicians of that pay grade existed.

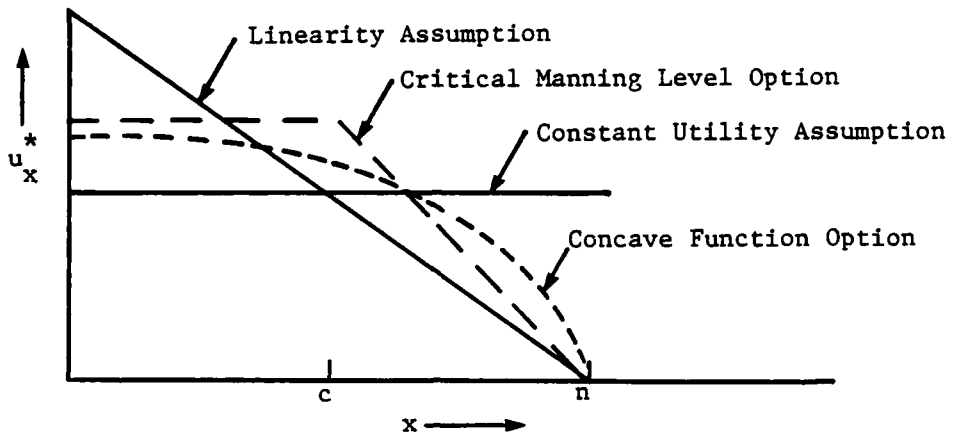
One desirable feature that is not included in the proposed approach is the capability for personnel substitution either among pay grades within a specific skill category or among skill categories for a specific pay grade. That is, if a specific activity is short an electronic technician of Grade E-6, there is no provision for filling that vacancy with an electronic technician of a different pay grade or with a person of Grade E-6 with a different rating.

The discussion thus far has addressed the underlying concepts of the proposed approach. The actual implementation of this approach, as described in Chapter IV, represents an initial attempt to apply these concepts to evaluating Navy personnel readiness in the presence of assumed personnel shortfalls. This implementation consists of two major components: data base consolidation and optimization computer program design. The data base consolidation embodies the transformation of the basic personnel data bases to utility structured data bases. This data base consolidation resulted in a considerable reduction in the

number of data base factors. That is, officer designators, EP ratings, and civilian occupational code groups were each assigned to one of seven utility skill groups (252 separate categories reduced to seven utility skill groups) and the various officer, enlisted, and civilian pay grades were assigned to one of 18 utility pay grades (88 separate pay grades reduced to 18 utility pay grades). The principle advantage of this consolidation is the reduction in the maximum possible number of allocation optimizations from 22,176 to 504 for a given computer run. This results in a substantial reduction in required computer running time. A disadvantage of this consolidation is the loss of identity of actual billets. That is, the distribution of shortfalls among officers, enlisted personnel or civilians are specified in terms of utility skill groups and utility pay grades. The utility skill group results cannot reasonably be transformed back to specific officer designators, EP ratings, or civilian occupational code groups. However, the utility pay grade results can, for the most part, be transformed back to officer, enlisted and civilian pay grades. This could be offset somewhat by increasing the number of utility skill groups so that each skill group would contain fewer officer designators, EP ratings, and civilian occupational codes and the skill group definitions themselves could be revised to be more related to specific Naval functions. For example, the definitions could coincide with the definitions of the Shore Mission Areas. This revision of definitions would also result in a more efficient basis for assigning officer designators, EP ratings, and civilian occupational codes to specific utility skill groups. Of course, this would require the establishment of a new and improved set of utility values for the skill groups. Even if the original seven skill groups were maintained, an improved set of utility values should be established since the values used in this analysis were somewhat arbitrarily generated. Another area where improvement is required is in the componentization of shore based activities

where the nature of these activities should be more compatible with that of the afloat activities (ships and aircraft squadrons) than are the Shore Mission Areas. One such option would be to use the actual shore activities such as Alameda Naval Air Station, Oakland Naval Supply Center, Washington Naval Shipyard and so on. This revision, as well as the skill group redefinition, would obviously increase the number of data base factors and thus increase computer running time requirements. On the other hand, it should also add credibility to the results obtained through the use of the approach.

The Utility Optimization Computer Program (UALLOC), described in Section IV.E represents a convenient and efficient tool for evaluating personnel readiness in the presence of personnel shortfalls. The principal drawback of the program is that it generates abnormally high values for personnel readiness in relationship to the personnel availabilities obtained, as can be seen through perusal of the tables presented in the preceding section of this chapter. For example, in Table V-1 which provides the results for shortfalls across the entire Navy population, the Shore Mission Area results for a 20% shortfall indicate personnel availabilities of .779 for officers, .785 for enlisted personnel, and .800 for civilians, while the personnel readiness value obtained is .955. The high readiness values generated by the program imply that the linearly variant utility assumption, used to establish the relative utility values of personnel authorized to an activity within a specific utility skill group/pay grade combination, places too little utility value at the end of the personnel scale. One possible option to correct this problem would be to establish a critical manning level, say 80%, where relative utility would be constant up to this critical level and then decrease linearly up to the 100% level. Another option would be to use a concave function instead of a linear function to represent relative utility. The figure below illustrates the functions associated with these two options as well as the functions associated with the original linearity assumption and a



constant utility assumption. In the figure, x denotes the x^{th} person out of n authorized to an activity and u_x denotes the relative utility associated with the x^{th} person. Implementation of either of the two options would require a major revision of the optimization subroutine of the computer program with only minor revisions to the main program. Another drawback of the program is the assumption that shortfalls are uniform over utility skill groups and pay grades. That is, if a shortfall of, say, 80% is assumed, then each utility skill group/pay grade combination is assumed to have an 80% shortfall. One possible remedy to this problem would be to allow non-uniform shortfall distributions over the utility skill groups and pay grades. This would allow evaluation of personnel readiness in such cases where there is a higher shortfall among, say, personnel in the highly critical skill areas or with higher pay grades than among those in less critical skill areas or with lower pay grades. Implementation of the above two proposed improvements would result in a more useful and credible computer program as a tool for evaluating personnel readiness in the presence of personnel shortfalls.

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