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A cost comparison between active and naval reserve force FFG-7 class ships

Dudolevitch, Robert Francis

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A COST COMPARISON BETWEEN ACTIVE AND NAVAL RESERVE FORCE FFG 7 CLASS SHIPS

by

Robert Francis Dudolevitch

June 1993

Thesis Advisor: David R. Henderson
Co-Advisor: Richard D. Milligan

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A Cost Comparison between Active and Naval Reserve Force FFG-7 Class Ships

by

Robert Francis Dudolevitch
Lieutenant Commander, Supply Corps, United States Navy
B.A., University of Rhode Island, 1979

Submitted in partial fulfillment of the requirements for the degree of

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June 1993

Author: [redacted]
Robert F. Dudolevitch

Approved by: [redacted]
David R, Henderson, Thesis Co-advisor

[redacted]
Richard D. Milligan, Thesis Co-advisor

[redacted]
David R. Whipple, Chairman,
Department of Administrative Sciences

ABSTRACT

This thesis is a cost comparison between Active Fleet and Naval Reserve Force (NRF) Oliver Hazard Perry class guided missile frigates (FFG). It examines the rationale for having a Naval Reserve surface ship program and documents the cost savings attributable to the transfer of a ship to the NRF. A representative annual cost to operate an Active Fleet FFG is compared to the annual cost of a NRF FFG; the primary source of cost data is the Visibility and Management of Operating and Support Costs (VAMOSC) data base provided by the Naval Center for Cost Analysis. The thesis also sets up theoretical depreciation schedules for selected ships to examine how this expense would affect annual operating costs for both NRF and Active Fleet ships.

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I. INTRODUCTION

A. PURPOSE

The purpose of this thesis is to capture and evaluate costs associated with operating and supporting Oliver Hazard Perry class guided missile frigates (FFG-7 class); then to compare the costs between Active Fleet and Naval Reserve Force (NRF) ships. Sixteen of the fifty-one Perry class frigates have been transferred to the NRF in an effort to improve reserve readiness and provide cost savings. It is generally recognized that transfer of forces to the NRF will result in lower operating expenses. This thesis will quantify the difference between Active Fleet (AF) and NRF ships' operating costs for all FFGs. It will also factor the present value of future compensation such as retirement accrual into a ship's annual operating cost.

Additionally, since the transfer of modern ships to the reserves represents the utilization of expensive items of capital investment, this thesis will compute annual operating cost using civilian depreciation methods. Although not generally used in government accounting, depreciation is useful in arriving at an annual expense to be assigned for the use of investment items.

B. METHODOLOGY

This thesis will use the Visibility and Management of Ships Costs (VAMOSC) data base as the primary source of information on annual operating expense. It will also draw on the Naval Sea Systems Command ship acquisition data base to set up theoretical depreciation schedules.

Performance will also be studied to determine whether measurable differences exist in operating performance between AF and NRF ships. This thesis will use Operational Propulsion Plant Examination (OPPE) and Supply Management Inspection (SMI) results and data of Pacific Fleet ships to determine whether significant material and operational performance differences exist between the two categories of ships.

II. BACKGROUND

A. THE NAVAL RESERVE FORCE

The primary mission of the U. S. Navy is to conduct sustained combat operations at sea in support of American national interests under Title 10 of the U. S. Code. The mission of the Naval Reserve under 10 USC 262 is to provide trained units and qualified personnel to augment the Active Fleet in time of war, national emergency and at such other times as national security requires.

Naval reserve forces were first established in the late nineteenth century when revolutionary changes in ship design and construction such as steam propulsion, rifled artillery, steel armor plating, made operating naval forces very capable but also very expensive. Every major naval power created a naval reserve because the cost of maintaining large regular navies was prohibitive. Reserves would make wartime expansion of the navy possible while allowing lower peacetime expenditures. In the United States, the Naval Reserve was administered by state naval militias that operated as a branch of the National Guard in coastal states. Soon after war broke out in Europe, the Naval Reserve became a Federal government function by the Congressional Act of March 3, 1915. After America entered World War I, 30,000 officers and 305,000 enlisted men served on active duty in the Naval Reserve.

In World War II much of the naval expansion which took place was made up by the Reserve. By January 1945, seventy-five percent of the 3.2 million men and women on active duty were reserves.[1]

In the defense build-up of 1978-1986, the Naval Reserve took on new significance. Because of the increasingly long lead times on ship construction, the U. S. did not anticipate being able to build ships and put them into commission during a general conventional war with the Soviet Union. We would presumably have to fight with ships already in commission. Accordingly, it was decided to expand the Naval Reserve Force and provide them with more modern platforms by transferring sixteen Oliver Hazard Perry class FFGs and eight Knox class FFs from the Active Fleet. As NRF units, the ships would have composite active and reserve crews. The full-time portion of the crew includes both regular Navy (USN) and reserves (USNR/TAR); TAR stands for Training and Administration of Reserves. For organizational and reporting purposes, TARs are different from regular USN, but since they are full-time, TARs cost virtually the same as USN crew members. The part-time port'on of the crew (approximately twenty-six percent of the ship's complement) is called Selected Reserve (SELRES). SELRES is defined as "that portion of the ready reserve

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[1] Administration of the Navy Department in World War II, RADM Julius A. Furer, Naval History Division, Department of the Navy, 1959.

consisting of units and individual reservists designated by the Chief of Naval Operations as so essential to initial wartime requirements that they have priority over other reserve elements" (OPNAVINST 1001.21). In peacetime, SELRES members drill one weekend each month and two weeks each summer for a total of 38 days per year. In the event of a general mobilization, the SELRES portion of the crew would be brought on active duty for one year and the NRF ships would deploy with the Active Fleet. Wartime employment of 51 FFGs (including 16 NRF) and 50 FFs (including 8 NRF) would be done as illustrated in Table 1:

TABLE 1 WARTIME EMPLOYMENT OF FRIGATES	
Amphibious Forces	8
7 Military Convoys	63
10 Underway Replen- ishment Groups	30
Total	101[2]

This deployment of forces would have been possible only by mobilizing SELRES crews on the 24 NRF combatant ships. It must also be noted that with the decommissioning of AF Knox class frigates, the above scenario is no longer envisioned, but it is presented as an illustration of how the NRF ships would be integrated into the Active Fleet in time of war.

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[2] Naval Institute Guide to Ships and Aircraft of the U. S. Fleet, 15th edition, Norman Polmar, U. S. Naval Institute Press, 1993.

B. OLIVER HAZARD PERRY CLASS FRIGATES

The Oliver Hazard Perry class frigates comprised the numerically largest U. S. surface ship building program since WWII with fifty-one units completed for the U. S. and four units sold to the Royal Australian Navy. The genesis of the Perry class was Chief of Naval Operations, Admiral Elmo Zumwalt's Project 60 of 1971. Project 60 sought to solve the problem of block obsolescence of WW II-era surface combatants; many Fletcher, Gearing and Forrest Sherman class destroyers were coming up on retirement and the USSR was in the midst of Admiral Gorshkov's naval build-up. Unless the U. S. could respond accordingly, it appeared that Sea Lines of Communication (SLOC) to Western Europe would be threatened in the event of war or international crisis. As Admiral Arleigh Burke said to Zumwalt, "You need numbers."[3]

Perry class patrol frigates would be the low end of Zumwalt's controversial High-Low mix. The "low" ships were designed-to-cost so that a maximum number of fairly effective, relatively inexpensive ships could provide sea control over a wide area and relieve more expensive cruisers and destroyers to escort the carrier battle groups. The cost constraint was to: design, build and deliver the ships for $50 million each (1973 dollars).[4] The cost constraint was never attained as

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[3] On Watch, Elmo R. Zumwalt, Jr. New York, NY 1976.

