Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author) Operations Analysis Department Navy Fleet Material Support Office 5450 Carlisle Pike, P. O. Box 2010 Mechbg., PA 17055	2a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED 2b. GROUP

3. REPORT TITLE

Load List Range Rule Study

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)

5. AUTHOR(S) (First name, middle initial, last name)

L. Miranda Moore

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
	35	4

8a. CONTRACT OR GRANT NO.	9a. ORIGINATOR'S REPORT NUMBER(S)
b. PROJECT NO. 9321-E13	158
c.	9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report)
d.	

10. DISTRIBUTION STATEMENT

Distribution of this document is unlimited.

11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY

13. ABSTRACT

The number of adds and deletes that resulted from the proposed 1983 Tender and Repair Ship (AD/AR) Load List (TARSLL) update was unacceptably high. The current methods for building a TARSLL or AS (Attack) load list do not consider whether the item is currently a load list item. This has resulted in excessive load list churn, increased workload on-board the ships and an increased net investment. This study evaluated several different alternatives for determining the range of load list items. The study also examined different load list quantity computation schemes and depth protection levels. The feasibility of building a common segment of the AD/AR TARSLL for the Atlantic and Pacific Fleet was also evaluated. Specific alternative methods for building a load list were analyzed and recommendations were made.

DD FORM 1 NOV 65 1473 (PAGE 1)

S/N 0101-807-6801

Security Classification

LOAD LIST RANGE RULE STUDY

OPERATIONS ANALYSIS DEPARTMENT

NAVY FLEET MATERIAL SUPPORT OFFICE

Mechanicsburg, Pennsylvania 17055

Report No. 158

LOAD LIST RANGE RULE STUDY

REPORT NO. 158

PROJECT NO. 9321-E13

SUBMITTED: L. M. Moore
L. M. MOORE
OPERATIONS RESEARCH ANALYST

APPROVED:
G. J. ANGELOPOULOS, CDR, SC, USN
DIRECTOR, OPERATIONS ANALYSIS
DEPARTMENT

F. L. FILIPIAK, CAPT, SC, USN
COMMANDING OFFICER, NAVY FLEET
MATERIAL SUPPORT OFFICE

MAR 01 1984

DATE: ___________

Abstract

The number of adds and deletes that resulted from the proposed 1983 Tender and Repair Ship (AD/AR) Load List (TARSLL) update was unacceptably high. The current methods for building a TARSLL or AS (Attack) load list do not consider whether the item is currently a load list item. This has resulted in excessive load list churn, increased workload on-board the ships and an increased net investment. This study evaluated several different alternatives for determining the range of load list items. The study also examined different load list quantity computation schemes and depth protection levels. The feasibility of building a common segment of the AD/AR TARSLL for the Atlantic and Pacific Fleet was also evaluated. Specific alternative methods for building a load list were analyzed and recommendations were made.

TABLE OF CONTENTS

Executive Summary

1. Background. The number of adds and deletes that resulted from the proposed 1983 AD/AR load list update was unacceptably high, resulting in increased workload on-board the ships and an increased net load list investment.

2. Objective. The objective of this study was to modify the current load list methods for the AD/AR and AS (attack) tenders to reduce the number of range changes as a result of load list updates while not reducing tender effectiveness. Additional tests were also run to evaluate depth computations and the commonality of Atlantic and Pacific loads.

3. Approach. Alternative loads were built maintaining the current total number of items and 90% net effectiveness goal. These test loads were then evaluated by comparing the load list quantities against three months worth of actual Fleet demand.

Three methods for determining load list range were tested. The first method tested was to build the load list by retaining all of the items that were on the 1980 load list and were still candidates for the 1983 load list, and supplementing these items with the fastest moving 1983 candidates that were not on the current load. The second method was to reduce the range cut for items that were on the previous load list, making it easier for items that were already on-board to remain there. The third method tested was to use different range cuts based upon whether an item's demand forecast was based upon historical demand or the Best Replacement Factor (BRF).

Several alternatives impacting the depth were also evaluated. First, alternative test loads were built by increasing the minimum protection level from 2% to 50% and 60%, respectively. Under these conditions, a load list item would be stocked to a depth at least as large as its expected demand. Secondly, the AD/AR load was built by dividing the total ocean demand by the total number of active ADs and ARs in that ocean, excluding the AD/AR in overhaul.

The last portion of the study determined the feasibility of building a common Atlantic and Pacific portion of the load list. This test was to determine the commonality between the 1983 Pacific and Atlantic AD/AR load lists.

4. Findings. The most effective method for controlling range changes was by retaining old load list items that were still candidates and supplementing them with the fastest moving adds. For the AD/AR, adds were decreased by 43% and deletes were decreased by 62%. For the AS there was a 40% decrease in adds and a 70% decrease in deletes.

Two depth rules were evaluated with the new range criteria. For the AD/AR, retaining the 1980 depth as opposed to computing a new depth resulted in a less expensive load and higher effectiveness. For the AS, computing a new depth resulted in higher overall effectiveness with a slightly higher cost.

Raising the minimum protection level from 2% to 50% or 60% resulted in a more expensive load with no increase in effectiveness. The depths of most Equipment-Related (ER) items were not changed by increasing the minimum protection level.

The effects of factoring the total Atlantic ocean demand by the five active tenders versus the usual six for the AD/AR resulted in a slightly more expensive load with a 1% to 3.7% increase in effectiveness. Effectiveness for ER items also increased.

The results of the commonality study showed that at least 73% of all the fastest movers for one Fleet were already common to the other Fleet. At least 32% of the items that were not common were not even on the candidate file of the other Fleet.

