1998-09-15

The Maritime Preposition Force Ship 2010

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NAVAL POSTGRADUATE SCHOOL
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Technical Report

The Maritime Preposition Force Ship 2010

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REPORT DOCUMENTATION PAGE	Form Approved OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*	2. REPORT DATE 19 April 1999	3. REPORT TYPE AND DATES COVERED Technical

4. TITLE AND SUBTITLE Maritime Preposition Force Ship 2010	5. FUNDING NUMBERS
6. AUTHOR(S) Profs. C. N. Calvano & R. C. Harney; LTs. R. Weekly, G. McKerrow, T. Anderson, J. Arrington, J. Kan, & R. Vaidyanathan	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Naval Postgraduate School Monterey, CA 93943-5000	8. PERFORMING ORGANIZATION REPORT NUMBER NPS-ME-99-002
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSORING / MONITORING AGENCY REPORT NUMBER
11. SUPPLEMENTARY NOTES The views expressed in this report are those of the authors and do not reflect the official policy or position of the Department of Defense or the U.S. Government.	
12a. DISTRIBUTION / AVAILABILITY STATEMENT Approved for public release; distribution unlimited.	12b. DISTRIBUTION CODE

14. SUBJECT TERMS: STOM, OMFTS, Maneuver Wafare, Ship Design, Expeditionary Warfare	15. NUMBER OF PAGES 296
	16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFI-CATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	UL

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. 239-18 298-102

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The Maritime Preposition Force Ship 2010

This report documents a systems engineering and design capstone project undertaken by students in the Total Ship Systems Engineering program at the Naval Postgraduate School. The project was performed under the direction of Professors C. N. Calvano and R. Harney. The officer students who comprised the design team were: LT Thomas Anderson, LT Jess Arrington, LT Joseph Kan, LT Gary McKerrow, LT Rajan Vaidyanathan, and LT Randolph R. Weekly.

ABSTRACT

A systems engineering approach to the design of a ship which will satisfy the requirements for a Maritime Prepositioning Force (MPF) for the year 2010 and beyond is presented. This ship, the MPF 2010, will provide the means by which the United States Marine Corps will be able to successfully employ the tenets of Operational Maneuver From the Sea (OMFTS) and the Ship-to-Objective Maneuver (STOM) against an objective.

The current Maritime Prepositioning Ship (MPS) squadrons are used to preposition supplies, vehicles, and equipment throughout the world for use by a Marine Air-Ground Task Force (MAGTF) of Marine Expeditionary Force – Forward, MEF (FWD) size, in times of crisis. However, these squadrons presently require that a secure airfield and port (or beachhead) be available so that the prepositioned MPS assets can be offloaded and married with arriving MAGTF personnel ashore. As such, the current MPS squadrons do not support the concepts of OMFTS and STOM.

The MPF 2010 will provide the capability to embark a MEF (FWD), marry the MEF (FWD) with its prepositioned equipment while en route to the objective, and then act as sea base from which it will be able to employ air, ground, and amphibious assets to project power ashore.

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I. INTRODUCTION

The current Maritime Prepositioning Ship (MPS) squadrons are used to preposition supplies, vehicles, and equipment throughout the world for use in times of crisis by a Marine Air-Ground Task Force (MAGTF) of Marine Expeditionary Force – Forward, MEF (FWD) size. Current doctrine requires that a secure airfield and port (or beachhead) be available near the objective so that the prepositioned MPS assets can be offloaded and married ashore with arriving MAGTF personnel. It is further necessary that a friendly airfield capable of supporting the MAGTF Air Combat Element (ACE) be located near the objective.

A MAGTF is a combat force which may consist of marine units as small as a Marine Expeditionary Unit (MEU) or as large as a MEF (FWD). Throughout this document the term MAGTF will be understood to mean a MEF (FWD), with the implication that the capabilities discussed would also apply to smaller units.

Maritime Prepositioning Force (MPF) 2010 and Beyond is the concept by which a next-generation MPF will contribute to forward presence and power projection: capabilities which will remain central to U.S. deterrence and conflict resolution strategies well into the next century, [1]. This is achieved by employing the USMC tenets of Operational Maneuver From the Sea (OMFTS) and Ship-to-Objective Maneuver (STOM), which enable MAGTF forces to engage an objective without the need to secure and defend a port or beachhead.

OMFTS is a concept that was developed in 1980 and has since been successfully employed in operations such as Operation Desert Storm. OMFTS calls for using the sea as maneuver space to bring the troops as close as possible to the objective. Using the sea as battle space forces the enemy to defend a vast area, providing the MAGTF an opportunity for deeper power projection, [2]. STOM refers to the direct movement of personnel and equipment from the ship to the objective without requiring a beachhead to be established. STOM aims at thrusting combat units in a fighting formation in sufficient strength against the objective to successfully accomplish the mission, [3].

As mentioned above, the current MPS squadrons are not capable of supporting the doctrines of OMFTS and STOM due, in part, to their reliance on securing an airfield and port (or beachhead) to marry MAGTF cargo and personnel. Additionally, MPS squadrons currently provide no capability to support MAGTF aircraft at sea.

The objective of this design project is to produce a ship, which in sufficient numbers will thoroughly implement the MPF 2010 and Beyond concept. This ship, hereafter referred to as MPF 2010, operating in a squadron of five, will be capable of fully supporting an ACE consisting of Joint Strike Fighters (JSFs), MV-22s, and other rotary-wing aircraft. Onboard a MPF 2010 squadron will be pre-staged all equipment currently found on a MPS squadron, as well as the current Fly in Echelon (FIE) vehicles and equipment. MPF 2010 will provide for the at sea arrival of MAGTF personnel and the at sea marrying of MAGTF personnel with their equipment prior to reaching the Amphibious Objective Area (AOA). Upon arrival at the AOA, the MPF 2010 will provide a seabase from which MAGTF air, ground, and amphibious assets can project power deep into enemy territory.

II. REQUIREMENTS SETTING

The first step in the ship design process is to determine the requirements for the new ship design. These requirements can be broken down into two categories: requirements that are being met by current ship designs and requirements that are not. Requirements that are being met by a current ship design may be satisfied in the new ship design by either implementing design features that are being utilized in current ships or developing innovative new solutions to these requirements. In either case, the requirement has already been identified and a solution to the requirement exists.

The second requirement category, requirements which are not currently being met, is often more difficult to define than the first. This, in part, is due to the fact that when a new strategy or operational concept is defined, it is frequently difficult to translate that strategy or concept into tangible requirements for a ship design. This was the case with the translation of the Ship-to-Objective Maneuver (STOM), Operational Maneuver from the Sea (OMFTS), and MPF 2010 and Beyond concepts into requirements for the design of the Maritime Prepositioning Force (MPF) 2010 ship. The implementation of these concepts using Maritime Prepositioning Ships (MPS) is a concept that is radical departure from the current practice. As a result, a significant period of time was required to determine the requirements for MPF 2010. The first six weeks of the design project were spent determining the requirements for the MPF 2010.

The Center for Naval Analysis (CNA) conducted a Mission Area Analysis (MAA) of the sea-basing concept for the MPF 2010 and Beyond. The result of this MAA was a set of requirements for **several ship designs**, the combination of which were intended to meet the needs of the MPF 2010 and Beyond [4], [5], [6]. Our design team used the CNA derived requirements as a starting point for the requirements derivation for our MPF 2010 ship. We modified and added to the requirements delineated by CNA in order to produce the requirements for a **single ship design** that would meet the needs of the MPF 2010 and beyond.

The end result of our requirements setting process was the preparation of an Operational Requirements Document for Maritime Prepositioning Force – 2010 and Beyond. This student-developed ORD is included in this technical report as Appendix A.

III. DESIGN DECISIONS

In order to translate ship requirements into a ship design, decisions must be made regarding how those requirements will be met. These decisions will be constrained by the requirements themselves, the technologies currently available, those technologies that are anticipated to be available in the future, and the collective experience of the individual members of the design team. Notwithstanding the constraints that limit these design decisions, there remains a considerable degree of latitude with respect to the direction that the design process can take. In order to guide the design process to a well-defined design that meets the ship requirements, certain major design decisions must be made early in the design process. These decisions should provide the process with sufficient focus that the final design can be reached in a timely manner, while allowing adequate latitude in the design process so as to not stifle creativity or discount unique solutions to a problem. This was the objective when the primary design decisions for MPF 2010 were made.

A. DESIGN PHILOSOPHY

Early in the design phase of MPF 2010 several design premises were identified which served to guide the design process. These premises were the primary driving forces that helped to determine the general direction of the overall design process. These premises were:

- The desire to maintain Marine unit cohesion.
- The maximization of mission flexibility.
- The desire to achieve commonality of design between MPF 2010 ships to the maximum degree possible.
- The desire for MPF 2010 ships to have capabilities more commensurate with military rather than civilian application.
- The intent to use innovation to the maximum degree possible.

The maintenance of unit cohesion was considered to be extremely important. In order to employ STOM in a timely manner, MAGTF units must be able to operate both efficiently and expeditiously. If a unit is subdivided into its smaller components, then a finite period of time is required to reconstitute that unit into its original form. Each additional subdivision of a smaller component adds yet another finite time period required for reconstitution. Additionally, if a unit is required to marry with equipment, further time is required if that equipment is not co-located with the personnel of the unit. Finally, the further a unit is subdivided and spread out over many ships, the more coordination is required to reconstitute that unit prior to engaging an objective. Therefore it was determined that in order to minimize the delays associated with the transfer of personnel and equipment between ships prior to the implementation of STOM, the MPF 2010 ships would have a size and configuration allowing entire units (personnel plus their equipment) to be co-located in a single ship. The premise of maintaining unit cohesion was applied at the infantry battalion level, the tank company level and the artillery battery level. This, of course, played a major role in the determination of both the size and number of MPF 2010 ships that would be required to support a MEF (FWD).

Mission flexibility and commonality of design are really two sides of the same coin. Commonality of design provides the MAGTF Commander with the maximum flexibility possible. If the MPF 2010 ships are essentially interchangeable, the MAGTF Commander has the freedom to reconfigure ship load-outs (as with aircraft, for example) to meet the individual mission needs of that Commander. Further, if one ship is rendered incapable of performing its mission, a specific mission capability is not completely lost, since the remaining ships of the squadron have at least part of the same capability. This assumes that care is taken to prevent a loadout with all equipment of a certain type being placed on a single ship. Commonality of ship design also allows the MAGTF Commander the flexibility to engage multiple objectives with similarly capable platforms over a large littoral region. Finally, commonality of ship design provides for streamlined production and similarity of maintenance and operation between ships.

Innovative and new concepts were aggressively sought out and investigated. The transition from the current maritime prepositioning ship design to the design generated by the MPF 2010 and Beyond concept required a significant departure from "conventional thought."

Although not specifically mentioned as a design premise, the number of ships with respect to the impact on overall cost was a factor which influenced the determination of squadron size. A squadron of many ships of a smaller size would increase the force survivability (i.e. losing one out of ten small ships reduces force capability by a smaller magnitude than losing one out of five larger ships). However, as the number of ships to perform a given mission is increased, the overall cost of that squadron of ships increases as well. Additionally, a force of many small ships would not be capable of satisfying the previously mentioned premised of maintaining unit cohesion to the degree desired.

B. DESIGN OBJECTIVES

The Maritime Pre-positioning Force (MPF) 2010 and Beyond concept is based upon four fundamental pillars: force closure, amphibious task force integration, indefinite sustainment, and in-theater reconstruction and redeployment of the MAGTF. Further, it will be necessary for MPF 2010 ships to be pre-deployed for extended periods of time in anticipation of the time at which they will be required to employ a Marine Air-Ground Task Force (MAGTF) in Operational Maneuver From The Sea (OMFTS) and Ship-to-Objective Maneuver (STOM). The design objectives of this project are intended to efficiently and effectively incorporate the requirements derived from these four pillars, along with the pre-positioning requirement, into the design of the MPF 2010 ship. These objectives are divided into three parts, in descending order of priority: primary, secondary, and tertiary objectives. Numerical order within objective groups does not imply precedence.

1. Primary Objectives

a) The combined capacity of 5 ships shall provide the required support for an entire MAGTF (excluding heavy lift and electronic countermeasure aircraft), its Naval Support Element, and its associated equipment, vehicles, and aircraft. All ships will be interchangeable, subject to load-out.

b) Load out flexibility.

c) Operational flexibility.

d) Flexibility of USMC support operations.

e) Ability to navigate to and dock at Blount Island.

f) Seaworthiness.

g) Rapid deployment and recovery of MAGTF.

h) Capability to sustain MAGTF forces from sea.

i) Capabilities to receive re-supply at sea.

j) Cargo handling capabilities which include:

    1) Selective retrieval.

    2) Automation to the maximum degree feasible.

    3) The ability to perform maintenance "in place" or with minimal movement of surrounding cargo.

    4) Ease of cargo access and movement.

    5) Minimization of movement of cargo

2. Secondary Objectives

a) Anti-ship missile self-defense capability.

b) Capability to embark MAGTF personnel en route to the objective.

c) Interoperability with other U.S. military assets (including C4I).

d) Minimization of the number of support personnel, during both pre-positioning and MAGTF employment.

e) Minimization of ship maintenance during both pre-positioning and MAGTF employment.

f) Compatibility and flexibility for navigation in restricted waters and ports.

g) Habitability.

3. Tertiary Objectives

a) Combat Survivability.

b) Commonality between systems.

c) Ability of multiple U.S. shipyards to construct.

d) Use of commercial off-the-shelf technology (COTS) where feasible.

e) The employment of modularity of construction where possible.

f) To design in modularity of upgrade where possible.

g) Safety of personnel.

h) Cost minimization.

It should be noted that signature reduction was not considered to be an important requirement of this design. Nevertheless, it was deemed important to have an estimate of the ship's signature for use in vulnerability analyses. The signature analyses are documented in Appendix E.

C. HULL, MECHANICAL AND ELECTRICAL (HM&E) STUDIES

There are several HM&E alternatives that meet the requirements as specified in the Operational Requirements Document (ORD). The feasible alternatives considered have been outlined below.

1. Hull

Three types of hulls were considered feasible: Single Mono-hull, Advanced Double Mono-hull, and a combination of the two.

a. Single Mono-hull

Single mono-hull ships are built with traditional transverse frames and longitudinal stiffeners. Among their advantages are the facts that the single mono-hull design has been proven on US aircraft carriers and that industry has the experience and technical base to build this type of hull.

b. Advanced Double Mono-hull

Advanced double mono-hull ships are constructed with inner and outer hulls connected by longitudinal web members. The advantages of this design include improved resistance to underwater explosions, improved damage control, and improved resistance to grounding damage. The disadvantage of the advanced double mono-hull is that the manufacturing process has not been fully implemented.

c. Combination Single and Double Mono-hull

A hybrid single and double mono-hull ship utilizes the traditional single hull design throughout most of the ship, but incorporates double hull structure in critical areas. The critical areas to be housed within the double hull structure could include cargo, vehicle and machinery spaces.

d. Hull Selection

The single mono-hull was chosen for the MPF 2010 ship design due to the advantages stated in III.C.1.a as well as its reduced cost and weight relative to the other hull forms considered. The additional benefit of reduced cost was also a factor. Since MPF 2010 will be provided a certain amount of protection by escort ships, these factors were considered to be of greater importance than the improved strength and damage control features provided by the other hull forms considered.

2. Waterborne Asset Debarkation Method

The MPF 2010 ship must be capable of launch and retrieval of several waterborne assets, including LCACs, AAAVs, and a LCU. Three methods were considered feasible: stern elevator, traditional well deck and partial well deck.

a. Stern Elevator

Stern elevators, as used aboard Sea Barge class merchant ships, allow for the movement of transport assets from various decks to the water. Advantages of this method include:

- Direct access to multiple decks.
- Ability to facilitate the launch and retrieval of both waterborne and air cushion assets.

Disadvantages include:

- Large volume requirement.
- Maintenance and reliability concerns associated with heavily mechanized system exposed to submersion in seawater.

- Limited rapid launch and retrieval capability due to limited elevator deck area and elevator transit time.

b. Traditional Well Deck

Traditional well decks, as used on board most US amphibious platforms, consist of a large space, partially submerged and open to the sea when in the ballasted condition. Advantages include:

- Simple and well tested design.
- Allows for rapid launch and retrieval of waterborne assets.
- System is relatively reliable and allows for redundancy.

Disadvantages include:

- Inability to launch and retrieve LCACs and LCU simultaneously.
- Ballast and deballast processes are time consuming.
- Impact on ship's displacement.
- Significant volumetric requirements for ballast tanks.

c. Partial Well Deck

The partial well deck concept is based on flooding only a section large enough to float a single LCU. The remainder of the well deck is slightly sloped with its aft end partially submerged. Advantages of this concept are:

- Ability to simultaneously operate LCACs and LCU.
- Ability of LCACs and AAAVs to access water without use of a mechanical system (100% reliability).
- Minimizes ballast/deballast requirements (smaller capacity system, lesser impact on ship's displacement).

Disadvantages are the complexity of design and reliability of constantly submerged partial well deck stern gate.

d. Waterborne Asset Debarkation Method Selection

The partial well deck method was chosen for the MPF 2010 ship. The choice of partial well deck over traditional well deck was based on the advantages outlined in the sections above. The choice of a partial well deck over an elevator was based on the functionality advantages of both cargo and vehicle flow into a well deck (further elaborated on in section IV.A.).

3. Propulsion System

MPF 2010 ships will be propelled by electric drive. This method of propulsion was selected for several reasons. First, electric drive provides greater flexibility with respect to the physical location of the prime movers. A ship using a direct coupling method, as with a reduction gear, would be required to locate the prime movers in a position physically near the propulsion shaft. This attribute limits both the placement of the prime movers and the flexibility of design of the adjacent compartments. Electric drive allows the designer to place the prime movers virtually anywhere within the ship. Prime mover placement is of primary importance for air breathing propulsion systems. Propulsion system efficiency is markedly affected by the gas flow resistance associated with long runs of intake and exhaust ducting. Further, propulsion system intake and exhaust ducting take up space that could otherwise be used for cargo, personnel, or other systems.

As mentioned above, a directly coupled propulsion system places limitations on the design of the surrounding compartments, since these compartments must accommodate the geometry of the propulsion system. In order to maximize the efficiency of cargo loading, stowage, and retrieval, it became necessary for the propulsion space geometry to be defined by the geometry of the cargo stowage and handling systems, rather than the other way around. Electric drive allows for the prime movers to be placed in locations that are the least obtrusive to the cargo stowage and handling system.

Electric drive also provides the most efficient use of power sources. The prime movers that power the electric drive will also be used to supplement power provided to the systems supporting MAGTF operations. Since it is anticipated that MPF 2010 will either be operating at slow speeds or at anchor during amphibious operations, the prime movers utilized for propulsion operations at higher speeds can be used to support the electrical loads associated with the amphibious operation. Similarly, MPF 2010 will not be required to operate at high speeds to support MAGTF air operations, thus allowing the "surplus" propulsion power to be used elsewhere.

a. Prime Movers

MPF 2010 will use medium speed diesel engines and gas turbines as prime movers (CODAG). The ship will employ an Integrated Power System (IPS) architecture. The IPS architecture provides power for ship's service electrical and auxiliary loads from the electric propulsion system. A few of the advantages to the electric propulsion and IPS architecture are flexibility of plant layout, load diversity between prime movers, economic use of prime movers, ease of control, low noise and vibration characteristics, and redundancy.

b. Propeller

A controllable pitch propeller would be desirable since it reacts faster and provides better motor efficiency than a variable pitch propeller. However, due to the large shaft horsepower requirements for MPF 2010, a controllable pitch propeller is not feasible. A variable pitch propeller will be used. Due to the operating characteristics of an AC electrical motor, the reversing and speed control can be accomplished without the need for special mechanical components or the use of a controllable pitch propeller. The use of an electric drive with a variable pitch propeller provides greater response and control than a direct mechanical drive using a variable pitch propeller.

4. Electrical System

a. Generation System

As noted in the propulsion discussion, non-propulsion related electrical loads will be supplied by the CODAG power plant.

b. Distribution System

The MPF 2010 ship's service electrical distribution will be comprised of a dual ring bus configuration which feeds an AC zonal system. This arrangement will provide both flexibility and reliability. The main bus will supply the various zones via step down solid state converters. These converters will supply voltage at levels required by the electrical components in each zone, i.e. 460V and 110V. Each zone can be supplied from either the port or starboard main bus (via automatic bus transfer protection).

c. Power Management System

The power management system will provide for intelligent load shedding from the load to the switchboard. Load shedding will be provided for by computer controlled sensors located at major loads and switchboards. This protection will be in addition to the traditional mechanical means.

d. Emergency Power

Medium speed diesel engines will be provided for in port use and emergency power generation.

5. Combat Systems

Although nominally non-combatant ships, an MPF 2010 squadron will be sailing in harm's way. The MPF 2010 ships may stay just over the horizon, but this does not diminish the fact that shore-launched antiship missiles, floating and anchored mines, and submarine- or patrol boat-launched torpedoes can reach any ship engaged in STOM or OMFTS operations. Given the high value associated with each MPF 2010 ship and its cargo, and remembering the fate of the *Atlantic Conveyor* during the Falklands War, it was decided that minimal self-protection was essential to supplement whatever protection that supporting combatants might provide.

Besides the self-protection function, each MPF 2010 ship will be required to perform traditional navigation functions and to direct flight operations of its attached aircraft. Ships carrying JSF aircraft will be required to be able to conduct close air support operations at any time for Marines deployed ashore. Ships carrying rotary-wing or tilt-rotor aircraft will use these assets to launch airmobile assaults and to resupply forces ashore. All ships will have to control dozens of small craft (LCAC, AAAV, LCU, lighterage, etc.) during amphibious assaults, resupply, re-embarkation, and reconstitution operations. These requirements to control extensive sea and air assets and provide limited self-protection force each MPF 2010 to have a minimal combat systems suite.

a. Sensors

1). Surface/Air Search Radar

MPF 2010 will employ a conformal active phased array radar system. The radar will have the capability to track multiple surface targets to a maximum range of 25 nautical miles and multiple air targets to a maximum range of 125 nautical miles.

MPF 2010 will have the capability to utilize real time radar information from non-shipboard sources via tactical data links. MPF 2010 will also employ aerostats and unmanned aerial vehicles (UAVs) as mobile radar platforms, which will also provide real time target information via tactical data links. These mobile radar platforms will greatly extend the effective range of MPF 2010's sensory capabilities.

2). Navigation Radar

MPF 2010 will utilize the aforementioned surface/air search radar for navigational purposes. A Furuno radar, or future equivalent, will be used as a back up navigational radar.

b. Electronic Countermeasures

MPF 2010 will employ the SLQ-32 (V)4 or future equivalent to electronically counter (soft-kill) anti-ship missiles. The countermeasures suite will be highly integrated with the on-board radars and with tactical data systems in order to provide the maximum of capability from a minimum of hardware. The integrated system will be used to provide cueing and guidance to the Evolved Sea Sparrow Missiles chosen for hard-kill self defense.

c. Command, Control, Communications, Computers, and Intelligence(C4I)

The Joint Maritime Communications Strategy (JMCOMS) is both a technical and program strategy which implements the communications segment of the Navy's Copernicus C4I architecture, [7]. The Automated Digital Network System (ADNS) is the backbone of JMCOMS. MPF 2010 will employ ADNS to meet its C4I requirements. ADNS will support all interior and exterior communications required for MPF 2010 to fully support MAGTF operations.

d. Defensive Weapons

MPF 2010 will employ NATO's Evolved Sea-Sparrow missile system (ESSM) as a hard-kill anti-ship missile defense system. The NATO ESSM was chosen over the Close in Weapons System (CIWS) due to its greater range of missile kill. CIWS has a first hit range of one nautical mile whereas the NATO ESSM has an intercept range of eight nautical miles. An analysis of the effectiveness of these defensive systems against a hypothetical missile attack is presented in Appendix F.

IV. FEASIBILITY STUDY

In the course of defining the major design parameters for the Maritime Prepositioning Force (MPF) 2010 ship, two parameters were identified which were considered to be of such importance that it was necessary to conduct a comparative analysis of variations of these parameters.

The first parameter identified was the method of amphibious embarkation/debarkation. Two options for this method were examined. The first option was to conduct amphibious operations via a well deck. The second option was to conduct amphibious operations via a stern elevator.

The second parameter identified was the placement of cargo and vehicles. The options for these methods were to either have the cargo above the vehicles or the vehicles above the cargo. The cargo-above-vehicles option was determined to more efficiently utilize space due to vehicle ramp arrangement and was selected for employment with the well deck option. It was expected that the more efficient utilization of cargo and vehicle space would shorten the length of the well deck option. This arrangement will hereafter be known as option A.

The elevator option was combined with the vehicle-above-cargo option. As originally conceived, the stern elevator option was expected to be shorter than the well deck option. Since the vehicle-above-cargo option was considered to be less space efficient that its alternative, it was anticipated that combining this option with the stern elevator option would help limit the overall size of the ship. This arrangement will hereafter be known as option B.

Due to time limitations, no further consideration was given to the other two possible permutations of the identified parameters (i.e. combining the well deck and vehicles-above-cargo options or combining the elevator and cargo-above-vehicles options). Analyzing the four permutations would have been too labor intensive for the time available to perform the analyses.

As the design of option B progressed, it was determined that there would be insufficient strength to adequately support the elevator outside the skin of the ship. The elevator was then placed inside the ship, resulting in option B being much longer than originally conceived.

The following sections will discuss options A and B in more detail. For reasons later explained in section (IV.C.), option A was selected over option B. Since the majority of this report is devoted to the description of option A, the rest of this section will describe option B more thoroughly than option A.

A. OPTION A

1. Cargo Placement

The first major premise of option A is the centralization of cargo with respect to ship-to-shore transport assets. These assets can be divided into two major categories: aviation and waterborne. In this option the cargo deck is ‘sandwiched’ between the aviation assets located above and the waterborne assets (i.e. LCACs, LCU, and lighterage) located below.

Aviation Assets

Cargo

Waterborne Assets

Figure 1. Notional View of Cargo Transport Assets

This arrangement allows for the most direct path between cargo and transport assets. There are several advantages to this including:

- Minimal number of handling points
- Independent routing paths for various cargo types
- Minimal distance of travel (faster delivery)

Locating the cargo deck above the waterborne assets also yields the added benefit of greater available length and width of cargo compartments.

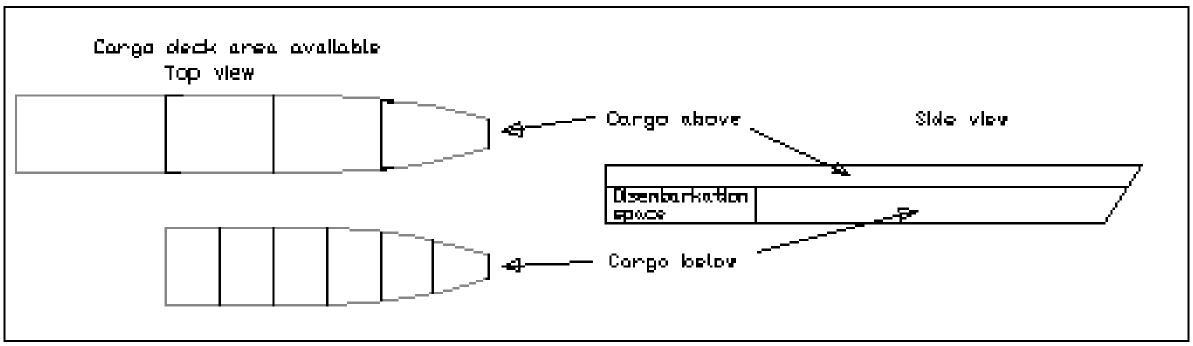

Figure 2. Cargo placement

Spreading the cargo out over a greater deck area alleviates the need for containers to be stacked as high or as closely together (as is the case with the cargo below, Figure 2), thereby providing greater accessibility. In Option A 41.7% of all containers are directly accessible by overhead cranes and 50% of all cargo internal to containers is accessible via forklift. This advantage is enhanced when, to the maximum extent possible, cargo is segregated by transport type. In general, containers will be loaded directly on to waterborne assets while aircraft and ground vehicles will transport pallet size loads. By placing aircraft and vehicle cargo in the 50% of containers that are accessible by forklift, the cargo going to these assets is more readily accessible. Similarly, since containers to be transported with cargo intact do not need to be accessed, they can be closely packed for optimal use of deck space.

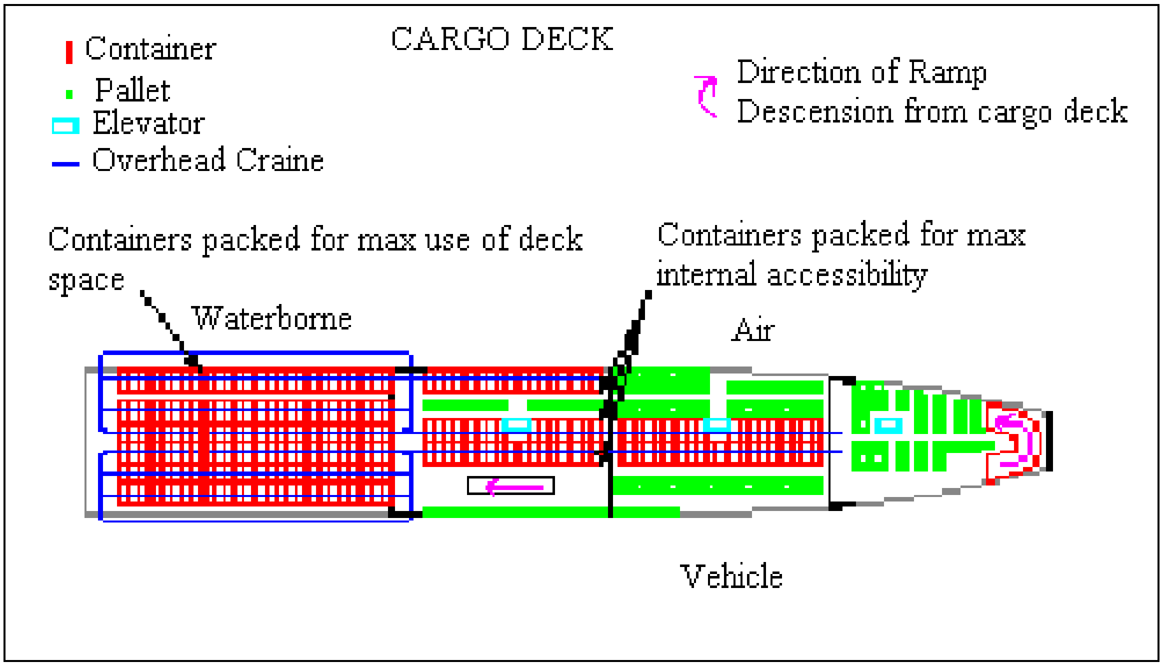

Figure 3. Cargo Deck Layout

The selection of cargo loading method for each transport asset type was made with the goal of minimizing each of the following: number of handling points, potential for system failure, effect of a single point failure, loading time, system complexity for users, and system maintenance requirements. Containers being transported by waterborne assets are lowered from the cargo deck by an overhead crane system directly on to the vessels or lighterage (single crane lift). Pallets being transported by aviation assets are lifted from the cargo deck to the flight deck by 1 of 3 elevators (forklift to elevator to forklift). Pallets being transported by ground vehicles are loaded directly into the vehicles on the cargo deck (single forklift). There are several advantages to this vehicle loading method:

- Unlike an elevator or crane delivery system, the failure of a vehicle only impacts the ability to load that single vehicle.
- Loading efforts are confined to and concentrated on the cargo deck, vice being spread over multiple vehicle decks.
- Due to the assembly line nature of vehicle loading and unloading, vehicles can be loaded/unloaded more rapidly. The speed of embarkation/debarkation is not limited by capability of an interim delivery system (as with an elevator).
- Vehicles can be loaded/unloaded as part of embarkation/debarkation evolution, allowing flow of process during evolution execution (vehicle deck to cargo deck to debarkation pt or vice-versa).
- Deck space that would have been used for loading systems is otherwise available for vehicles.