[4] Ibid.

Drydocking Selected Restricted Availability (DSRA). The SRAs the ships were built for an average of $108 million (1973 dollars). The closest the shipbuilders could come to the constraint was the Estocin (FFG-15), which was delivered for $80 million after Bath Iron Works had conquered the learning curve. Subsequently, costs rose as later versions (flights) of the Perry class had additional major equipments installed at construction. The acquisition cost of the fifty-one ships was 16.795 billion 1991 dollars, or $330 million per ship (source: NAVSEA 017 ship acquisition data base).

The ships were commissioned between 1977 and 1989. They displace between 3600 and 4100 tons and their primary mission is anti-submarine warfare (ASW). They also have anti-air and anti-ship capability with their Mark 13 guided missile launcher and forty missile magazine. They were not originally delivered with Naval Tactical Data System (NTDS) and therefore could not be fully integrated into the carrier battle group (CVBG) anti-air warfare scheme in a high threat environment. Despite that shortcoming, they are excellent platforms and are useful to CVBGs in low threat or ASW scenarios. They are extremely good at ASW, especially with the addition of the LAMPS MKIII SH-60B helicopter (in FFG-8 and FFG-36 through 61), and the SQQ-89 ASW system with associated SQR-19 towed array sonar (in FFG-8 and FFG-28 through 61).

Twelve FFGs were deployed in support of operation Desert Shield/Storm where they were involved in blockade, surveillance and special operations against Iraqi-held islands and observation platforms. Two of the ships have been heavily damaged in action - the Stark (FFG-31) was struck by two Iraqi Exocet missiles (one Exocet warhead did not explode but its fuel added to the devastating fire which killed 37 crewmen) in 1987 and the Samuel B. Roberts (FFG-58) hit an Iranian-laid mine in 1988. Both ships were saved by excellent damage control and were repaired and returned to full service. Stark's repairs cost approximately $90 million and Roberts' cost approximately $37.5 million.

Given the nominal thirty-year life expected of surface combatants, all of these successful ships would be in commission until the year 2007 with the last one being decommissioned in 2019. However, recent defense plans show that possibly all FFGs will be retired in this decade.

III. MANPOWER COSTS

A. MANNING

As with any weapon system, manpower is a crucial consideration. The FFG-7 class is no exception. Cost and manpower constraints were central issues in the design of this ship.

In effect, the Perry class FFG replaced the Gearing and Forrest Sherman classes of destroyers. In comparison to the Gearing class DD, with a displacement of 2800 tons and a crew of 370, the Perry class displaces 3600 - 4100 tons with a crew of 214; the ship is 46% larger with a crew 42% smaller than the Gearing. This reduction in manpower reflected a thirty-year jump in technology from the WWII Gearings with their labor-intensive 5-inch, 38-caliber guns and analog fire control system to the 1970s-era FFGs with its highly automated, digital Mk 92 fire control system, integrating the ship's sensors with the Mk 75 gun and missile launcher. In propulsion, the FFG was also much more automated with computer-controlled gas turbine engines instead of the labor-intensive 600 pound per square inch steam propulsion system on the earlier ship. Automated weapons and propulsion result in a lower payroll and what came to be called the "minimum manning concept". Maximum automation and minimum manning have been successful on the Perry class, but present unique challenges as well, especially for the NRF ships, where "minimum manning" has been taken to a new level. Table 2 presents a comparison between AF and NRF manning on the Perry class.

TABLE 2 MANNING OF FFG-7 CLASS		
AF	NRF	
16 Officer	14 Officer	2 SELRES
198 Enlisted	145 Enlisted	54 SELRES

(Source: BUPERS Activity Manning Document)

The NRF ships have a 25.7% reduction in their full-time manning and an overall reduction of approximately 22.4% in mandays of labor available. The NRF ship has 49,828 mandays/year of labor available compared to 64,200 for an AF ship. The manday figure is arrived at by counting 300 days per full-time crew member per year and 38 days per SELRES crew member per year.

B. PAY AND ALLOWANCES

The military pay system is one of the more complex that could be found in any organization. All service members receive a combination of Basic pay, allowance for quarters (in cash or in kind), and subsistence allowance (in cash or in kind). In addition, there are other pays and allowances which pertain to ship's crews such as Family Separation Allowance (FSA), Career Sea Pay, Imminent Danger pay, Flight Deck pay and Reenlistment bonuses for individuals in undermanned ratings or specialties. Two individuals in identical paygrades, performing in identical billets could be paid widely varying amounts based on time in grade and whether or not that person is married or single, and whether or not that person is living in government quarters.

Payrolls between ships can vary widely based on whether the ship is fully manned to its Basic Allowance (BA), whether it is in homeport (where there would be no entitlement to FSA, Imminent Danger pay or Flight Deck pay) or whether there is sufficient government housing in a particular homeport (if there is a shortage of government housing, there would be larger payments of BAQ and VHA).

AF FFGs have averaged $4.71 million in personnel cash outlays per year during FYs 89-91 while NRF FFGs have averaged $3.78 million over the same period. This represents a savings of 19.7% for the NRF ship. (Source: VAMOSC data base). The VAMOSC data base reflects cash payments to individuals for pay and all allowances and re-enlistment bonuses, as well as government contributions to FICA and Servicemens' Group Life Insurance (SGLI). VAMOSC receives manpower data from the Defense Finance and Accounting Service - Cleveland Center (DFAS) and its Joint Uniform Military Pay System (JUMPS) which makes payments to individuals in the case of direct deposit, and records the payments by each ship's Unit Identification

Code (UIC), whether paid centrally by direct deposit or locally by the ship's disbursing officer.

C. BASIC PAY AND RETIREMENT ACCRUAL

Military retirement is computed using Basic Pay only. Various allowances and bonuses are not included. The JUMPS system which provides information to the VAMOSC data base does not reflect retirement accruals. Intragovernmental transfer of funds from Military Personnel, Navy (MPN) and Reserve Personnel, Navy (RPN) appropriations to the Military Retirement Fund are handled centrally do not show on individual accounts and therefore are not present in JUMPS or VAMOSC.

A discrete breakdown of Basic Pay is not available from the VAMOSC data base. However, it is possible to assign a portion of the Retired Pay Accrual (RPA) to the ship level by making a few basic calculations:

a. compute Basic Pay for the ship using official pay rates and Activity Manning Documents provided by BUPERS,

b. assign a RPA amount using tables provided by the DoD actuary for both full-time and SELRES rates.

Table 3 provides Basic Pay data for AF and NRF ships.