5. Recommendations. It is recommended that the future AD/AR and AS (attack) load lists be built by retaining all of the items that were on the previous load list and are still candidates, and supplementing these items with the fastest moving new adds to obtain the desired range. Those items that are left on the AD/AR load should retain their previous load list quantity rather than using the math model to derive new load list quantities. These quantities should be reviewed periodically to ensure that they are still accurate when forecasting the demand for each AD/AR. The depth for the ASs should be recalculated each time a load list is produced. The total ocean demand placed against the AD/AR should be divided by the number of active tenders in that ocean area, excluding tenders in overhaul, but with each AD and AR still receiving a load.

I. INTRODUCTION AND BACKGROUND

The Tender and Repair Ship Load List (TARSLL) is a document that specifies the range and depth requirements for ADs (Destroyer Tenders) and ARs (Repair Ships). The industrial support to be provided by this load list should be sufficient to support the Fleet for a 90 day period during deployment without resupply. The AD/AR TARSLL is ocean-tailored; i.e., the same load list is used to support every nonsubmarine hull in an ocean area. In the Atlantic Ocean, for example, all of the anticipated demand (based on historical demand where possible and anticipated usage for new equipments) is accumulated and then divided by the number of ADs and ARs in the Atlantic Fleet. The range (variety of items) and depth (quantity of the item) of the load are then determined using the demand for one tender. Each AD and AR in the Atlantic Ocean receives the same basic load list.

Parts of this study were also performed for the AS(Attack) TARSLL. The AS load list is hull-tailored as opposed to ocean-tailored. This means that a load list is prepared for a specific submarine tender and contains material required for it to support its assigned hulls. The industrial and resupply mission for the AS should be sufficient to support its assigned hull mix for a 90 day period after mobilization without resupply.

The TARSLL is determined by using a model designed by the Navy Fleet Material Support Office (FMSO). The model contains a group of mathematical routines that select the candidate items to be included in the load list. It computes the appropriate depth for each load list item and measures the predicted effectiveness of the load list produced. The depth of an item is the quantity of an item included on the load. A variation of this model was used to build the load lists for this study. The data to build the TARSLL is contained in the Weapons System File (WSF) and the Mobile Logistic Support Force (MLSF) Demand History File located in the Navy Ships Parts Control Center (SPCC).

When the 1983 AD/AR Lant TARSLL was built, it showed that out of 16,765 items, 10,246 were additions to the current load list (adds) and 8,577 items were deleted from the current load list (deletes). This resulted in over a 60% change from the 1980 TARSLL. If this load list were used, not only would it result in a high stock fund cost but would also cause an increased workload on-board the ships. Several methods were tested to reduce the amount of churn from one load list update to the next.

The current methods for building an AD/AR or AS TARSLL do not take into account whether or not an item is already a load list item at the time the document is produced. Instead, load list models determined range based only on anticipated demand. Not considering the current load list results in excessive range changes, increased load list investments, and increased tender workload. The first part of this study looked at several ways of maintaining more of the old load list items that still have an application.

Another potential problem with the 1980 load list was the amount of protection the high-cost Equipment-Related (ER) items were provided. An ER item is an item that is on an Allowance Parts List (APL) applicable to a supported ship that passes the component cut. A Nonequipment-Related (NER) item is defined as an item that has MLSF demand but is not on an APL that passes the component cut. The component cut is a way of eliminating APLs as possible candidate selections and will be further defined in this report.

The current method for determining depth does not allow as much protection for the high-priced/low demand items as it does for less expensive items with equal or greater demands. This may result in high cost/low demand receiving under 50% protection, whereas low cost/high demand items receive over 85% protection. The test loads for this part of the study raised the minimum protection levels from 2% to 50% and 60% for ER items.

Another part of the depth study tested building the Atlantic AD/AR load list by dividing the total ocean demand by five tenders instead of the usual six tenders. The reason for this was that one tender is always in overhaul at any point in time. Although the demand was determined using only five tenders all six tenders would still receive a load.

In the past there have been situations where an Atlantic AD/AR has had to do repair or industrial work for a Pacific ship. Because the Atlantic and the Pacific load lists are calculated using different demand and configurations there is a possibility that an Atlantic AD/AR would not have the material to support a Pacific ship. This situation led to the idea of a common portion of the Atlantic and Pacific AD/AR load lists to support these occasions. The third segment of this study tested the feasibility of having a common segment for the two load lists.

II. APPROACH

The test load lists built for the AD/AR study used the two year demand period August 1980-July 1982. The actual demand used to evaluate the results was reported to SPCC by the USS SIERRA (AD-18) from September through November of 1982. The test loads for the AS portion of the study used the two year demand period December 1981-November 1982. The test loads were evaluated with demands reported by USS FULTON (AS-11) for February through April of 1983. The test loads for the AD/AR and the AS were built to satisfy an anticipated 90% net requisition effectiveness for both ER and NER items.

After the test loads were built they were evaluated by using 90 days of actual demand to determine the effectiveness of the test loads. The effectiveness was measured in terms of gross, model and net requisition effectiveness, and gross, model and net unit effectiveness. Separate model and net effectiveness statistics are also shown for ER items. Effectiveness measures are defined below:

- Gross Requisition Effectiveness. The number of requisitions for load list items demanded and satisfied divided by total requisitions for all items demanded (load list items + nonload list candidates + noncandidates).
- Model Requisition Effectiveness. The number of requisitions for load list items demanded and satisfied divided by the total number of requisitions demanded for candidate items.
- Net Requisition Effectiveness. The number of requisitions for load list items demanded and satisfied divided by the number of requisitions for load list items demanded.
- Gross Unit Effectiveness. The number of units for load list items demanded and satisfied divided by total units for all items demanded.