2. Vehicle Placement

In this option there are 3 vehicle decks, each of which utilizes 2 circular ramps for travel between decks and a race track style transit path for intra-deck travel. The circular ramps minimize vehicle deck space use while allowing for a smooth transition to inter-deck travel paths. The travel paths provide several advantages:

- Greater accessibility of vehicles. Seventy-six percent of all vehicles have direct access to travel path. No vehicle has more than one vehicle between it and the travel path.
- Ease of path reconfiguration. Travel paths are driven by the number and geometry of vehicles required for storage, rather than by any physical barriers.
- Flexibility in ramp access in case of breakdown or battle damage.

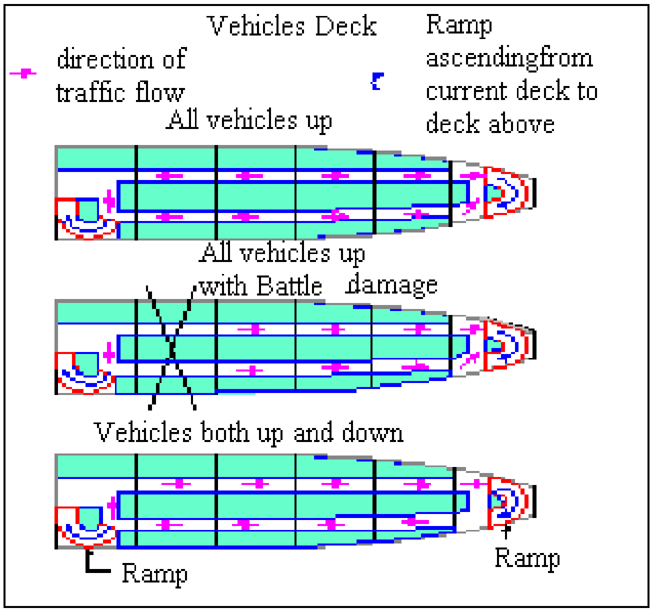

Figure 4. Vehicle Flow Paths

The second major aspect of option A is the use of a traditional well deck for embarkation/debarkation of LCU, LCACs and AAAVs. A traditional well deck, as used on board most US amphibious platforms, consists of a large space, partially submerged and open to the sea when in the ballasted condition.

B. OPTION B

Option B differs from option A in that the cargo holds are just above the keel, with the vehicle decks above the cargo. Additionally, Option B employs a stern elevator, vice a well deck. All other major systems and arrangements (i.e. combat systems, the flight deck, the hangar space, the propulsion system, etc) are identical to Option A. The operations of the cargo and vehicle decks are described below.

1. Cargo

In order for MPF 2010 to support an MEF (FWD), a great deal of supplies and support equipment must be pre-positioned on board. The method of storage of this heterogeneous arrangement of supplies and equipment can be broken down into the four categories: supplies stored in containers, supplies stored on pallets, liquid supplies, and vehicles. The term cargo will refer to the containers and pallets carried by the MPF 2010 squadron in support of the MEF (FWD).

The required cargo and liquid supplies in each ship in the MPF 2010 squadron are listed in Table 1 [4]. The containers and pallets are further divided into three holds aboard each ship. The separation of cargo into three different holds is for ammunition safety requirements of current Navy regulations.

Type	Force	Ship
Containers	3002	601
Pallets	18360	3672
Liquid – fuel	6,100,000 gal	1,220,000 gal
Liquid–water	400,000 gal	80,000 gal

Table 1 MPF 2010 Cargo Lift Requirements

It is intended that these ships be civilian manned and that the number of military personnel required on board for preposition operations is kept at a minimum. Further, it is intended that re-supply at sea and reconfiguration of supplies and equipment is accomplished with a minimum number of personnel. This dictates that cargo be handled in the most efficient manner possible. There are four major operation functions that cargo handling falls within. These are: loading the vehicles for the initial assault, transferring container cargo to the ready service pallets cargo areas, providing resupply to the force ashore, and replenishment at sea. Each of these operations is discussed below.

a. Vehicle Loading

Once operational commanders decide how they are going to meet their assigned objective, the supplies that they will need can be loaded onto the vehicles. This is accomplished by the pallet handling system, which is comprised of two parts: the vehicle deck pallet handling system and the cargo hold pallet handling system.

The pallet handling system in the cargo hold consists of two overhead lifts controlled by a cargo computer and an operator. Any request for a desired item to be loaded onto a vehicle is entered into the computer by the operator. The pallet that meets the requirement is then located by the computer, and a lift is dispatched to pick the pallet out of its storage bin. At the same time an elevator is scheduled to take the required cargo to the desired vehicle deck. The lift then moves the pallet to the scheduled elevator. The lift will place the pallet in the elevator and is then released to fulfill another request. The computer will employ a sorting and queuing algorithm to efficiently employ the elevators and lifts in cases where there are multiple requests outstanding. Additionally, the computer will track the status of all cargo. Once the elevator arrives at the vehicle deck, the vehicle deck pallet handling system takes over.

The vehicle deck pallet handling system has two modes of operation. If the vehicle load out is occurring simultaneously with vehicle offload, the vehicles will be scheduled to arrive at the appropriate elevator at the moment that vehicle's respective supplies are made available at the elevator. The pallet handling system will the pick up the pallet from the elevator, and place it on the vehicle. If the pallet is to be broken down among several vehicles, the pallet handling system will move the pallet to a staging area adjacent to the elevator.

If the pallets are being loaded prior to vehicle offload, the pallet handling system will pick the pallet up from the elevator and move it to the vicinity of the appropriate vehicle. An operator will then be required to control the lift to load the vehicle. There are 4 lifts in each section of the vehicle decks for a total of 64 pallet lifts on the vehicle decks. The lifts in each section of the vehicle deck can be cross-connected to allow the lifts to go from one section to another.

A similar procedure occurs for the loading of aircraft; the primary difference being that when the elevators reach the flight deck, a pallet truck and operator is required to move the pallet to the specific aircraft to be loaded.

b. Restocking the Ready Service Pallets:

Once the pallet handling system moves the cargo up to the vehicle or flight decks, the restock of the ready service pallets can commence. This can take place at the same time or after the initial load out of the vehicles and aircraft. There are two methods of restocking. The first is accomplished by retrieving specific pallets out of a container; the second by emptying the container completely.

There are lifts between each container (Figure 5), allowing a forklift to be brought up to the level of the container to unload it. This method is normally used when only a few pallets are needed out of a container.

After the pallets are loaded onto the lift, the lift is lowered back down to the deck of the cargo hold. After the lift has been lowered, the same forklift used to unload the container moves the pallets to a centerline conveyor system that is used to move the pallets towards the pallet stowage area. As a pallet arrives between the cargo holds, the pallet handling system will scan the pallet's bar code identifier, pick it up, and place the pallet in the appropriate spot within the ready service pallet area.

If an entire container is to be unloaded, it is picked up out of its original position and placed in the centerline of the cargo hold. This allows for a forklift operator to place the pallets directly on the conveyor while unloading the container. Once a pallet is on the conveyor system, the operation is as discussed above.

Restocking of the ready service pallets requires an additional forklift operator, as well as the pallet handling system operator. The container cranes are monitored and controlled by the same operator who is monitoring the pallet system.

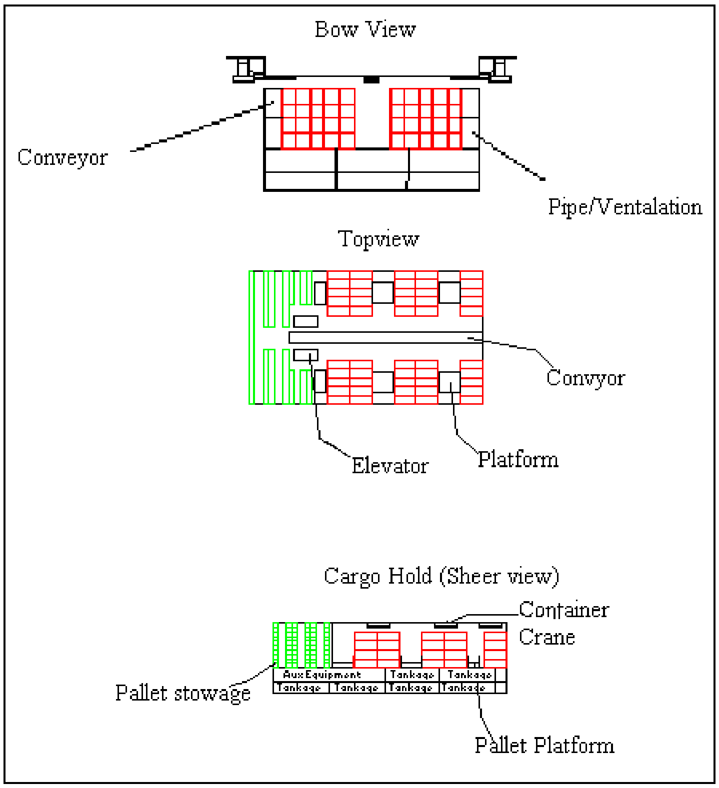

Figure 5. Option B Cargo Hold.

c. Resupply of forces ashore

Resupply of forces ashore will occur either by sea or by air. The pallets required to go ashore by air are scheduled and handled just as they are for initial load-out. The pallets are picked up by the handling system and sent to the flight deck by the elevator. A pallet truck then takes the pallet from the elevator to the appropriate area on the flight deck.

Resupply by sea may occur by one of two methods: either via the stern elevator or via lighterage.

If cargo is going to go ashore by being loaded in the vessel (LCAC or LCU) on the stern elevator, the cargo is sent to the 4th vehicle deck on the elevator. There the pallet handling system on the vehicle deck takes the pallet and places it on the required craft on the stern elevator. If it is necessary for a container to go ashore, the container crane will pick up the container, and place it on the elevator, which will take it to the 4th vehicle deck. A forklift will be required to move the container from the elevator to the craft on the stern elevator.

If resupply is to occur via lighterage, the following methods will be used. If pallets are to be loaded, the pallet handling system will place them on either the port or starboard outboard conveyor system to be moved to the sideport doors. At the sideport door the pallet is lowered via crane down to the lighterage. Containers are handled in a similar manner. The container cranes will place the container on the outboard conveyor and the crane at the sideport door will lower the container to the lighterage below.

d. Replenishment at Sea

Each sideport door will have a Refueling at Sea (RAS) receiving station and a sliding pad eye for STREAM operations. The pallets that are received will be placed on the outboard conveyor system by the same crane used for lighterage offload, and then either loaded into the pallet ready-service slots or reloaded into the empty containers. While containers cannot be received in the same manner currently, a similar system to the STREAM rigs can be developed for future use by commercial ships.

Additionally, resupply can occur by air. As the pallets are landed on the flight deck they will be loaded into the elevators by pallet trucks and then sent to the cargo holds. The pallet handling system will then either move the pallet to the ready service pallet area or to a staging area for loading into a container by a forklift.

2. Vehicles

The CNA study, [4], determined that a total of 860,000 ft^2 of space would be required to stow the MEF (FWD) vehicles. Each MPF 2010 ship will contain 255 vehicle spots, which will provide 102,000 ft^2 of space for vehicles. When the additional area required for fire lanes, ramps, structural members, and ventilation systems is taken into account, the total area per ship becomes 314,000 ft^2. Therefore the total amount of vehicle area provided by the squadron is 1,570,000 ft^2, which far exceeds the requirement determined by the CNA study. Further, the vehicle space arrangement is designed such that it would not be necessary to disperse the vehicles of a single combat unit throughout the squadron, thus preserving unit integrity.

a. Ramps

Ramps are required for vehicle travel between the different vehicle decks, between the vehicle deck and the flight deck, and between the ship and the pier. Each ramp class is discussed below.

1) Vehicle Deck Ramps:

Each vehicle ramp between decks will be divided into two segments, each segments is 15 feet wide for a total of 30 feet of width. Each ramp will have the capability to be raised and locked into position. This provides for greater climate control flexibility and damage control isolation. Each ramp needs to support a 25 ton load. Each ramp will make an 11 degree angle with the deck.

2) Flight Deck Ramp:

This ramp is the same as a Vehicle ramp.

3) Pier Ramp

This ramp is provided to allow vehicle offload to a pier or to lighterage. The ramp is 40 feet wide, and is divided into two retractable sections. The first section of the ramp stows under the deck of the lowest vehicle deck. When it is extended it is 100 feet long. The second section, extends out from the bottom of the first section and is another 75 feet long. This allows the ramp to be extended down to the lighterage at water level. This entire ramp will require adequate structural strength to support 70 tons for off-load of vehicles.

3. Elevator

As originally conceived, the elevator was intended to be external to the skin of the ship. However, during the evolution of the "Option B" concept, it was determined that in order to provide adequate strength for the elevator, it would need to be supported within the skin of the ship. Thus, the elevator is actually within a well deck and requires the use of stern gates. The bottom of the elevator trunk is 10 feet below the waterline. When elevator operations are to commence, the bottom of the elevator trunk is allowed to flood through the use of a sea valve. Once the trunk is flooded to the waterline, the lower stern gate can be moved out of the way, and the upper gate can be opened.

In this configuration, the two LCACs are stowed on one elevator platform, while the LCU is stowed on the second. When the LCAC is to be launched the elevator platform is lowered to the point where the LCAC can leave the stern of the ship. The same procedure is used when the LCU is to be launched. The platform is lowered to the point that the LCU can float clear of the trunk. In order to launch AAAVs, up to four AAAVs are loaded onto the platform. The platform is then lowered to just above the waterline and then the stern of the platform is lowered (independently of the forward end) to the waterline. The AAAVs would then drive off of the end of the platform into the water. Each amphibious craft could be recovered by lowering the platform to the appropriate level for that craft, and then allowing the craft to "drive" onto the platform.

C. FEASIBILITY STUDY COMPARISON

1. Analysis

A design analysis of options A and B was conducted using ASSET. The summary reports are shown in Figure 6 and Figure 7. The following significant differences were noted:

a) Option B is 80 feet longer than option A. Option B has 10 feet more of beam than option A.

b) Option B has 1.8 feet greater draft than option A.

c) The transverse metacentric height for option B is at 20.8 feet (13.8% of beam) and the transverse metacentric height for option A is at 11.8 feet (8.4% of beam).

d) Option B requires 51,370 more shaft horsepower to drive the ship at the required sustained design speed. Therefore, option B would require an additional LM 5000 gas turbine engine, while still overloading the engines.

e) Option B displaces 22,460 more tons than option A.

f) Option B contains approximately 2.7 million more cubic feet of space than option A. Of this space, approximately 750,000 cubic feet is due to the extra space (which is unusable for cargo) that is taken up by the stern elevator.

The vehicle flow paths for option A were such that a vehicle would drive from a vehicle deck to a cargo deck to be loaded with cargo. Option B would use cargo elevators to bring the cargo from a cargo deck to a vehicle deck for vehicle loading. The net difference between these options is that a single point cargo distribution failure (cargo elevator) on option B would have a greater impact than a single point cargo distribution failure (vehicle) on option A. Additionally, since option A does not require elevators for the movement of vehicle cargo, the total number of elevators can be reduced. The remaining elevators would be primarily used for movement of cargo to and from the flight deck. Finally, the cargo distribution method of option A allows vehicles to be loaded more rapidly.

The cargo arrangement for option A requires fewer handling points than that of option B, which introduces fewer potential cargo handling failure points. Further, cargo in option A is more centrally located with respect to vehicle, vessel, and aviation off-load points than option B.

The well deck arrangement of option A will not allow simultaneous operation of LCUs and LCACs, as LCUs require a "wet" deck and LCACs require a "dry" deck. The elevator arrangement of option B will allow simultaneous LCU and LCAC operations, since each could fit on one of the two elevators and each elevator can be independently "wet" or "dry."

Since the cargo arrangement of option A requires that vehicles are driven through the cargo deck (which would not be done in option B), ammunition safety is of concern. In order to comply with current ammunition safety requirements, additional bulkheads will be required on the cargo deck of option A in order to segregate ammunition.

The vehicle arrangement and vehicle flow patterns of option A will require that bulkheads on these decks (which will be below the damage control deck) contain damage control doors. The existence of such bulkhead penetrations below the damage control deck is of concern.

2. Conclusions

Option A is was chosen over option B for the following reasons:

a) Option A displaces less than option B, and therefore requires less power than option B.

b) Option B is larger than option A, and is therefore more expensive to construct and operate.

c) Option A handles cargo more efficiently than option B (due to fewer handling points and short cargo transit distance). Further, a single point cargo distribution failure (vehicle) on option A will have a much smaller impact on cargo distribution than a similar failure (cargo elevator) on option B.

d) As was shown in above, there is a large difference between the volumes of options A and B. This was due to a difference in assumptions of space requirements. This discrepancy was not evident in the early stages of design and therefore was not corrected prior to the completion of design analysis. The difference in assumptions resulted in an additional (unnecessary) volume of approximately 1 million cubic feet being added to option B. Obviously, this has significantly impacted the outcome of the design analysis. Were this additional volume to be removed, the design summary of option B would very likely be much closer to that of option A.

e) The volume discrepancy notwithstanding, the addition of the stern elevator as currently employed does render approximately 750,000 cubic feet of space useless for cargo or vehicles. This, in addition to the reduced reliability of an elevator system (compared with the more reliable, proven method of a well deck), would still render option B less desirable than option A.

In order to mitigate the deleterious effects of the well deck design of option A, it was decided that the well deck area of option A be modified. The modification segmented the option A well deck area into two areas: a dry-deck area (approximately 100 ft wide) for the off-load of vehicles and LCACs; and a smaller well deck area (approximately 35 ft wide) to be used for LCU operations. This region will be lower in the ship than the original option A design, such that in the fully loaded condition it will not be necessary to ballast the ship in order to conduct well deck operations. The dry-deck will be configured such that in the fully loaded condition LCACs and AAAVs will be able to simply drive off of or onto the end of the ship, without the need for ballasting of the ship. Further, this configuration will allow for a much more rapid deployment or recovery of vehicles and LCACs than the elevator version.

```
    ASSET/MONOCV VERSION 4.2.0 - DESIGN SUMMARY -  12/ 7/98 12:50.54

PRINTED REPORT NO. 1 - SUMMARY

SHIP COMMENT TABLE
     MPF 2010 MODEL STARTED BY RAJAN AND TOM
     DATE STARTED: 27 AUG 1998
     STOPPED AT HULL GROUP ITEM 44
     CALLED PAT H CONCERNING UNDERRATING OF PD GENS AND OVER LOADING
      OF SEP GEN PAT SAYS THIS IS A FLAW OF THE PROGRAM AND SHOULD
     IGNORED PAT ALSO COMMENTED THAT THE FAILURE IN THE AVIATION MODULE
     WITH REFERENCE TO THE SWBS COULD BE A BUG IN THE PROGRAM AND
     REFERED US TO THE ASSET HELP PAGE

  PRINCIPAL CHARACTERISTICS - FT          WEIGHT SUMMARY - LTON
LBP                          950.0     GROUP 1 - HULL STRUCTURE  33253.4
LOA                          985.9     GROUP 2 - PROP PLANT       4811.9
BEAM, DWL                    140.0     GROUP 3 - ELECT PLANT      1672.1
BEAM, WEATHER DECK           140.0     GROUP 4 - COMM + SURVEIL   1072.1
DEPTH @ STA 10               106.0     GROUP 5 - AUX SYSTEMS      2909.9
DRAFT TO KEEL DWL             35.0     GROUP 6 - OUTFIT + FURN    4236.2
DRAFT TO KEEL LWL             33.1     GROUP 7 - ARMAMENT            5.1
FREEBOARD @ STA 3             72.9     ---------------------------------
GMT                           11.7     SUM GROUPS 1-7            47960.8
CP                            .720     DESIGN MARGIN                  .0
CX                            .955     ---------------------------------
                                       LIGHTSHIP WEIGHT          47960.8
SPEED(KT):  MAX= 27.5  SUST= 25.0      LOADS                     37971.1
ENDURANCE: 12000.0 NM AT 20.0 KTS      ---------------------------------
                                       FULL LOAD DISPLACEMENT    85931.9
TRANSMISSION TYPE:           ELECT     FULL LOAD KG:  FT            59.5
MAIN ENG: 4 F DIESEL @ 15000.0 HP
SEC ENG:  3 GT       @ 39100.0 HP      MILITARY PAYLOAD WT - LTON25887.0
SHAFT POWER/SHAFT:     74525.9 HP      USABLE FUEL WT - LTON      9814.3
PROPELLERS: 2 - CP  - 23.0 FT DIA

PD GEN:   7 SOLID ST @  3000.0 KW
                                                 OFF  CPO   ENL    TOTAL
24-HR LOAD                  9953.2     MANNING   465   46  3780     4291
MAX MARG ELECT LOAD        13702.9     ACCOM     471   49  3812     4332

     AREA SUMMARY - FT2                     VOLUME SUMMARY - FT3
HULL AREA            -    487000.    HULL VOLUME          -  11689610.
SPONSON AREA         -    248354.    SPONSON VOLUME       -   2665165.
SUPERSTRUCTURE AREA  -    252160.    SUPERSTRUCTURE VOLUME -  2496258.
---------------------------------    ---------------------------------
TOTAL AREA           -    987514.    TOTAL VOLUME         -  16851030.
```

Figure 6. Option A ASSET Design Summary Report

ASSET/MONOCV VERSION 4.2.0 - DESIGN SUMMARY - 12/ 7/98 12:52.57

PRINTED REPORT NO. 1 - SUMMARY

SHIP COMMENT TABLE
MPF 2010 MODEL STARTED BY RAJAN AND TOM
DATE STARTED: 27 AUG 1998
STOPPED AT HULL GROUP ITEM 44
CALLED PAT H CONCERNING UNDERRATING OF PD GENS AND OVER LOADING
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IGNORED PAT ALSO COMMENTED THAT THE FAILURE IN THE AVIATION MODULE
WITH REFERENCE TO THE SWBS COULD BE A BUG IN THE PROGRAM AND
REFERED US TO THE ASSET HELP PAGE

PRINCIPAL CHARACTERISTICS - FT	
LBP	1030.0
LOA	1070.3
BEAM, DWL	150.0
BEAM, WEATHER DECK	150.0
DEPTH @ STA 10	119.0
DRAFT TO KEEL DWL	35.0
DRAFT TO KEEL LWL	35.0
FREEBOARD @ STA 3	84.0
GMT	20.8
CP	.730
CX	.955

SPEED(KT): MAX= 27.3 SUST= 25.0
ENDURANCE: 12000.0 NM AT 20.0 KTS

TRANSMISSION TYPE: ELECT
MAIN ENG: 4 F DIESEL @ 15000.0 HP
SEC ENG: 4 GT @ 39100.0 HP
SHAFT POWER/SHAFT: 101519.8 HP
PROPELLERS: 2 - CP - 24.0 FT DIA

PD GEN: 8 SOLID ST @ 3312.8 KW

24-HR LOAD	11297.5
MAX MARG ELECT LOAD	17888.9

WEIGHT SUMMARY - LTON	
GROUP 1 - HULL STRUCTURE	48196.6
GROUP 2 - PROP PLANT	6055.3
GROUP 3 - ELECT PLANT	2116.6
GROUP 4 - COMM + SURVEIL	1135.7
GROUP 5 - AUX SYSTEMS	3320.2
GROUP 6 - OUTFIT + FURN	4841.3
GROUP 7 - ARMAMENT	5.1
SUM GROUPS 1-7	65670.9
DESIGN MARGIN	.0
LIGHTSHIP WEIGHT	65670.9
LOADS	43076.8
FULL LOAD DISPLACEMENT	108747.7
FULL LOAD KG: FT	55.4

MILITARY PAYLOAD WT - LTON	28018.3
USABLE FUEL WT - LTON	12631.7

	OFF	CPO	ENL	TOTAL
MANNING	465	46	3780	4291
ACCOM	471	49	3812	4332

AREA SUMMARY - FT2	
HULL AREA	- 714509.
SPONSON AREA	- 141320.
SUPERSTRUCTURE AREA	- 273395.
TOTAL AREA	- 1129224.

VOLUME SUMMARY - FT3	
HULL VOLUME	- 15377010.
SPONSON VOLUME	- 1532348.
SUPERSTRUCTURE VOLUME	- 2706470.
TOTAL VOLUME	- 19615830.

Figure 7. Option B ASSET Design Summary Report

V. SHIP'S DESCRIPTORS

A. NAVAL ARCHITECTURE CURVES.

A naval architectural analysis of the hull form generated by ASSET for option A included the intact static stability curves and the ship hydrostatic properties curves (light ship only). The fully loaded ship lacked intact static stability at heel angles of greater than 45°. Although considerable effort was expended to obtain model convergence for angles greater than 45°, intact stability for the full displacement ship could not be achieved for these angles. This deficiency requires further detailed investigation and would be rectified during the next design iteration. A complete naval architectural analysis is given in the ASSET reports in Appendix C.

1. Body Plan

The body plan for the MPF 2010 is shown in Figure 8.

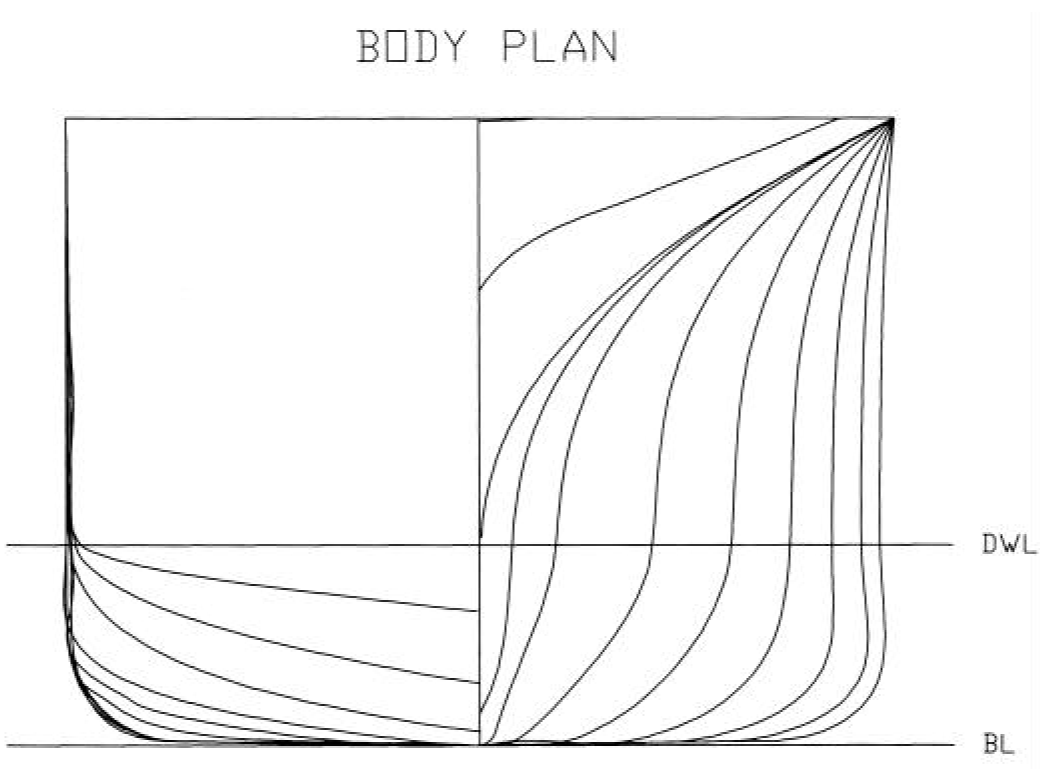

Figure 8. MPF 2010 Body Plan

2. Isometric View

The isometric view of the hull form is as shown in the Figure 9.

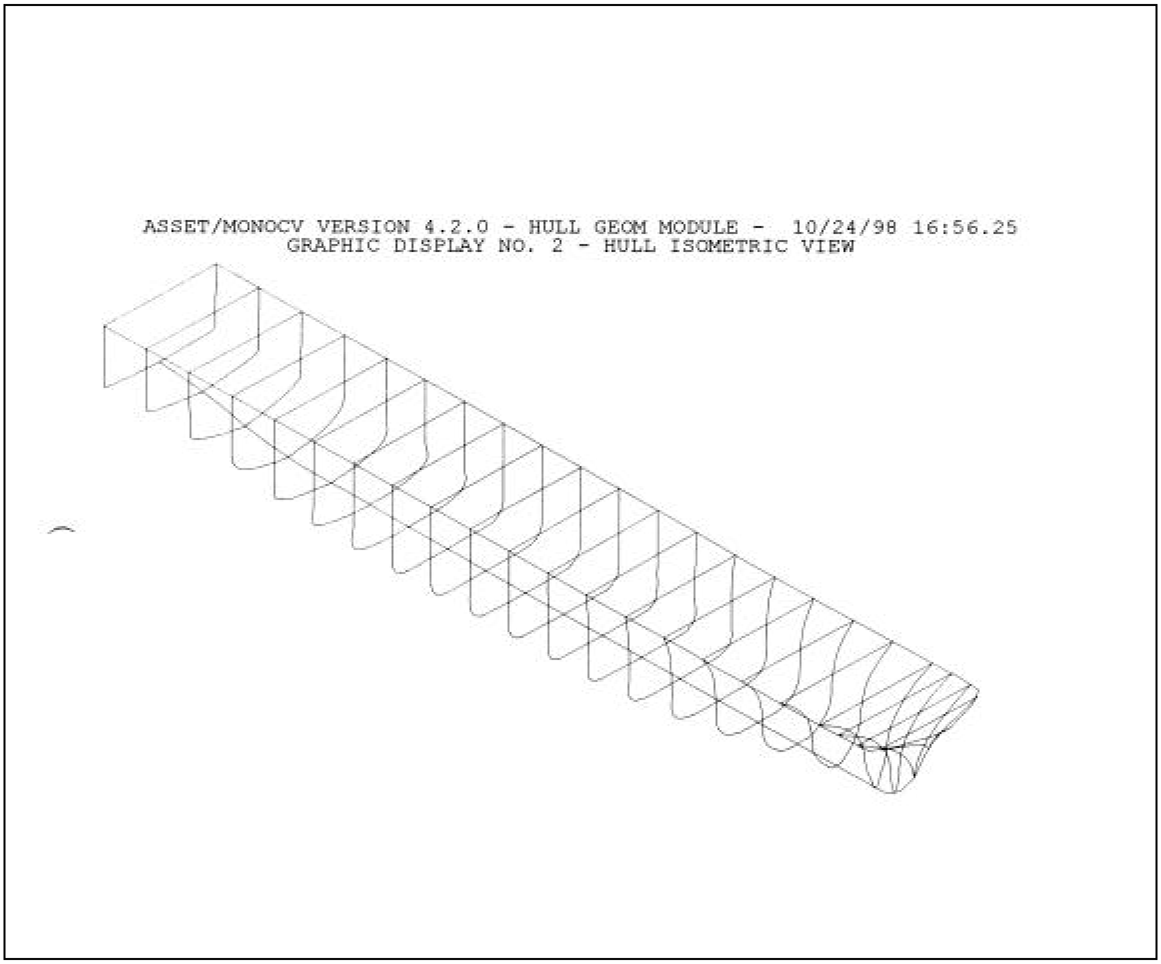

Figure 9. MPF 2010 Isometric view of hull

3. Section Area Curve

A section area curve for level trim at the DWL is shown in Figure 10

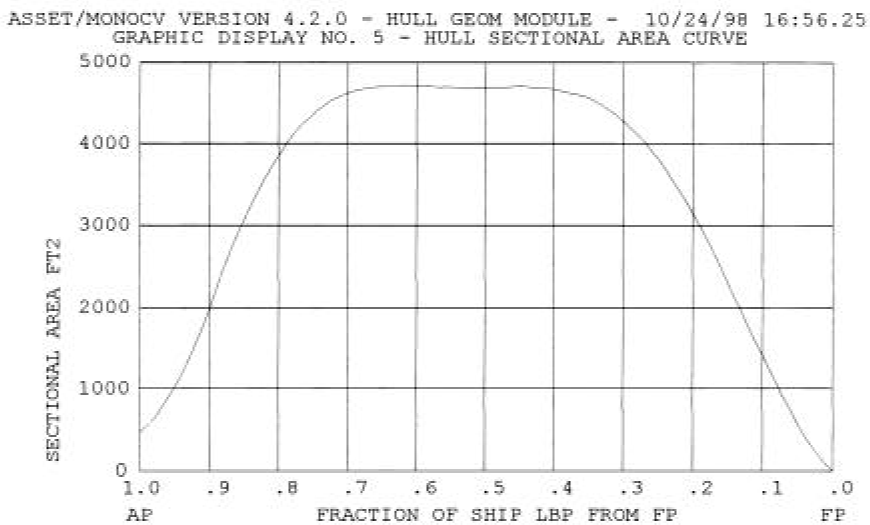

Figure 10. MPF 2010 Section Area Curve

4. Hydrostatic Properties at Level Trim

The hydrostatic properties at level trim for the light ship are shown in Figure 11.