TABLE 3 FY 91 BASIC PAY (FULL-TIME)				
Paygrade	Rate	Billets AF/NRF	AF Total	NRF Total
O-5	47,832.27	1/1	47,832.27	47,832.27
O-4	39,238.50	1/1	39,238.50	39,238.50
O-3	32,280.75	4/4	129,123.00	129,123.00
O-2	25,605.62	3/3	76,816.86	76,816.86
O-1	18,727.66	7/5	131,093.62	93,638.30
E-8	26,207.03	2/2	52,414.06	52,414.06
E-7	22,016.66	12/11	264,199.92	242,183.26
E-6	18,437.99	30/26	553,139.70	479,387.74
E-5	15,058.80	46/36	692,704.80	542,116.80
E-4	12,413.61	58/44	719,989.38	546,198.84
E-3	10,843.81	47/26	509,659.07	281,939.06
			3,216,211.18	2,530,888.69

(Source: Congressional Budget Justification of
of Estimates dated February 1991)

Table 4 provides the computation for the SELRES portion of the NRF crew:

TABLE 4 FY 91 SELRES BASIC PAY			
Paygrade	Billets	Rate	Total
O-1	2	1,976.81	3,953.62
E-7	1	2,323.98	2,323.98
E-6	4	1,646.23	7,784.92
E-5	10	1,589.54	15,895.40
E-4	18	1,310.33	23,585.94
E-3	21	1,144.62	24,037.02
	56		77,580.88

From Tables 3 and 4 we can derive that the in FY 91, a representative annual basic pay for AF and NRF FFGs was approximately $3,216,211.18 and $2,608,469.57, respectively. The savings on basic pay was approximately $607,741.61 for the NRF ship. From the above information we can further derive the approximate Retired Pay Accrual based on each ships basic pay.

D. RETIREMENT COMPUTATION

Three distinct retirement formulas apply for three distinct populations in the military. For persons entering the military prior to September 8, 1980, retirement benefits are computed on the member's final basic pay (FINAL PAY). For persons entering on or after September 8, 1980, the average of the highest 36 months of basic pay is used instead of final basic pay. This formula is referred to as HI-3. The retirement benefits of these first two populations are adjusted each year by the percentage increase in the Consumer Price Index (CPI), referred to as "full CPI protection". Persons entering on or after August 1, 1986, have retirement based on the final 36 months average basic pay, but their benefits are annually increased by the change in the CPI minus 1 percent. At age 62, their benefits are restored to the level of benefits that would have been received with full CPI protection. After that one-time restoration, their benefits are adjusted at CPI minus 1 percent for the rest of their lives. This group is referred to as REDUX. In FY 92, the population of the military was distributed as follows: 37% entitled to FINAL PAY, 24.2% to HI-3, and 38.8% REDUX.

Reserves retire after 20 years of creditable service, the last eight of which must be in a reserve component. Reserve retired pay is not payable until age 60. Years are determined using a point system where 360 points equals a year of service. One point of service is awarded for each day of service or drill plus 15 points for a year's membership in a reserve component. A creditable year of service is one in which at least 50 points are earned. A member cannot retire without 20 creditable years, although points earned in non-creditable years are used in the benefit calculation.

Prior to 1983, military retirement was a "pay-as-you-go" system, whereby the money was appropriated only for members actually receiving their pensions in that year; this is also referred as an unfunded system. Public Law 98-94, enacted in September 1983, established a military retirement fund whereby appropriated funds would be transferred into the fund based on a percentage of a member's pay received during that year. Appropriated funds would be transferred into the retirement fund based on the calculated present value of the future retirement payments for the total active duty and drilling reserve population.

The computed retired pay accrual costs are shown in Table 5.

TABLE 5
RETIREMENT COST AS A PERCENTAGE OF BASIC PAY

Benefit Formula	Full-Time	SELRES
FINAL PAY	42.2	11.7
HI-3	37.2	10.8
REDUX	31.5	9.8
Weighted Avg.	36.8	10.7

(Source: Valuation of the Military Retirement System)

Table 5 percentages are the result of Net Present Value (NPV) computations based on predicted cash flows in and out of the Military Retirement Fund. Economic assumptions in the actuarial model are a nominal interest rate of 7.5% on the fund's assets (which are invested in Treasury Bonds) and inflation rate of 5%, resulting in a real interest rate of

2.5%. On the liability side of the computation, pay raises are set at 5.5% per year which results in a real interest rate of .5%. These economic assumptions were in effect in both FY 91 and 92.

As can be seen from Table 5, Reserve retirements are less expensive than full-time retirements. This is a result of both the point system (where a creditable year may be much less than 360 points) and time-value of money computation resulting from reserves (SELRES) not receiving retirement benefits until age 60.

Using the percentages in Table 5, and the totals from Tables 3 and 4, we can calculate the annual retirement cost for an AF ship as $1,183,565:

($3,216,211 X 36.8%).

The retirement cost would be $939,668 for the NRF ship:

($2,530,888 X 36.8%) + ($77,580 X 10.7%).

This represents an additional $243,897 savings for the NRF ship (which is not reflected in the VAMOSC data base) and a total manpower savings of $1.172 million per year per ship.[5]

[5] Valuation of the Military Retirement System, Office of the Actuary, Department of Defense.

IV. MAINTENANCE COSTS

A. MAINTENANCE CONCEPT

Maintenance of both AF and NRF Perry class frigates is governed by the same Class Maintenance Plan (CMP). Theoretically, there should be no difference in maintenance costs, except those attributable to higher operating tempo (OPTEMPO, roughly equivalent to underway days per quarter), or differences in configuration. As to configuration, the latest flight of frigates had RAST, fin stabilizers, Close-in Weapon System (CIWS) 20-mm gun, and SQQ-89 sonar installed at construction, while not all of the first and second flights had these systems backfitted in them. (RAST - Recovery Assistance Securing and Traversing - is the American version of the Canadian Bear-trap system which is used to winch down SH-60B helicopters onto the flight deck in heavy weather and then to maneuver the helos into their hangars).

The minimum manning concept, discussed in Chapter III, has a profound influence on the Perry class maintenance practice. Because the ships were designed with manning constraints, it was imperative that organizational level (O- level) maintenance (maintenance performed by the ship's crew) be reduced to the minimum possible level. Intermediate (I-level) and Depot level maintenance would be increased to keep these ships at the highest possible readiness.

The CNO also imposed an operating availability target of 90% during the design phase of this class. Reaching 90% availability would mean that on any day, 45 of the 50 planned ships would be available for operational requirements, with only five being in an extended shipyard overhaul period. Earlier ship classes operating availability was approximately 70% based on an 18-month overhaul every five years. In order to meet these goals, the Progressive Ship Maintenance (PSM) strategy was developed. PSM "compensates for reduced manning by minimizing organizational level maintenance while maintaining maximum operational availability."[6]

Since these ships were built with cost constraints, there is less redundancy than had previously been designed into destroyer-type surface combatants (e. g. two engines vice four, one shaft vice two, one air search radar vice two). To maintain operational effectiveness and survivability, critical systems are therefore replaced before they fail based on the system's expected life or mean time between failures (MTBF) analysis.

Each Perry class frigate has a 61-month operating cycle during which it will receive six one-month Intermediate Maintenance Availabilities (IMAV) accomplished by destroyer tenders or their shore-based equivalent, the Shore Intermediate Maintenance Activity (SIMA), two two-month Selected Restricted Availability (SRA), and one three-month

[6] FFG-7 Class Maintenance Plan

Drydocking Selected Restricted Availability (DSRA). The SRAs replace the eighteen-month shipyard overhaul that was common in the earlier destroyers' maintenance and operating cycles. Theoretically, the CNO's goal of 90% operational availability for this ship class is met if the SRAs are seven weeks long and the DSRA is 11 weeks long vice the two and three month periods cited above. IMAVs do not count against the 90% goal because the ship is not in the same state of disrepair as in an SRA and could be made ready for sea in the event of an emergency in a relatively short time.

During the remaining 48 months of the 61-month cycle, the ship makes three six month overseas deployments, is in homeport, the local operating areas, refresher training, law enforcement operations, etc.