- Gross Unit Effectiveness. The number of units for load list items demanded and satisfied divided by total units for all items demanded.
- Model Unit Effectiveness. The number of units for load list items demanded and satisfied divided by the total number of units demanded for candidate items.
- Net Unit Effectiveness. The number of units for load list items demanded and satisfied divided by the number of units for load list items demanded.

Gross effectiveness is not broken out by ER and NER because demand for noncandidates are not identified as ER or NER. Since net effectiveness is a measure of how well load-list items demanded are satisfied, it cannot be used to compare load lists with different ranges.

III. CANDIDATE FILE SELECTION

A. AD/AR Candidate File. The 1980 AD/AR TARSLL was built using a 7 and 2 component cut for its candidate file. The 7 part of the 7 and 2 component cut means that if an APL contains at least one item which requires IMA support to remove and replace it and has no 3M demand in three years, it has to be on at least 7 ships to be a candidate for the load list. The 2 part means that if an APL has 3M-usage by an afloat IMA in the last three years, it has to be on at least 2 ships to be a candidate. Because of this component cut large numbers of items were eliminated from the candidate file and, therefore, had no way of making the load list. SPCC did a new WSF extract for the same ships supported by the 1983 AD/AR TARSLL using a component cut of 1 and 1 instead of 7 and 2. This created a candidate file with 237,316 items. The 7 and 2 component cut candidate file had 129,541 items. The larger candidate file was used in most of the following tests.

B. AS Candidate File. For an item to make the AS candidate file, it must only be installed on one of the supported ships. SPCC built the candidate file for the AS-11 USS FULTON. This file had 101,158 items.

IV. ANALYSIS OF THE AD/AR AND AS-11 RANGE DETERMINATION STUDY

A. New Load List Based on Previous Load. Two alternative test loads were built by retaining all the 1980 load list items that were still candidates. These basic loads were then supplemented with the fastest moving 1983 adds to get the desired range. To build a load in this manner would automatically reduce the workload by leaving items on-board the ship that would have been deletes using the original method. This would also reduce the amount of material required to buy and, therefore, save money. These test loads were built in two ways. The first test load used the same load list quantity (depth) for the items that remained on the load as computed in the 1980 load list. The second test load kept all the load list items that were still candidates but used the TARSLL math model to derive new load list quantities using more recent demand and ship configuration.

The AD/AR test loads were built using both the 7 and 2 component cut and the 1 and 1 component cut. There was only one test load built using the 7 and 2 component cut for comparison purposes only because it has been decided that the 1 and 1 component cut will be used in the future. The 7 and 2 test load used the 1980 quantities. The benchmark for these tests was the original 1983 load list built by SPCC.

After the new loads were built, they were evaluated using three months worth of actual demand to determine their effectiveness. The statistics for these tests are shown below:

TABLE I

New AD/AR Load List Using 7-2 CC

	AD/AR Benchmark	AD/AR New Load Using 1980 Quantities
# LL Items	16,765	16,765
$ Value	$2,941K	$2,853K
# Adds	10,246	7,599
$ Value	$1,799K	$1,275K
# Deletes	8,577	5,930
$ Value	$1,938K	$1,289K
Gross Requisition Eff	22.3%	22.4%
Gross Unit Eff	22.0%	22.3%

TABLE II

New AD/AR Load List Using 1-1 CC

	New Load Using 1980 Quantities	New Load Using Most Recent Demand
# LL Items	17,723	17,723
$ Value	$2,225K	$2,423K
# Adds	5,869	5,869
$ Value	$ 501K	$ 727K
# Deletes	3,228	3,228
$ Value	$1,076K	$1,076
Gross Requisition Eff	25.8%	25.3%
Net Requisition ER-Eff	72.3%	70.8%
Gross Unit Eff	25.3%	24.6%
Net Unit ER Eff	55.4%	54%

TABLE III

New AS Load Lists

	Benchmark	New Load Using 1980 Quantities	New Load Using Most Recent Demand
# LL Items	18,065	18,065	18,065
$ Value	$5,761K	$5,236K	$5,904K
# Adds	9,769	3,878	3,878
$ Value	$3,026K	$ 782K	$ 782K
# Deletes	8,408	2,517	2,517
$ Value	$2,759K	$ 341K	$ 341K
Gross Reqn Eff	63.9%	48.1%	60.6%
Net Reqn ER-Eff	87.7%	85.0%	88.0%
Gross Unit Eff	74.2%	55.9%	73.0%
Net Unit ER-Eff	84.6%	72.5%	83.5%

The AS-11 and the AD/AR 7-2 component cut test loads were built with the same range as the 1980 load for comparison purposes. The loads for the AD/AR component cut 1-1 were built closer to 18,000 and contains the same number of items as the benchmark in the following study, evaluating alternative range cuts.

The new load lists that were built based on the previous load (TABLEs I, II and III) showed that the adds and deletes were reduced from the benchmark in all three tests. The new loads built for the AD/AR using the 1 and 1 component cut (TABLE II) had fewer adds and deletes, a cheaper overall load and increased effectiveness over the new load that was built using the 7 and 2 component cut (TABLE I). Between the two new loads using the 1 and 1 component cut for the AD/AR, the one using the previous load list quantities as opposed to quantities based on the most recent demands showed better overall results. These two tests only reflected a difference in depth, and therefore, was only reflected in the dollar value. The range did not change. In order to compare the model ER effectiveness of this new load with the original benchmark, a new candidate file was created consisting of the load list items of the new load using the 1980 quantities and all of the candidates that did not make the load from the original benchmark. The model requisition ER effectiveness of the new candidate file was 54.3% compared to 53.7% for the original benchmark. The model unit ER effectiveness went from 41.7% from the original benchmark to 49.6% with the new candidate file. This final test showed that of all three methods of building the load list (TABLEs I and II), the one that was built by retaining the 1980 load list items and their depth that were still candidates in 1983 satisfied the ER demand the best. The new load using the 1980 quantities resulted in a less expensive load, the dollar value of adds was less and the effectiveness was slightly better than the new load using the most recent demand. The Depot Level Repairables (DLRs) were split out and looked at separately. There were a total of 203 DLRs. Of these, only eight were demanded in the three months worth of actual demand used to evaluate the load lists. Although the DLRs are higher priced items, they had very little impact on effectiveness.