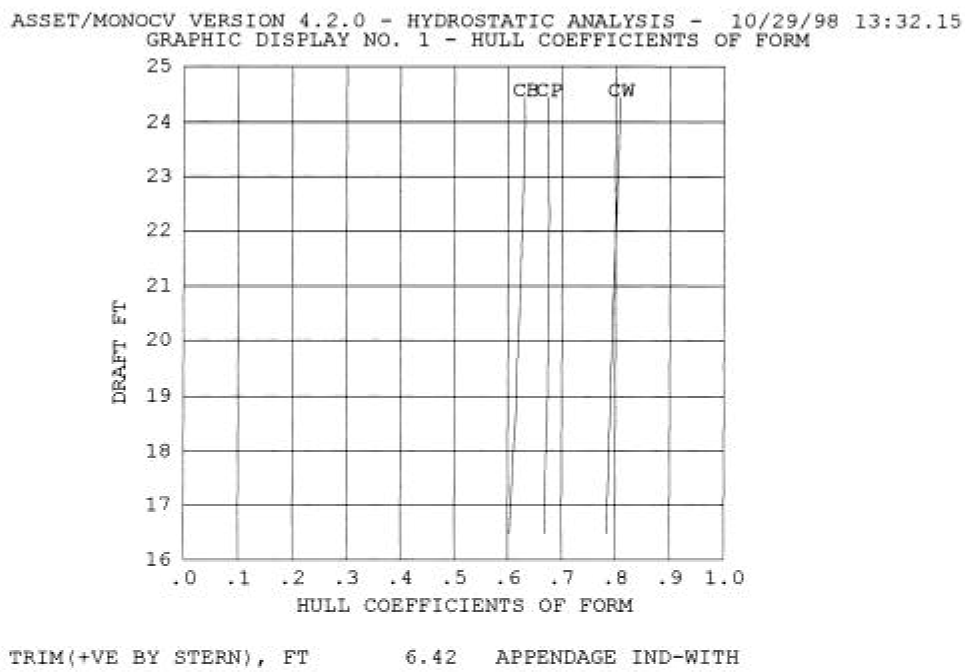

Figure 11. MPF 2010 Light Ship Hydrostatic Properties at level trim

5. Floodable Length Curve

The floodable length curve is used to determine the allowable compartment lengths, which will ensure that the margin line is not submerged, should the compartments spanning the defined factor of subdivision become flooded. U.S. Navy regulations require ships to sustain flooding damage up to 12.5 % of LBP [8] or 125 feet for MPF 2010. Figure 12 shows the floodable length curve for the MPF 2010 ship. As seen from the graph, a length of at least three compartments can be open to sea and still not submerge the margin line of the ship. This can be attributed to the huge reserve buoyancy of the ship and the fact that these calculations were made for the light ship.

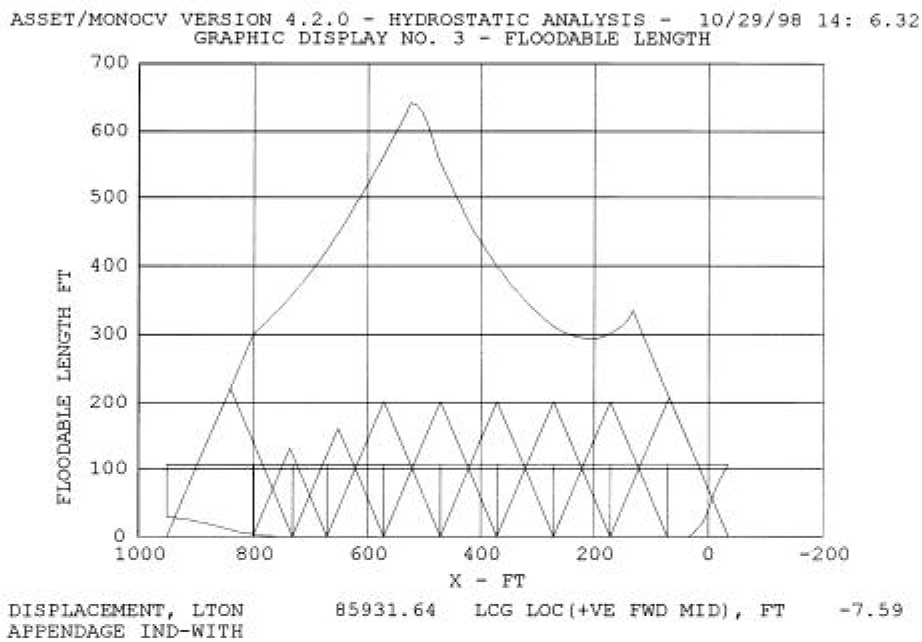

Figure 12. Floodable Length Curve

6. Intact Stability with Wind Heeling Arm

An intact stability curve with a 100 knot wind speed is shown in Figure 13. The maximum righting arm is 22 feet at a heel angle of 35°. Also noteworthy is the fact that a positive righting arm extends well past 90°.

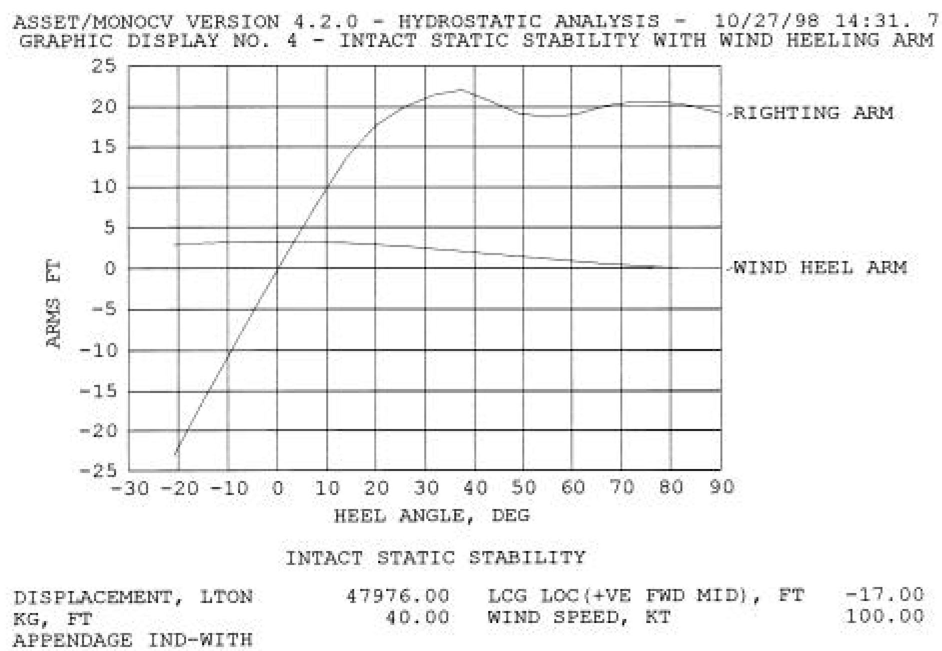

Figure 13. Intact Stability with Wind Heeling Arm (Light ship)

7. Intact Stability with Turn Heeling Arm

An intact stability curve for a turn at 20 knots with a turn radius of 1972 ft is shown in Figure 14. Once again, the maximum righting arm is 22 feet at 35° and there is a positive righting arm well past 90°.

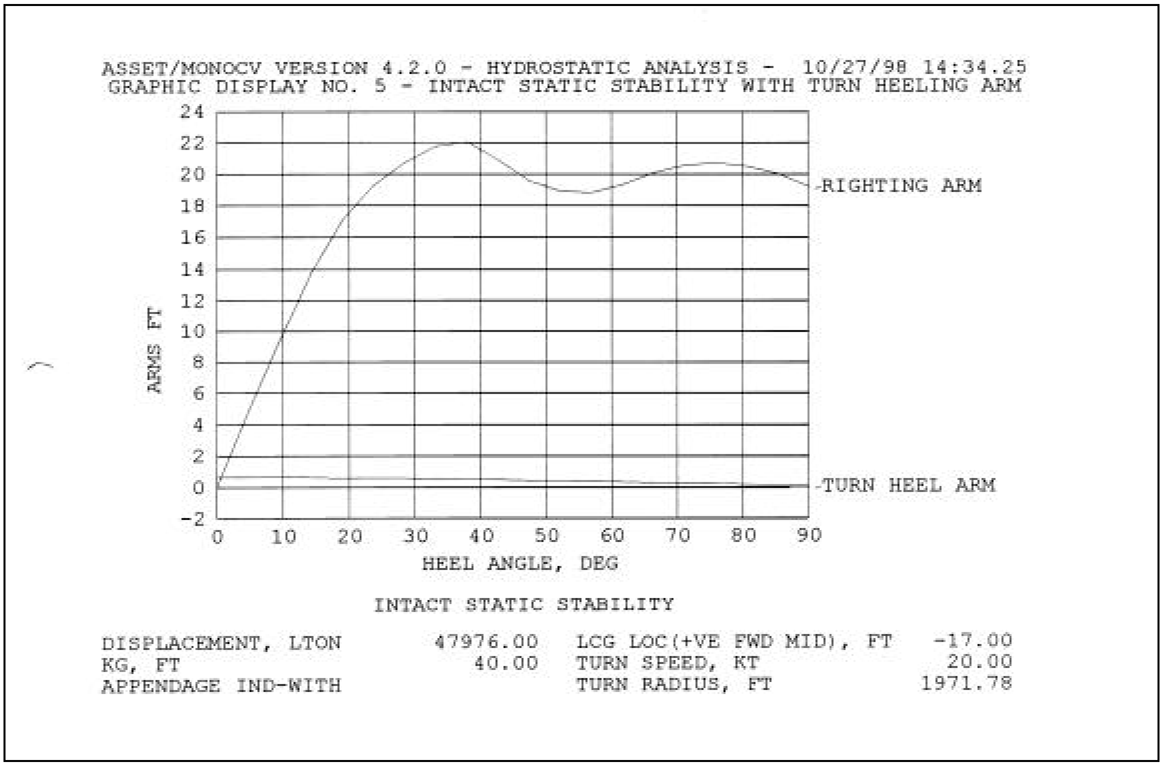

Figure 14. Intact Stability with Turn Heeling Arm (Light ship)

8. Ship View

Figure 15 through Figure 17 are the standard ship views for the MPF 2010 ship.

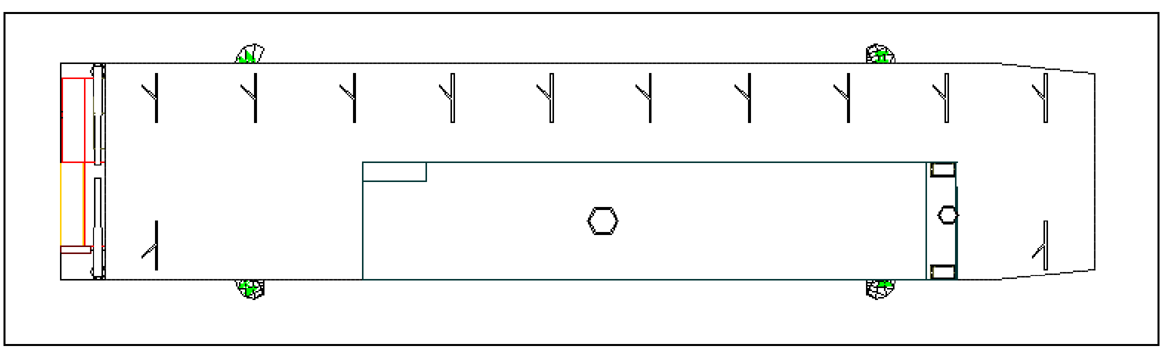

Figure 15: Plan View

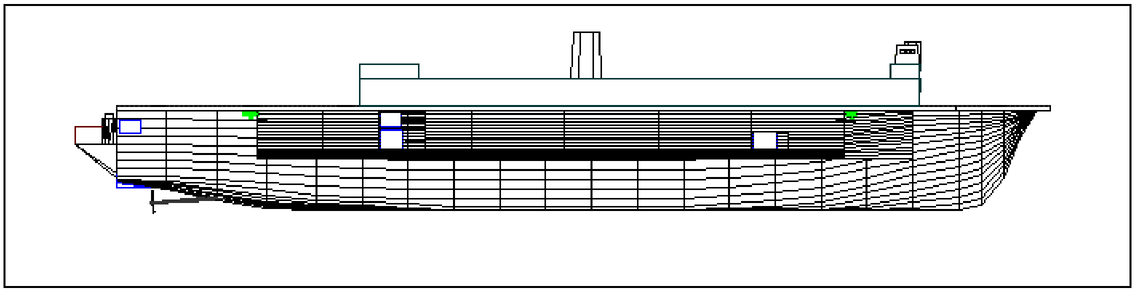

Figure 16. Sheer View

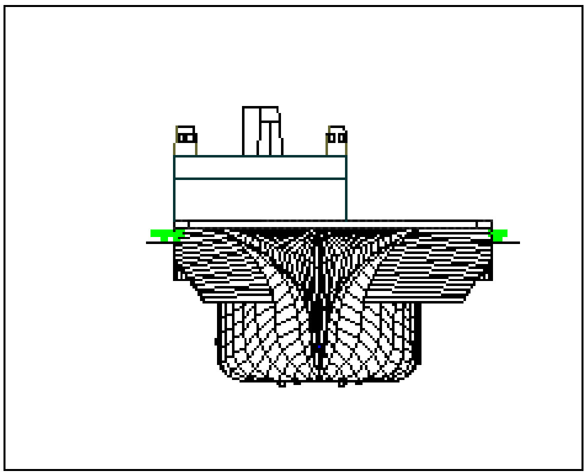

Figure 17. Body View

B. SHIP SPACE ASSIGNMENT AND LAYOUT

1. Cargo Deck

The MPF 2010 dry cargo storage requirement of 4166 containers was specified by the Center for Naval Analysis (CNA), [4]. This cargo can be stored on board MPF 2010 in containers and/or subdivided into pallets. Each container is capable of storing 16 pallets. The CNA assessment that 72% of the dry cargo would be containerized and 28% of the dry cargo would be palletized was adopted for this design (2,999 containers and 18,388 pallets). Each MPF 2010 ship utilizes a single cargo deck with space for 665 containers and 3940 pallets (Figure 18). In general, containers will load directly onto waterborne assets while aircraft and ground vehicles will transport pallet size loads. Cargo will be segregated and stored by transport type to the maximum extent possible.

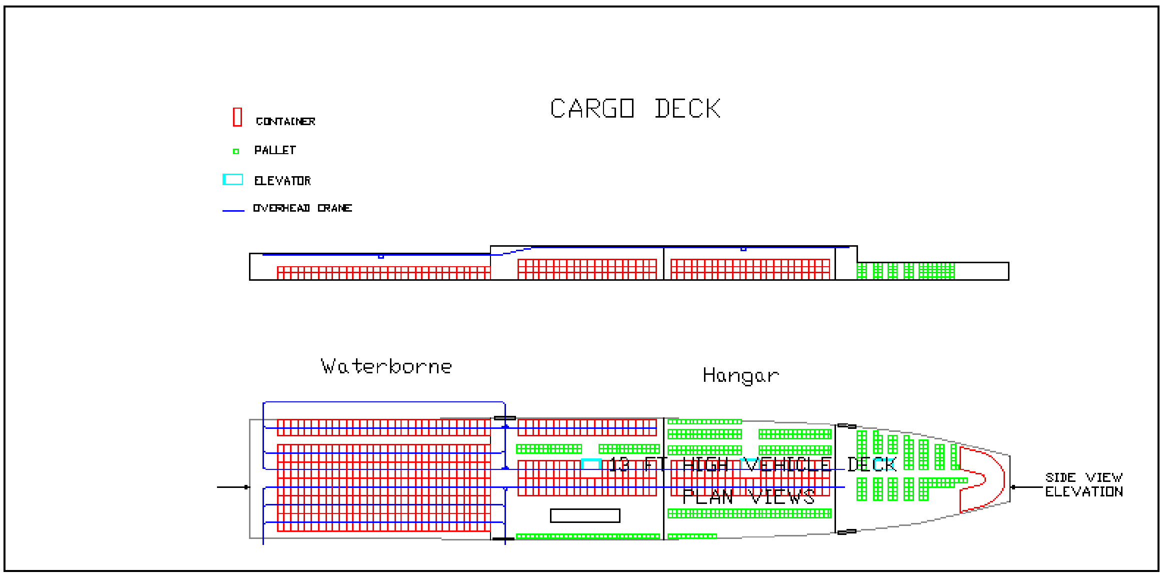

Figure 18. Cargo Deck Layout

a. Cargo to Hangar

Cargo going to the hangar will primarily be in the form of pallets (it is possible that some ammunition will be brought to the flight deck in container form). It will be stored on pallet shelving and in directly accessible containers, in the immediate vicinity of 1 of the 3 cargo elevators. The elevators transit exclusively between the cargo deck and the hangar. Three elevators provide for both increased capacity and redundancy. Forklifts are used to transport the pallets to and from the elevators.

b. Cargo to Vehicles

For reasons previously discussed in section IV. A., bringing the vehicles to the cargo (as opposed to the reverse) has been determined to be the most efficient and flexible method of cargo distribution. Vehicles access the cargo space through the forward ramp and pull into a predetermined loading area (Figure 19). Cargo is removed from its storage area by forklift as the vehicle transits to the cargo deck. The cargo and vehicle arrive at the loading area simultaneously, minimizing the time of the evolution. Once loaded, the vehicle uses the aft ramp to access the upper vehicle deck. The vehicle may then either return to its designated parking spot, proceed to the well deck for amphibious off-load, or proceed to a side ramp for off-load to a pier or lighterage.

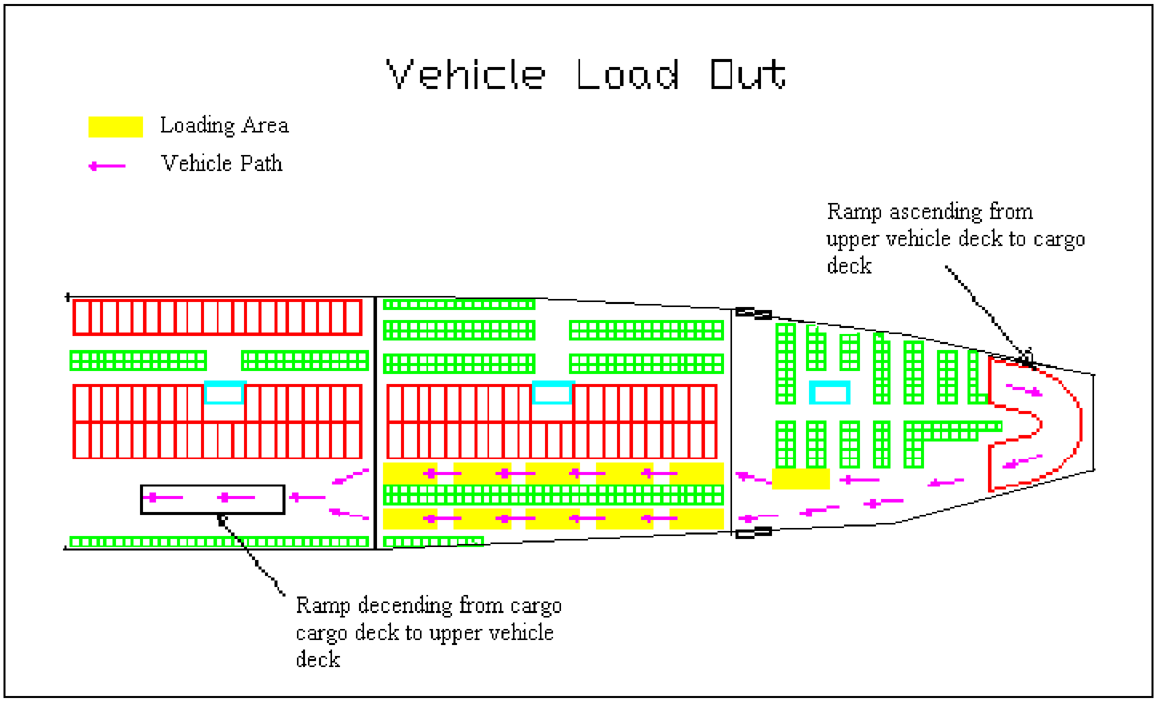

Figure 19: Vehicles Loading Paths

c. Cargo to Waterborne Assets

Cargo going to waterborne assets will be delivered by overhead crane and, in most cases, will be in the form of containers. The cranes operate on rails in the overhead of the ship interior and extend external to the hull and aft for 272 ft on both the port and starboard sides (Figure 20). Lighterage is positioned under these external sections to allow for loading. Cut outs in the aft section of the cargo deck allow for containers to be lowered directly into the well deck or well deck staging area. Ten cranes operate independently on the rail system providing for both increased capacity and redundancy.

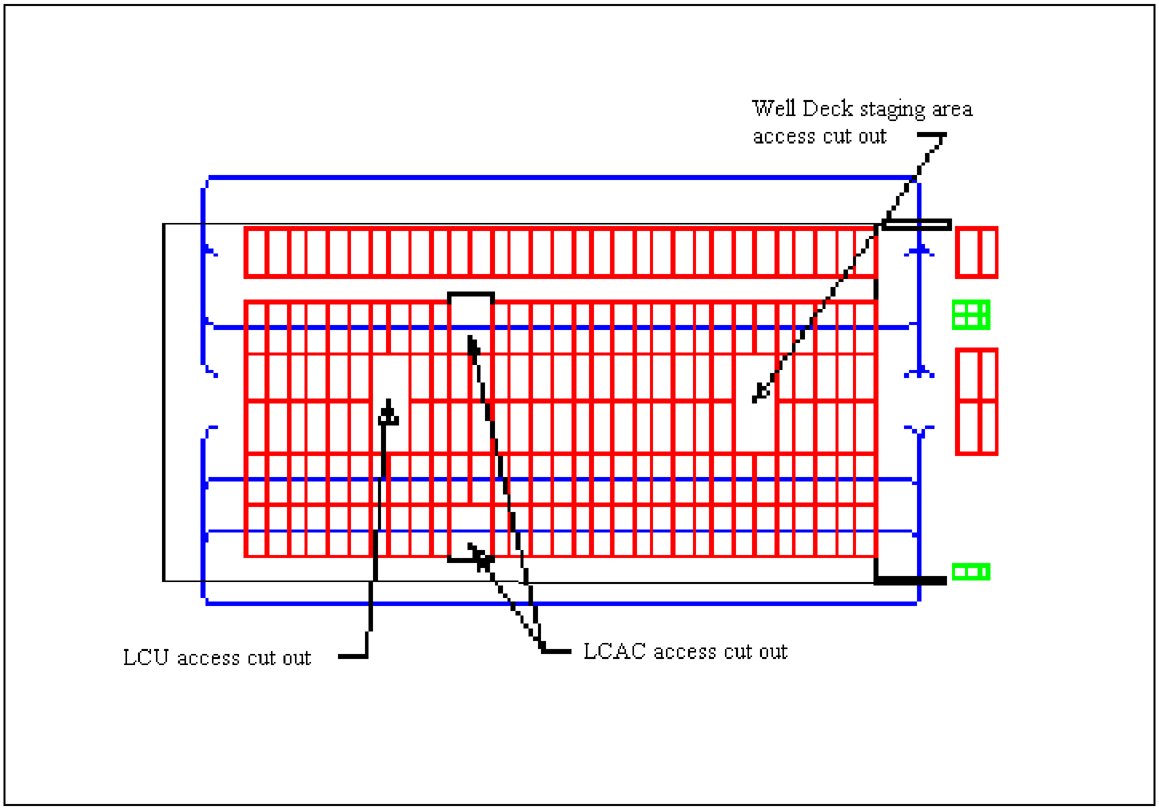

Figure 20. Watercraft Loading Paths

d. Cargo Load Out In Port

In port containers and pallets are loaded through side doors (forward and aft) and by use of the external section of the overhead crane system aft. Athwartships transit lanes, which begin at the side doors, are accessible by the overhead crane system to allow for container placement. Side doors are also the primary in port means of vehicle on and off load.

e. Cargo Reconfiguration

The primary advantage of this design is the accessibility of cargo, which by its very definition limits the amount of reconfiguration necessary. In cases where cargo does need to be moved, the overhead crane system allows for transport of any container to any container space. Additionally there is a 10-ft. wide vacant space available at the end of the last row of containers to allow for the temporary placement of top containers when gaining access to bottom containers (Figure 20).

2. Vehicle Decks

The capacity and functionality of the vehicle decks is a crucial component of both the ship and its mission. Vehicles must be easily accessible and have ease of access to on-load/off-load points, while minimizing the their volumetric storage requirements.

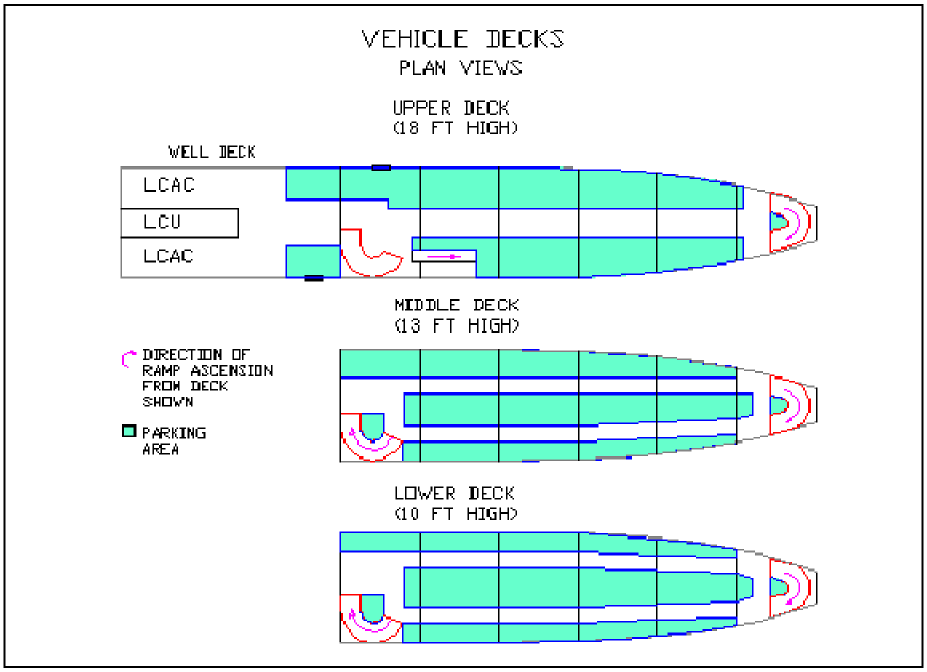

Figure 21. Vehicle Decks of the MPF 2010

The MPF 2010 vehicle deck design encompasses 3 vehicle decks of heights 10, 13, and 18 feet (Figure 21). Each of these decks accounts for approximately 1/3 of the vehicle deck area provided. The deck of the upper vehicle deck is flush with the partial well deck, which allows for direct vehicle access to the LCACs, LCU, and open water (Figure 21). Also located on the upper vehicle deck are 2 ramps leading to and from the cargo deck and 2 side doors allowing access to lighterage.

Each vehicle deck utilizes 2 circular ramps for travel between decks and a racetrack style transit path for intra-deck travel. The circular ramps optimize vehicle deck space use while allowing for a smooth transition to the intra-deck travel paths. The travel paths provide several advantages:

- Accessibility of vehicles. Seventy six percent of all vehicles have direct access to the travel path. No vehicle has more than one vehicle between it and the travel path.
- Ease of reconfiguration. Travel paths are driven by the number and geometry of vehicles required to be stored, not by any physical barriers.
- Flexibility in ramp access. The travel paths are flexible and easily reconfigured to allow for continued vehicle ramp access in the event of path blockage due to vehicle breakdown or battle damage (see Figure 4).

The ship's vehicle deck requirements are driven by the size and number of vehicles required by the MAGTF and it's support elements (MAGTF vehicles are listed in reference [4] Table B-2). Additionally, the desire to stage vehicles by unit has a significant impact on required vehicle deck area. Keeping company size units on the same ship prevents confusion and separation during assault operations.

The proposed load out of vehicle units by ship is listed below (Table 2), [5].

Ship 1	Ship 2	Ship 3	Ship 4	Ship 5
Ground Combat Element				
Bat HQ, SRV CO	Det MP Co	Inf Bat HQ Co	Inf Bat HQ Co	Tank Co
Reg HQ Co	Det Comm Co	Weapons CO	Weapons CO	155 Battery
Tank HQ Co	Det Truck Co	CE Support CO	CE Co	
155 Battery	Det Recon Plt	Tank Co	Tank Co	
Arty HQ	Inf Bat HQ Co	AAAV Co	LAV Co	
	Weapons CO	155 Battery	155 Battery	
	CE HQ Co			
	Tank Co			
	AAAV HQ Co			
	AAAV Co			
	155 Battery			
Combat Service Support Element				
			Motor Transport General Support Co	MP Co
				Landing Support Batt HQ

				Beach Group
				Landing Support Co
				Landing Support Equipment Co
				Motor Transport Batt HQ
				Motor Transport Direct Support Co
Command Element				
Surveillance, Recon and Intel Group				
Radio Batt				
A Co				
B Co				
HQ Co				
Comm Batt				
HQ Co				
Direct Support Comm Co				

Table 2. MEF(FWD) Unit/Ship Assignment

Since the MPF 2010 design concept requires commonality of capability between all ships of the squadron, the ship with the greatest vehicle deck requirement becomes the baseline. As can be seen in Table 3, ship 4 has the largest deck area requirement. This table is based solely on vehicle dimensions and does not take into account vehicle spacing.

	Ship 1	Ship 2	Ship 3	Ship 4	Ship 5
Deck Area (ft^2)	65,126	68,833	70,477	92,344	77,674
number of vehicles	460	357	388	410	457

Table 3. Vehicle Area Requirements

To ensure that the MPF 2010 design meets all vehicle deck area requirements, each vehicle in the most restrictive case (ship 4) has been assigned a specific storage location. The vehicles and their locations are listed in Table 4 and Table 5, respectively. With the layout shown in Figure 22.

The result of this analysis is that for the most restrictive case (ship 4) all vehicles can be arranged such that they fit within the approximately 132,000 ft^2 of parking space available (182,000 ft^2 including transit lanes). The entire MPF 2010 squadron of five ships provides 910,000 ft^2 of vehicle deck area, which exceeds the 860,000 ft^2 called for by the CNA study, [4].