B. ORGANIZATIONAL LEVEL MAINTENANCE

It is recognized that FFGs have a reduced on board self-maintenance capability. The CMP states that the organization level is tasked to:

- Maintain proper operating environment for ship's equipment.
- Perform specified Planned Maintenance and operational testing on a continuing basis.
- Perform corrective maintenance that is within organization capability and within operational constraints.

The CMP and design of the ship call for maximum use of repairable modules for timely restoration of critical systems. These modules are carried as on-board repair parts, and the failed units are repaired off-ship as Depot Level Repairables (DLR). By use of DLRs and maintenance assistance modules, trouble shooting and repair of critical systems are accomplished quickly.

Even with the reduced O-level repair capabilities, it is estimated that 100 of the 198 crew members (50.5%) are in maintenance ratings on AF ships and 78 of the 145 (53.8%) on the NRF ship (based on average Current On Board (COB)).[7] A list of these ratings is presented in Table 6.

TABLE 6
FFG-7 MAINTAINER RATINGS

EM	ET	EN
HT	GSM	GSE
IC	DC	FC
GM	GMM	GMG
TM	STG	SK
SN	FN	

The PACFLEET frigate study (often referred to as the Admiral Janes study) defined the above ratings as maintainers because their work centers have ownership of the major weapons, electronics, propulsion and auxiliary and electrical systems of the ship. While storekeepers (SK) do not own equipment, their primary role is to provide repair parts to the maintenance work centers, hence their inclusion in the

[7] Pacific Fleet NRF Frigate Study, 1991, chaired by RADM D. A. Janes, USNR.

maintainer ratings. Based on the Admiral Janes study, we could conclude that 50-53% of the enlisted manpower costs could be assigned to O-level maintenance.

However, even in the maintainer ratings a considerable amount of time is devoted to professional training, general military training, damage control training, administration, in-port and underway watch standing. To further complicate the issue, even non-maintainer ratings will have some damage control planned maintenance (PMS) in their spaces. Estimated per ship O-level maintenance cost is provided in Table 7:

TABLE 7
O-LEVEL MAINTENANCE COSTS

Category	AF	NRF
Enlisted Manpower	1,003,371	825,939
Repair Parts	548,669	460,882
Consumables	87,294	76,156
Ships Force Matl	63,647	61,958
Repairable Modules	604,671	514,188
Totals	2,307,652	1,939,123

(Source: VAMOSC data base)

The enlisted manpower costs are a subset of the totals provided in Chapter III. They were derived using the PACFLEET NRF Frigate study which concluded that 50.5% of the enlisted billets were in maintainer ratings on AF FFGs and 53.8% on the NRF FFGs.

Table 7 represents three year (FYs 89-91) averages of VAMOSC data element 1.1.1.3 (enlisted manpower) multiplied by

.505 and .538 and then multiplying that product by .5 (on the assumption that half of maintainer time is spent on maintenance and half is spent on watch standing, training and administrative duties).

Consumables costs were the three-year averages of VAMOSC data element 1.2.3.2 multiplied by .5. This was done because there is no discreet breakdown in the Navy's cost accounting system to sort repair-related consumables (e. g. rags and greases) from other consumables such as copying paper or paper plates.

Ship's force material is the cost of material consumed by the ship's crew during an overhaul (SRA/DSRA). It is material issued by the shipyard for jobs to be accomplished by the ship.

Repair parts costs were a three-year average of VAMOSC data element 1.2.2 in the case of AF ships. For NRF ships this data element was judged to be unreliable because the cost of repair parts for FY 91 was $0 for all 16 ships, $0 for FFGs 23 and 25 in FY 90 and ranged from an unrealistic $8,000 (FFG-22) to a more realistic $452,000 (FFG-25) in FY 89. As a result of this apparently missing data, the repair parts category for NRF FFGs in Table 7 was derived by multiplying the AF repair parts cost by .84, on the assumption that since the other O-level maintenance categories (enlisted manpower, repairable modules, S/F material, and consumables) were 84% of the AF averages, then repair parts would account for roughly the same proportion of O-level costs. The actual VAMOSC amounts for data element 1.2.2 reflected an average cost of $126,348 (23% of the AF cost) for repair parts over FY 89-91.

C. INTERMEDIATE LEVEL MAINTENANCE

Intermediate Level maintenance on FFGs is performed by Navy personnel at SIMAs, by Destroyer Tenders (AD), and by Ship Repair Facility Guam and Yokosuka (SRF). Intermediate Maintenance Activities (IMA) perform both corrective and periodic maintenance under the CMP. I-level work includes:

- Progressive maintenance (CMP) work items; replacement before wearout as directed by PERA (Surface).

- Corrective maintenance, including work items with assistance from ship's force.

- Deferred planned maintenance (PMS).

- Maintenance actions based on condition monitoring/trend analysis as approved by the Type Commander.

- Additional essential repairs identified after submission of the IMAV work package; the short duration of the IMAV necessitates that such repairs be limited to mission-essential or safety-essential repairs.

Costs for I-level maintenance are presented in Table 8.

TABLE 8
I-LEVEL MAINTENANCE COSTS

Category	AF	NRF
Labor	264,977	290,938
Material	64,046	98,687
Commercial Industial Service	57,663	92,208
Totals	386,686	481,833

(Source: VAMOSC data base)

The amounts in Table 8, represent three-year averages from FYs 89-91, except for labor which is FY 91 data only. The reason labor is not a three-year average is that labor was greatly underreported in FY 89-90 at the IMAs. Under new Defense Business Operating Fund (DBOF) rules (in effect in FY 91), IMAs have much greater incentive to report all labor hours, because that is now the basis for determining their operating budgets. The labor cost is the total reported labor hours multiplied by $18.18 (by the VAMOSC program), which was the Composite Standard Rate for the paygrade E-6, taken from NAVCOMPT Notice 7041 for FY 91. The E-6 pay rate was selected by the Naval Center for Cost Analysis (NCA) based on their study of I-level maintenance, which determined that Petty Officer First Class was the average paygrade performing IMA maintenance. The Composite Standard Rate includes basic pay, allowances, and retired pay accrual for that pay grade.

The material cost is a total for data elements 2.3 (Material), 2.3.1 (Afloat Repair Parts) and 2.3.2 (Ashore Repair Parts). It should be noted that VAMOSC reports do not add 2.3.1 and 2.3.2 to arrive at 2.3. Those two elements are presented independent of any other elements and totals. They are added together in this thesis for a more complete capturing of I-level costs.

Commercial Industrial Service (CIS) is the cost of I-level maintenance which is contracted out due to workload limitations at the IMAs.

The cost of I-level maintenance is approximately 16.8% of O-level maintenance for AF ships and 24.8% of NRF ships. Per the VAMOSC data base, the typical NRF ship receives approximately 25% more support from IMAs than the AF ship. As would be expected, given their reduced manning, NRF ships need more off-ship assistance than their AF counterparts.

D. DEPOT LEVEL MAINTENANCE

Depot level maintenance is shipyard (commercial or government) overhaul work accomplished in support of the CMP. As would be expected, depot-level maintenance is that type of maintenance requiring a greater level of industrial capability than is available at either the organizational or intermediate level. FFGs normally receive seven months of depot-level overhaul work during the 61 month cycle in 2 SRAs and 1 DSRA. Depot level work consists of the following general actions:

- Preserving the underwater body; maintaining sea-connected tanks, valves, pipes and fittings; and maintaining the cathodic protection and prairie/masker systems.

- Repairing the propeller, shafting, struts, reduction gear, clutches and sonar domes.

- Repairs requiring heavy-lift capability and special tools and test equipment.