The AS portion of the study showed different results. Both the adds and deletes of the new test loads were significantly lower than the benchmark, however, the results of the two different methods for determining depth were different. Although the overall cost of building the load was higher when the most recent demand was used, the overall effectiveness of the load was much higher than when the depth was computed using the previous loads depth. The gross effectiveness was slightly higher using the benchmark but the reduction of adds and deletes outweighted the difference in effectiveness. The net requisitions ER effectiveness for the test load was higher than the benchmark while the net unit ER effectiveness was lower. The final effectiveness test was performed on the DLRs from the new load using the 1980 load list quantities. There were a total of 438 DLRs. Of these, 102 were demanded in the three months worth of actual demand used to evaluate the load list. Like the AD/AR DLRs, these DLRs had very little impact on effectiveness.

B. New Load Lists Built on Different Range Cuts. The current TARSLLs determine range based on the total number of units demanded during a two year period. If an item's historical demand is not available, the items Best Replacement Factor (BRF), and population (POP) on the ships supported by the load are used to estimate the two year total demand. For an item to be selected for the load, the candidate items total demand is compared with a pre-selected value called the range cut point. All candidate items with a total demand greater than or equal to the range cut point are included in the load list. Reference (1) of Appendix A concluded that a range cut was necessary in load list computations but did not specify what the most effective range cut should be. Both the AD/AR and the AS load list models use a range cut of 4; i.e., four demands in two years. The test load lists in this part of the study were built by allowing current load list items to have a range cut that was a fraction of the range cut for nonload list items. The fractions used for the tests were .25, .50 and .75. For example, using the .25 range cut factor, if a range cut of 4 was used for new items, the items that were on the previous load would have a range cut of 1 (4 x .25). The previous load list items would only have to have one demand in two years instead of 4 demands in two years. Because this method only effected the items that were on the old load, a reduction in range and cost can only be seen in the deleted items. By lowering the range cut for old load list items, more items were allowed on the load. This caused the range of items to increase as the range cut was factored. This study was done using a component cut of 1 and 1. Three different benchmark loads are shown in TABLE IV. The original benchmark is the original 1983 load list built by SPCC using a component cut of 7 and 2 and a range cut of 4 for all items. The second benchmark used the 1 and 1 component cut candidate file with a range cut of 4. This resulted in a much larger range of items. The third benchmark used the 1 and 1 component cut candidate file but the range cut was raised to 8.5 to obtain a range of approximately 18,000 items. The third benchmark, range cut 8.5, was then used to build the loads with reduced range cuts for the old load list items. The benchmark for the AS test was the original 1983 load list built by SPCC. The results of the AS range tests can be seen in TABLE V.

TABLE IV

AD/AR Range Criteria Statistics

	RC=4 cc=7-2 Original Benchmark	RC=4 cc=1-1 Benchmark 2	RC=8.5 cc=1-1 Benchmark 3	RC=6.375 cc=1-1	Same for New Items RC=4.25 cc=1-1	RC=2.125 cc=1-1
# LL Items	16,765	27,877	17,723	18,311	19,059	20,046
$ Value	$2,941K	$4,978K	$2,071K	$2,089K	$2,275K	$2,382K
# Adds	10,246	18,711	10,138	10,138	10,138	10,138
$ Value	$1,799K	$4,085K	$1,344K	$1,344K	$1,344K	$1,344K
# Deletes	8,577	5,916	7,497	6,090	6,161	5,174
$ Value	$1,938K	$2,183K	$1,967K	$1,899K	$1,703K	$1,589K
Gross Req Eff	22.3%	25.6%	23.2%	23.5%	23.9%	24.3%
Model Req-ER Eff	53.7%*	52.4%	46.0%	46.9%	47.8%	48.9%
Gross Unit Eff	22.0%	21.3%	21.2%	21.3%	21.3%	21.4%
Model Unit-ER Eff	41.7%*	32.3%	31.7%	31.8%	31.9%	32.2%

*Can't be compared with CC 1-1 due to different universe of candidate.

TABLE V

AS Range Criteria Statistics

	RC=4 Benchmark	RC=3 RC-F=.75	Same for New Items RC=2 RC-F=.50	RC=1 RC-F=.25
# LL Items	18,065	18,659	19,607	20,965
$ Value	$5,761K	$6,199K	$6,630K	$7,236K
# Adds	9,769	9,769	9,769	9,769
$ Value	$3,026K	$3,026K	$3,026K	$3,026K
# Deletes	8,408	7,814	6,866	5,508
$ Value	$2,759K	$2,265K	$1,819K	$1,193K
Gross Req Eff	63.9%	64.7%	65.6%	66.5%
Model Req-ER Eff	60.0%	61.6%	63.4%	65.3%
Gross Unit Eff	74.2%	74.3%	74.5%	74.6%
Model Unit-ER Eff	78.6%	78.9%	79.3%	79.6%

When the range cut for old load list items was factored, the overall range of the load increased because more old load list items were allowed to remain. It would be expected that with a larger range of items there would be fewer deletes and better effectiveness. For both the AD/AR and the AS, as the range cut for old load list items decreased, the number of deletes also decreased. The gross requisition effectiveness of the test loads surpassed that of the benchmark load by .3% to 1.1% for the AD/AR and .8% to 2.6% for the AS. The model requisition ER effectiveness increased from the benchmark .9% to 2.9% for the AD/AR and from 1.6% to 5.3% for the AS. Any effectiveness that changed less than 1% was not considered significant.