VEHICLE CONFIGURATION FOR SHIP 4

I series	Name	Number	Length	Width	Height
D0085	GP.75T 2W M116	1	12.3	6.6	7
D0209	12.5 T PWR 4x4	77	33.2	8	8.6
D0215	TANKER 5K	16	30.7	8	8.7
D0235	LOW BED M870	2	43	10.5	7.1
D0860	CARGO 1.5T M105	10	13.9	7	8.2
D0876	22.5 T MK14	50	38	8	8.6
D0878	PWR 5TH WHL ADT	2	22.2	8	5.5
D0879	20T 4X4 PWR W/SC	17	38	8	10
D0880	TANKER 400G M149	3	13.5	7	7
D0881	MK-18 RIBBON	10	22.8	10.6	7.6
D1001	AMBULANCE M997	2	17	7.2	8.5
D1002	AMBULANCE M1035	2	15.5	7.2	6.1
D1059	CARGO M923	21	26	8.2	10.1
D1110	TANKER 1200G(M939)	1	23.2	8.8	14
D1134	5T 6X6	17	23.9	8.2	10.1
D1158	M998	31	15.5	7.2	6.1
D1159	ARMT CAR	12	15.5	7.2	6.6
E0665	155MM M198	6	24.7	9.3	7.2
E0942	ANTI-TANK	4	24.2	8.3	10.5
E0946	COMMAND	1	24.2	8.3	10.5
E0947	25MM CARRIER	14	24.2	8.3	10.5
E0948	LOGISTIC	3	24.2	8.3	9.4
E0949	MORTAR CARRIER	2	24.2	8.3	9.4
E0950	MAINT/RECOVERY	1	24.2	8.3	9.4
E1377	TRACKED M88	1	27.2	11.25	11.3
E1888	M1A1	14	36.2	15	10

Table 4. Ship 4 Vehicle Breakdown

VEHICLE CONFIGURATION FOR SHIP 4

I series	Name	Number	Length	Width	Height
D0085	GP.75T 2W M116	1	12.3	6.6	7
D0209	12.5 T PWR 4x4	77	33.2	8	8.6
D0215	TANKER 5K	16	30.7	8	8.7
D0235	LOW BED M870	2	43	10.5	7.1
D0860	CARGO 1.5T M105	10	13.9	7	8.2
D0876	22.5 T MK14	50	38	8	8.6
D0878	PWR 5TH WHL ADT	2	22.2	8	5.5
D0879	20T 4X4 PWR W/SC	17	38	8	10
D0880	TANKER 400G M149	3	13.5	7	7
D0881	MK-18 RIBBON	10	22.8	10.6	7.6
D1001	AMBULANCE M997	2	17	7.2	8.5
D1002	AMBULANCE M1035	2	15.5	7.2	6.1
D1059	CARGO M923	21	26	8.2	10.1
D1110	TANKER 1200G(M939)	1	23.2	8.8	14
D1134	5T 6X6	17	23.9	8.2	10.1
D1158	M998	31	15.5	7.2	6.1
D1159	ARMT CAR	12	15.5	7.2	6.6
E0665	155MM M198	6	24.7	9.3	7.2
E0942	ANTI-TANK	4	24.2	8.3	10.5
E0946	COMMAND	1	24.2	8.3	10.5
E0947	25MM CARRIER	14	24.2	8.3	10.5
E0948	LOGISTIC	3	24.2	8.3	9.4
E0949	MORTAR CARRIER	2	24.2	8.3	9.4
E0950	MAINT/RECOVERY	1	24.2	8.3	9.4
E1377	TRACKED M88	1	27.2	11.25	11.3
E1888	M1A1	14	36.2	15	10

10 FT HIGH DECK

1st Compartment		2nd Compartment		3rd Compartment	
not utilized		not utilized		not utilized	
4th Compartment		5th Compartment		6th Compartment	
D1159	9	D0881	3	E0665	6
D1002	2	D0878	2	D0881	7
D0880	3	D1158	31		
D0085	1	D1159	3		
not fully utilized					

13 FT HIGH DECK

1st Compartment		2nd Compartment		3rd Compartment	
D1134	2	D0209	10	D0209	10
		D0860	10	E0947	1
		D1001	2	E0948	3

Table 5. Ship 4 Vehicle Placement

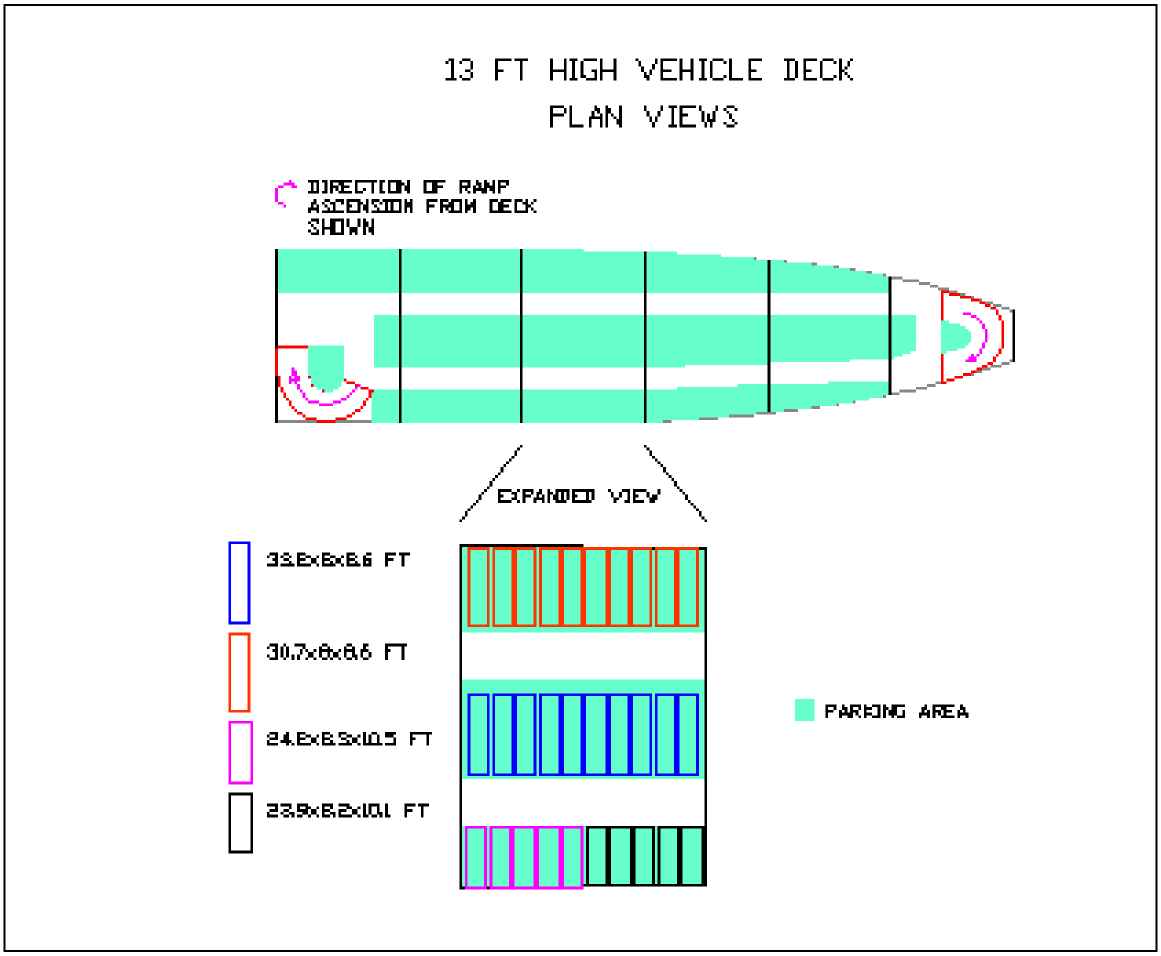

Figure 22: 5th deck Layout

3. Well deck

MPF 2010 will have a well deck capable of conducting dry and wet operations simultaneously. The well deck will consist of a 35 ft wide, 10 ft deep, and 130 ft long well. The well will be located at the stern and will be vertically positioned within MPF 2010 such that it will not be necessary to ballast down the ship (when in the fully loaded condition) to conduct wet operations. The bottom of the well is 10 feet below the waterline. When well operations are to commence, the well is allowed to flood through the use of a sea valve. Once the well is flooded to the waterline, the stern gate can be moved out of the way. One utility landing craft (LCU) will be housed in the well when not in use. The well will be used for LCU (or future equivalent craft) operations.

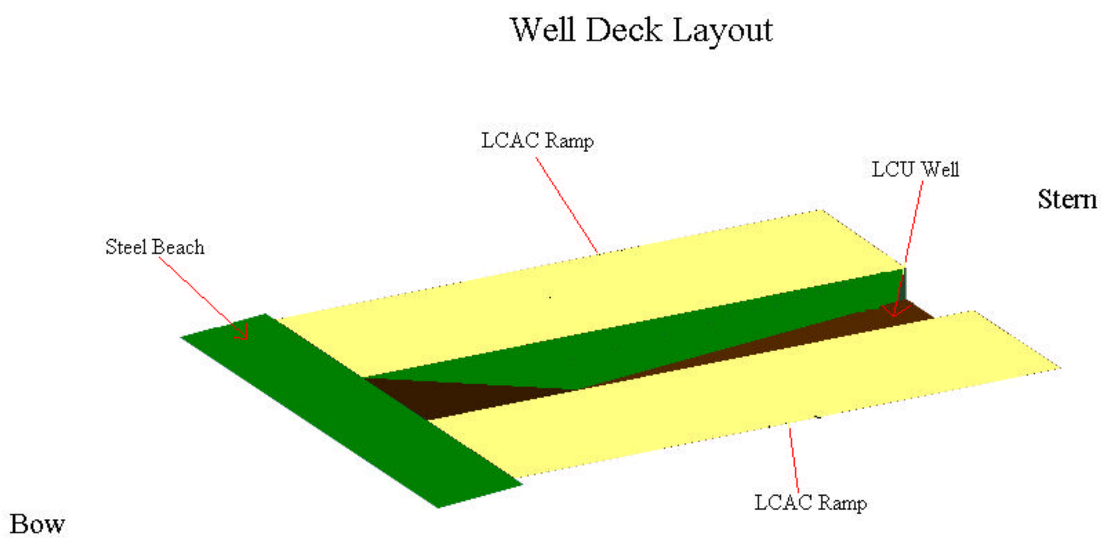

Figure 23: Well Deck Design

There will be a 48 ft wide ramp at either side of the well. Each ramp will extend down to the bottom of the well at an inclination of 3 degrees. The ramps will be 13 ft high and 190 ft long. At the top end of the ramps will be a steel beach area of 90 ft in length and 140 ft in width. One Landing Craft Air-Cushion (LCAC) will be stowed on each ramp on either side of the well. The ramps will be used for the launch and recovery of LCACs and AAAVs (or future equivalents).

4. Flight Deck

The flight deck is 1000 feet long and 220 feet wide. An aircraft hangar which is 600 feet long, 120 feet wide, and 30 feet high is located on the starboard side of the flight deck. The leading edge of the hangar is 140 feet aft of the forward edge of the flight deck. The starboard side of the hangar is flush with the starboard side of the flight deck. This hangar and flight deck arrangement gives MPF 2010 the appearance of a large LHD (see Figure 16). The hangar will contain five doors that are 50 feet wide and 20 feet high to allow aircraft and equipment to transit to and from the flight deck. There will be a hangar door located at each of the forward and aft ends of the hangar and three doors spaced along the port side of the hangar. These hangar doors will open and close by sliding on rails located within the hangar.

The flight deck length and width was primarily driven by two factors. The first was the requirement that adequate flight deck space be provided so that 12 MV-22 aircraft could launch from a single MPF 2010 nearly simultaneously. The second factor was the displacement of MPF 2010. The displacement of MPF 2010 resulted in a ship longer than originally anticipated, which allowed the flight deck to be slightly longer than would be required to meet the MV-22 requirement. Therefore there is slightly more room on the flight deck than would be required for the near simultaneous launch of 12 MV-22s. Since 3 MPF 2010 ships are anticipated to be loaded out with 12 MV-22s each, this will allow the near simultaneous launch of 36 MV-22s in support of the transport of an infantry battalion to the objective.

Flight deck geometry was also driven by the requirement to launch and recover Joint Strike Fighter (JSF) aircraft, although this requirement was not as restrictive as the MV-22 requirement. Consideration was given to providing sufficient flight deck space for the JSF launch under all anticipated conditions of aircraft loading, mission range, wind over deck and ambient temperature. Without catapults, all aircraft will be required to launch under their own power. A jet blast deflector (JBD) is located 700 feet from the leading edge of the flight deck, which will allow nearly 700 feet of flight deck from which the JSF will be able to launch. The JBD can be raised into position or lowered out of the way as needed. Due to the length of flight deck provided for JSF launch, a ski jump at the end of this length was not considered necessary.

If necessary, the entire 1000 feet length of the flight deck can be used for maximum load take off under limiting weather conditions by all aircraft. Additionally, the entire flight deck length could be used for casualty landing situations, such as an aircraft returning with one engine inoperative. Further, barriers will be provided for the recovery of damaged aircraft.

JSFs will land on three dedicated landing areas equipped with Jet Blast Collectors (JBCs) on the aft end of the ship. The JBC system will collect, cool and redirect the hot JSF exhaust overboard. The JBC are 60 feet in diameter, are spaced 10 feet apart, and each aft edge is located 10 feet forward of the aft end of the flight deck. The exhaust gases will be collected and directed down under the flight deck to be cooled by a heat exchanger and then directed out the aft end of the ship just below the flight deck level.

Primary flight control (Pri-Fly) is located above the hangar on the port side, its port side flush with the port side of the hangar. Pri-Fly is 60 feet long and 20 feet wide, with its trailing edge flush with the aft end of the hangar. This location provides Pri-Fly a direct view of JSF launch and recovery operations. Camera coverage is to be used for the portions of the flight deck and hangar that are not in direct view of Pri-Fly.

a. Tow Robots

The idea of tow robots or ‘towbots’ was borrowed from last year’s total ship systems engineering team that worked on the CVX design, [9]. The towbots are fully automated requiring no ‘man in the loop’ except for commands from the aircraft controllers directing the aircraft's placement. The towbots will handle the maneuvering and tie downs of all aircraft. The towbots will automatically mate to tow points on the various aircraft when on deck movement or tie down is required. No aircraft will be required to taxi under its own power and thus flight deck safety will be enhanced through the reduction of jet blast and noise levels. The towbots will attach themselves to the deck by an electro-hydraulic grappling system and provide multi-axis stability through extendable mechanical arms. Since the towbots attach from underneath, the existing aircraft footprint is maintained.

Conventional tie down methods may be will be employed in heavy weather or when the aircraft are not required to move right away. In these circumstance the towbot will assist through providing a means of transporting the tie down chains, so that only a single person is required to install the tie down chains.

b. Aircraft Parking

An analysis of the aircraft load-out variants is given in Appendix B. Based on this analysis, two variants were defined: one with JSF aircraft and no MV-22 aircraft and one with MV-22 aircraft and no JSF aircraft. The same ship design was required to handle both loadout variants. The implications are described below.

1). JSF Load-Out

JSF launch and recovery will be conducted on the port side and aft end of the flight deck, respectively, discussed in section VI.E1. The remaining area of the flight deck, which includes the forward starboard corner and the area just aft of the hangar, will be used in addition to the hangar for parking of the 30 JSF and four SH-60 aircraft of this load out.

The flight deck aft of the hangar will be used to ready JSFs for launch. If necessary, approximately 13 JSFs can be parked in this section while maintaining a clear path for other aircraft moving to the hangar. Up to an additional eight JSFs can be parked on the forward starboard portion of the fight deck and still leave adequate room for JSF flight operations.

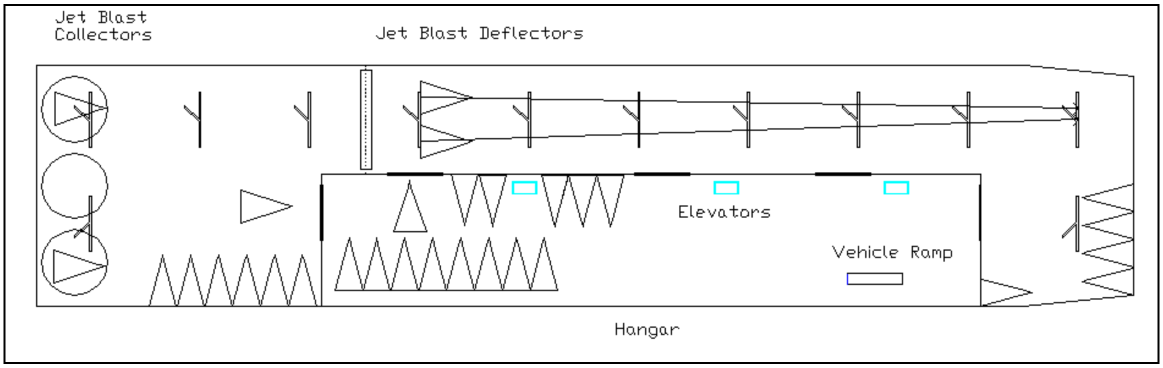

Figure 24. Flight Deck Arrangement (JSF Load out)

The remaining JSFs and SH-60s can be parked in the hangar and still leave adequate room for the transiting and maintenance of all aircraft. Indeed, the hangar can fully house all embarked aircraft (of either load-out) if necessary. A notional parking arrangement is shown in Figure 24.

2). Rotary Aircraft Load-Out

Launch and recovery of the MV-22 and CH-53 aircraft will be conducted from 12 spots on the flight deck (see Figure 25). These spots are 100 feet in diameter and will provide adequate clearance for the launch and recovery of either MV-22 or CH-53 aircraft in a nearly simultaneous fashion. These twelve spots were configured to support the nearly simultaneous launch of 36 MV-22 aircraft from three MPF 2010 ships in support of the airlift of an infantry battalion to the objective. An additional space is available (100 feet by 110 feet rectangle) just aft of the hangar which may be used for the pre-staging of aircraft or equipment.

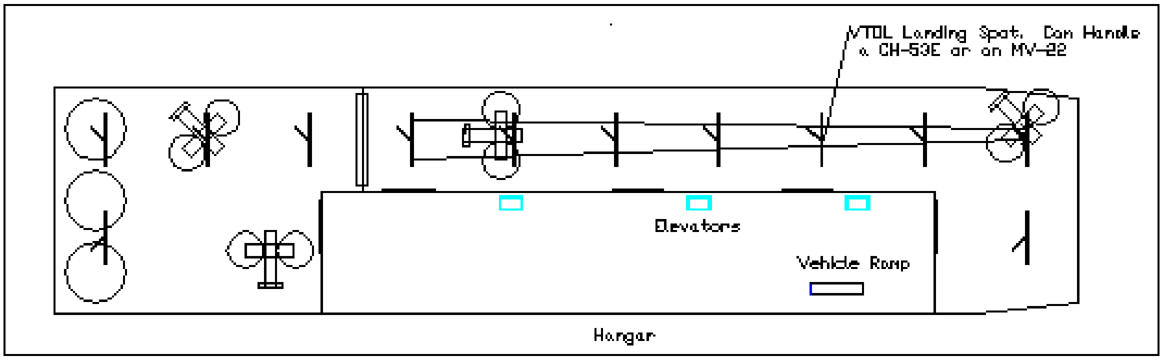

Figure 25. Flight Deck Arrangement (Rotary Wing Load Out)

c. Refuel/Rearm

Power and fuel hookups will be provided through accesses on the deck at each of the landing spots. Additional hookups will be provided at various locations on the flight deck and in the hangar bay. De-fueling can be accomplished at any of the landing spots or outside each of the five hangar doors prior to aircraft entering the hangar if necessary.

Rearming will be accomplished by weapons robots that can be configured for each type of aircraft. The weapons robots (see section V.B.6.b.) will traverse the elevators in the hangar bay to obtain weapons from the cargo compartment and then return via these elevators. Since these robots are free to move to and from the hangar, flight deck, and cargo compartments, this system is extremely flexible. Rearming can be accomplished at any convenient location. For example, JSFs could be rearmed and refueled while queued for take off at the aft part of the hangar or parked on the after flight deck. De-arming will also be accomplished by the weapons robots

5. Hangar

a. General Description:

MPF 2010 hangar general dimensions and positioning on the flight deck are described in section V.B.4. Within the hangar, small rooms are located outboard of the elevators for offices and heads. Hatches are placed in various locations in the hangar for movement between the flight deck and hangar. Ladder wells are provided for movement to the pilot house, primary flight control, and to upper level storage rooms or offices.

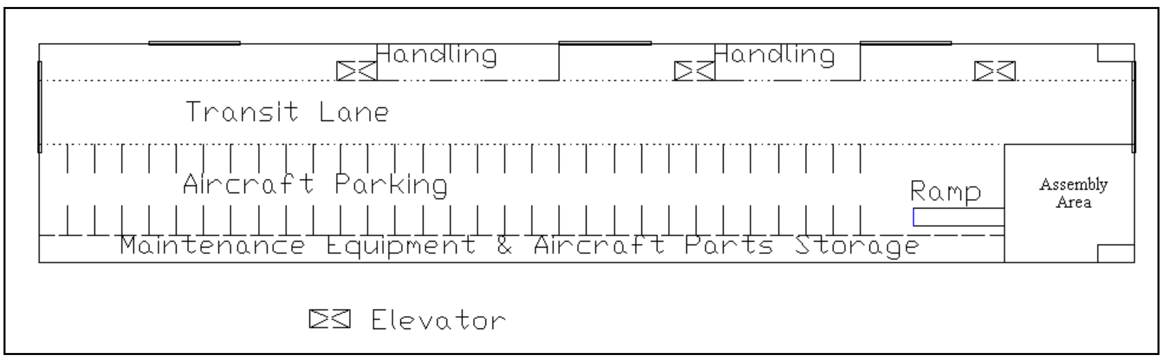

Figure 26. Hanger Layout

b. Aircraft Stowage

Under normal conditions the aircraft will be parked in the maintenance spaces just inboard of the maintenance equipment. There are 30 spaces 15 feet wide each located there. The remainder of the aircraft will be parked on the flight deck.

As previously mentioned, the hangar size allows all aircraft of either notional load-out to be stored in the hangar at the same time. Although not a requirement, this is desired in the event of adverse weather. It also provides greater flexibility for flight deck operations, see Figure 27 and Figure 28.

The stowed dimensions of the aircraft are summarized in the below table:

Aircraft	Length (ft)	Width (ft)	Height (ft)
JSF	45	30	12
MV-22	63	19	19
CH-53	61	29	19
AH-1	46	11	14
UH-1	46	10	14
SH-60	41	11	13

Table 6: Aircraft Dimensions

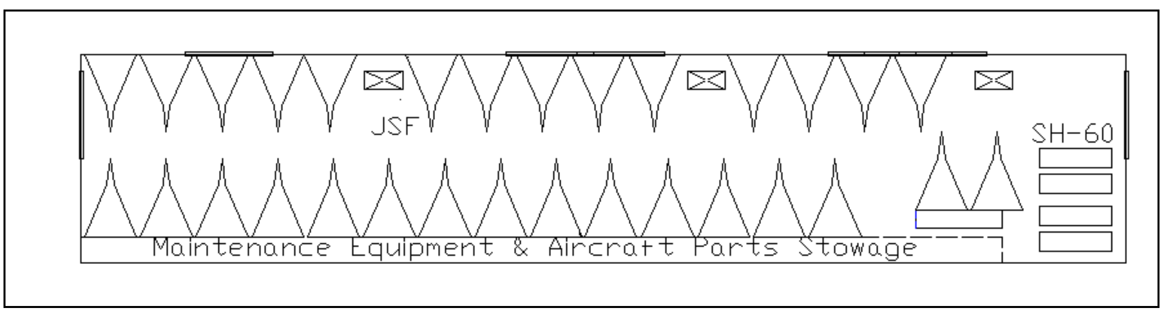

Figure 27. JSF Parking

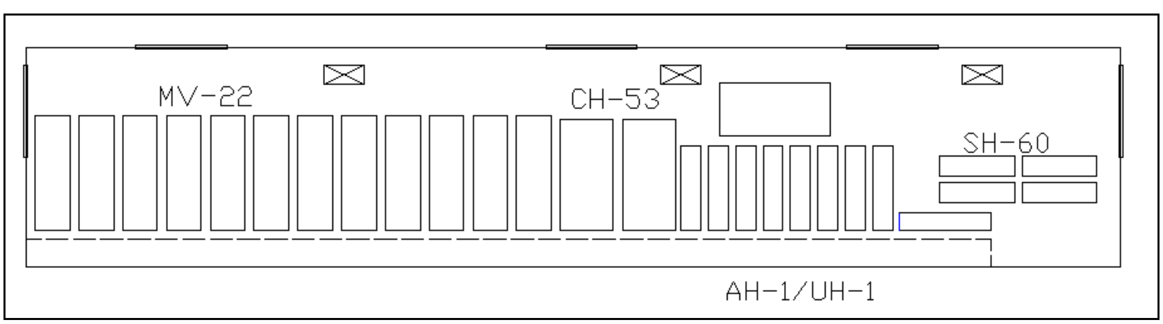

Figure 28. Rotary Wing Parking

c. *Aircraft Flow*

A transit lane running the entire length of the hangar is located near the port side. The transit lane is not to be used for aircraft parking under normal conditions. The transit lane is to be used for aircraft, vehicle, and cargo movement within the hangar. Additionally, all the hangar doors can be accessed from the transit lane.

d. *Aircraft Maintenance*

The hangar height of 30 feet is such that the most limiting maintenance on the tallest aircraft can be conducted while within the hangar bay. To facilitate maintenance an overhead crane runs on tracks covering the 550 feet in the longitudinal direction over the maintenance area.

The starboard wall of the hangar bay is dedicated to maintenance shops, test equipment and large aircraft parts storage. This area is 530 feet by 15 feet and runs most of the starboard length of the hangar.

Maintenance Shops List
Non destructive testing and inspection
Engine test cell
Avionics Repair
Engine Repair
Machine Shop
Composite Repair
Structure Shop
Hydraulic/pneumatic
Tire and wheel shop

Table 7: Aircraft Maintenance Shops

1). Minor Aircraft Maintenance

Minor aircraft maintenance can be accomplished in any convenient location in the hangar or on the flight deck.

2). Intermediate Level Maintenance

Intermediate level maintenance will be accomplished while aircraft are parked in the maintenance area. A long-term parking or maintenance area is provided in the forward starboard corner of the hangar.

e. Storage

Hangar deck space is allocated for aircraft handling equipment storage forward of the two aft elevators. Forward of the aft elevator is a 100 ft by 20 ft (2000 ft^2) area. Forward of the middle elevator is an 80 ft by 20 ft (1600 ft^2) area, see Figure 26. This is a total of 3600 square feet of deck space for aircraft handling equipment storage. This area is to be used for towbot and weapons robot parking. Maintenance equipment, test equipment, and aircraft parts storage spaces are located along the starboard bulkhead between the maintenance shops.

Office or storage rooms will be located above the main hangar deck above the aircraft handling equipment storage areas, the elevators and/or above the starboard maintenance equipment areas.

Any additional stowage will be located below the hangar in the cargo or vehicle decks. These decks will be accessed via the cargo elevators or vehicle ramp.

6. Ordnance Handling System

a. General Operation

The method of storage, assembly, transportation, and mating of ordnance to aircraft onboard the current Nimitz class aircraft carriers requires large amounts of deck space and is labor intensive. The concept of the ordnance handling system on the MPF 2010 leverages robotics, automation, and other technologies to reduce the manpower required and simplify weapons handling process while maintaining or improving the current safety level.

The existing weapons handling method onboard U.S. aircraft carriers requires that the weapons be manually removed from the magazine, loaded on skids, and moved to the assembly areas. In the assembly areas, the weapons have aerodynamic surfaces and targeting systems installed (fuses and arming wires are installed on the flight deck) and then are staged in the assembly area or on the hangar deck. Due to the amount of time it takes to move the large number of weapons skids from the assembly areas to the flight deck, some weapons may be stowed outboard the island on the flight deck in what is commonly known as a "bomb farm." Loading of the aircraft is done manually and with the aid of bomb hoists. This system requires approximately 300 personnel to operate (200 for weapons assembly alone), limits the use of the aircraft elevators during surge operations and crowds the flight deck with dangerous amounts of explosives, [9].

We assume that air launched weapons of the future will be completely self contained in all up round units that require little or no assembly, thereby reducing the number of weapons assembly personnel required. Precision Guided Munitions (PGMs) give increased kill probabilities and thus reduce the total number of weapons to be handled. The weapons will be shipped and stored in the same containers and will be located in the magazine portion of the cargo holds below the flight deck. These containers will be designed to interface with the weapons robots and thus reduce the number of personnel required in the weapon transfer and loading operations. Weapons will be armed by fail-safe electronics after aircraft launch. No installation of aerodynamic surfaces, targeting systems or fuses will be required.

The weapons robots will traverse one of three elevators in the hangar bay to obtain weapons from the cargo compartment and then return via the same elevators. Since the robots are free to move in the hangar and on the flight deck, this system is extremely flexible. Rearming can be accomplished at any convenient location in the hangar or on the flight deck. A sufficient quantity of robots will be onboard to meet aircraft turn around requirements.

Alternatively, weapons containers may be brought up to the hangar by container handlers via the cargo elevators. This can decrease rearming time by removing the need for the weapons robots to travel to the cargo decks each time that weapons are required for loading. However, this method places large amounts of explosives on the hangar deck, which is undesirable.

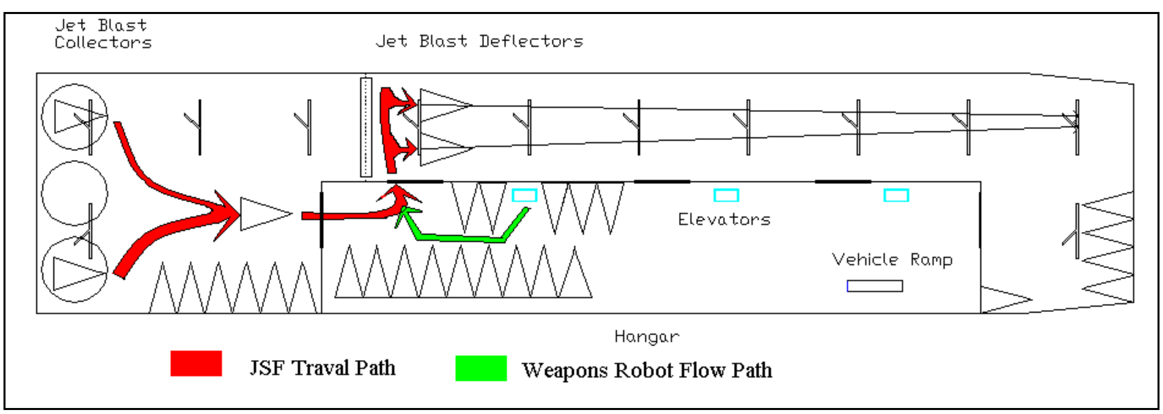

Figure 29. Notional Weapons Flow Path

b. Weapons Robot Description

Each weapons robot will be manually operated by a single operator. This machine-assisted arming and rearming will be an improvement over the current manpower-intensive weapons handling operations. The weapon robots will be capable of transiting the flight deck, hangar bay, cargo elevators and cargo holds. The robots will be large enough to carry a full load of weapons and be able to install such weapons on any aircraft. This includes the internal and external carriages of the JSF.

The weapon robots will remove weapons from the weapons shipping containers and move them to the rearming point. The weapons will conduct self diagnostics when unpacked by the weapons robot and report the results of these diagnostics to the operator. The robot will then place the weapons onto secure carrying fasteners interior to the robot. In addition to missiles and bombs, the weapons robots will be able to rearm gun systems on all aircraft and install additional external fuel tanks when needed. De-arming will also be accomplished by the weapons robots in the reverse manner. The robots would then transport the weapons back to storage container in the cargo holds.

7. Electrical Distribution and Propulsion Systems

a. Prime Movers

MPF 2010 will employ three sets of prime movers. The first set of prime movers will be primarily used to power MPF 2010 at its endurance speed (20 kts). These prime movers are four Medium Speed Colt-Pielstick Diesels having a brake horsepower of 15,000 HP each. The diesels are directly coupled to a 6.6 kV, 60 Hz three phase generator which produces 11 MW of electrical power.

The second set of prime movers will be employed by MPF 2010 when speeds higher than endurance speed are required (up to a maximum speed of 27.5 kts). These second-set prime movers are three LM 5000 marine gas turbines rated at 39,100 brake horsepower each. Each LM 5000 gas turbine is directly coupled to a 6.6 kV, 60 Hz three phase generator which produces 23.3 MW of power.

In addition to the above prime movers, two Caterpillar 3608 medium speed diesel engines are installed for in-port and emergency power use. These engines are rated at 3100 brake horsepower each and are directly coupled to 460V 60 Hz three phase generators which produce 2500 kW of power each.

b. Electrical Distribution System

The main propulsion generators will feed the main electric bus in a ring bus configuration (see Figure 30). The main electric bus will distribute electrical power from the ship's generators to MPF 2010's propulsion, ship's service, and auxiliary loads. The main bus will be connected to the ship's generators via switchboards and associated electrical (i.e. automatic bus transfer) components for parallel operation. The main bus will be designed to cross-connect between the port and starboard sections automatically through an integrated power control system that monitors for the electric bus faults and damage.