- Installing ship alterations (SHIPALT) and ordnance alterations (ORDALT) packages identified in the Fleet Modernization Program (FMP).

- Accomplishing other repairs not within the capability of the I-level as designated by the CMP.[8]

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[8] FFG-7 Class Maintenance Plan.

Given the capital requirements for both government and commercial shipyards, it is not surprising that depot-level work is very expensive. The average annual cost of depot-level maintenance is $6.31M for each FFG, including both NRF and AF combined (compared to the $2.73M for both O and I-level). Fleet Modernization accounted for $4.38M per ship per year, or 69% of depot-level work. When Fleet Modernization is factored out, on average, the cost of depot-level repairs are actually seen to be less than O-level costs ($1.93M for depot-level v. $2.19M for O-level). Some equipment removed and replaced under a SHIPALT or ORDALT may have needed replacement or rework irrespective of the modernization program and that portion of the work cannot be determined from the VAMOSC data base. While it was surprising to the author that O-level maintenance costs more than depot-level, it should be considered that an FFG has O-level maintenance taking place every day of its life, while depot-level work is taking place during only 10% of its life. Table 9 presents a comparison of depot-level repair and modernization costs:

TABLE 9 DEPOT-LEVEL MAINTENANCE COSTS		
Category	AF	NRF
Repairs	2,512,249	1,471,159
Modernization	3,846,919	5,601,417
Material	2,895,884	3,684,291
Totals	6,197,168	7,072,576

(Source: VAMOSC data base)

Material costs are a subset of Modernization. The figures above are three-year averages. During the period FY 89-91, NRF ships have had lower depot-level repair costs and higher modernization expenses than AF FFGs. The modernization costs, however, are more of an investment than an operating cost. The higher modernization cost for NRF ships was a result of the Reserves operating first and second flight ships, and NAVSEA desiring to bring these ships up to a more modern configuration.[9] NAVSEA's philosophy has since changed with the unveiling of a planned 340 ship fleet; now any available FMP funds will be used on the most capable third and fourth flight ships.

The reader should be aware that the use of averages (means) may be misleading in the case of modernization as the bulk of the modernization funding was expended on relatively few ships. Even though the average annual modernization cost is $3.8-5.6M per ship, that amount is not representative of

[9] Per phone interview with CDR K. Holden and Mr. Dave Schmitt of NAVSEA PMS-330 conducted 15 April 93.

how the FMP is executed. For instance, FFG-7 and FFG-15 received $55M and $50M modernizations that included SQQ-89 sonar, raising maximum displacement to 4100 tons and installation of fin stabilizers. In these two modernizations, approximately 40% of NRF FMP funding was expended. Additionally, FFGs 9, 11 and 14 received approximately $35M modernizations, so approximately 73% of NRF modernization funding was used on five ships.

In the case of AF ships, FFG-50 received a $77M modernization consisting primarily of the Coherent Receiving and Transmitting (CORT) upgrade to the Mk 92 fire control system. The CORT upgrade is designed to improve detection and tracking of incoming targets in a electronic countermeasure (ECM) clutter environment. This modification brings FFG-50 up to virtually the same configuration as the FFG-61 which received CORT at new construction. Ten other AF FFGs received extensive modernizations costing over $20M per ship; as a result, on the AF side, $302M was expended on 11 ships, or 75% of FMP money on roughly one-third of the ships.

V. OPERATING COSTS

A. DIRECT COSTS

The categories of operating costs are fuel and lubricants (POL - petroleum, oil, lubricants), ammunition expenditure, purchased services, which includes utilities, and equipment/equipage replacement. Fuel costs are driven by Operating Tempo (OPTEMPO). OPTEMPO for ships not undergoing an SRA/DSRA is set at a level that allows them to achieve and sustain the level of training readiness that their Type Commanders (COMNAVSURFLANT and COMNAVSURFPAC) consider necessary to support deployed operations. OPTEMPO is used to budget the expenditure of fuel. AF ships are allotted 51 underway days per quarter while deployed and 29 days per quarter when not deployed. NRF ships are allotted 18 days per quarter (source: NAVCOMPT, CNO code N-82). It would be logical that based on their higher OPTEMPO that AF ships would have higher fuel costs and a resultant higher state of readiness because of the greater opportunity for underway training. Table 10 presents the average fuel costs for FYs 89-91.

TABLE 10 POL COSTS				
	89	90	91	Average
AF	981,978	835,461	1,807,206	1,210,390
NRF	637,063	592,500	1,099,938	776,500

(Source: VAMOSC data base)

During the three year span of this study, the average NRF ship consumed 64.15% as much POL as its AF counterpart which is what would be expected given the OPTEMPO constraints placed on it. This represents a $433,890 savings per NRF ship per year. Ninety-nine percent of the POL cost consists of Navy distillate fuel (F-76) which is burned in both the LM-2500 gas turbine engines and in the four ships service diesel generators, with the remainder being engine or reduction gear lubricating oil. The Desert Shield deployments caused a dramatic increase in POL costs in FY 91.

Other major categories of operating expenses are expendable ammunition, equipage, and purchased services (including utilities). These categories are presented in Table 11.

TABLE 11 OPERATING COSTS		
Category	AF	NRF
POL	1,210,390	776,500
Purchased Services	273,009	312,612
Utilities	190,825	253,696
Supplies (non-maint.)	87,294	76,156
Equipage/Equipment	53,735	52,604
Ammunition	486,074	308,563
Totals	2,110,502	1,526,435

(Source: VAMOSC data base)

Utilities are a subset of Purchased Services. The data above are three-year averages from the VAMOSC data base, except for NRF utilities. This data element (1.3.3) had a cost of $0.00 for all NRF FFGs except the Copeland, FFG-25. The $253,696 cited above is a computed using a master's thesis by Patrick Reardon which compared utility costs in FFGs and FFs and concluded that on average, NRF FFGs had utility costs 32.94% higher than AF FFGs.[10] The NRF utility cost is the AF utility multiplied by 1.3294. Reardon's thesis concluded that the NRF ship has higher utility charges because of lower OPTEMPO; more days in port means lower fuel costs but higher utility costs. For comparison, the NRF frigate Copeland (FFG-

[10] Reserve Manning of the FF-1052 and FFG-7 Class Frigates: A Critique of the Accuracy and Completeness of Existing Costing Studies, Patrick R. Rearden, Naval Postgraduate School, Monterey, CA, 1987.

25) had utility expenses that averaged $291,000 during period FY 89-91. However, based on Reardon's thesis, $291,000 appears to be too high to use as a representative amount for NRF FFG utility costs .

In addition to utilities, purchased services includes ADP equipment and service rentals, printing services, telephone service, and postage charges.

The ammunition category includes the cost of 76mm, and 20mm gun ordnance, missile training shots, small arms and pyrotechnics. The higher cost attributed to AF units is a result of the requirement that deploying ships get more opportunities to practice live firing exercises as part of the deployment workups. NRF ships have fewer opportunities for this.

Equipment/Equipage is the cost of items classified as neither consumables nor repair parts. This category of equipment is subject to a higher degree of control because of high unit cost, vulnerability to pilferage or essentiality to ships mission. Examples include foul weather gear, binoculars, and electronic test equipment. (Source: VAMOSC volume I).

Non-maintenance supplies are consumable items such as copying paper, paper plates, cleaning gear and toilet paper. For the purposes of this thesis, this cost was derived by taking the consumable data element 1.2.3.2 and multiplying by

.5 on the assumption that half of the consumables used are repair-related and half are not.