C. <u>Review of Adds and Deletes</u>. If the National Item Identification Numbers (NIINs) of either the adds or deletes had not been updated properly, there would be a possibility that the same items that were being deleted were being added again under a different NIIN. Vitro reviewed the large number of adds and deletes to find out if this was the case. This review concluded that NIIN updates or item substitutions was not the problem. No more than 10 items on either the AD/AR adds and deletes or the AS adds and deletes matched each other.

The small numbers of matches between the add file and the delete file indicated that the NIINs had been updated correctly and were not a factor in the number of adds and deletes.

SPCC was requested to manually review the adds and deletes to determine a reason for the large numbers. They were given both the adds and deletes for component cut 7 and 2 and component cut 1-1. The same reasons were found for both sets of adds and deletes. These results were considered legitimate and were documented in reference (2) of Appendix A. They were:

1. Deletes:

   a. 76.2% had no demand and no APL applicability;

   b. 1.2% had APL applicability and no demand and/or no population;

   c. 22.2% had Federal Stock Class (FSC) exclusions;

   d. .3% of equipment was obsolete.

   e. Note: The majority were Federal Stock Group (FSG) 59 (electrical) and 53 (hardware), both of which are excluded;

2. Adds:

   a. 57.1% were demand based;

   b. 14.6% had APL applicability with a large POP;

c. 21% had APL applicability and experienced demand;

d. 7.3% had APL applicability and experienced high BRF.

D. Load Lists With Different Range Cuts For Historical Vs. BRF*POP. The current method for building a TARSLL requires that the historical demand items and the BRF*POP items use the same range cut. The purpose of this test was to identify the load list quantity based on separate range cuts for historical demand items versus BRF*POP items. This portion of the study used the AD/AR 7 and 2 component cut candidate file. The results using the 1 and 1 component cut candidate file would follow the same trend but the range values would be greater. The results are shown in a matrix form with range cut values for BRF*POP across the top and historical demand along the side. If the load list was built using this method, we would have the ability to control the ratio of new equipment type items to historical demand items. The matrix is shown below in TABLE VI.

TABLE VI

cc=7-2
BRP*POP Range Cuts

HIST RANGE CUTS	.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5
1	41,303	32,949	28,857	26,580	24,999	23,948	23,097	22,466	21,942	21,523	21,136
2	38,532	30,178	26,086	23,703	22,228	21,177	20,326	19,695	19,091	18,752	18,365
3	36,465	28,111	24,019	21,742	20,161	19,110	18,260	17,628	17,104	16,685	16,298
4	35,502	27,148	23,056	20,777	19,198	18,147	17,296	16,765	16,141	15,722	15,335
5	34,533	26,177	22,087	19,810	18,229	17,178	16,327	15,696	15,172	14,753	14,366
6	33,774	25,420	21,328	19,051	17,470	16,419	15,568	14,937	14,413	13,994	13,607

The four test loads shown in the boxes were chosen for evaluation. These were chosen because their range values were closest to 18,000. Built into the math model is a demand filter for NER items. This demand filter will automatically eliminate a NER item from the load if four or less units are demanded or there are one or less frequencies in two years. The BRF*POP items are all ER items since by definition all these items come from the WSF. Because of these two conditions, the NER range was a constant value of 3,791 as long as the historical range cut was less than or equal to five. Any change in range seen for range cuts less than or equal to five was caused by ER items. In the evaluation statistics, the largest changes occur in ER effectiveness statistics. These effectiveness statistics are shown in TABLE VII.

TABLE VII

HIST vs. BRF * POP Effectiveness
cc = 7-2

	RC=4 Original Benchmark	HIST=2.0 BRF*POP=5.5	HIST=3.0 BRF*POP=3.5	HIST=4.0 BRF*POP=3.0	HIST=5.0 BRF*POP-2.5
## LL Items	16,765	18,365	18,260	18,147	18,229
$ Value	$2,941K	$3,325K	$3,324K	$3,427K	$3,321K
# Adds	10,246	11,880	11,601	11,486	10,674
$ Value	$1,799K	$2,193K	$2,132K	$2,235K	$2,141K
# Deletes	8,577	8,510	8,336	8,336	8,491
$ Value	$1,938K	$1,835K	$1,839K	$1,838K	$1,850K
Gross Req Eff	22.3%	23.1%	22.8%	22.4%	22.0%
Model Req-ER Eff	53.7%	57.1%	55.8%	54.3%	52.7%
Gross Unit Eff	22.0%	22.0%	22.0%	22.0%	22.0%
Model Unit-ER Eff	41.7%	41.9%	41.9%	41.8%	41.6%

The only significant changes in effectiveness occur in the model requisition ER effectiveness. Changes in dollar value, adds and deletes are minimal. One explanation for the increase in ER effectiveness when there was a greater percentage of historical demand items was that historical demand items experienced some type of demand within the last two years and therefore, were more likely to experience demand in the next 90 days. Since BRF*POP items did not experience any demand within the last two years, they were less likely to experience any during the actual demand period used for the tests.