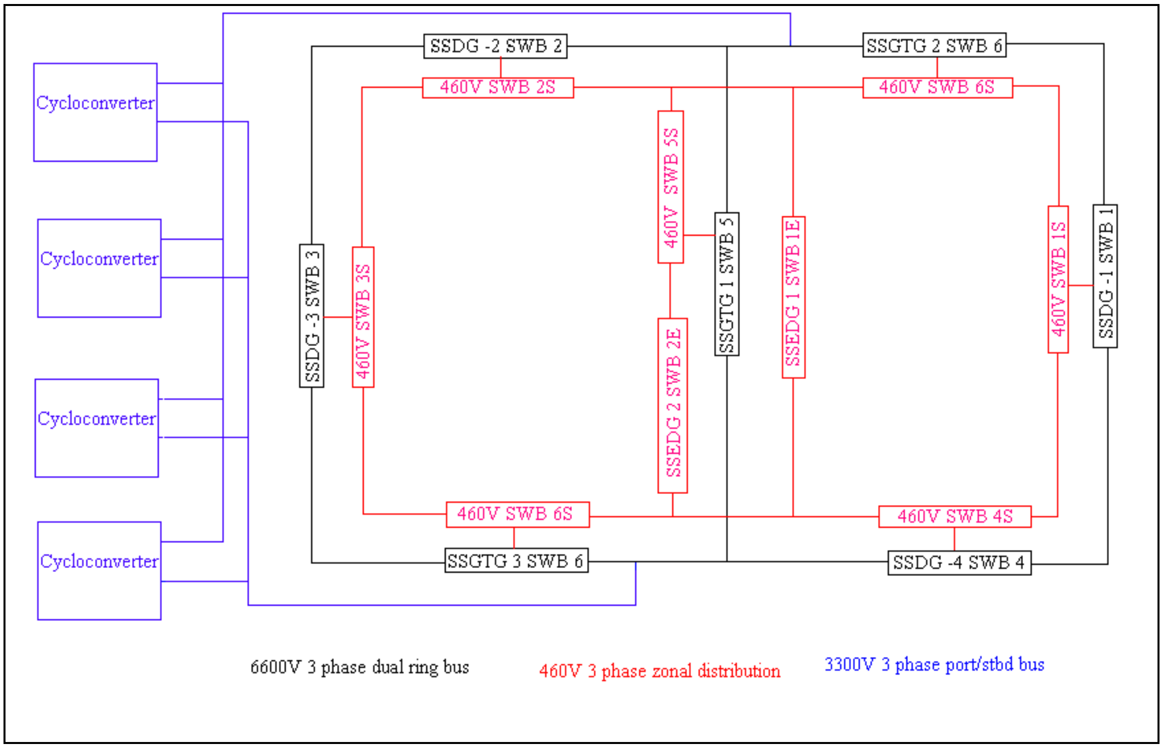

Figure 30. Electrical Distribution Diagram

c. *Propulsion Motor*

MPF 2010 propulsion power is provided via 12-pulse cycloconverter that is supplied by the main electric bus. The cycloconverter is transformer fed, with the transformers providing a voltage step down from 6.6 kV (electric bus voltage) to 3.3 kV (electric drive motor voltage). The cycloconverter controls the voltage and frequency being supplied to the main propulsion motors. There are two 59,000HP (44 MW) main propulsion motors connected to each shaft (for a total of four motors). The main propulsion motor design is a synchronous motor having a six-phase stator and 20-pole rotor. The cycloconverter supplies variable frequency (between 0 and 24 Hz), constant-voltage power to the main propulsion motor (3.3

kV) which produces a shaft speed between 0 and 144 rpm. The main propulsion motor is air-cooled.

8. Auxiliary Systems

a. Fuel Distribution System

MPF 2010 has a fuel distribution system that will provide JP-5 fuel for MAGTF vehicles, surface craft, and aircraft. This fuel distribution system is divided into four zones: one zone for each vehicle deck and a fourth zone for the flight deck. The fuel system piping is eight inches in diameter. Each fuel zone has four service pumps rated at 45 gpm each with an output pressure of 150 psi each. Each fuel zone also has 2 purifiers.

b. Water Distribution System

The MPF 2010 water distribution system is divided into six zones. Four of these zones are identical to the fuel distribution zones, with two additional zones for ship's service. The water system piping is eight inches in diameter. Each zone will have two pumps rated at 25 gpm each with at output pressure of 75 psi each. The flight deck and ship service zones each have a booster pump rated at 25 gpm each with an output pressure of 45 psi each.

Makeup water is supplied by a reverse osmosis system. This system will be the Offshore Marine Laboratories Inc SWSF 80-6607548-3 (or future equivalent) which produces a makeup of 66,000 gallons per day. Two of these units will be used onboard each MPF 2010 ship.

c. Miscellaneous Auxiliary Systems

MPF 2010 will have the following miscellaneous auxiliary systems:

1) Electrical service stations will be provided at the flight deck to support aircraft operation and maintenance. These electrical service stations will provide both 60 Hz and 400 Hz power to the aircraft. The 60 Hz power will be provided by the main electrical distribution bus. The 400 Hz power will be provided via four 400 Hz frequency converters which will be supplied by the main electrical distribution bus. Each frequency generator is rated at 2 kW of power.

2) Six 400 ton chill water A/C plants will be provided to support climate controlled cargo holds and personnel spaces

3) H_2O_2 plants will be provided to supply oxygen for pilots and to the medical ward.

4) Six refrigeration compressors, each rated at 200 tons, will be provided to meet the refrigeration requirements for food to support the approximately 4,000 personnel that can be accommodated aboard.

5) Two sewage treatment plants and two incinerators will be provided to process the black and gray water that will be generated by MPF 2010.

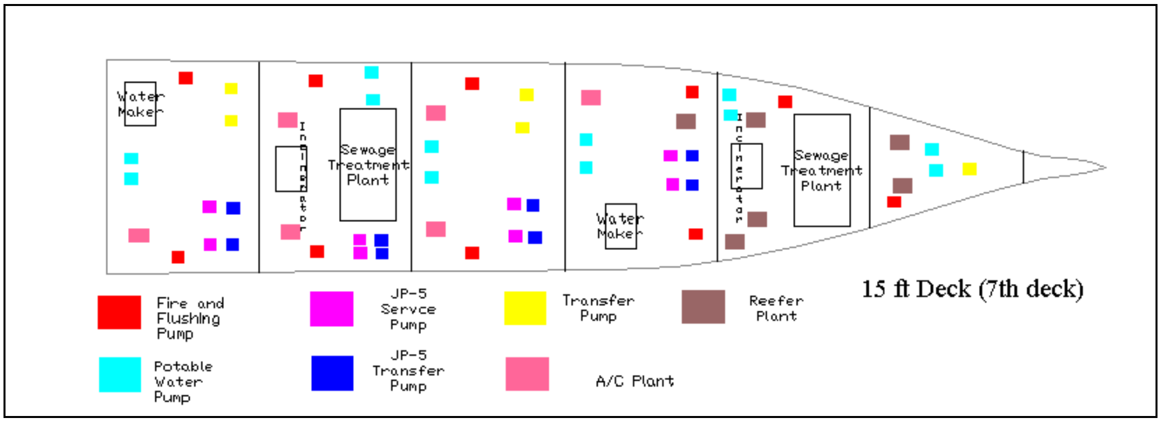

Figure 31. Auxiliary Equipment Layout

9. Weapons Systems

a. Description

MPF 2010 will have a basic self defense capability. This will be accomplished via two systems: the AN/SLQ-32 (V) 4 and the NATO Evolved Sea-Sparrow missile system (ESSM), or future equivalents.

The AN/SLQ-32 (V) 4 is an enhanced variant of the (V) 3 that is provided for ships of this size. It provides for the capability of warning, identification, and direction-finding of incoming radar-guided anti-ship missiles. It also provides early warning, identification, and direction-finding of radar associated with the targeting and launch of missiles, jamming for the prevention or delay of targeting and launch of such missiles; and the deflection of incoming missiles from own ship, [10].

The ESSM missile system will operate in conjunction with the Combat Direction System (AN/UYQ-70 (V) or future equivalent). The Combat Direction System will provide threat missile initial track data to the ESSM system via the MPF 2010 C4I system. At that time the ESSM system will acquire the threat missile, schedule the intercept, and then launch a defensive missile.

MPF 2010 employs 4 ESSM launchers, each of which contains eight missiles. The missile launchers will be located at the forward-most and after-most portions of the sponsons, as shown in Figure 32.

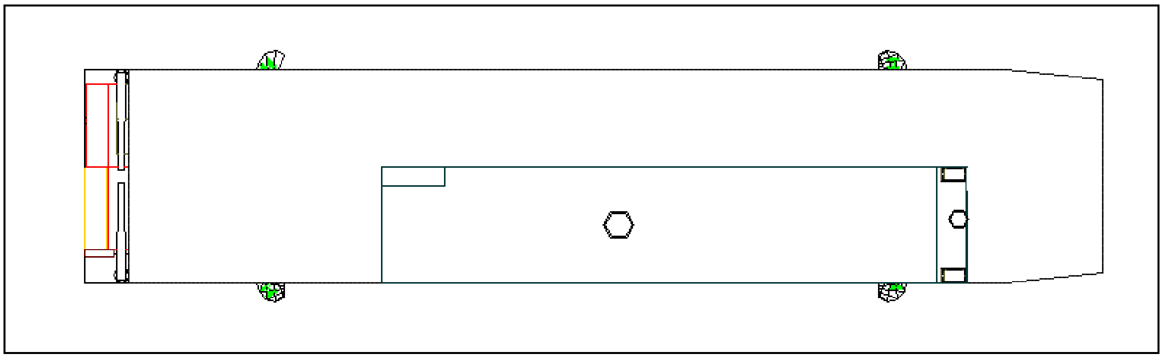

Figure 32. ESSM Placement

Since this system is a “last ditch” anti-ship missile defense, missiles for at-sea reload are not anticipated to be part of the MPF 2010 ammunition load-out.

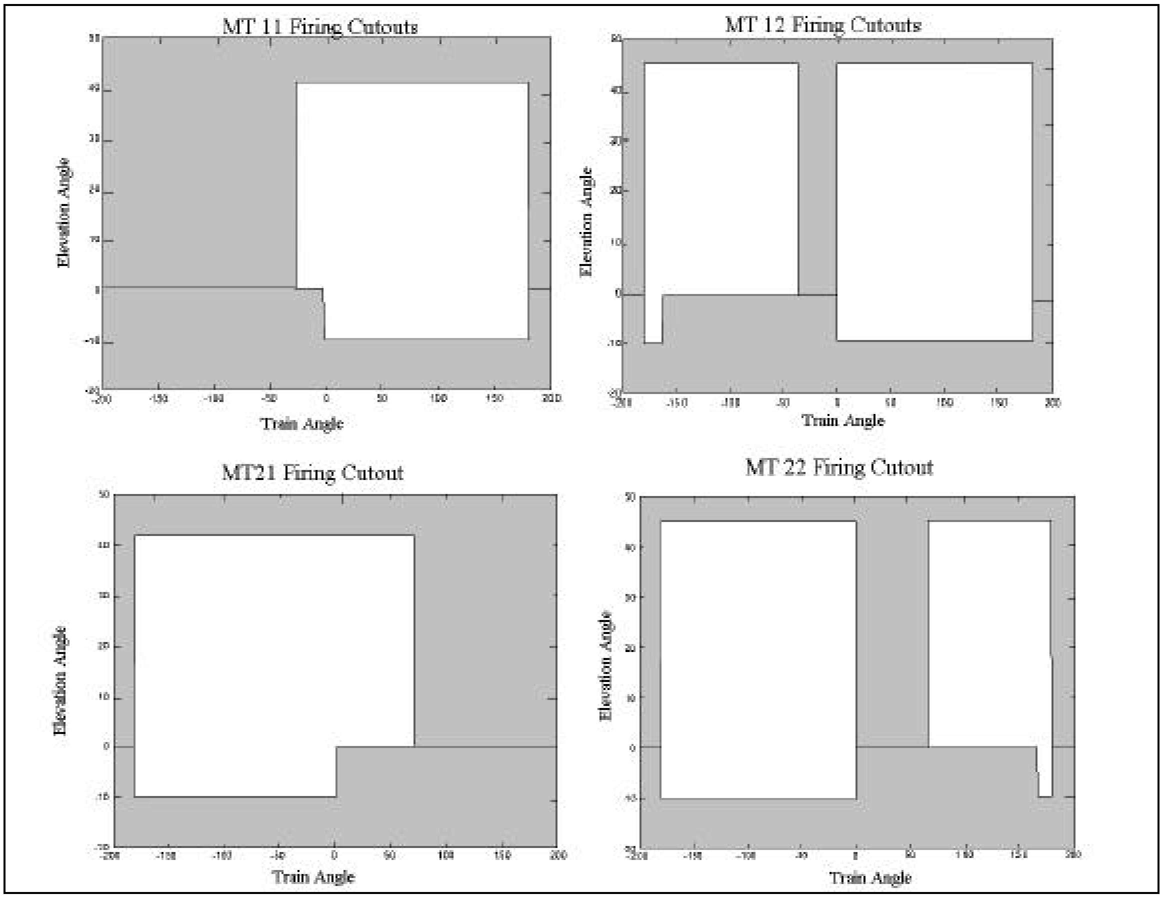

Figure 33. ESSM Coverage Diagram

b. Coverage

The ESSM and AN/SLQ-32 (V) 4 systems each provide 360^0 of anti-ship missile defense coverage. ESSM coverage as estimated from geometric ray tracing is shown in Figure 33. Defensive system effectiveness is discussed in section VI. G.

10. Sensors

The MPF 2010 sensor architecture is comprised of two legacy systems and two sets of multi-function arrays (MFA). The legacy systems are the NATO Evolved sea-Sparrow missile (ESSM) director and AN/SLQ-32 (V) 4 Electronic Warfare (EW) System, both of which have stand-alone antennas. The MFAs will function as the ship's radar emitter/receivers. These MFAs also have the capability to support secondary functions of EW, ESSM directing, and communications. Therefore, the MFAs can act as backup antennas for EW, ESSM directing, and communications. The first set of MFAs will operate in the frequency range 1-5 GHz (E/F bands). The second set will operate from 6-18 GHz (H/I/J bands), [11].

One of the most dangerous threats to the MPF 2010 is the low altitude, supersonic, sea skimming anti-ship cruise missile. These weapons may not be noticed by any sensor until they are almost on top of own ship. Thus, at a minimum, MPF 2010 must be able to detect incoming sea skimming missiles as soon as they come over the radar horizon. By requiring a detection range of 125 nmi for all targets, we assure that the sea skimmer will also be detected once above the radar horizon. An analysis of a hypothetical missile engagement is given in Appendix F.

By making some simplifying assumptions we can calculate an example of the required peak power to detect an incoming threat based on the radar equation. Assumptions:

1. Targets are Swirling II
2. P_{pk} = Peak Power (Watt)
3. A_T = Array area (m^2)
4. σ = 0.1 (m^2) = Target radar cross section
5. α = 2.3e-3 (km^{-1}) = atmospheric extinction coefficient
6. k = Boltzman's constant (J/K)
7. T = 300 (K) = electronics temperature
8. B = 10e6 (1/sec) = receiver noise bandwidth

9. F = 3 = Amplifier noise figure
10. λ = 0.1 (m) = Radar wavelength; (3 GHz)
11. R = 125 (nmi) = 231.5 (km) = Required detection range
12. CNR = 10 = Carrier to Noise ratio based on

- 10 pulse integration
- probability of false target is 10e-10
- probability of target detection is 0.99

The radar equation used in our study in shown in Equation (1):

$$CNR = \frac{P_{PK} A_T^2 \; s \, e^{-2aR}}{4pkTBF \; l^2 R^4} \tag{1}$$

Thus, the required peak power, $P_{pk}A_T^2$ is 13.00 x 10^9 W-m^4. For an array with a surface area of 20 m^2, this is equivalent to 32.5 MW peak power. In other words, there is 3.25 Joules in each 100-nanosecond pulse. This is a quite reasonable power level.

a. Sensor Locations

The MPF 2010 large size provides ample surfaces to locate sensors. Exterior sides of the hangar will be used to mount the planar phased arrays for both MFA systems. One face of each array will be attached to the top ten feet of each side of the hangar. The hangar walls are 30 feet high. Thus, the average MFA height is 25 feet above the flight deck and 96 feet above the waterline. The hangar's tilt benefits the arrays by allowing near zenith coverage.

Each of the four ESSM launchers will be co-located with a director. The director and the launchers will be placed on the corners of the sponsons. The two AN/SLQ-32 (V) 4 assemblies (containing the band 2 and 3 arrays) will be located fore and aft on platforms just outboard of the port and starboard sponsons, below the flight deck level. The AN/SLQ-32 (V) 4 band 1 spiral antennas will be located in enclosed mast located on the hangar.

b. Sensor Coverage

The radar height of 96 feet above the waterline allows good coverage to the horizon. The zero target height distance to the horizon is greater than 16 nmi or about 30 km. A 10 feet high sea skimming missile is detectable at 21 nmi while a 30 feet high missile will be above the radar horizon at 25 nmi. The carrier to noise ratio (CNR) is calculated based on the above peak power level for a standard 1 m^2 target. For a worst-case target exhibiting Swerling II cross section fluctuations, a CNR of 23 dB (or 200) is adequate to provide 90% detection probability and 10^{-8} false alarm probability. Comparing this CNR requirement against the table, we see that the nominal system is adequate for detecting the standard target out to about 200 km (or 110 nmi). (See Table 8) By scaling, this same radar would be capable of detecting a 0.001 m^2 target (cross section comparable to a very small missile) at ranges in excess of 42 km if it is above the radar horizon.

Target Height (ft)	Radar Height (ft)	Range (nmi)	Range (km)	CNR
0	96	16.3	29.9	911047.28
10	96	21.6	39.5	284686.76
15	96	22.8	41.7	227664.66
20	96	23.8	43.5	190165.61
30	96	25.5	46.6	142813.95
40	96	26.9	49.2	113716.51
50	96	28.1	51.4	93895.94
75	96	30.8	56.3	64057.07
100	96	33.0	60.4	47498.77
500	96	53.6	98.1	5736.84
1000	96	69.0	126.3	1830.49

2500	96	99.7	182.3	325.64
5000	96	134.2	245.5	74.12
7500	96	160.7	294.0	28.85
10000	96	183.0	334.8	14.21
25000	96	279.9	512.0	1.15
50000	96	389.1	711.7	0.12

Table 8. Detection Range (1 m^2 target)

Locating MFAs on each side of the hangar provides 360-degree sensor coverage. Similarly, the ESSM missile directors and AN/SLQ-32 (V) 4 sensors are also located to provide 360-degree coverage.

11. Command, Control, Computers, Communications, Intelligence, Surveillance, and Reconnaissance

Copernicus is the Navy's initiative to make command, control, communications, computers, and intelligence (C4ISR) systems responsive to the warfighter, [7]. One of the fundamental principles of Copernicus is that C4ISR systems be "joint" from birth. Further, the Copernicus architecture is based upon the following five pillars:

- Global Information Exchange Systems (GLOBIXS) ashore
- CINC Command Complexes (CCC) ashore
- Tactical Command Centers (TCCs) afloat
- Battle Cube Information Exchange Systems (BCIXS) afloat
- Tactical Data Information Exchange Systems (TADIXS) afloat [12]

The third pillar of the Copernicus architecture is the TCC. The current TCC system is the Navy Tactical Command System Afloat (NTCS-A). JMCIS afloat is the follow on system to NTCS-A and will be employed by MPF 2010 to satisfy the data fusion requirements of the MAGTF.

In response to the Copernicus vision, PWM 176 has developed the Joint Maritime Communications Strategy (JMCOMS), which addresses the BCIXS and TADIXS pillars of Copernicus. The primary system which is being developed and fielded by PMW 176 to satisfy the requirements of JMCOMS is the Automated Digital Network System (ADNS). MPF 2010 will employ ADNS as the backbone of its C4ISR system.

In conjunction with ADNS, PMW 176 is developing and fielding the Integrated Terminal Program (ITP) for satellite communications systems that operate above 2 GHz. MPF 2010 will employ ITP systems in conjunction with ADNS.

PMW 176 also has a strategy in place for developing a system that will meet Naval communications requirements for frequencies between the ranges of 100 kHz and 2 GHz, known as SLICE. The SLICE strategy will meet existing requirements from legacy programs, address present fleet requirements, and provide a nucleus for hosting new waveforms, protocols, dynamically adaptive bandwidths and power controls, [13]. SLICE will culminate in the fielding of the Digital Modular Radio (DMR). DMR will be a flexible, adaptive, interoperable, software configurable radio applying open systems architecture that will be installed on all deploying battle groups by FY01. The Joint Chiefs of Staff (JCS) C4 Directorate has recently authorized an Operational Requirements Document (ORD) for the Joint Tactical Radio (JTR). JTR will meet the joint communications requirements for frequencies between 2 MHz and 2 GHz and will have superceded DMR by the time MPF 2010 is operational. Therefore, MPF 2010 will employ JTR in conjunction with ADNS.

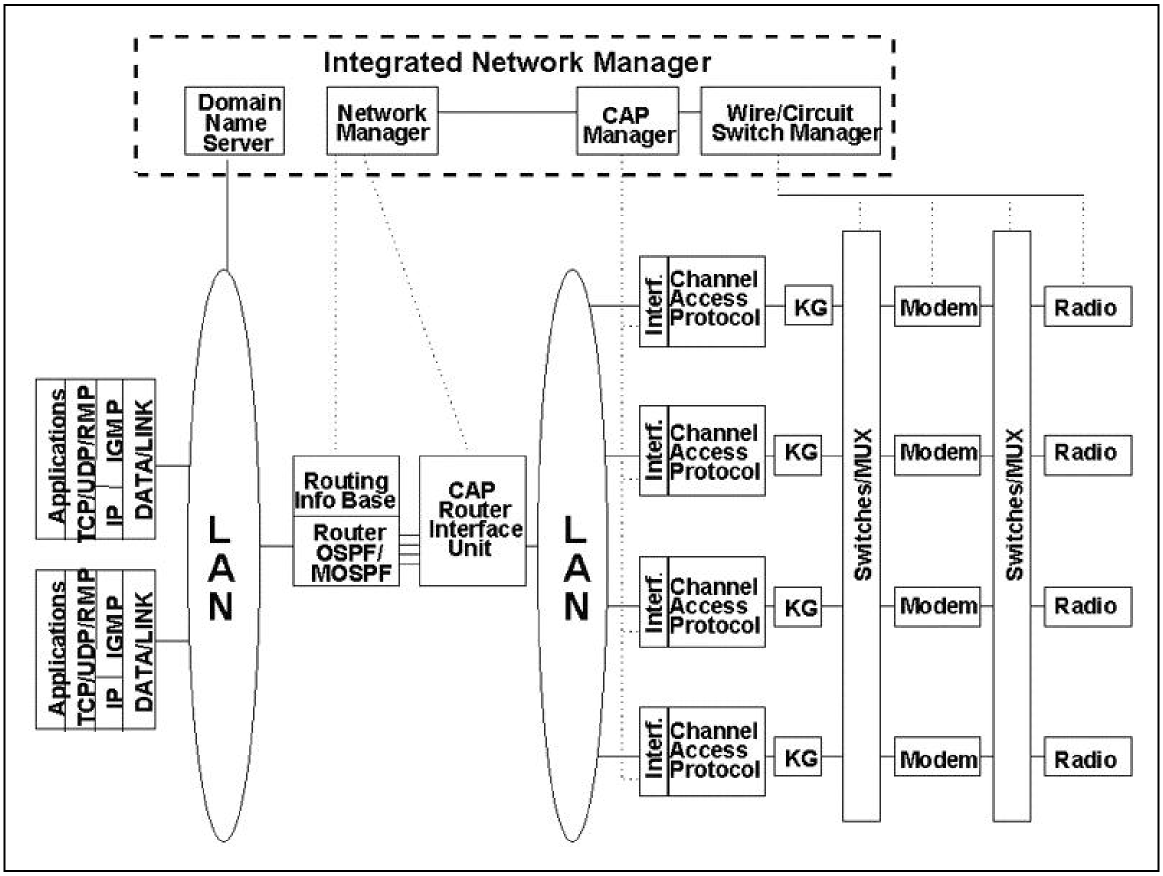

Figure 34. ADNS Functional Layout

a. Automated digital Network System (ADNS)

ADNS (see Figure 34) is an aggregate of both proven and cutting edge Internet technologies implemented to satisfy the current and future data management and communications needs of the Navy. It provides internet-like connectivity between the Local Area Networks (LANs) of ships and shore stations via existing communications circuits. As such ADNS provides the architecture for a wireless Radio Wide Area Network (Radio-WAN) comprised of these ship and shore LANs, [14]. ADNS manages existing communications circuits in such a manner that it is transparent to the user. It also increases spectrum utilization efficiency by a factor of four, [13]. Further, ADNS provides for more rapid communication through the elimination of delay caused by human intervention.

The increase in spectrum efficiency is realized through the balanced use of communications circuits. Communications circuits in the past have been stove-piped. That is, certain circuits have been designated for certain uses and allocated a given number (or type) of users. Consequently, this has led to the overuse and congestion of some circuits while other circuits have received infrequent use. It has been necessary to reserve certain high priority circuits in order to ensure that vital communications are received in a timely manner, although this has also resulted in an inefficient use of available bandwidth. ADNS increases bandwidth efficiency by monitoring communications circuit loading and automatically determining which communications circuit will be used to transmit data. ADNS also allows for the prioritization of data so that information of higher priority will still be transmitted in a timely manner, despite the elimination of reserved channels. It also employs congestion management schemes to avoid and/or minimize circuit congestion.

ADNS increases communication speed through its automation and network connectivity. In the past a commander would need to draft a message (in either paper or electronic form) and then give that message to personnel in radio. The radio personnel would then need to type or download the message into their system, make the appropriate connections to the necessary communications circuit, and then transmit the message. Now with ADNS, all that a commander needs to do is type the message into a computer terminal and then send the message.

ADNS primarily employs three Internet technologies to meet the C4ISR needs of MPF 2010: Internet Protocol (IP), Integrated Services Digital Network (ISDN), and Asynchronous Transfer Mode (ATM). These technologies are implemented and coordinated by the three functional elements of ADNS: the Integrated Network Manager (INM), Routing and Switching (R&S), and Channel Access Protocols (CAPs) (see Figure 34).

1). Integrated Network Manager (INM)

The INM provides management functions for both the network and the communications aspects of ADNS. These management functions extend from that of controlling the interaction of the system with local LANs to that of controlling the operation of an entire Radio-WAN.

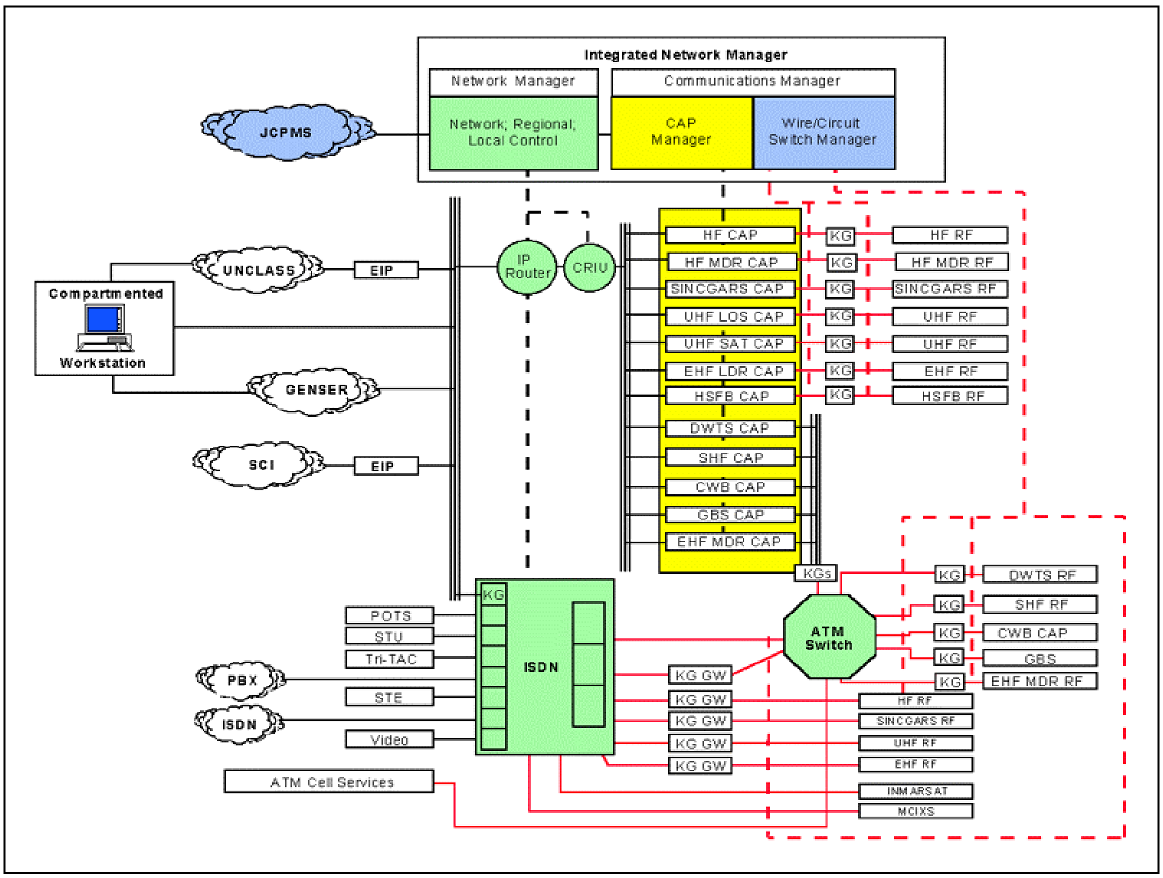

Figure 35: Detailed ADNS Layout

2). Routing and Switching (R&S)

The R&S subsystem provides the interface between the user and the RF communications systems. It is comprised of IP routers, ISDN switches, and ATM switches.

3). Packet Data System (PDS)

The PDS (see Figure 35) will employ IP addressing and routing for non real time data such as files, e-mail, and record message traffic. The PDS will provide for prioritization of traffic via use of the Channel Access Protocol (CAP) and the CAP Router Interface Unit (CRIU). The CRIU assigns the traffic (or datagram) a priority based upon knowledge of the user and the user's application. The CAP then sorts through the datagrams, allowing the higher priority ones to be transmitted first.

4). Integrated Services Digital Network (ISDN)

ISDN is an industry standard that supports real time digital voice transmission and data transmission at rates up to 192 KBPS (basic service) or 2.048 MBPS (primary service), [15]. ISDN primary service will be used for the interior communications circuits on board MPF 2010 to transmit both real time voice and video information. ISDN will be used for secure voice and video communications external to the ship.

5). Asynchronous Transfer Mode (ATM)

ATM is an industry standard which is ideal for high bit rate transmission of voice, video, and data services. ATM can implement on a Synchronous Optical Network (SONET), which can achieve data transfer rates of 9.95 Gbps (OC-192).

Unlike IP which transmits information on a “best effort” basis, ATM provides a guaranteed quality of service that is very important to real time communications. ATM also provides bandwidth on demand. ATM will be used for high data rate transmission throughout the ship’s LAN and the Radio-WAN network.