The NRF ship has operating costs $584,067 less than the AF ship and 74% of this savings is a direct result of lower OPTEMPO and the resultant saving in fuel costs.

B. INDIRECT COSTS

Indirect costs include off-ship training, publications, ammunition handling, and engineering technical services (ETS). These costs are available from VAMOSC data elements 4.1 through 4.4.

Training (element 4.1) is the cost of "C" and "F" school courses applicable to ships. This category is essentially an allocation of overhead for the shore training support that these ships receive. The allocation base chosen by the Naval Center for Cost Analysis (NCA) and the Naval Education and Training Program Management Support Activity (NETPMSA) is the number of personnel assigned to the ship. For example, the total allocated cost for officer courses is determined by NETPMSA calculating the total cost of all officer shipboard training courses. This amount is then divided by the total number of officers assigned to all ships. The cost per officer is then multiplied by the number of officers assigned to each ship to obtain a per ship officer training cost. A similar logic is used by NETPMSA for enlisted training courses. The cost allocated to AF FFGs was $376,751 per ship in FY91 and $285,438 for NRF ships. Fiscal Year 1991 was the first year that this data element was computed for VAMOSC. Because allocation bases are notoriously arbritary and there is no way of verifying the accuracy of this particular allocation base, the averages for training will not be included in per ship totals later in this thesis.

Engineering Technical Services (element 4.3) costs are the costs of engineering services incurred by the ship while not in IMA or depot availability. Ammunition handling (4.4) is the cost of on-loading/off-loading the ship's ammunition by Naval Weapon Stations and is recorded against the ship's Unit Identification Code. The per ship cost for 4.2, .3 and .4 was $122,084 for AF ships and $118,872 for NRF ships. These data are based on FY 91 costs from the VAMOSC data base.

VI. DEPRECIATION COSTS

A. RATIONALE FOR DEPRECIATION

Depreciation is a method used by industry to indicate the loss of value of capital items as they are used over their lives. Depreciation is not generally used in government accounting and is in fact used in business largely for the tax advantage derived from having lower profits as a result of the additional expense. This thesis does not advocate the use of depreciation as a matter of routine. Theoretical depreciation schedules will be done for selected FFGs in this thesis strictly as an academic endeavor to provide information on how much the annual ship operating expenses would be effected if this method of accounting were used.

Depreciation is defined as "that portion of the cost of a tangible operating asset that is recognized as expense in each period of the asset's life."[11] In business accounting, assets as valuable (330 million each in 1991 dollars) as Perry class frigates would merit capitalization (i. e. placement in an asset account) and expensing over time through depreciation. In traditional government accounting, funds are simply obligated when a contract for construction of the ship is signed and then expended (i. e. paid to the shipyard)

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[11] Financial Accounting, Robert K. Eskew and Daniel L. Jensen McGraw-Hill, 1992.

through progress payments as the ship is completed, is outfitted and goes through post-shakedown availability (PSA). What matters most in government accounting is the obligation and expenditure of funds.

In business, under Generally Accepted Accounting Principles (GAAP) and a standard double-entry accounting system, the acquisition of a $330,000,000 asset would be recorded as a debit (increase) to the capital equipment account and a credit (decrease) to the cash (or accounts payable) account. There would be no net change in the firm's asset position, as one $330 million asset (cash) had been exchanged for another (a ship). The expense would be recorded as depreciation over the life of the ship; 1/30th or $11M per year for 30 years using straight-line depreciation.

In government accounting, there would be an obligation of $330M at contract signing and expenditures totalling $330M as the ship was built and delivered, with the final progress payment being made after PSA. The outlay of $330M is recognized as an expenditure, but the receipt of a ship is not recognized as an asset in official financial accounting records. For the government, there is a net loss (the cash outlay) of $330M up front and no depreciation expense over the 30-year life of the ship.

B. STRAIGHT-LINE METHOD

The straight-line method is the simplest method of depreciation. As the name implies, this method would allocate an equal amount of the acquisition cost to each year of the ship's expected life. Use of the straight-line method implies that an equal amount of utility is obtained from the asset during each year of its life. Surface combatants have a nominal life of 30 years, so in our hypothetical depreciation schedule 1/30th of the depreciable cost would be expensed each year. Under GAAP, the historical cost of the asset is used with no adjustment upward to account for inflation or increase in market value.

The median cost of AF frigates was $191,633,000 for the Crommelin, FFG-37. Under the straight-line method, the annual depreciation expense for FFG-37 would be $6,387,767. The median cost for NRF FFGs is the mid-point between Fahrion, FFG-22 and Lewis B. Puller, FFG-23, which is $139,348,500. Using this median price, a representative annual depreciation expense for NRF FFGs can be calculated -- $4,644,950. Various theoretical depreciation expenses are shown in Table 12.

TABLE 12
SRAIGHT-LINE DEPRECIATION EXPENSE

Ship	Acquisition Cost	Annual Depreciation
FFG-7 NRF	272,800,000	9,093,333
FFG-22/23	139,348,500	4,644,950
FFG-15 NRF	103,424,000	3,477,483
FFG-61 AF	383,678,000	12,789,267
FFG-37 AF	191,633,000	6,387,767
FFG-26 AF	109,799,000	3,659,967

The source of acquisition costs was NAVSEA 017 Ship acquisition data base (the rounding to the nearest thousand was done in the data base). The ships selected represent the high, median and low costs for the AF and NRF categories in order to show the range of depreciation expense that would result.

If depreciation expense (straight-line method) were used in government accounting, it would add between $3.5 and $12.8M per year to each ship's operating and support costs. FFG-7 was the highest cost NRF ship costing 272 million 1973 dollars. FFG-61 was the highest cost AF ship and its costs are shown in 1984 dollars.

C. ACCELERATED DEPRECIATION

The sum-of-the-year's-digits (SOYD) method is a fairly common accelerated depreciation method used on the assumption that most of an asset's value is consumed early in its life (which is debatable in the case of ships). This method assigns a higher rate of depreciation in the first years based on a ratio that uses the sum of the digits in the asset's life. For a ship with a 30-year life, this would involve adding the numbers 1+2+3...+29+30 to get 465. The ratio used for the first year depreciation would be 30/465 which equals .064516129. In other words approximately 6.5% of the depreciable cost would be expensed in the first year and only approximately .2% would be expensed in the thirtieth year.

For FFG-61, the first year's expense would be $24,753,419 and its last year's would be approximately $825,113 under this system (in actual practice in SOYD, the depreciation amount for the last year is whatever is left in the account in order to reach $0.00).

Table 13 lists hypothetical depreciation that would be expensed in 1991 under SOYD depreciation.

TABLE 13
SOYD DEPRECIATION EXPENSE

Ship	Year/Ratio	Annual Depreciation
FFG-7	14/.03656	9,973,333
FFG-22/23	9/.04731	6,592,832
FFG-15	11/.04301	4,448,344
FFG-61	2/.06237	23,928,305
FFG-37	8/.04946	9,478,622
FFG-26	10/.04516	4,958,665

The depreciation amounts above are derived by taking the year the ship commissioned (commissioning date was December 1977 for FFG-7) and counting backwards from 30. Since 1991 was FFG-7's 14th year in commission, and counting backwards from 30, the ratio is 17/465 or .038709. The acquisition cost (from Table 12) was 272,800,000.

$$272,800,000 \times .038709 = 9,973,333$$

Under SOYD depreciation schedules, the depreciation for 1991 would range from a low of $4.4M up to $24M, a substantial increase from the straight-line method. The reason for the higher expense under SOYD is that none of the ships had reached the half-way point of their lives based on a 30-year life. FFG-61's expenses would be especially affected since it was commissioned in 1989.