E. Summary of Range Determination Study. Three methods for determining range were discussed in this section. They were:

- Method I - Building the load list by retaining items that were on the previous load list and were still candidates and supplementing these with the fastest moving adds to obtain a desired range.
- Method II - Building the load list by allowing current load list items to have a range cut that was a fraction of the range cut for nonload list items.
- Method III - Building the load list with the flexibility of using different range cuts for historical demand versus BRF x POP.

Out of the three methods tested, Method I resulted in a less expensive load, fewer adds and deletes and better overall effectiveness.

V. AD/AR AND AS-11 DEPTH ANALYSIS STUDY

A. New Load List Based on Higher Minimum Protection Levels. To compute load list quantities on the TARSLL, the math model computes a separate risk for each item. Risk is equal to one minus protection. In order for the risk/protection values to stay within reasonable bounds, certain constraints are applied to the computations. These constraints, the maximum allowable risk and the minimum allowance risk, are currently set at 97.725% and 2.275%, respectively. Because risk is the complement of protection, the minimum and maximum protection levels are 2.275% and 97.725%, respectively. An item with protection less than 50% will have a computed load list quantity less than the expected quarterly demand; i.e., the item would have a negative safety level.

The purpose of this portion of the study was to determine the effect of applying a minimum protection level of 50% and 60% instead of 2.275% for ER items. With these new models, a load list item was stocked to a depth at least as large as its expected demand. The component cut 1 and 1 candidate file was used for the AD/AR protection level study. TABLEs VIII and IX show the results for the AD/AR and the AS-11.

TABLE VIII

Protection Level Statistics for AD/AR
RC=8.5

	Benchmark cc=1-1 Prot.Lev-2-98%	cc=1-1 Prot.Lev-50-98%	cc=1-1 Prot.Lev=60-98%
# LL Items	17,723	17,723	17,723
$ Value	$2,071K	$2,163K	$2,263K
Gross Req Eff	23.2%	23.2%	23.3%
Model Req-ER Eff	46.0%	46.2%	46.3%
Gross Unit Eff	21.2%	21.2%	21.3%
Model Unit-ER Eff	31.7%	31.8%	31.9%
Net Rqn Eff	68.0%	68.1%	68.3%
Net Req-ER Eff	65.7%	65.9%	66.2%
Net Unit Eff	49.7%	49.7%	49.7%
Net Unit-ER Eff	38.2%	38.2%	38.3%

TABLE IX

Protection Level Statistics for AS-11

	PL=2-98% Benchmark	PL=50-98%	PL=60-98%
# LL Items	18,065	18,065	18,065
$ Value	$5,761K	$8,097K	$9,289K
Gross Reqn Eff	63.9%	64.3%	64.4%
Model Req-ER Eff	60.0%	60.7%	61.0%
Gross Unit Eff	74.2%	74.3%	74.3%
Model Unit-ER Eff	78.6%	78.8%	78.9%
Net Req Eff	90.7%	91.2%	91.4%
Net Req-ER Eff	87.7%	88.6%	89.1%
Net Unit Eff	87.3%	87.4%	87.5%
Net Unit-ER Eff	84.6%	84.8%	85.0%

The results of both of these studies revealed that a 2% to 98% protection level was adequate. Both tests of increased minimum protection indicate that the changes have little effect on load list effectiveness, however, the cost of the load increased as the protection level increased. These results show that the depth of most ER items are not changed by increasing the minimum protection to 60%. The expected future demand for many of these items is so small that even a minimum depth of one unit already provides more than 60% protection against stockout so no increase in item depth occurs. These results were consistent with the results of a similar study that is documented in reference (3) of Appendix A.

B. New Load List Based on Five Tenders Vs. Six. Since the AD/AR TARSLL is ocean-tailored, the anticipated demand is accumulated for an entire ocean area and then divided by the number of ADs and ARs servicing that ocean. The number of ADs and ARs in the Atlantic Ocean is currently six. Out of these six tenders, at least one is normally in overhaul at a given time. The third portion of this study determines the effect of factoring the Atlantic Fleet anticipated demand for AD/ARs by five instead of the usual six. All six ships would still carry a load but the load would be determined for a five ship base. Since the ASs are hull-tailored, the factoring is not required. The results of this factoring can be seen in TABLE X.

TABLE X

Protection Level Statistics

	Benchmark cc=1-1 6 Tenders Prot.Lev-2-98%	cc=1-1 Prot.Lev-2-98% 5 Tenders
# LL Items	17,723	17,723
$ Value	$2,071K	$2,154K
Gross Req Eff	23.2%	23.8%
Model Req-ER Eff	46.0%	46.8%
Gross Unit Eff	21.2%	22.8%
Model Unit-ER Eff	31.7%	34.5%
Net Rqn Eff	68.0%	69.7%
Net Req-ER Eff	65.7%	66.9%
Net Unit Eff	49.7%	53.4%
Net Unit-ER Eff	38.2%	41.5%

The gross effectiveness of the new load did not rise more than 1% but the model and net effectiveness rose bewteen 1% and 3.7%. The dollar value of the new load was slightly higher.

C. Summary of AD/AR and AS-11 Depth Analysis Study. One method of building the load list based on different depth criteria was tested for the AD/AR and the AS-11. It was:

- Method I - Building the load list using a 50% and 60% minimum protection level instead of a 2.275% minimum protection level.

A second depth criteria was tested for the Lant AD/AR:

- Method II - Building the load list based on five tenders versus six tenders.

Method I resulted in a more expensive load with no increase in effectiveness. Method II resulted in a slightly more expensive load with a 1% to 3.7% increase in effectiveness.