6). Channel Access Protocols (CAPs)

The CAP is the protocol by which datagrams are sorted and traffic congestion is monitored. Each RF transmitter has a corresponding CAP that controls the flow of datagrams to that transmitter. The CAP has a queue (or storage space) for each priority level that can be assigned to a datagram. The highest priority queue is permitted to send its datagrams to the RF transmitter immediately. Lower priority queues must wait until all higher priority queues have been emptied before they are permitted to send their datagrams to the transmitter. Since each queue has a finite size, there is the potential for it to become full. Once a queue becomes full any new datagrams are lost. In order to prevent, or at least minimize, the loss of datagrams a congestion control mechanism is used. As a given CAP queue is filled to a predetermined (maximum) threshold level, this information is provide as feedback to the CRIU, which will implement congestion control procedures. Two examples of congestion control are source quench (i.e. a method which prevents sources below a predetermined priority level from transmitting datagrams for a given period of time) and load sharing (i.e. direct datagrams to another, less heavily used RF channel).

b. Joint Tactical Radio (JTR)

The JTR will be a software-reprogrammable, multi-band/multimode capable, networkable radio and will provide simultaneous voice, data, and video communications, [16]. JTR will also be capable of:

- supporting secure and non-secure voice, video and data communications using multiple narrow-band and wide-band waveforms.
- operating in a radio frequency spectrum from 2 MHz to 2 GHz.
- providing scaleable networking services for connected RF (over the air) networks, host networks and hybrid networks.
- providing a scaleable and interoperable means to establish point-to-point (two way), multipoint (two way), multicast (up to 100 selected nodes), and broadcast capability between/among any user-selected nodes in a joint network.
- providing for mobile JTRs to readily transfer between authorized networks. This transfer will be transparent to the user.
- providing routing capability, interface connectivity that extends into the IP, and military packet networks.
- supporting encrypted Global Positioning System (GPS) in addition to other channels supported.
- performing dynamic intra-network and inter-network routing for data transport based on priority.
- selectively transmitting individual location information to selected JTR nodes.
- incorporating military and commercial satellite and terrestrial communications above 2 GHz (objective goal). Were this objective to be achieved, JTR would supplant ITP.

The above capabilities uniquely suit JTR to operate in conjunction with ADNS. JTR will be implemented on board MPF 2010 and will be assumed to be in use by all MAGTF forces. JTR not only provides the capability to support the RF needs of the ADNS system, it also provides the network radio capabilities for MAGTF forces to be linked to the MPF 2010 ADNS system via a Radio-WAN.

c. Littoral Region Area Network (LRAN)

LRAN is envisioned to provide a multiple path information network between forces ashore and sea based shipboard units. It will provide multiple path backbones for high bandwidth communications in support of naval expeditionary units located up to 200 nautical miles from shore, [17].

ADNS and JTR are ideally suited for the implementation of a LRAN in support of MAGTF operations. The LRAN would be a Radio-WAN with each MPF 2010 ship as a node of the WAN. Individual MAGTF units with JTRs would also comprise nodes of the WAN. In this manner complete connectivity is provided between all units of the MAGTF via the JMCOMS structure.

d. Tactical Data Network (TDN)

The TDN is a system of data communications gateways and servers interconnected with one another and their subscribers via a combination of common user long-haul transmission systems organic to the Fleet Marine Force (FMF), LANs, single channel radios, multi-channel communications, and the switched telephone system. The TDN is intended to augment existing communications systems infrastructure to provide the commander an integrated, standardized, and interoperable data network, forming the communications backbone for MAGTF Tactical Data Systems (TDSs), [16]. TDN will be fully interoperable with the JMCOMS structure.

As MAGTF operations progress, there may be a point in time at which the MAGTF commander desires to move a portion of the MAGTF Command and Control (C2) assets ashore. As this occurs, the TDN will be deployed as an extension of the LRAN. The TDN will be based ashore and will interface with MPF 2010 as a node of the LRAN. The TDN will absorb MAGTF units (which were previously components of the LRAN) as members of the TDN's sub-network. These units will still be provided connectivity with all other units of the Radio-WAN, although now this connectivity will be via the TDN. The MAGTF commander will have connectivity with all MAGTF units either via the TDN sub-network or via the larger LRAN.

Connectivity with the TDN can either be via the Radio-WAN portion of the LRAN or fiber optic cable. The fiber optic cable could be run from the TDN ashore, through the surf zone, and out to either an underwater fiber network or to an anchored aerostat, [17]. In order to conserve RF bandwidth, MPF 2010 could connect directly with the undersea fiber network (via fiber links connected to a buoy). Another RF bandwidth conserving option would be to link MPF 2010 and the aerostat via a communications laser. The aerostat would provide an interface between the fiber optic cable and the communications laser.

e. Aerostats

Aerostats will be used to increase both the communications range and capacity of MPF 2010. As mentioned above, aerostats may be used to provide a fiber optic/communications laser interface between the MAGTF units ashore (via TDN) and MPF 2010 in order to conserve RF bandwidth in support of the Radio-WAN. Further, aerostats can be used as a means to increase the range for line of site (LOS) communications (either laser or RF). A single aerostat tethered at an altitude of 200 meters (656 ft) provides an area of coverage of about 7800 km^2 (2274 nmi^2) and a LOS range of about 27 nautical miles, [17]. Additional aerostats would provide additional LOS range, and thus providing greater mobility for the MPF 2010 while still maintaining network connectivity.

A third benefit of using an aerostat would be as an elevated radar platform. A high altitude radar configured aerostat would increase the range at which MPF 2010 could track enemy forces (air and ground), as well as track and direct

MAGTF aircraft at extended ranges. This function could be performed in addition to the communications capabilities of the aerostat. Long range air target tracking (tethered airborne early warning) would provide for defensive air-to-air employment of the MAGTF's JSF aircraft, if the aircraft carrier accompanying the battle group were damaged, sunk, or otherwise precluded from providing extended range air superiority. If the elevated radar were configured as a moving-target indication ground surveillance radar, the need to deploy J-STARS aircraft from CONUS to support MAGTF operations would be minimized.

f. Unmanned Air Vehicles (UAVs)

UAVs will be employed as an alternative to or in addition to aerostats in order to increase the LOS communications range of the Radio-WAN. Each UAV can be configured as a network relay that would provide connectivity to MAGTF units over the horizon. Further, UAVs could also be used as mobile radar platforms, just as with the aerostats, maintaining data links with MPF 2010. As with the aerostats, this would increase the effective coverage of both communications of radar ranges of MPF 2010.

12. Habitability

a. Berthing Facilities

Each MPF 2010 ship will provide berthing for all personnel within the sponsons. The one exception will be the ship's master, who will have a sea cabin adjacent to the bridge, in addition to his stateroom.

Military Sealift Command (MSC) civilian personnel will be allocated berthing space as outlined in Table 9, in accordance with COMSC Instruction 9330.6D, [4]. The MSC officers will be located in the starboard sponson on the 2nd deck. The MSC enlisted will be located in the starboard sponson on the 3rd deck.

	Quantity	Area/Man (ft^2)	Area (ft^2)
MSC Master	1	200	200
MSC Cheng	1	200	200
MSC XO	1	200	200
MSC Acheng	1	200	200
Other MSC Officers	4	175	600
MSC Enlisted	25	140	3500
Total Area (ft^2)			**4900**

Table 9. Area Allocated For MSC Personnel Berthing

Military personnel will be allocated berthing space as outlined in Table 10. The number of berthing spaces allocated for military personnel reflect at least a ten percent margin in addition to that required to support a Marine Expeditionary Force. The ten percent margin was applied to permanent party military personnel as well. Berthing area data includes head facility space for both officers and enlisted and lounge space for enlisted. Wardroom space is in addition to that indicated below.

A cursory habitability analysis was conducted for the berthing spaces of military personnel. Reference 8 was used for guidance, although a detailed analysis was not conducted. The intention of the analysis was to show that adequate berthing space and sanitary facilities could be allocated for the number of personnel onboard MPF 2010. More in depth analyses would be conducted on subsequent iterations of the design. Figure 36 through Figure 40 show the berthing (excluding wardroom) arrangements and space allocated for sanitary facilities for all personnel. The berthing spaces are arranged in modules. The total number of modules and the corresponding number of personnel that they will accommodate are shown in Table 11.

	Quantity	Area/Man (ft^2)	Area (ft^2)
MGTF Commander	1	270	270
Senior Officers	120	68.0	8,160
Navy Junior Officers	16	45.0	720
Marine Junior Officers	240	30.0	7,200
Permanent Party Enlisted	144	22.7	3,264
Naval Support Element Enlisted	288	19.9	5,724
Marine Enlisted	3,584	16.0	57,344
Total Area (ft^2)			**82,682**

Table 10. Area Allocated for Military Personnel Berthing

The bunks shown in Figure 36 through Figure 40 are stacked above one another. Depending on the berthing arrangement, bunks may be stacked 2, 3, or 4 high, as indicated in Table 11.

Sanitary facility space was analyzed to determine the number of accommodations that could be provided in each space and are indicated in Figure 36 through Figure 40. The tabulation of sanitary facilities per individual is shown in Table 12.

A review of Figure 36 through Figure 40 and Table 10 and Table 11 will reveal that some personnel will be allocated more Spartan accommodations than others. This difference in accommodations was based first on an individual's rank and then on the amount of time which it would be expected that a given individual remain on board. Therefore, permanent party officer and enlisted personnel were given more robust accommodations than their counterparts who would be embarked for a shorter period of time.

	Number of Modules	Bunks Per Stack	Personnel Per Module	Personnel Per Group
Senior Officers	15	2	8	120
Navy Junior Officers	1	2	16	16
Marine Junior Officers	10	3	24	240
Permanent Party Enlisted	2	3	72	144
Naval Support Element Enlisted	3	3	96	288
Marine Enlisted	56	4	64	3,584
Total Personnel Per Ship				**4,392**

Table 11 Personnel Breakdown MPF 2010

	Personnel Per Shower	Personnel Per Water Closet	Personnel Per Urinal	Personnel Per Sink
MGTF Commander	1.0	1.0	1.0	1.0
Senior Officers	4.0	4.0	4.0	4.0
Navy Junior Officers	4.0	4.0	4.0	4.0
Marine Junior Officers	6.0	6.0	6.0	6.0
Permanent Party Enlisted	9.0	12.0	9.0	9.0
Naval Support Element Enlisted	16.0	24.0	24.0	12.0
Marine Enlisted	21.3	21.3	21.3	16.0

Table 12. Sanitary Facility Accommodations

MSC officer and Senior military officer berthing will be located on the 2nd deck in the starboard sponson. Junior military officer, MSC enlisted, and permanent party military enlisted berthing will be located on the 3rd deck in the starboard sponson. USMC enlisted berthing will be located on the 2nd and 3rd decks in the port sponson. Berthing for the Naval Support Element (NSE) will be located on the 4th and 5th decks in the port sponson.

Although specific decks have not been identified in which to locate messing facilities for all personnel embarked on MPF 2010, sufficient undesignated space is available.

b. Medical Facility and Convalescent Hospital

A medical facility will be located on the number six deck of the port sponson. An area of 6,300 ft^2 has been allocated for this facility. This facility will be capable of providing for the routine medical and dental needs of all personnel embarked on MPF 2010. Further, it will provide for the combat medical and dental needs of a MAGTF (MEF) for the first 30 days of combat operations. This medical facility will contain:

- Two medical operating theaters.
- Two dental operating theaters.
- A ten bed post surgical suite.
- Associated medical laboratories and supply facilities.
- Miscellaneous triage and consulting rooms.

An additional 4,140 ft^2 of space is allocated adjacent to the medical facility for a 414 bed convalescent hospital.

c. Miscellaneous Spaces

Additional space has been provided in the sponsons for messing facilities, exercise rooms, wardrooms, laundry facilities, store rooms, office space, etc. This space has not been specifically designated. The available sponson area is indicated in Table 13.

Sponson	Deck	Area (ft^2)
Starboard	2	10,472
	3	8,720
	4	10,080
	5	10,080
	6	6,300
Port	2	2,800
	3	2,800
	4	16,956
	5	22,680
	6	7,560
Total Available Area		98,448

Table 13. Undesignated Sponson Area

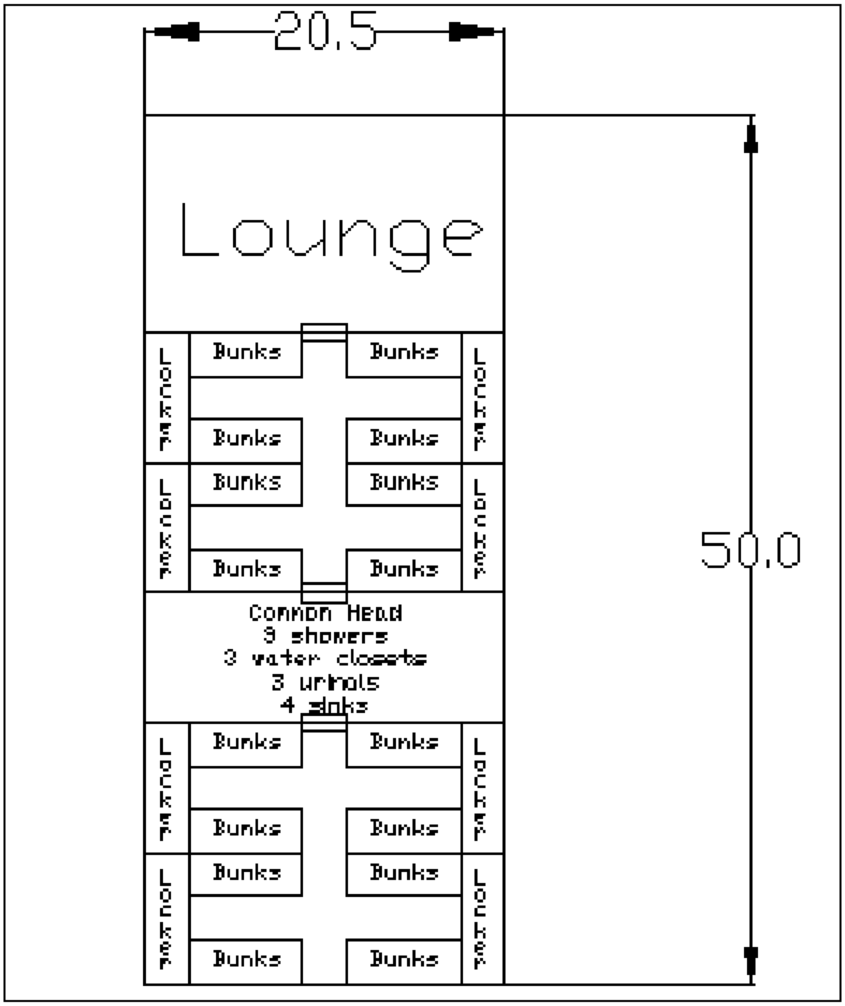

Figure 36. Marine Enlisted Berthing

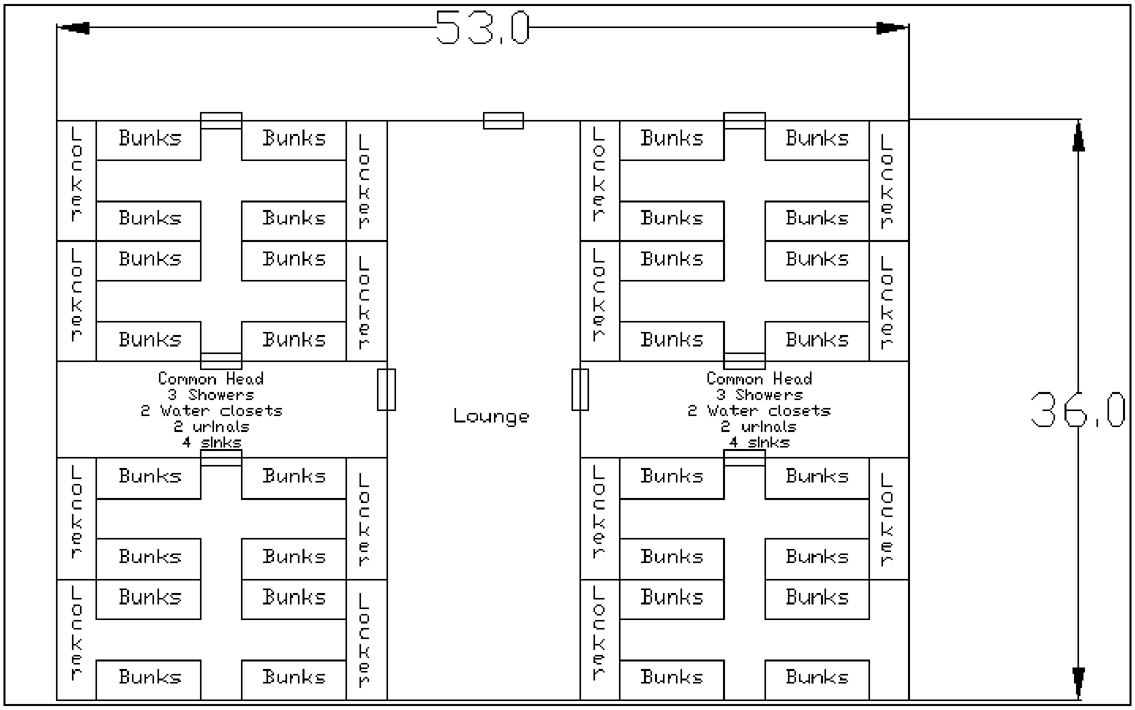

Figure 37. NSE Enlisted Berthing

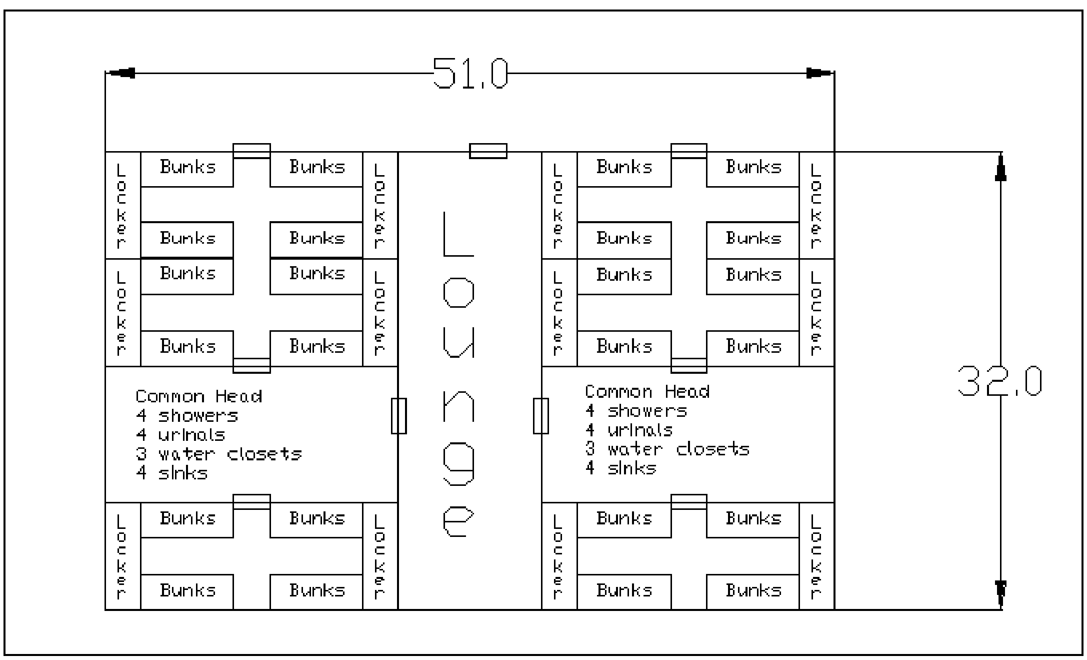

Figure 38. Permanent Military Enlisted Berthing

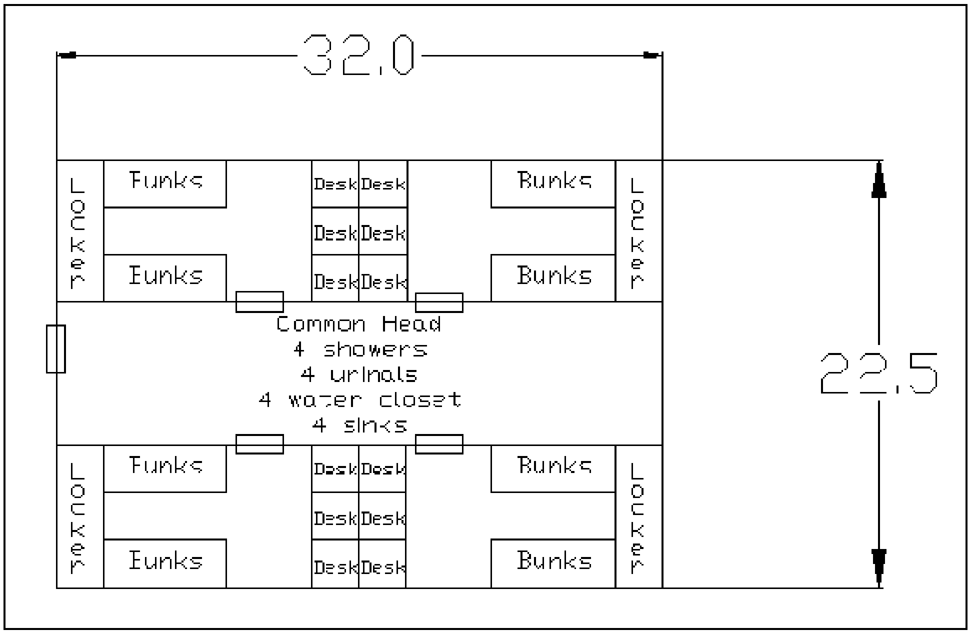

Figure 39. Junior Officer Staterooms

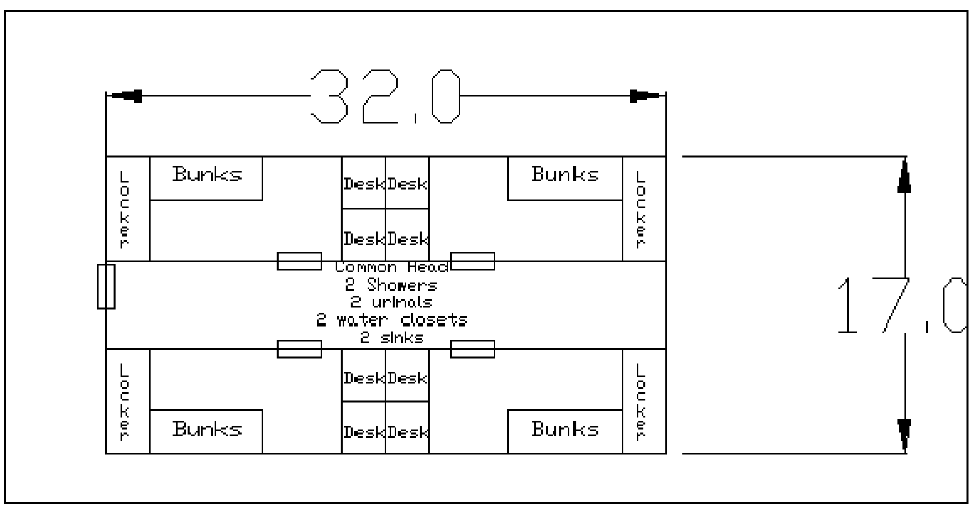

Figure 40. Senior Officer Staterooms

13. Lighterage

MPF 2010 will contain lighterage to support the on-load and off load of personnel, vehicles and equipment. This lighterage will be comprised of one LARC V, one Side Loading Warping Tug (SLWT), four powered causeway sections, two Mike 8 boats, and ten causeway sections non-powered (CSNP) per ship. The CSNP will be capable of operating in sea state 3. Each of the CSNP are assembled from three smaller sections which fold up to the size of an ISO container (8' X8' X 20'). These sections will be stowed in the cargo hold. The remainder of the lighterage will be stowed on the stern sponson.

C. DAMAGE CONTROL

The MPF 2010 damage control systems will have the ability to contain and minimize damage, utilizing only the permanent party crew and automated systems. The primary objective of the damage control systems will be to withstand battle damage to the maximum extent possible and continue to fight the ship. The damage control efforts are designed around four areas: cargo area; flight deck and hanger bay; crew spaces; and engineering spaces.

To support these efforts MPF 2010 will be provided with a variety of systems to combat damage. These systems are discussed in the following sections:

1. Fire main.

The fire main will be provided sea water from 10 fire pumps, each of which will have a flow rate of 500 gpm with an output pressure of 150 psi. These fire pumps will provide sea water through vertical rises to a fire main loop located on each deck, the hangar bay, and flight deck.

2. AFFF system.

The Aqueous Foam Fire Fighting (AFFF) system consists of eight AFFF stations each containing 750 gal AFFF tanks with a proportioning system. The AFFF stations are provided with sea water from the fire main.

3. Fire Detection System

The fire detection system will employ video and thermal imaging sensors augmented by flame detectors. These sensors will be located in the engineering spaces, the cargo holds, the stern off loading area, and the vehicle decks. All of these systems will be monitored and controlled from a central location (damage control central) via fiber optic connections on a damage control Local Area Network (LAN). The damage control LAN will be a sub-network of the Automated Digital Network System (ADNS).

4. Cargo and vehicle deck fire suppression system.

The cargo and vehicle decks will be provided with overhead sprinkling system. The overhead sprinkling system will be dual in nature in that both sea water and AFFF piping will routed to each space. Upon detection of a fire, the damage control LAN will activate the appropriate sprinkling system depending upon the type of cargo in the space. The cargo holds will have the capability to be flooded if ammunition is carried in them and where applicable. These spaces will also have manned fire stations and fire extinguishers where appropriate.

5. Flight deck and hangar fire suppression system.

The flight deck and hanger bay have both AFFF and fire main supplies. The flight deck has four zones of AFFF sprinklers imbedded in the flight deck. There is one zone forward of the island, two zones beside the island and one zone aft of the island. This will allow complete coverage of the flight deck. The flight deck also has remote controlled AFFF cannons located along the island and flight deck to provide direct fire fighting capability without using AFFF sprinklers or risking personnel on the flight deck. The hangar bay will be divided into three sections by blast proof sliding doors. The hangar bay is provided with AFFF overhead sprinkling and manned fire stations.

6. Engineering space fire suppression system.

Engineering spaces with be provided remotely operated CO_2, overhead sprinkling (AFFF and seawater), and manned firing fighting stations. Upon detection of a fire, the damage control LAN will automatically activate the appropriate system (sprinkler or CO_2) depending upon the type of equipment in the space (i.e. electrical equipment vs. a diesel generator). These spaces will also have manned fire stations and fire extinguishers where appropriate.

7. Berthing.

All berthing spaces will be provided with overhead sprinkler systems supplied by the fire main. These spaces will also have manned fire stations and fire extinguishers where appropriate.

8. Operations and combat spaces.

These spaces will have manned fire stations and fire extinguishers where appropriate.

9. Watertight bulkhead doors.

The vehicle decks on the MPF 2010 ships are located below the damage control deck. In order to effectively utilize these decks it will be necessary for doors to be placed in the watertight bulkheads between the different vehicle spaces. Each door will be 10 feet wide and the height of the deck. There will be two doors per portal, which, when both are opened, provides a 20 foot wide driving lane.

Each door will actually be comprised of two doors approximately four feet from each other (see Figure 41). An eductor suction is located between the doors. There are additional eductor suctions located within each vehicle space next to the doors. These doors are normally closed and hydraulically dogged while at sea. During offload the doors are undogged and held open by an electro-hydraulic arm. If for some reason power fails the doors will automatically close. These doors do not slam shut on the loss of power but rather close slowly, allowing personnel or vehicles to get out of the way.

As stated above each door will have an eductor suction on both sides of the door, allowing for dewatering of any leak by from damage on the other side of the door. Additionally each space will be equipped with a syntactic foam system, allowing the space to be filled with foam which will displace the flooding water and thereby preserve most of the compartment buoyancy. This foam will render any vehicles or equipment within the space inoperable until depot level maintenance can be performed.

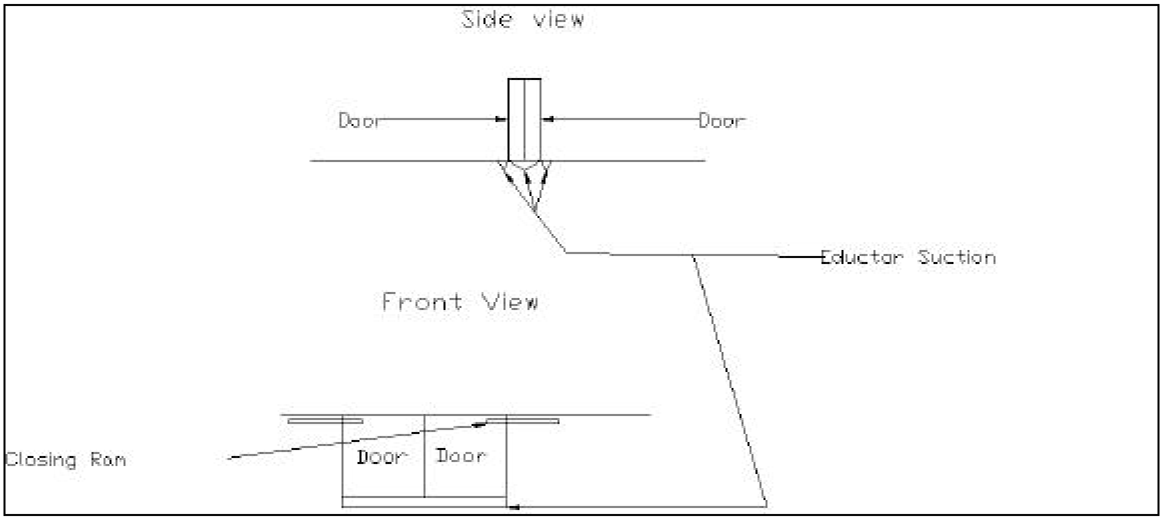

Figure 41. Watertight bulkhead doors

D. STRUCTURAL HARDENING

The MPF 2010 is required to have structural hardening to resist mine, anti-ship missile (ASM), and torpedo weapons as per OPNAVINST 9070. ASSET assigns a value of 0.3 KSF for the shock foundation indicator, which defines the degree of shock hardening for calculation of foundation weights. Most new combatants are built to a 0.3 KSF shock standard.

Although ASSET takes into consideration certain aspects of shock hardening requirements, it does not by itself ensure that a given design is satisfactorily shock hardened. Shock trials are the only means to ensure adequate shock hardening, through testing the ship and its systems under combat-like conditions, short of an actual conflict. These trials are required for the lead ship of each new construction ship class that requires shock hardening. Although shock trials would be conducted on the lead MPF 2010 ship, they are clearly beyond the scope of this analysis.

Finite element modeling and simulation provides a viable, cost effective alternative to live fire testing. Such an analysis is a separate topic for research itself,

[18]. Were an adequate amount of time available, a Finite Element Analysis would be conducted on the MPF 2010 hull structure.

E. WEIGHT REPORT

The full load displacement of the initial design of the MPF 2010 ship is 85,932 (long) tons. The light ship displacement is 47,961 tons. In comparison, the LHD class amphibious assault ship has a full load displacement of 40,532 tons while the Nimitz class aircraft carrier has a full load displacement of 102,000 tons. As expected, since the capability of the MPF 2010 ship falls somewhere between that of an LHD and an aircraft carrier, so too does the displacement. Cargo and vehicles account for approximately 59% of the difference between the light ship and full load displacements. A full ASSET WEIGHT and SWBS breakdown is given in Appendix C, 'Weight Module'. The weight estimates were achieved using Asset's MONOCV version 4.2.0 weight reports. These reports are based on historical data and user input. It should be kept in mind that since the ASSET model was based on an initial design, many weight inputs are based on rough approximations. As result, some items, such as ramps between decks, payload and stern gates may not be correctly or fully accounted for in the SWBS weight reports. Further iterations in the design spiral and an in-depth weight analysis would be necessary to achieve more accurate weight information.

F. MANNING ANALYSIS

In order to determine the permanent party military manning of the MPF 2010 ships, a functional description of required tasks must be determined. CNA has determined that while MPF 2010 is in a prepositioned status a 45 person Military Sealift Command (MSC) crew will operate MPF 2010 in a manner similar to the current maritime prepositioning ships, [4]. However, due to the added functionality provided by MPF 2010, there are several duties related to the maintenance and operation of certain MPF 2010 equipment and systems which cannot be performed by the MSC crew. These duties will be performed by the permanent party military personnel.

Since the MPF 2010 ships will possess a self defense capability, it will be necessary for an officer of appropriate rank to be on board to authorize weapons release. This Officer in Charge (OIC) will be a post-department head LT Commander or Commander. The OIC will be responsible to the MPF 2010 ship's Master and the Squadron Commodore for the performance of the Military crew. The OIC will be assisted by an assistant Officer in Charge (AOIC). The AOIC will be a first tour department head or a second tour division officer.