What does depreciation tell us? It takes into account the building cost and spreads that out over the lifetime of the asset. Depreciation makes the owner cognizant of the cost of an asset and this cost is taken into account in the utilization of the asset over its entire life. Government accounting treats the construction cost of an asset as a sunk cost (and therefore not relevant in deciding how the asset is used). However, the fact that the government could sell the ship makes it not **literally** a sunk cost. Therefore, a case could be made for depreciating the construction of the ship. In business accounting, the construction cost is relevant because it is not treated as a sunk cost (part of the construction cost will show as an expense on the business' income statement every year of the depreciable life of the asset).

What would be the operating and support cost of FFGs if the government used depreciation? Table 14 provides the totals for all operating and support costs.

TABLE 14 TOTAL FFG O & S COSTS		
Category	AF	NRF
Manpower	5,895,777	4,724,208
Operations	2,110,502	1,526,435
Maintenance	7,888,135	8,667,593
Indirect Costs	122,084	118,872
Subtotals	16,016,498	15,037,108
Depreciation	6,387,767	4,644,950
Totals	22,404,265	19,683,058

The costs cited above are taken from previous tables in this thesis. They are based on VAMOSC data with deviations from VAMOSC as described in the above text. The maintenance category has the enlisted manpower costs subtracted out but modernization costs are still included. The depreciation cost is theoretical and reflects the straight-line depreciation based on the median acquisition costs.

Table 14 summarizes all operating and support costs for the first time in this thesis. Not counting depreciation, the operating and support cost difference is $979,390 in favor of the NRF ship. By counting depreciation the difference widens to $2.721M.

VII. PERFORMANCE

A. ENGINEERING READINESS

The engineering examination for ships consists of Light Off Examinations (LOE) and Operational Propulsion Plant Examinations (OPPE). "LOEs and OPPEs conducted by the Propulsion Examining Board (PEB), reflect current fleet standards for the measurement of engineering readiness."[12] The LOE/OPPE consists of:

- Material condition; a comprehensive evaluation of the ships main propulsion and auxiliary machinery spaces and equipment.

- Level of knowledge; written and oral testing of engineering department personnel to determine skill levels and effectiveness of training.

- Administration; inspection of engineering department training records, engineering logs, lube oil program, etc.

- Firefighting; evaluating of the ship's ability to control large fires in the engineering main spaces.

- Operations; evaluation of the engineering watch sections to safely operate the engineering plant in both normal and emergency conditions.

The LOE includes the first four categories, and the OPPE has all five. These are extremely demanding exams and failure can have severe consequences for the careers of the senior engineering personnel and the commanding officer.

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[12] Pacific Fleet NRF Frigate Study.

How have the ships performed on these exams and is there a difference between AF and NRF ships? The NRF PACFLT Frigate Study documented that during the period 1981-1991 AF FFGs failed the OPPE/LOE 17 times in 94 examinations or 18.1% of the time. NRF FFGs failed in 8 of 29 inspections, for a failure rate of 27.58%. In the interim period since the study was released in August 1991, NRF FFGs have failed 5 of 18, so the NRF failure rate is holding about steady; AF FFGs have failed once in 16 examinations for a rate of 6.35% The total rate for the period 1981 through March 1993 is shown in Table 15.

TABLE 15
LOE/OPPE FAILURE RATES

Category	No. Exams	No. Failures	Failure Rate
AF	109	18	16.5%
NRF	47	13	27.7%

The source of the above data is the PACFLT frigate study and LOE/OPPE message reports provided by COMNAVSURFPAC code N8 for the period since August 1991.

In one recent inspection, the Thach (FFG-43) experienced a main engine casualty during the underway period of the OPPE, resulting in an incomplete in October 91. The incomplete is not counted in the above summary.

Table 15 indicates a measurable difference exists in engineering readiness and training between AF and NRF FFGs. To quote from the PACFLT study:

> With fewer personnel onboard, NRF ships have a reduced capability to self-train because the Engineering Casualty Control Training Team (ECCTT) is the off-going watch section. This limits the number of drills that can be run because the ECCTT must go back on watch in four hours, and it must comply with fatigue and heat stress safety requirements. Additionally, with less skilled personnel and fewer available manhours, it is impossible to perform all the required maintenance. The limited supervisory personnel are spread thin as a result of manning cuts, with no corresponding cut in requirements or responsibilities...This is particularly evident on already minimally manned FFGs.

The fact that NRF ships are 67% more likely to fail a major engineering inspection than their AF counterpart is most likely a direct result of reduced manning. This thesis does not have a methodology for assigning a financial cost associated with reduced engineering readiness, but with reduced manning and its $1,171,569 saving per year per ship, comes a higher probability of lower engineering readiness. With lower engineering readiness, additional management attention (both on-ship and off-ship) must be devoted to passing the re-OPPE or re-LOE and there is an opportunity cost associated with this.

B. MATERIAL CONDITION

As evidenced in the LOE/OPPE examination, material condition is more likely to be degraded in engineering equipment and spaces. In the PACFLT frigate study, one other area of material condition was cited - the Current Ships Maintenance Project (CSMP). The CSMP is a listing and description of all open (incomplete) maintenance actions. These actions are recorded by a Job Control Number (JCN). In

August of 1991, the average NRF FFG CSMP contained 1761 jobs and the average for AF FFGs was 1427. The NRF CSMP was 23% larger than the AF. The PACFLT study concluded that this was more a result of homeport than of NRF status. Long Beach-based ships had a much higher JCN count than San Diego-based ships; and most of the NRF ships are stationed in Long Beach. They attributed the larger maintenance backlog to the SIMA at Long Beach. As a result of the PACFLT frigate study, the maintenance backlog was closely managed with the result that the average JCN count now stands at 991 for NRF and 948 for the AF (Source: Maintenance Resource Management System data provided by NAVSEA Detachment PERA (Surface) Philadelphia, PA.)

The CSMPs have been successfully reduced and probably reflect a higher state of readiness for both AF and NRF FFGs. But it should be noted that regardless of the cause, the larger CSMP on the NRF ship probably was reflected as a maintenance cost avoidance in FYs 89-91 and likely required higher expenditures in I-level and depot level for FY 92s and 93. Fiscal Year 1992/1993 VAMOSC data was not available for this thesis. The VAMOSC is generally available in the June of the next year.

C. SUPPLY MANAGEMENT

In the area of supply management, the NRF ships are actually outperforming their AF counterparts. As judged by COMNAVSURFPAC Supply Management Assessments (SMA), NRF FFGs attained higher average scores in all four inspected areas. The areas are:

- Accountability
- Sustainability
- Crew Support
- Level of Knowledge

The PACFLT frigate study reported higher scores for the NRF FFGs and that trend has continued in the period since the study was released. The grades assigned are Failing, Marginal, Good, Excellent and Outstanding. By assigning a numeric value of 0 = Failing, 1 = Marginal, 2 = Good, 3 = Excellent, and 4 = Outstanding, it is possible to compute average scores for each category of ship. These scores are presented in Table 16.