VI. AD/AR LANT AND PAC COMMALITY STUDY

The purpose of the AD/AR Lant and Pac Commonality study was to determine the feasibility of building a separate segment of the Atlantic load list consisting of Pacific unique fastest movers and building a separate segment of the Pacific load list consisting of Atlantic unique fastest movers in addition to the normal ocean-tailored AD/AR TARSLL. This study was done using the 7 and 2 component cut candidate file because a 1 and 1 component cut candidate file for Pacific items was not available. The 1983 Atlantic load list had 16,765 items and the 1983 Pacific load list had 17,849 items. Out of these, 10,759 items were common to both. The study in reference (4) of Appendix A described the commonality of demand between the Atlantic and Pacific Fleets.

To test the feasibility of a common load list, the 1,000, 2,500 and 5,000 fastest moving Pacific and Atlantic load list items based on demand were extracted. It was then determined how many out of the 1,000, 2,500 and 5,000 fastest moving Pacific items were on the Atlantic load list and vice-versa. In each case, the percentage of Pacific fastest movers that were not Atlantic load list items and were not even Atlantic candidates and vice versa was established. TABLEs X, XI and XII show the results of the study.

TABLE XI

1000 Fastest Movers

1000 Fastest Lant Items - $231K
1000 Fastest Pac Items - $549K

	# Noncommon LL Items	$ Value Per Ship	# Noncandidates Out of Noncommon
Lant	69 (7%)	$17K	32 (46%)
Pac	65 (7%)	42K	44 (68%)

TABLE XII

2500 Fastest Movers

2500 Fastest Lant Items - $367K
2500 Fastest Pac Items - $817K

	# Noncommon LL Items	$ Value Per Ship	# Noncandidates Out of Noncommon
Lant	299 (12%)	44K	95 (32%)
Pac	345 (14%)	98K	183 (53%)

TABLE XIII

5000 Fastest Movers

5000 Fastest Lant Items - $603K
5000 Fastest Pac Items - $1,117K

	# Noncommon LL Items	$ Value Per Ship	# Noncandidates Out of Noncommon
Lant	1,178 (24%)	136K	449 (38%)
Pac	1,347 (27%)	231K	170 (53%)

The results of this study showed that at least 73% of all the fastest movers for one Fleet were already common to the other Fleet. Out of the items that were not common, at least 32% of those items were not even on the candidate file of the opposite Fleet. To put a common section of Atlantic load list items on each Pacific ship, the normal TARSLL would still have to be built. This normal TARSLL would then be augmented with the items that were common to the Atlantic Fleet but were not already on the Pacific load list. Since the majority of items were already common, the cost of building this common section for each ship would be too high for what would be achieved.

A Cog breakdown of the 449 Atlantic load list items that were not Pacific candidates is shown in TABLE XIV. The same Cog breakdown can be seen in TABLE XV for the 710 Pacific load list items that were not Atlantic candidates. These items were taken from 5000 fastest movers (TABLE XIII).

TABLE XIV

Lant LL Items Not Pac Cand

Cog	Frequency	%
1H	37	8.2
1R	1	.2
2Z	1	.2
5R	1	.2
9C	144	32.0
9G	41	9.0
9H	2	.4
9N	38	8.5
9O	1	.2
9Q	12	2.7
9Y	1	.2
9Z	170	37.9

TABLE XV

Pac LL Items not Lant Cand

Cog	Frequency	%
1H	79	11.1
1R	1	.1
7G	1	.1
7H	5	.7
9C	204	28.7
9F	2	.3
9G	70	9.9
9H	3	.4
9K	1	.1
9L	3	.4
9N	66	9.3
9Q	14	1.9
9Y	8	1.1
9Z	253	35.6

The distributions for the two tables were amazingly similar. For the Atlantic items, 70% were either 9C (construction) or 9Z (industrial) material. Sixty-four percent of the Pacific items fell into these categories. These items are ER items and could be important to a mission.

VII. SUMMARY AND CONCLUSIONS

This study reviewed the present method for building the AD/AR and AS load lists. Several new methods were also looked at and comparisons were made to determine which methods were the most efficient.

For the AD/AR and AS range study, five new test load lists were built and evaluated. The first test load was built by retaining all the 1980 load list items that were still candidates and supplementing these with the fastest moving 1983 adds. This load retained the same load list quantities that were computed in building the 1980 load list. The second test load was built the same way except that instead of using the 1980 load list quantities for the items that remained on the load list, the math model computed the quantities based on the most recent two year demand, if available, and the most recent BRF and supported population if demand was not available. The last three range study test loads were built by factoring the range cut for the items that were on the 1980 list by 25%, 50% and 75% so that these items had a better chance to remain on the 1983 load list.

For both the AD/AR and the AS-11, the first method of computing the load had fewer adds and deletes and had better overall effectiveness. It is recommended that the AD/AR and AS load lists be built by retaining the current load list items that are still candidates and supplementing these with the fastest moving adds to obtain a desired range. The ADs and ARs should maintain their current load list quantities and have a range of approximately 18,000 using a component cut of 1 and 1. The ASs should compute a new depth each time the load list is produced.

The depth portion of this study looked at three alternative test loads for the AD/AR and two alternative test loads for the AS-11. The first two test loads for both the AD/AR and the AS-11 increased the minimum protection levels from 2% to 50% and 60%, respectively. The results showed that the cost of the load increased with no increase in effectiveness. Therefore, it is recommended that the protection level for high cost/low demand items continue to be 2%-98%. The third alternative test load for the AD/AR was built by factoring the total Atlantic Ocean demand by five tenders versus the usual six. Although the total cost of the load increased, it was determined that the amount of increased effectiveness was worth the entire cost. By the results of the study, it is recommended that the AD/AR load list be factored by one less than the number of ships in an ocean area but that all the ships in that ocean still receive a load.