An enlisted crew is required to fulfill two broad categories of functions. The first function category is that of the normal operation of MPF 2010 military systems, to include its self defense systems. The second is the maintenance and initial operation of the equipment that will support the embarkation of the MAGTF. Due to the rapid response nature of these ships, each of these systems must be maintained in a readiness condition that will support immediate MAGTF embarkation and combat operations within a matter of days.

It will be necessary for the enlisted crew to be large enough to support a condition III watch bill to provide a self defense capability for the ship. While it is possible to augment the condition III watchstanders from CONUS, it is desired that they remain aboard for the duration of their tour so that the watch teams will remain proficient. Additionally, while the ship is in a pre-deployed status, these personnel will be necessary for the maintenance of MPF 2010 military systems. A four-section watch rotation is envisioned as the norm for these ships in condition III. This allows for the training of personnel, the qualification of new personnel, and crew rest.

All equipment that is currently maintained by the MSC will continue to be maintained by the MSC. This includes the periodic maintenance that is performed by MSC teams which embark the current maritime prepositioning ships at regular intervals for that purpose. Permanent party military personnel will operate, repair, and conduct preventive maintenance on all MPF 2010 military systems, which are primarily the self-defense and C4ISR systems.

Finally, it will be necessary for the permanent party military crew to support the initial arrival of the MAGTF amphibious craft and aircraft. It will be necessary for the permanent party military personnel to maintain a high degree of proficiency with respect to MAGTF embarkation evolutions, particularly in flight deck operations. It is assumed that the initial MAGTF personnel to embark MPF 2010 will be capable of assuming these duties. As such it will only be necessary for the permanent party personnel to support the initial phase of the MAGTF embarkation.

The military crew necessary to support each MPF 2010 ship is shown in the following table. A total of 96 uniformed personnel are need for each ship. This is in addition to the 45 MSC crew required for the operation of the ship. This means each ship of the squadron will have a crew of 141. In addition, the flagship of the squadron will embark the Commodore and his staff, a group of between 10 and 20. The manning requirement for the MPF 2010 squadron is therefore 480 uniformed personnel and 225 MSC personnel.

Station	Billet		Rate/Rank	Watch	Repair	total Watch standing Requirement
Ship	OIC			1		1
	AOIC			1		1
SLQ-32						
	Watch Sup		EW2, EW1	1		4
	MM		EW1, EW2, EW3		4	
Cooks			MS2, MS3	2		2

ESSMS	WCC		FCC, FC1,	1		4
	LCC		FCC, FC1, FC2, FC3	2		8
	LaCC		FC2, FC3	4		16
	MM		FCC, FC1, FC2, FC3		28	
Radar	RCC		OS2, OS3	1		4
	MM		ET2, ET3		4	
CIC						
	Sup		OSC, OS1	1		4
	Link Control		OS2, OS3	1		4
	NTCS-A		OS2,OS3	1		4
	R/T		OS3, OSSN	1		4
	AIC		OSC, OS1	1		4
Radio	Sup		RM1, RM2	1		3
	OP		RM2, RM3	1		12
	MM		ET1, ET2, ET3		15	
Electronic Repair						
	Sup		ETC, ET1	1		
	MM		ET1, ET2, ET3		6	
Mechanical Repair						
	Sup		Engineering Chief		1	
	AIMD		USN/USMC E-4, E-5, E-6		4	
	Ship repair		MM/HT/DC E-6, E-5, E-4		4	
	DCC		Engineering Chief	1		4
	Rover		E-6, E-5, E-4	1		4
Flight deck						
	LSO		OIC/AOIC	1		
	LCP		AIMD	1		
	2 suits		Ship Repair	2		
	1 cannon		Ship Repair	1		
	chock and chain		FC/GM/ET	4		
					15	81
			Total		96	
WCC	Weapons Control Console					
LaCC	Launcher Control Console					
Sup	In charge of space/operation					

DCC	Damage Control Central
MM	Maintenance Man
LCC	Local Control Console
RCC	Radar Control console

Table 14: Manning Functional Breakdown

G. COST ANALYSIS

The MPF 2010 lead ship acquisition cost was calculated using the MIT Math Model (described in Appendix D), as outlined below.

1. Cost Model

The cost is estimated using several cost factors that are based on the algorithms formerly used in the ASSET computer program and those of the MIT Math Model, used in the MIT XIII-A program. They use a series of factors to operate on weights of the various weight groups, as well as factors for non-weight related items. The cost factor for each weight group is calculated, from which the cost of margin is estimated. A ten percent margin was used for the MPF 2010 ship. Engineering, and construction, and assembly costs are then applied to the above cost factors. The summation of all these costs yields the lead ship construction cost. A ten percent profit margin was used to estimate the total lead ship price. As mentioned in Appendix D, this is only the shipbuilder portion of the price. Not included is the cost of changes during construction, the cost of government-furnished equipment (GFE), or the cost of growth in the program caused by changes in government requirements.

2. Acquisition cost estimate

An Excel worksheet was used to calculate the ship acquisition cost using the above model. This model estimates a **lead ship cost of $816 million**. The Center for

Naval Analysis (CNA) reported a lead ship acquisition cost of $577 million for a squadron of five modified T-AKR 300 ships. These ships would be used to meet the CNA option 'A' requirement, which is a replacement of the current pre-positioning capability, and does not support the rotary wing and fixed wing assets of the MAGTF. The MPF 2010 ship design is based on CNA requirement option 'D', which fully supports all MAGTF tactical aircraft (for the purposes of this analysis, the MAGTF EA-6B and KC-130 aircraft are not considered to be tactical aircraft). The ability of the MPF 2010 to fully support all MAGTF tactical aircraft is the primary reason for the difference in lead ship cost estimates.

A life cycle cost estimate was not conducted due to time constraints and the complexities involved in such a calculation. A life cycle cost estimate would be appropriate for a more detailed design analysis.

VI. OPERATIONS

A. MPF 2010 PREPOSITIONING

There are currently three Maritime Prepositioning Force (MPF) squadrons: MPRSON One, which operates in European waters; MPSRON Two, which operates out of Diego Garcia; and MPSRON Three which operates out of Guam and Saipan, [19]. None of the MPF squadrons have "permanent" home ports. Rather, they are continuously forward-deployed, rarely travel together, and routinely visit various allied ports within their respective areas of responsibility. On 24-hours notice, each MPF ship can leave port and reach any region in its area of responsibility within approximately seven to ten days.

It is anticipated that the MPF 2010 squadrons will be prepositioned in a manner similar to that of the present-day MPF squadrons.

B. NOTIONAL OPERATIONAL TIMELINE

This section outlines the sequence of events which will occur from the time the tasking order is received until the time at which the MPF 2010 squadron arrives in the Amphibious Objective Area (AOA). This timeline is notional in that the actual times involved would depend on several factors, such as the location of each ship when the crisis occurs, where the crisis occurs and the classified operational plan for the squadron affected. It describes how the elements discussed in the sections in this chapter fall into place as the ship proceeds to the AOA.

The timeline is based on the fact that the MPF 2010 squadron will be used to augment an Amphibious Readiness Group (ARG) that is on-station conducting operations. It is assumed that a Carrier Battle Group (CVBG) is in the vicinity of the AOA providing air superiority. The fifteen day timeline (Figure 42) is based on the ability of the ARG to conduct unstained combat operations for fifteen days before the MPF 2010 squadron arrives on the scene.

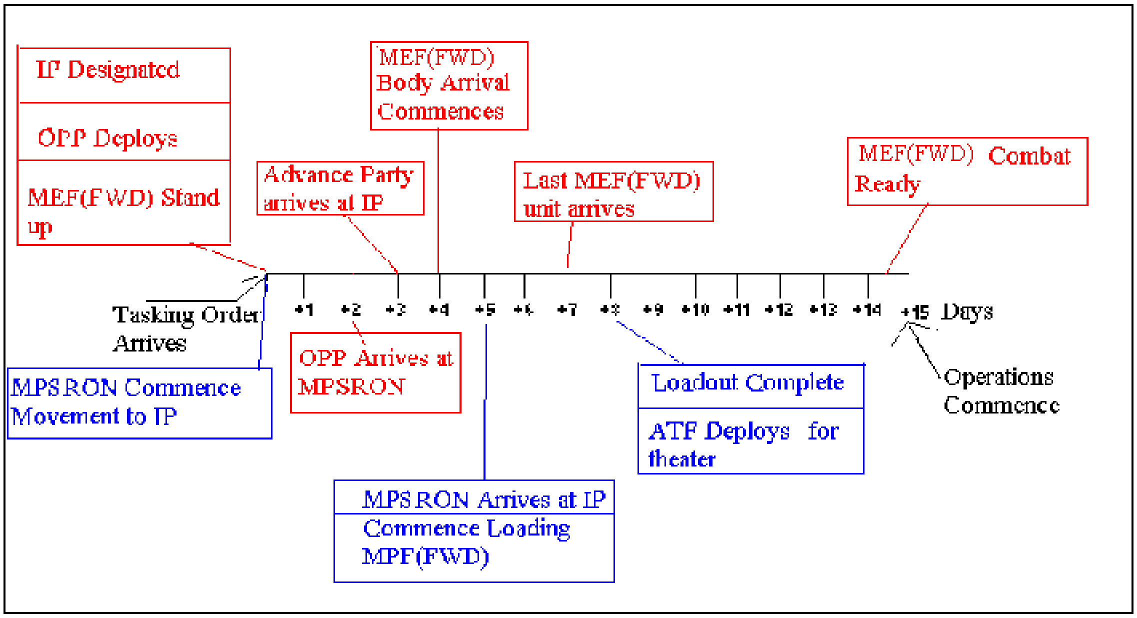

Figure 42. Notional Time Line

Once the tasking order is received and the MPF 2010 ships are underway, the Operational Preparation Party (OPP) will be the first to come onboard as the ships steam towards the Intermediate Staging Point (ISP). The OPP is separate from the Advance Party (as described in VI.C.2.), that will arrive onboard each MPF 2010 in time to support the embarkation of the MAGTF. The OPP will prepare the prepositioned equipment, vehicles, and craft for use by the Marines upon the arrival of the MAGTF. Once the MPF 2010 ships arrive at the ISP, the MAGTF will be embarked (as described in VI.C.). It is estimated that it will take three days to bring an entire MEF (FWD) of 18,000 personnel on board the five ships in the squadron. During the remaining time the MAGTF personnel will become familiarized with the MPF 2010 ships as they transit to the AOA.

C. MAGTF EMBARKATION

In time of crisis, the appropriate MPF 2010 squadron will be immediately dispatched to the region of concern. Shortly after the MPF 2010 squadron is dispatched, a Marine MAGTF (MEU or MEF) will leave CONUS, enroute to the MPF 2010 squadron. In order to allow the MAGTF to execute its mission immediately upon arrival in the region of concern, it is necessary to provide an Intermediate Staging Point (ISP). The ISP will be a port or other area where the MAGTF can embark the MPF 2010 squadron in an expeditious manner.

1. Intermediate Staging Point (ISP).

It will be necessary for the ISP to be located at or near an airport capable of supporting strategic lift aircraft. The strategic lift aircraft will ferry MAGTF personnel and their carry-on gear and equipment to the vicinity of the ISP. The ACE will have the option of either flying directly to the MPF 2010 squadron or via the ISP.

Once at the ISP, the MAGTF may transit to the MPF 2010 squadrons via air, sea, a combination thereof, or in-port embarkation. Although it is not necessary for the ISP to be located adjacent to a port facility, an in-port embarkation would probably be the fastest and most economical way to embark the MAGTF.

Were a port facility unavailable to accommodate the MPF 2010 squadron, it is still possible to embark the MAGTF via organic lighterage, amphibious craft, and most of the rotary-wing aircraft of the ACE. In order to embark the MAGTF in this manner, it would be necessary for the MPF 2010 squadron to approach relatively close to the ISP and either slow or stop for the duration of the embarkation. The ferrying of a MEF size MAGTF to the MPF 2010 squadron would require that all available craft make numerous trips, would take a considerable amount of time, and would be arduous on the craft and crews. This method would also risk the damage or degrade of craft necessary for the mission. It is for these reasons that an in-port embarkation is preferred.

Another option would be to embark the MAGTF via a high speed amphibious craft similar to the Russian Pomornik class air cushion vehicle (ACV). The Pomornik is capable of carrying 310 troops at a speed of 55 knots to a range of 300 nautical miles. A similar United States ACV would greatly facilitate the expeditious embarkation of the MAGTF. However, such an ACV is not currently under development.

2. Advance Party

Due to the minimum number of personnel maintained on board the MPF 2010 ships, it is expected that an advance party of support personnel would arrive on board the MPF 2010 ships prior to MAGTF embarkation. The advance party personnel would be of sufficient quantity and skill to be able to support the embarkation of the MAGTF from either air or sea. In the event that MAGTF personnel are embarked in-port, it would still be necessary for a sufficient number of flight support personnel to arrive on board the MPF 2010 ships prior to the embarkation of the ACE. It is assumed that the personnel normally embarked on MPF 2010 ships would be able to adequately support flight operations for the arrival of one or two aircraft. However, these arriving aircraft would need to contain adequate personnel to support subsequent flight operations.

3. Logistics

The MPF 2010 squadron will contain adequate supplies to support at least the first 30 days of combat operations. This will include items such as MREs, canned goods, flour, rice, beans, etc. However, it is important that the MPF 2010 squadron take on perishable foodstuffs, in addition to the food items already on board. This would be accomplished sometime prior to the arrival of the MPF 2010 squadron to the area of concern. Examples of such items would be fresh fruits and vegetables, milk, and meat. The perishable foodstuffs could be either brought on board with the MAGTF, or by re-supply en route. Although the perishable foodstuffs are not a requirement for the accomplishment of the mission, they would be a considerable boost to morale, and as such should be a primary consideration.

4. Shipboard Familiarization

A primary function of the MPF 2010 squadron is to support the STOM. In order to accomplish this objective, it is requisite that all MAGTF personnel have some degree of familiarization with the ships that they will be on board. Since the MAGTF will not normally be embarked on the MPF 2010 ships, it is unlikely that any of the MAGTF personnel will have anything more than the most rudimentary knowledge of these very large ships. Thus, it is very important that some method of shipboard familiarization be available to all MAGTF personnel.

The MPF 2010 ships will contain numerous interactive computers with touch sensitive screens to allow personnel to learn information about the ship that is relevant to that person. These computers will be located in all berthing areas and staterooms, thus providing ready access to all personnel. Each computer will be connected to a central computer via a high-speed network that will allow retrieval of any information about the ship. This information will range from the rudimentary, such as the location of the nearest head, to the complex, such as how to operate the ship's anti-ship missile defense system. The less complex information will be contained locally on each computer, while the more complex information would be retrieved from the central computer. Each computer would also be able to interact with the C4ISR system, assuming that the user satisfies appropriate security protocols.

D. AMPHIBIOUS OPERATIONS

1. Introduction

The primary objective of MPF 2010 is to support the STOM as part of Marine Corps OMFTS tactical concept of operations. MPF 2010 will support the STOM using both amphibious and air assets. MPF 2010 has been designed to meet the requirements for two basic operating scenarios [6, Notice 14 and 22]:

- MAGTF support as currently provided by the maritime prepositioning ship (MPS) squadrons.
- Support and Reinforcement of the MAGTF from the sea. This is accomplished either by employing the MPF 2010 squadron as a "sea-base" of ships operating closely together or as a force of ships operating semi-independently in geographically diverse regions.

Both operations embrace the concept of OMFTS. The first scenario assumes that MPF 2010 will off-load the MAGTF in a permissive environment either in-stream using organic lighterage or via a pier, similar to how MPS squadrons conduct operations currently.

The second scenario anticipates that the MPF 2010 squadron will conduct STOM in or near a hostile environment, generally beginning from over the horizon (OTH) ranges to within 4 nmi, using organic air assets, lighterage, LCACs, LCUs, and AAAVs for force delivery and sustainment. The deployment of the MAGTF from MPF 2010 will commence once the ship is within 25 nmi of the beach-landing site.

2. Assumptions

As stated in the requirements document (see Appendix A, requirement 2. b.), it is assumed that when in an unfriendly environment, MPF 2010 will operate in coordination with a CVBG and an Amphibious Ready Group (ARG). The Carrier Battle Group Air Wing will provide air superiority in the region. The MPF 2010

JSFs will provide ground support to the landing troops, as required. It is also assumed that the operational objective is 60 nmi inland or 85 nmi from the seabase.

3. Combat Operations

MPF 2010 supports rapid amphibious deployment (and recovery) of MAGTF forces through its ability to conduct LCU, LCAC, AAAV and over-the-side operations simultaneously. Due to its split well deck design, MPF 2010 can support LCU operations while it is launching and recovering LCACs and/or AAAVs. Once MPF 2010 has deployed its organic lighterage, it is capable of offloading (and onloading) equipment via either its over-the-side cranes or its side ramps as well via the well deck.

Combat loaded personnel can proceed directly from their berthing areas in the sponsons to the vehicle decks, flight deck, or the well deck staging area in order to embark the appropriate craft or vehicle. Once personnel have embarked their respective craft or vehicle, they are able to immediately debark MPF 2010 via one of the above mentioned means. This arrangement of berthing, vehicle decks, flight deck, well deck, and side ramps provides for the rapid amphibious deployment (and recovery) of personnel.

The ships of the MPF 2010 squadron, acting either semi-independently or as a sea base, commence amphibious and air operations from 25 nmi offshore. Initially one battalion of infantry is offloaded by air (via MV-22) and one battalion by AAAV, nearly simultaneously. An additional battalion is later inserted via air (air operations are more fully discussed in section VI. E.). Within the same time frame, the Landing Support Battalion, one Tank Company, and the Light Armored Recon Company are moved to the beach by LCACs organic to the MPF 2010 ships. Two LCACs and one LCU will be organic to each MPF 2010 ship. Although this is not consistent with CNA assumptions, it was felt that the number of LCACs available from the ARG (sufficient to handle the requirements of a battalion) would be insufficient to handle the requirements of a brigade. Furthermore, removing the LCAC assets from the ARG would reduce the ARG's ability to conduct its own assignments. In making this decision, the team also considered that this may require the procurement of additional LCACs (only a limited number have been procured to date), or the development and procurement of a follow-on design. Once ashore, this force in combination with elements from the ARG (if already present), will secure the immediate coastal area permitting the ships of the MPF seabase to move to within four miles of the beach. The remainder of the Ground Combat Element (GCE) scheduled to move ashore is offloaded using a combination of organic lighterage , LCAC's and LCUs.

The 360 person Landing Support Battalion (LSB) supports the subsequent movement of vehicles and personnel ashore during the movement ashore of the equipment heavy battalions. Upon completion of the movement ashore, the Landing Support Battalion is withdrawn offshore to the seabase via returning watercraft. The MPF 2010 squadron then moves back to a point 25 nmi from the beach. From this position the MPF 2010 squadron will be able to commence resupply and combat service support to the shore party by air.

E. FLIGHT DECK OPERATIONS

The Air Combat Element (ACE) of the MAGTF will operate from MPF 2010 ships operating at sea. This method is different from the current MPS employment method in which the ACE is operated from secure shore based airfields near the objective. This new method is fundamental to the implementation of the STOM. By basing the ACE onboard MPF 2010, the MAGTF's flexibility and responsiveness is magnified. Additionally, the limitation of required secure shore based airfields is removed.

It is assumed that 148 aircraft comprising JSF, MV-22, SH-60, AH-1, UH-1 and CH-53 aircraft [4] will operate from all five ships of the MPF 2010 squadron. The distribution of MAGTF aircraft among ships is described in Appendix B. The JSF and AH-1 aircraft will primarily be utilized for strike and close air support of Marines on shore. Although use of the JSF in an air combat role is possible, it is assumed that this mission is delegated to aircraft from the supporting aircraft carrier. This simplifies JSF flight operations immensely. The UH-1 aircraft will be primarily used for command and control and medical evacuation. MV-22 and CH-53 aircraft will be used for transporting cargo and personnel from the MPF 2010 to and from shore. Finally, the SH-60 will be utilized for search and rescue (to include plane guard) and provide a minimal mine spotting capability.

1. Aircraft Flow

a. JSF Load-Out

JSFs will land on three dedicated landing areas with jet blast collectors (JBC) at the aft end of the flight deck. The JSF will shut down its engine upon landing. Movement of JSF thereafter and until subsequent re-launch will be accomplished by towbots that will attach to the front wheel of the JSF. This will enhance the safety of, reduce noise level on, and minimize jet blast damage to the flight deck. The towbots will move the JSF about the flight deck and hangar to parking, maintenance, rearm/refuel and launch areas as necessary.

The forward starboard flight deck will be available for launch and recovery of miscellaneous rotary wing aircraft. Aircraft and/or cargo can be pre-staged in this 140 feet by 120 feet location during JSF operations. Once a pause in JSF launch operations occurs, a rotary wing aircraft could be launched, recovered, or allowed to transfer cargo. Access to and from the hangar for these operations will be via the forward hangar door. A minimal capability to send and return cargo and personnel to and from the beach may be conducted through this location. Additionally, the SH-60 functioning as plane guard would operate from this area.

b. Rotary Aircraft Load-Out

Rotary wing aircraft will set down at the various landing spots on the flight deck. If an aircraft is to be immediately flown again it will remain on its spot until ready to launch again. It will be rearmed and refueled, loaded, or unloaded as necessary while in place on the flight deck. Aircraft that will not be immediately turned around will shut down their engines, fold their rotors and/or wings as appropriate, and be towed to the hangar or elsewhere on the flight deck as necessary by a towbot.

2. Force Deployment

Under normal conditions, the MPF 2010 squadron is forward deployed without the MAGTF onboard. The MAGTF personnel and aircraft are brought to the forward-deployed ships as the need arises. Force deployment may be accomplished with the ships tied up next to the pier in an intermediate port or while the ships are underway to the objective. In the later case, all personnel, their carry on equipment and all the aircraft of the ACE must be brought onboard by air.

An air traffic control team will be initially flown onboard with the advance party. These first aircraft must land with minimal assistance from onboard personnel. Once the ships are ready to receive the remainder of the MAGTF and its equipment, the remaining aircraft will be flown onto the appropriate ships.

3. Force Supply

A requirement for initial assault is that the MPF 2010 shall be capable of expeditiously off-loading three infantry battalions in support of combat operations at a range of 25 nautical miles from the beach. The MPF 2010 shall be capable of off-loading the first battalion via MV-22s, a second battalion via AAAVs, and a third battalion via a second wave of MV-22s.

After this initial assault, Marines on shore must be supplied and re-supplied with vehicles, ammunition, equipment, fuel, etc. to support their mission. Consistent with STOM, no shore basing will be conducted. The Marines will be supplied directly from the MPF 2010 squadron via MV-22 and CH-53 sorties, as well as via amphibious assets. If necessary, the MPF 2010 squadron will support continuous aviation operations of all aircraft from all five ships.

MV-22 and CH-53 aircraft will additionally be required to return personnel and equipment to the MPF 2010 as the situation dictates. This includes returning injured personnel to the ship-based hospitals and damaged vehicles and equipment to onboard repair facilities.

4. Fire Support

Close air support to the Marines ashore will be provided by the 60 JSFs and 18 AH-1 Super Cobras assigned to the MAGTF. The JSFs will operate from the two JSF load out ships. The Super Cobras will operate from the three rotary load out ships. The close air support mission is thus spread throughout all ships in the squadron.

F. REPLENISHMENT

There are a number of scenarios in which MPF 2010 can be replenished at sea while simultaneously providing support for MAGTF operations. These scenarios range from assault operations by specific elements of the MAGTF engaging limited objectives over limited periods of time (from one to ten days), to sustained combat operations by the entire MAGTF over an indefinite period of time. Since the MPF 2010 squadron will only have a sufficient quantity of supplies to support 30 days of MAGTF operations, it is necessary that there be a system whereby the MPF 2010 can be re-supplied while remaining forward deployed. To support these missions MPF 2010 must be able to sustain the flow of supplies, personnel, and support to the MAGTF, have the ability to be replenished from outside sources, and transfer personnel and equipment between ships of the squadron. To investigate the issue of re-supply and support, two scenarios will be given along with the operation of MPF 2010 to support these scenarios.

The first scenario is the assault operation of limited duration. In this case the MPF 2010 would expend a portion of its cargo, as determined by the length and intensity of the operation. Upon completion of the operation, the MAGTF personnel and equipment can be recovered, and MPF 2010 can then retire from the AOA. MPF 2010 can then proceed to a port facility where the expended cargo can be replaced, the wounded transferred to a shore hospital facility, and own ship's supplies can be replenished. MPF 2010's 25-knot maximum speed supports the ability to rapidly transit from the AOA to a port and back. In the situation where the port facilities are not available or the MPF 2010 must remain in the AOA, replenishment ships will provide re-supply. While using replenishment ships allows the MPF 2010 to remain in the AOA, the effort and the amount of time required to accomplish re-supply is greater. While in the AOA wounded would be cared for by MPF 2010's organic hospital.

The second scenario is that of sustained combat operations ashore. This scenario is the most demanding on the ability to re-supply MPF 2010. In this scenario the MPF 2010 may exhaust all of its cargo in support of operations. As each ship is emptied it would either retire from the AOA and rendezvous with Combat Logistics Force (CLF) replenishment ships or proceed to a nearby friendly port for re-supply. One of the key issues involved with the conduct of sustained combat operations via MPF 2010 is the need for dedicated support. The amount of supplies and support required would quickly overwhelm the CLF replenishment ships that would be operating in support of the Amphibious Task Force. In order for MPF 2010 to remain near the AOA, it would be necessary for dedicated shuttle ships to be provided to augment the capacity of the CLF replenishment ships. Otherwise, it would be necessary for MPF 2010 to repeatedly transit to and from a re-supply port. The MPF 2010 organic hospital will care for the MAGTF wounded for the first 30 days of combat operations, and then be augmented by a dedicated hospital ship thereafter. Any MPF 2010 ship transiting to a re-supply port would also have the option of off-loading its wounded there, assuming that appropriate medical facilities were available.

Regardless of the scenario, MPF 2010 will provide greater flexibility for re-supply. With port facilities available MPF-2010 can rapidly, at 25-knots speed, transit to a port where it can load supplies with organic cargo handling equipment. In cases where the port is relatively close (i.e. about a day's transit), MPF 2010 can reload faster than it would be able to at sea. During this time period, the remaining MPF 2010 ships would be able to "take in the (operational) slack" left by the ship which was being re-supplied. This would allow the MPF 2010 ships to re-supply at a port on a rotating basis. Indeed, if no more than 4 MPF 2010 ships are required to be on station, one MPF 2010 ship could be continuously involved in transiting and re-supply.

In the event that the CLF replenishment ships are used for re-supply, there are three methods available. The first method is underway replenishment using the Standard Tensioning Replenishment Along Method (STREAM) system. This is the most common method of underway replenishment for U. S. Navy ships. STREAM requires that the receiving and the supply ship be fitted with special equipment. MPF 2010 will be fitted with this equipment and will be able to conduct replenishment along side. A full explanation of underway replenishment using the STREAM can be found in Reference [20]. The second method is the Vertical Replenishment (Vertrep). The Vertrep uses helicopters or MV-22's to lift supplies from the replenishment ship to MPF 2010. (It should be noted Vertrep can be used for re-supplying from shore to ship also.) The last method is the in-stream method. This method uses either CLF replenishment ships or shuttle ships that are married to MPF 2010 so that supplies can be quickly transferred from one ship to the other. This method is the second fastest way to re-supply MPF 2010, but it requires a low sea state and requires compatibility between ships for transferring cargo. This method allows MPF 2010 to remain in the AOA and to be re-supplied quickly. An alternative in-stream method can be accomplished while MPF 2010 and either the shuttle ships or the CLF replenishment ships are at anchor. In this case re-supply would occur via lighterage, which is slower and would also require a low sea state

There are a few significant items of note. First, MPF 2010 has the inherent ability to consolidate supplies between ships in the squadron. As noted above, one ship could be emptied to allow it to retire from the AOA and re-supply while other ships remain on station and support the MAGTF. Second, containerized cargo can only be loaded on MPF 2010 in port or by using the in-stream method of re-supply. This means that any containerized cargo on a re-supply ship will have to be unloaded to palletized cargo for STREAM replenishment.

In comparison to current MPS ships, MPF 2010 is extremely more robust in its ability to be re-supplied in support of the MAGTF.

G. SUSTAINMENT OF FORCE

MPF 2010 will be fully capable of independently sustaining a MAGTF for the first 30 days of combat. After the first 30 days of combat, MPF 2010 will be fully capable of sustaining a MAGTF with regular support from re-supply assets. MAGTF sustainment will consist of resupply, medical evacuation (Medevac), force movement, and delivery of maintenance contact teams, [4].

Depending on the distance of the landing force from the MPF 2010, resupply may be accomplished via lighterage, LCAC, LCU, or rotary wing assets. As the landing force becomes further removed from the MPF 2010, resupply will depend primarily upon rotary wing assets. The CH-53E will be the primary means by which the landing force will be resupplied from air, although the MV-22 may also be used for resupply. Medevac will be primarily conducted via UH-1N (4B) aircraft. The MV-22 may also be used for Medevac purposes.

Force movement will be conducted via LCAC, LCU, AAAV, and MV-22. As the landing force becomes more removed from the MPF 2010, or if rapid force movement is required, the MV-22 will be the primary vehicle for this task.

Due to the similar construction of all MPF 2010 ships, greater flexibility is provided for force sustainment. Since any aircraft or watercraft within the MPF 2010 squadron is fully interoperable with any MPF 2010 ship, and each MPF 2010 ship has similar support capabilities (such as medical facilities, for example), it is possible to conduct force sustainment from any MPF 2010 ship via any asset available. The only limitation is the supply load out of the individual MPF 2010 ship. This greatly enhances the MPF 2010 squadron's ability to expeditiously and efficiently sustain the MAGTF, whether collectively or individually.

VII. DESIGN EVALUATION

A. DESIGN DEVIATIONS

Once the initial design models for options A and B were shown to converge (i.e. they were feasible designs), these models were "frozen." In other words, no changes were allowed to the ASSET models once the models converged. This was done in order to allow the design of option A (which was chosen over option B) to be completed in the limited time allowed in the academic environment of the analysis. In a less constrained design environment, the ASSET model would have been revised over several iterations of the design spiral, until it was determined that a satisfactory design had been obtained.

This analysis represents the first iteration of the MPF 2010 design spiral. As the design progressed beyond the initial ASSET model, it was recognized that several changes to the model would be made. Some changes to the design would be of such a magnitude as to affect the stability, displacement, and/or power requirements of the ASSET model, while others would not. Small changes to the design are considered to be negligible and are not mentioned here. Changes to the design that are considered to have a significant impact on the ASSET model are listed below. These changes would be incorporated into the ASSET model and evaluated at the next iteration of the design spiral:

- Partial well deck vice a full well deck. Additionally, the wet portion (i.e. that used by the LCU) of the partial well deck is located lower than the full well deck
- Dual electric drive motors per shaft vice one electric drive motor per shaft.
- The blast collector system was not included in the original model.
- The stern lighterage stowage system was not included in the original model.

- The hangar was relocated 40 ft forward from the location in the original model.

In addition to the changes noted above, there are additional design changes which, although not incorporated in this iteration, would probably be incorporated at later iterations. An example of this is the hangar geometry. In order to minimize the large radar cross-section of MPF 2010, it is desirable to minimize the number of vertical surfaces that it presents. The largest vertical surface on MPF 2010 is the hangar. Upon the next design iteration the hangar would be tilted inwards by 10 degrees from the vertical for radar cross section reduction at the horizon. Additionally the tilt allows the radar and communications arrays imbedded in the exterior hangar walls to point towards zenith. Accounting for the 10 degree tilt, the top of the hangar becomes 589.6 feet by 109.6 feet or 64620 square feet. This will amount to a loss of 7380 square feet, which corresponds to a 10% reduction of the area available on top of the hangar.