TABLE 16
SUPPLY MANGEMENT ASSESSMENT

	ACC	SUS	CS	LK	Avg.
PACFLT Frigate Study					
AF	2.5	2.0	2.5	2.6	2.4
NRF	2.75	3.0	2.6	2.75	2.775
1991-1992 SMA Cycle					
AF	2.22	2.11	2.44	2.33	2.275
NRF	2.4	2.4	3.0	2.4	2.55

The 1991-92 inspection cycle includes SMAs on 5 NRF and 9 AF FFGs. In the area of supply management, the reduced manning is not a detriment to how well the supply department can do on its major inspection and, by extrapolation, the NRF FFG actually appears to be getting better support from its supply department than its AF counterpart. It would be nonsensical to say that reduced manning is an advantage for NRF supply departments; rather, it appears that reduced OPTEMPO gives the NRF supply department additional opportunities to use off-ship assistance to improve supply operations.

VIII. CONCLUSION

A. TOTAL SAVINGS

The bottom line is that sending an FFG from the Active Fleet to the Naval Reserve Force saves about $979,000 per year, or about 6.1% of all operating and support costs. This figure penalizes the NRF because it includes the modernization costs under depot-level repair. NRF ships are flights I and II and during 1989-1990, NAVSEA was attempting to modernize these ships (1989-1990) with the effect that NRF hulls received an average of $1.754M per ship more than AF ships under the Fleet Modernization Program. This expenditure was a discretionary cost and could have been avoided completely by freezing the configuration of those ships. With the FMP delta factored out, the savings of NRF vis a vis AF FFGs would be $2.733M per ship. This figure may penalize AF frigates because they are ordered to maintain a higher OPTEMPO and their depot-level maintenance costs are bound to be higher because of their more advanced configuration (RAST, SQQ-89, CIWS, fin stabilizer). Because AF and NRF FFGs are under the same class maintenance plan, it would be logical to expect roughly similar maintenance costs except for differences attributable to higher OPTEMPO or configuration. This brings us back to manpower savings - the $1,171,569 per year. The author of this thesis is of the opinion that manpower is the true savings in this whole equation. In total then, the NRF FFG program saves a total of $18,745,000 per year; the cost of one Active Fleet FFG. **In other words, by instituting the NRF surface ship program the Navy is able to operate the current mix of 35 AF and 16 NRF FFGs for the same cost as would be incurred by operating 50 AF FFGs. This means that the Navy gives up a full 15 deployable ships in return for only 16 NRF ships.** The Naval Reserve surface program is not the force multiplier that was envisioned in the early 1980s.

On the other hand, if the reader is of the opinion that $2.854M is the real per ship savings, then the Navy-wide savings would be $43,728,000 per year; under this assumption, the number of AF FFGs that could be operated at the same cost as the current mix would be between 48 and 49. In that case, the Navy gives up at least 13 deployable ships in exchange for 16 NRF ships. The Naval Reserve surface program has allowed the Navy to have a slightly larger Order of Battle, but at a cost of reduced readiness for 14 to 16 ships, and with significantly fewer deployable assets.

From these savings one would have to deduct any cost of duplication between active and reserve areas. To quote from the Chairman of the Joint Chiefs of Staff:

> We found areas of active and reserve forces that, if eliminated, better integrate the Total Force and preserve robust combat capabilities at lower cost. One such example is the parallel headquarters structures in the active and reserve components... In the Navy, there is a Commander, Naval Reserve Force; A Commander, Naval Air Reserve; and a Commander, Naval Surface Reserve, each

> with a headquarters staff duplicating the functions of one another and of the Active Navy component.[13]

By being in the business of operating surface ships, the Naval Reserve is forced to duplicate staff functions of the Active Navy. The costs of operating headquarters staff is beyond the scope of this thesis, but it could cut considerably into the $18M-44M savings achieved at the shipboard level by the NRF FFG program.

In a period of tight budgets, $18.75M-43.73M in savings is not to be dismissed lightly. On the other hand, one has to ask what is being bought for the money, regardless of any savings. It costs $245M per year in operating and support costs for the 16 NRF FFGs but they do not deploy. Can the Navy afford this large an annual expenditure on ships that are relegated to a training role only?

Civilian industry would not routinely underutilize capital assets in that way, except for short periods of time during a business down-turn. One reason they would not is that annual depreciation expense would be a visible reminder of initial cost of the capital item. As stated in Chapter VI, the initial cost is not treated as a sunk cost in business accounting.

Of course the Navy is not a civilian business. The Navy is in the business of projecting America's power overseas in

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[13] Report on the Roles, Missions, and Functions of the Armed Forces of the United States, Chairman of the Joint Chiefs of Staff, Washington, December 1992.

both peace and in war, generally through forward deployment. "The purpose of forward deployment is not only to 'show the flag' but to ensure that the United States can respond to a crisis almost immediately."[14] The Navy is unique among all the services in that 25 percent of its combat-capable forces are forward deployed at any time. Because the other services are not routinely forward deployed, a large reserve component appears to be a logical force structure. Because the Navy is routinely forward deployed, a large reserve component may be an illogical force structure.

Also, the utilization of 16 FFGs in the Naval Reserve Force is only possible as long as there are "excess" assets available. If Active Fleet OPTEMPO begins to exceed the CNO's stated limit, as it did in the Persian Gulf War, then some of this excess capacity no longer exists. As the Navy approaches a 340-ship Fleet (referred to as "Aspin Option C"), it will become more difficult to justify ships that do not deploy, especially as AF ships are forced to exceed stated OPTEMPO limits.

B. GULF WAR EXPERIENCE

The Gulf War will not be an accurate predictor of every future crisis involving the use of American armed forces, and it is dangerous and naive (indeed amateurish) to assume that we will have the advantages that we did in Desert

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[14] Navy Active and Reserve Force Structure and Mix Study, Center for Naval Analyses, Alexandria, Va., 1992.

Shield/Desert Storm in future hostilities; for example, future conflicts will not likely have ready-made infrastructure in-theater and an enemy who is willing to let American forces have six months to deploy massive forces without interference. But the war may be illuminating in one respect: it is probably a good example of how to employ Naval Reserve Forces in the future. The Naval Reserve units and personnel who participated in Desert Storm were mainly medical (10,456 personnel), mobile construction (2,475), logistics augment units (1,991), ship and SIMA augment personnel (1,783), cargo-handling battalions (961), logistic airlift squadrons (691) and Military Sealift Command (489).[15] Perhaps these units should be the future focal point for the Naval Reserve. "In the past, Naval Reserve capabilities -- and active Navy capabilities -- were structured and staffed for a global war and not necessarily focused on these resources needed in regional contingency. Consequently, the Gulf War experience identified the reserve capabilities that might be most directly applicable to projected contingency requirements. And, conversely, it revealed those reserve capabilities that might not be used heavily in this type and size of contingency."[16] NRF FFGs were not recalled in the Gulf War and are not likely to be deployed in future regional contingencies. The mobilization pictured in Table 1 is not

[15] Ibid.

[16] Ibid.

likely to happen. The scenario of convoy battles in the Atlantic against wolf packs of Soviet SSNs and SSGNs has gone away. "As we reduce the active force structure, DoD has been working with Congress to also reduce the reserve component, in a balanced way. The goal is to eliminate reserve elements, primarily Army, which are no longer required to face threats that have disappeared -- threats that led to the significant build-up in the 1980s in our reserve component structure."[17]

The Naval Reserve surface program was expanded as a result of Cold War planning scenarios that are now outdated. While it may be more glamorous to be associated with combat-capable forces, such as FFGs, the real payoff for the Naval Reserve will likely be in medical, transportation, and logistics areas. By concentrating in these areas, needless duplication will be eliminated and the Total Force objectives will be achieved at a lower cost.

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[17] Report on the Roles, Missions and Functions of the Armed Force of the United States, Chairman of the Joint Chiefs of Staff, Washington, D. C., 1992.

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