The final part of the study was to test the feasibility of building a common Atlantic portion of the Pacific load list and vice versa. After looking at the 1,000, 2,500 and 5,000 fastest moving items in each Fleet, it was decided that since at least 73% of the items were already common to each other, the additional cost of augmenting each load list would be too great.

The study shows that if these new methods of building load lists are implemented, the adds for the AD/AR would be decreased by 43% and the deletes by 62%. The overall cost of the load would be decreased by $633K, the cost of the adds would be decreased by $1,298K and the cost of the deletes would be decreased by $862K. The test load list for the AS-11 shows that the adds would be decreased by 40% and the deletes would be decreased by 70%. The total load cost would be increased by 308K but the cost of the adds would be decreased by $2,211K and the cost of deletes would be decreased by $2,418K. These figures reflect the savings of one load list in the Atlantic Fleet. With six AD/ARs, five ASs and SUBASE New London in the Atlantic Fleet and seven AD/ARs, three ASs and SUBASE Pearl Harbor in the Pacific, there would be a tremendous savings in cost, workload and effectiveness.

VIII. RECOMMENDATIONS

It is recommended that future load lists be built by retaining current load list items that are still candidates based on the configuration of the supported ships or based on MLSF demand. These items should be supplemented with the fastest moving candidates that are not on the current load to obtain a desired range. The ADs and ARs should retain their current depth. The ASs should compute a new depth at each load list production. The quantities for the AD/AR items that are left on the load should be reviewed periodically. The total ocean demand for the AD/AR should be divided by one less than the number of tenders in the ocean area but every tender should still carry a load.

APPENDIX A: REFERENCES

1. FMSO Operations Analysis Report 151 - Evaluation of AD/AR Tender and Repair Ship Load List Computations of 30 September 1982.

2. SPCC ltr 00312/VS/448 of 12 Dec 1983.

3. FMSO Operations Analysis Report 150 - Analysis of Attack AS(SSN) Tender Load List Model of 11 May 1982.

4. FMSO ALRAND Working Memorandum 358 - Analysis of AD/AR Tender Demand History.

Distribution List
Analysis Division
Afloat Analysis Branch (9321)

Commanding Officer
Navy Aviation Supply Office
Code SDB4-A
Philadelphia, PA 19111

Commander
Naval Surface Forces
U. S. Atlantic Fleet
Attn: Code N71
Norfolk, VA 23511

Commanding Officer
Naval Supply Center
Puget Sound (Code 40)
Bremerton, WA 98314

Commanding Officer
U. S. Naval Supply Depot
Code 51 (Guam)
FPO San Francisco 96630

Commanding Officer
U. S. Naval Supply Depot
(Yokosuka, Japan)
FPO Seattle 98762

Chief of Naval Operations
Navy Department (OP-91)
Washington, D.C. 20350

Director, Material Division
Chief of Naval Operations
(OP-412)
Washington, D.C. 20350

Commander
Naval Logistics Command
U. S. Pacific Fleet, Code 4121
Pearl Harbor, HI 96860

Commander Naval Air Force
U. S. Pacific Fleet
Attn: Code 44
NAS, North Island
San Diego, CA 92135

Commander Naval Air Force
U. S. Atlantic Fleet
Attn: Code 42
Norfolk, VA 23511

Commander
Naval Surface Forces
U. S. Pacific Fleet
Code N7
San Diego, CA 92155

Commander Submarine Force
U. S. Pacific Fleet, Code 41
Pearl Harbor, HI 96860

Commander Submarine Force
U. S. Atlantic Fleet
Attn: Code N5
Norfolk, VA 23511

Office of Naval Research
800 North Quincy Street
Attn: Code 411
Arlington, VA 22217

Director
Defense Logistics Agency
Attn: DLA-LO
Cameron Station
Alexandria, VA 22314

Mr. Bernard B. Rosenman
U. S. Army Inventory Research Office
Room 800, Custom House
2nd and Chestnut Sts.
Philadelphia, PA 19106

Commanding General
Attn: P800
Marine Corps Logistics Base
Albany, Georgia 31704

Commandant
Industrial College of the Armed Forces
Fort Leslie J. McNair
Washington, D.C. 20360

Department of Operations Research
Naval Postgraduate School
Monterey, CA 93940

Commanding Officer
Naval Supply Corps School
Attn: Code 40B
Athens, GA 30606

Defense Documentation Center
Cameron Station (2)
Alexandria, VA 22314

U. S. Army Logistics Management Center
Defense Logistics Studies Information
Exchange (2)
Fort Lee, VA 23801

Alan W. McMasters (3)
Associate Professor, Code 54 Mg
Naval Postgraduate School
Monterey, CA 93940

Department of the Air Force
Air Force Logistics Management
Center (Attn: Code XRP)
Gunter Air Force Station
Gunter, ALA 36114

Chief of Naval Material
Navy Department (MAT 0415)
Washington, D.C. 20360

U. S. Army Research Office
P. O. Box 12211
Attn: Robert Lanner, Math Division
Research Triangle Park, NC 27709

Center for Naval Analyses
2000 N. Beauregard St.
Attn: Stan Horowitz
Alexandria, VA 22311

Defense Technical Information Center
Cameron Station
Alexandria, VA 22314

Naval Postgraduate School
Attn: Library 0142
Monterey, CA 93940

President
Naval War College
Newport, RI 02841

Commanding Officer
Navy Ships Parts Control Center
Attn: Code 041
5450 Carlisle Pike
P. O. Box 2020
Mechanicsburg, PA 17055