B. REQUIREMENTS BEYOND THE SCOPE OF THIS ANALYSIS

During the requirements setting phase of this design project, a detailed list of in-depth design requirements was generated for MPF 2010 (Appendix A). A complete design analysis would either satisfy each of these requirements or address the reasons why the requirements could not be met. Due to the time constraints imposed by the academic nature of this design project, it was not possible to address every topic to the level of detail required for a complete design analysis. Requirements were addressed to the extent that a reasonable design for MPF 2010 could be analyzed. As has been stated elsewhere, this analysis was only the first iteration of the MPF 2010 design spiral, and as such several details have been undefined that would be defined in later iterations. Below is a list of requirements which have not been addressed in this iteration of the design spiral, but would be satisfactorily resolved in later iterations (see Appendix A):

- The ability to provide bulk fuel delivery via the Amphibious Assault Bulk Fuel System (ABSS) – Appendix A 1.a.
- Undesignated space is available for environmental waste management features that will meet federal regulations at the time of lead ship contract award – Appendix A. 1.f.
- An optimization of MPF 2010 maintenance planning with respect to its impact on material readiness and MPF 2010 availability to the operational commander – Appendix A 1.g 5.a.1).
- The ability to meet level two survivability requirements of OPNAVINST 9072.2 – Appendix A 4.e.1).
- It was not feasible to evaluate the operational requirements of Appendix A 4.e.6).
- Undefined space is available for non-aviation related shops and maintenance areas, however the requirement of Appendix A.4.f.2) would be further defined in later iterations.
- Human Systems Integration would be fully developed in later iterations – Appendix A. 5.c.

In addition to addressing the above noted design requirements, further iterations would more completely address those design requirements that were explored by this analysis.

C. ASSESSMENT OF DESIGN

Due to the large scope of this design project and the many facets of the concepts of OMFTS, STOM, and MPF 2010 and Beyond which were investigated for implementation into the design of MPF 2010, the main thrust of this analysis has been at the level of a feasibility study. We are confident that we have demonstrated that such a ship can be built. The next step will be the actual systems engineering of the vessel. Although some aspects of systems engineering were addressed in this analysis, a greater degree of systems engineering would be desired for the first complete iteration in the design spiral. Unfortunately, there was not sufficient time and manpower to systems engineer each aspect of the design to the level which we would desire. The following list is the result of a retrospective look at the project. It is composed of topics which the team feels were not adequately addressed, for the reasons previously mentioned.

1. Propulsion Plant

While the team believes the choice of propulsion plant was the correct one for this application, its choice was based on purely on qualitative analysis. A better approach would have been to select several permutations of propulsion plants and compare them based on fuel efficiency, cost, size, arrangement, reliability, responsiveness, environmental impact, weight, maintenance requirements, etc.

2. Collective Protection System (CPS)

CPS capability was not addressed. Analysis of the need for CPS would have begun with a chemical, biological and radiological (CBR) threat evaluation for the ship in its various missions. The next step would be to determine which portions of the ship it would be feasible to protect. This would be accomplished by quantitative analysis using criteria such as cost, ability to perform critical missions in CBR environment, and the potential for loss of life.

3. Sea State

Although the Operational Requirements Document (ORD) lists requirements for conducting various operations in specific sea states, no quantitative sea state analysis was conducted. There are several dynamic analysis programs that are capable of such simulations. Inputs to these programs are hull form and stability data, which are readily available from the ASSET model.

4. Damage Control Scenarios and Procedures

Even though we designated damage control personnel and systems, the adequacy of both to perform in specific scenarios was not evaluated. To have an acceptable degree of confidence in the ship's damage control capability, several damage scenarios would have to be analyzed using formulated damage control procedures and related timelines.

5. Abandon Ship

The ability to safely abandon ship at sea was not designed for or evaluated. The design for this capability should include all personnel associated with a full MEF (FWD) load out. This is a significant undertaking considering the need for lifeboats, off load points and the ability to account for over 4,000 personnel per ship.

6. Ammunition Storage

The design of the cargo deck incorporated the assumption that containers and pallets of ammunition could be stored in any storage location. This presupposes that in the future ammunition will be considered safe in any storage location or that portable container and pallet magazines will exist. No risk assessment was performed with respect to the development of these technologies, nor were any fall back contingencies developed.

7. Intermediate Staging Points (ISP)

The development of a 15-day timeline addressed the use of ISPs, however a list of acceptable ISPs was not addressed. Additionally the attributes required by an ISP were not delineated.

8. Embarkation Timeline

To accurately define the time necessary for embarkation the ISP locations must first be defined. Next a quantitative analysis of the window required for force embarkation would be formulated based on the number of troops, location of ship with respect to an available friendly airfield, and transport assets available.

9. Area Coverage and Timeline

A proper analysis must be preceded by the identification of acceptable ISPs and the creation of embarkation timelines for each ISP. These factor into the time distance calculations that would be necessary to validate coverage requirements.

10. Amphibious Operations Timeline

Another shortfall in timeline analysis is that of assault and reembarkation. It was assumed that the cargo and vehicle off-load times would be the same as for an existing MPS. To develop an accurate timeline, a quantitative analysis including forces, cargo, and assets would have to be developed.

11. Timeline for Aviation Operations

A quantitative analysis of aviation mission timelines, including mission types, number of sorties, and flight deck operations, was not preformed. This level of analysis would reveal whether the current numbers of aircraft and shipboard facilities are sufficient to meet the operational requirements.

12. Threat Evaluation

The MPF 2010 is undeniably a high value target. Each MPF 2010 squadron carries not only tens of thousands of troops but the vehicles, aircraft, and supplies for a MEF (FWD) to conduct 30 days of sustained operations. The primary threats to the MPF 2010 ship can be separated into four main categories.

Threat	Squadron Stand-off	Squadron Area Defense	MPF 2010 Self-Defense
AAW	CVBG Combat Air Patrol (CAP) & EA-6B	CVBG AEGIS Escorts	AN/SLQ-32, ESSM & MFA
ASuW	CVBG CAP & Escorts	CVBG AEGIS Escorts	None
ASW	CVBG SSN, Escorts & P-3s	CVBG Escorts & SH-60	USMC Infantry & Aviation Weapons
MINE	Intelligence	Mine Sweepers	None

Table 15. Threat Assessment

Of these categories, ASW and MINE pose the greatest risk. The CNA assumption that ASW and mine clearance operations would be conducted by other units was accepted as presented, [4]. Analysis of other units' capability and availability to conduct these operations should be weighed against the costs associated with designing these capabilities into MPF 2010. Additionally, an analysis should evaluate the possibility for and potential impact of terrorist attacks, unauthorized boarders and/or acts of sabotage against MPF 2010. With the MAGTF embarked, it may be possible to provide limited ASW capability using the infantry weapons carried on board. These include a number of crew-served automatic weapons and anti-armor missiles. The aviation assets (JSF and AH-1) once operational would also provide excellent ASW capabilities. The presence of the MAGTF would guarantee that terrorist attacks were suicide missions.

13. Full Battle Scenarios

No attempt was made by the design team to evaluate war games which involve the entire battle force including the MEF (FWD), MPF 2010 squadron, CVBG and ARG. Such scenarios could serve to identify weaknesses in the design or fundamental concepts of MPF 2010. These weaknesses would then require further evaluation.

14. Automation

This design proposed the use of robots for the movement and rearming of aircraft. Current technologies are available to construct these robots, but no effort was made by the group to design a robot suited for these tasks. To achieve this goal, a robot design and manufacture program would need to be created. The risk associated with program would need to be evaluated, as well as a contingency plan developed in case the robots were not available in time for use by MPF 2010.

15. Watch-standing and Maintenance

Manning requirements for routine operations are vastly different than those for operations when the MEF (FWD) is embarked. During routine operations, the duties of the limited size crew consist predominantly of watchstanding and maintaining systems in lay-up. The number of personnel required to fulfill these tasks was determined by team members' experience. A more accurate method of determining the type and number of ship's force personnel would have been to approximate the maintenance requirements of shipboard systems and then factor in watchstanding requirements. When the MEF (FWD) is embarked, approximately 18,000 more personnel will be utilizing shipboard services such as galleys, laundry facilities, etc. Additionally, all of the equipment in lay-up will need to be readied for use, tested, and pre-staged. Exactly how this is to be done and who will do it was not delineated.

16. Intermediate maintenance activity details

Although space was allocated on each ship for both an aviation and vehicle intermediate maintenance activity (IMA), the size of this space was chosen arbitrarily and was not the result of an analysis of IMA requirements. A better method would have been to list IMA required capabilities, identify the specific equipment needed to meet the IMA requirements, and then identify a specific location for each piece of equipment after taking into account how it will be accessed by vehicles or aircraft.

17. Cost Optimization

The ship was not cost optimized. No cost restrictions were imposed in designing this ship. A lead ship acquisition cost was calculated after the design was complete. At each stage of the design process, trade-off studies should have been conducted to cost optimize the ship. Due to time restraints and the complexity involved in such calculations, life cycle costs were not computed.

18. Required Re-Supplies

No calculations were made to estimate the amount of supplies required to indefinitely sustain the MEF (FWD) following the 30 day period during which the ship will sustain the combat troops ashore. The amount of re-supply and rate of replenishment required to indefinitely sustain the ground troops should be evaluated using different battle scenarios.

19. **Future Technology**

In the future, technological improvements will revolutionize the manner of war fighting. In our study, the personnel, vehicles, aircraft and equipment load out was based primarily on the war-fighting methods of today. The concepts of MPF 2010 and Beyond, OMFTS, and STOM require that our forces be much more mobile than at present. This may result in the requirement that forces be lighter and have weapons that can be moved more rapidly. In that case, the basic assumptions of our design would have to be re-examined.

20. High Speed Amphibious Craft

The LCU and the LCAC are the primary amphibious lift craft utilized by MPF 2010. Each craft has its disadvantages. The LCU is very slow, and therefore does not have a high speed over the horizon capability. The LCAC is weight limited. In order to effectively employ MPF 2010 from a relatively safe standoff distance, some type of heavy lift, high speed amphibious assault craft must be developed. Such a craft could be similar to the Russian Pomornik class air cushion vehicle (ACV) suggested for MAGTF embarkation (see Section VI C). Although the design of such a craft was not attempted, it does warrant further investigation.

21. **Number of Ships**

The choice of 5 ships per squadron was made relatively early on in the analysis. This decision was primarily driven by the desire to keep units and their equipment together on the same ship, so as to minimize the logistics required to move personnel and equipment between ships prior to an assault. It was also based on a qualitative assessment of cost, survivability, and operational flexibility. This decision had a major impact on almost every aspect of the MPF 2010 design. Given more time it would have been advantageous to evaluate several differently sized squadrons in greater depth, utilizing a quantitative analysis of factors such as cost, survivability, manning, and operational flexibility.

APPENDIX A MPF 2010 ORD

14 August, 1998

OPERATIONAL REQUIREMENTS DOCUMENT
FOR
MARITIME PREPOSITIONING FORCE(U)

1. (U) General Description of Operational Capability. The Maritime Pre-positioning Force 2010 (MPF 2010) primary missions are to pre-stage, transport and land personnel, cargo, vehicles and equipment to provide for a Marine Air Ground Task Force (MAGTF), anywhere in the World in direct support of military operations by the U.S. Navy and Marines. A MAGTF is defined to consist of a brigade-sized Marine Expeditionary Force (forward), including a ground combat element (GCE), aviation combat element (ACE), command element (CE) and combat service support element (CSSE). The principal mission of MPF 2010 is to support Amphibious operations; specifically, to embark, transport and land elements of a MAGTF in an assault by helicopters, landing craft, amphibious vehicles, lighterage or by any combination of these methods. This includes operations by the CSSE aboard ship and/or ashore for sustaining the landing forces.

a. (U) The MPF 2010 ships are enhanced replacements for the 13 merchant ships that currently comprise three MPF squadrons. MPF 2010 will be required to self load, transport, pre-assemble and self off-load troops, heavy vehicles, helicopters, landing craft, amphibious vehicles and both dry and liquid cargo. MPF 2010 will provide flag capability, over-the-side heavy lift capability, bulk fuel delivery via the Amphibious Assault Bulk Fuel System (AABFS) and offload over-the-beach/deployment of causeways.

b. (U) MPF 2010 will provide a capability for over-the-horizon (OTH) assault with Landing Craft, Air Cushion (LCAC), Advanced Amphibious Assault Vehicle (AAAV) and Vertical Take-Off and Landing (VTOL) aircraft (or future equivalent).

c. (U) MPF 2010 shall place special emphasis on the capabilities to support MAGTF operations, including aviation requirements. MPF 2010 ships with air capability shall have enhanced communications, and provide for simultaneous or sequential, combined and coordinated, air and surfaced launched amphibious assaults from over-the-horizon. MPF 2010 will also be capable of operating STOVL aircraft (i.e. JSF) in support of MAGTF operations. MPF 2010 will have the capability to conduct aviation Night Vision Device (NVD) operations consistent with the Navy's program.

d. (U) The MPF 2010 ship will have a replenishment-at-sea capability using both Vertical and Connected Replenishment Systems. Fueling-at-Sea stations will provide the capability to receive either JP-5 or Diesel Fuel Marine (NATO Code F-76). The ship shall have the capability to receive both fuels simultaneously. MPF 2010 shall have appropriate piping systems that provide the capability to pump JP-5 to a fuel bladder or tanker truck onboard the ship for re-supply of the landing force.

e. (U) Environmental waste management features to meet federal regulations at the time of lead ship contract award shall be designed into the MPF 2010. Due to the dynamic nature of environmental regulations, extra space and weight reservations (beyond standard margin practice and service life allowances) will be provided in this area.

f. (U) MPF 2010 ship maintenance planning is based on two levels of maintenance: Organizational, that is performed by ship's crew or assigned personnel; and Depot, that includes work by shipyards and other repair organizations. The duration and periodicity of these depot availability periods should provide optimum ship availability to the operational commander while maintaining material readiness at or above standards set forth by federal regulations and U.S. Coast Guard requirements.

g. (U) The MPF 2010 concept emphasizes the importance of providing a platform to embark MAGTF personnel and aircraft in addition to pre-staged vehicles and equipment, and to deploy the MAGTF assault force, equipment and aircraft in combat operations. MPF 2010 must have the capability to store and maintain MAGTF equipment and 30 days of supplies to support a MAGTF engaged in full combat operations. Additionally, MPF 2010 shall have the capability to marry the MAGTF personnel and equipment at sea.

h. (U) The MPF 2010, in conjunction with amphibious assault forces and carrier battle groups, are essential in the power projection role where contingency response is most likely. The objective is to have MPF 2010 ships capable of conducting numerous missions. Three squadrons of lift capability are required to support three MAGTFs to respond to contingencies in areas of our national interest.

i. (U) The design of MPF 2010 ships shall encompass as much commonality as practical, with only modest differences being made to support various capabilities. During peacetime, MPF 2010 will meet forward presence requirements by deploying as 4-6 ship squadrons which act as mobile forward located depots for the storage and maintenance of MAGTF cargo and equipment. These squadrons are only part of the basic deployment of a MAGTF, the other components will consist of the MAGTF personnel and aircraft. These squadrons can be expanded for opposed entry or divided to conduct single ship MAGTF special operations such as humanitarian and Non-Combatant Evacuation Operations (NEO). However, no specific design considerations need be made in anticipation of humanitarian and NEO missions.

2. (U) Threat.

a. (U) MPF 2010 will be confronted by a wide variety of sea, air and land-based threats ranging from conventional weaponry, including mines and terrorist weapons, to potential attacks employing nuclear, chemical, biological and other sophisticated weapons. The threat is posed by numerous, technologically-advanced forces, including aircraft, submarines and surface ships. MPF 2010 will be required to operate in the relatively shallow water of littoral regions where the threat posed by mines, small attack surface craft, submarines armed with wake homing torpedoes, land based aircraft (fixed and rotary wing), and coastal defense sites (artillery and missile) could also be significant.

b. (U) Based on the assumption that MPF 2010 will operate with a Carrier Battle Group and an Amphibious Ready Group, the threat to the MPF force is considered to be mitigated and self defense capability is all that is required.

3. (U) Shortcoming of Existing Systems. The implementation of the Marine Corps operational concept "Operational Maneuver from the Sea" (OMFTS) will render the current maritime pre-positioning force obsolete. Key elements of the OMFTS concept which are beyond the capability of the existing MPF include, but are not limited to:

a. (U) MAGTF embarkation and transport,

b. (U) fast debarkation (to include opposed entry) of MAGTF while underway,

c. (U) command and control and tactical support capabilities, and

d. (U) indefinite capability to sustain a MAGTF ashore.

Building additional ships of the existing class will result in an inability to execute the OMFTS concept and its underlying precept of Ship to Objective Maneuver.

4. (U) Capabilities Required.

a. (U) Embarkation of Personnel and Equipment. The MPF 2010 shall be capable of embarking a Marine Air-Ground Task Force (MAGTF) of 17,644 Marines and 1,193 Naval support personnel while en route to an objective area or while moored in a secured port:

1) (U) In addition to personnel, the MPF 2010 shall embark any necessary MAGTF equipment (with exception of C-130 and EA-6B aircraft) not included in the MPF 2010 pre-position load out.

2) (U) MPF 2010 will support en route embarkation of the remainder of the MAGTF via MV-22 and CH-53E aircraft (or future equivalent).

3) (U) Each MPF 2010 ship engaged in MAGTF en route embarkation shall possess sufficient aviation capability to ensure safety of aviation operations. A sufficient number of permanent party personnel shall be maintained on board MPF 2010 ships in order to adequately man the flight deck during initial MAGTF embarkation flights. It is assumed that MAGTF flight deck support personnel will be among first embarked and will carry out sustained aviation operations.

4) (U) MPF 2010 shall provide a method of ship familiarization to facilitate troop embarkation.

b. (U) MAGTF Debarkation/Assault Operations.

1) (U) The MPF 2010 shall be capable of expeditiously offloading 3 infantry battalions in support of combat operations at a range of 25 nmi from the beach. The MPF 2010 shall be capable of offloading the first battalion via MV-22's, a second battalion via AAAVs, and a third battalion via a second wave of MV-22's. Additionally, the MPF 2010 shall be able to transport a landing support battalion, 1 tank company, and a light armored Recon company to the beach concurrently with the infantry battalion offloads.

2) (U) The MPF 2010 shall be capable of offloading the remainder of the Ground Combat Element organic assault landing craft or lighterage at a range of up to 12nmi.

3) (U) MPF 2010 shall be capable of launching, loading, controlling, and recovering the following organic craft (or future equivalent) in offloading and transporting and on-loading the MAGTF personnel and equipment:

Waterborne		Aircraft	
LARC-V	4	MV-22	36
SLWT	4	CH-53E	8
CSP	16	AH-1W (4BW)	18
CSNP	30	UH-1N(4B)	6
LCM-8	8		
LCAC	TBD		
AAAV	109		
LCU	TBD		

4) (U) MPF 2010 shall provide for the operation, control and support of 60 Joint Strike Fighters (JSF). Additionally, MPF 2010 shall be able to conduct JSF operations currently with MV-22 operations.

5) (U) MPF 2010 shall be capable of simultaneous refueling, and loading of every aircraft. All aviation ordnance employed by aircraft of the MAGTF shall be carried and supported.

6) (U) Each MPF 2010 ship shall be capable of expeditiously on-loading returning troops and equipment in any order.

7) (U) MAGTF assembly and staging areas shall not be considered part of the cargo, equipment, vehicle storage or repair areas of MPF 2010.

8) (U) MPF 2010 shall provide a means for combat loaded troops to move to and from MAGTF assembly and staging areas via a reasonably direct route.

9) (U) MPF 2010 shall provide a means for any vehicle to be expeditiously transported to MAGTF assembly and staging areas.

c. (U) Cargo Handling and Stowage. MPF 2010 shall be capable of selectively retrieving pallets and containers from the storage area or cargo hold.

1) (U) MPF 2010 shall allow for cargo in pallets to be moved inside the cargo hold or be moved from one cargo hold to another for reconfiguration while at sea.

2) (U) MPF 2010 shall be configured in such a manner so as to allow for shipboard transfer of cargo from a cargo hold to a staging area while minimizing interference with other operations(i.e. container movement, flight ops, lighterage, etc.).

3) (U) MPF 2010 ships shall be capable of transferring containers between cargo holds and the flight deck, lighterage, or to a pier.

4)(U) MPF 2010 shall provide adequate space so that required periodic maintenance may be performed on stored equipment either while that equipment is in place or with minimal movement of surrounding equipment.

5)(U) MPF 2010 shall provide redundant handling and lift equipment.

d. (U) Support and Logistics.

1) (U) MPF 2010 shall maintain onboard sufficient supplies and equipment to support a MAGTF for 30 days of combat operations. MPF 2010 shall have the capability to support a MAGTF indefinitely when re-supplied at necessary intervals.

2) (U) MPF 2010 shall maintain onboard sufficient supplies equipment to support the MSC and permanent military personnel for a period of at least 90 days.

3) (U) MPF 2010 shall maintain onboard sufficient supplies and equipment to support non-permanent military personnel for a period of at least 60 days.

4) (U) MPF 2010 shall provide berthing, messing, and laundry facilities for the permanently embarked crew in accordance with current applicable regulations.

5) (U) MPF 2010 shall provide adequate facilities to provide for the berthing, messing, and laundry needs of embarked USN and USMC personnel. All military personnel shall be provided prepared, cooked meals while onboard.

6) (U) MPF 2010 shall provide medical and dental facilities to meet the routine medical and dental needs of all MAGTF and permanent party personnel embarked onboard. Additionally, MPF 2010 shall meet the combat medical and dental needs of the MAGTF for the first 30 days of combat operations. The following capabilities shall be provided in support of this requirement:

a) (U) Two medical operating theaters.

b) (U) Two dental operating theaters.

c) (U) Ten bed post surgical suite

d) (U) Associated medical laboratories and supply facilities.

e) (U) A 400 bed convalescent suite (from Marine berthing).

f) (U) Miscellaneous triage areas and consultation rooms.

7) (U) MPF 2010 will be outfitted with ship's spares and repair parts to support operations based on a 90 day logistic resupply factor.

8) (U) MPF 2010 shall provide appropriate security facilities for the stowage of classified or sensitive program information.

9) (U) MPF 2010 shall be capable of operating in U.S., foreign, and international waters in full compliance with U.S. and international pollution

control laws and regulations. A threshold is to meet federal requirements with objectives being those listed below.

a) (U) MPF 2010 shall provide sufficient capacity in the onboard collection, holding, and transfer tanks (CHT) to hold "gray water", as well as sewage for a period of 12 hours. The CHT tanks shall be of sufficient capacity store gray water and sewage produced by the MSC crew and embarked permanent military personnel. Additionally, a sewage treatment plant will be provided for use when the MAGTF is embarked.

b) (U) MPF 2010 shall provide for oil/water separators and associated systems to process bilge wastes so that discharged bilge water meets current environmental requirements.

e. (U) Survivability.

1) (U) MPF 2010 shall meet the level two survivability requirement of OPNAVINST 9070.1.

2) (U) Mission critical systems and equipment shall be shock hardened in accordance with OPNAVINST 9072.2.

3) (U) MPF 2010 shall have structural hardening to resist mine, anti-ship missile (ASM), and torpedo weapons.

4) (U) MPF 2010 shall have the capability for an active anti-missile defense system to be employed onboard.

5) (U) MPF 2010 will have no requirement for organic mine-sweeping capabilities.

6) (U) Operational Environment.

	Threshold*	Objective*
Conducts all required operations **	Sea State 3 (Ship takes best heading)	Sea State 4 (Ship takes best heading)
Conducts all required operations less in stream off load	Sea State 4	Sea State 5 (Ship takes best heading)
Conduct flight operations	Mid Sea State 5 (Ship takes best heading)	Max Sea State 5 (Ship takes best heading)
Conduct UNREP/Strikedown	Max Sea State 5 (Ship takes best heading)	Mid Sea State 6 (Ship takes best heading)
Conduct continuous efficient operations, i.e., other than replenishment, well deck, and flight operations	Mid Sea State 7 (Ship takes best heading)	Max Sea State 7 (Ship takes best heading)
Survive without serious damage to mission essential systems	Sea State 8 (Ship takes best heading)	Sea State 8 (Ship takes best heading)
Operate ship	Air Temp -12 to 32^{o}C (10-90^{o}F), *Water	As objectives, air temperature

System (except Electronics) Without Degradation	Temp -2 to 29°C (28-85°F) (Additionally, propulsion plant components taking air from the weather shall be capable of starting/operating in air temperatures between -29 and 52°C (-20 and 125°F) with a relative humidity of 0 to 100%). Equipment and machinery installed in exposed locations shall be capable of operating satisfactorily at a minimum temperature of -29°C (-20°F) with concurrent wind velocity of 40kts.	range will be expanded to -12 to 38°C (10-100°F) and water temperature range will increase to -2 to 38°C (28-100°F).

* World Meteorological Organization (Beaufort) Scale

** The ability to conduct operations in sea state 3 will not be limited by ship design features.

f. (U) <u>Maintenance</u>

1) (U) MPF 2010 shall provide completely outfitted shops, sufficient enclosed service areas for 25% of aircraft, test equipment, material stowage areas, ready service spares stowage, and storerooms for intermediate and operational level maintenance for aircraft.

2) (U) MPF 2010 shall provide completely outfitted shops, sufficient enclosed service areas, test equipment, material stowage areas, ready

service spares stowage, and storerooms for intermediate and operational level maintenance for vehicles and watercraft.

3) (U) An intermediate level maintenance capability should be provided for all aircraft that is part of a MAGTF.

4) (U) A ready service capability, located for convenient access to the flight deck, shall be provided.

g. (U) Navigation. MPF 2010 shall be able to navigate all navigable waters of depths greater than 35 feet. However, MPF 2010 shall not be required to transit the Panama Canal. MPF 2010 shall have navigation capabilities greater than or equal to that of LPD-17.

h. (U) System Performance. The following table identifies performance capabilities and characteristics in terms of thresholds and objectives. They are listed in priority order based upon their importance to amphibious assault echelon lift requirements and the amphibious warfare mission.

1) (U) Lift Capability (Net).

	Threshold
Vehicles, (ft^2)	860,000
Troops	18,837
Cargo, (ft^3)	3,159,920
JP-5, (Gals)	6,100,000
Potable water, (Gals)	400,000

2) (U) MPF 2010 shall have a minimum sustained speed of 25 kts and a minimum endurance speed of 20 kts (endurance range of 12,000 nmi).

5. (U) Integrated Logistic Support (ILS). MPF is required to interface with Landing Craft, Air Cushion (LCAC) other landing craft, and all VTOL aircraft in the U.S. Navy and Marine Corps inventory as of lead ship contract award. U.S. Army and NAT0 goals for standardization and interoperability are to be achieved to the maximum feasible extent, consistent with the requirements to operate with other ships and aircraft of the U.S. Military. MPS systems must be interoperable with interfacing platforms, shipboard systems, and required inter-Service equipment. Marine and Navy C4I system aboard MPS will be interoperable through adherence to Joint and Navy Department standards for information, information transfer, and information processing. Through application of joint standards, C4I systems also should be interoperable with other Services and Joint Systems.

a. (U) Maintenance Planning.

1) (U) MPF 2010 Maintenance. All mission essential systems and equipment should incorporate non-intrusive, mechanical means for diagnostics and maintenance data collection. Whether inherent to new designs or add-ons to Non-development Items (NDI), such features shall be pursued as a priority. Investments in such design features must be life cycle cost effective.

2) (U) MAGTF Equipment Maintenance. Access shall be provided to all cargo/vehicles on an as needed basis for maintenance and inspection. A

method shall be provided for the transfer of specific cargo and/or vehicles to shore and/or onboard maintenance spaces with minimal interference.

b. (U) Support Equipment. During MPF 2010 operations (MAGTF and NSE are embarked), additional requirements to provide messing, laundry and berthing shall be provided.

c. (U) Human Systems Integration. Manned systems or human engineering (HE) will be applied to the detail design, construction, and test and evaluation of the MPF 2010 ships. This analysis shall take into account all aspects of human systems integration such as view/line of sight requirements at key positions and equipment accessibility. This will afford maximum protection to personnel against operating or maintenance hazards and to minimize performance of unnecessary maintenance. Systems safety, logistics and engineering requirements will be integrated with human engineering.

d. (U) Computer Resources. All computer resources onboard MPF 2010 shall be IT21 compliant.

e. (U) Other Logistic Considerations. No unique facility or shelter requirements are anticipated for MPF 2010.

f. (U) Command, Control, Communications, Computers and Intelligence (C4I). The C4I installation in MPF 2010 shall be in accordance with the Navy's C4I architecture. Three distinct sets of users shall be provided for. They are the civilian mariners, the Naval Command Element and the MAGTF Command Element.

1) (U) As an objective, MPF 2010 should be equipped with a communication architecture that enhances battle force communications connectivity, flexibility and survivability through multimedia access and media sharing. Communication architecture should permit all users to share total network capacity on a priority demand basis in accordance with a communications plan. Automated monitoring and network management capabilities also should be provided to assist in the real-time allocation of communication resources. This should not only provide more efficient use of shipboard communication assets, but it also should enhance communication survivability by automatic re-routing if radio frequency jamming occurs. There should be a shipboard interface between the C4I architecture and an integrated interior communications and control system. This system would serve as the MPF 2010 collection and distribution system for outgoing and incoming traffic that is passed to/from shipboard users. Moreover, it should connect all shipboard components, systems, and departments for the purposes of passing all data, information, voice, video, and orders between onboard users. As an objective, this connection should be made using a Fiber Optic (FO) Local Area Network (LAN). However, as a fallback, existing architecture may be used to perform both external communication functions and integrated interior communication control system functions.

2) (U) MPF 2010 Ship Radio Communication System (RCS) should support the following functional requirements to support all three sets of users:

a) Secure and Non-Secure joint, interoperable voice communications with shore stations, other fleet ships, and members of the landing force to provide:

- Naval Command and Control
- Landing Force Command and Control
- Bridge-to-bridge communications
- Tactical Air Command and Control
- Landing Craft Control/Direction
- Medical Evacuation Command and Control

b) Tactical Data Link Communications

c) Reception of High Speed Fleet Broadcast

d) Tele-printer and message preparation and distribution for both command and administrative message traffic

e) Reception of meteorological broadcasts

f) Monitoring of emergency/distress channels

3) (U) Naval C4I Requirements. Naval C4I shall be provided by the integrated application of Joint Maritime Command Information System (JMCIS), Advanced Combat Direction System (ACDS), Advanced Tactical Data Links (Links 11, 16, and 22), CEC, Amphibious Assault Direction System (AN/KSQ-1) and radio communication systems. The following capabilities shall be included:

a) (U) An information processing and display system that provides the Commanding Officer, Tactical Action Officer (TAO) and the Landing Force with the capability to plan, direct, and monitor the tactical situation.

b) (U) A computer-based data processing system that supports both tactical and administration functions. The system shall be used to maintain large databases for coordination of operational/targeting data, logistics, aircraft scheduling, accounting data, and intelligence data.

c) (U) An information processing and display system to coordinate sensor data and link data and maintain the tactical database.

d) (U) As a goal, ability to effectively interface USMC and USN C4 systems aboard ship and during transition ashore.

5) (U) USMC C2 Requirements. Separate USMC C2 capabilities will be provided onboard the MPF 2010. The MAGTF commander will have the option to direct operation aboard a MPF 2010 ship or ashore as the situation dictates.

a) (U) The Marine Tactical Command and Control System (MTACCS) (MAGTF C2, Ground C2, Aviation C2, Combat Service Support C2, Tactical Logistical Control C2 Intel Comms) shall be used aboard ship. MPF 2010 should have C4I interface and operational capabilities with functional components of MTACCS.

b) (U) Embarked Landing Force (LF) units must receive encyclopedic data and periodic updates from theater and national intelligence centers, via the Naval Intelligence Processing System (and its follow-on) and via the DOD Intelligence Information System (DODIIS).

g. (U) Transportation and Basing. MPS Class ships will be based at the Naval Stations in Norfolk, VA, Guam and Diego Garcia. Periodic cargo off-load, inspection, upgrading and reload will be conducted at Blount Island, Florida. No new berthing or special training facilities is envisioned. The adequacy of facilities will be reassessed throughout the design process.

h. (U) Standardization, Interoperability and Commonality. Standardization, interoperability and commonality shall be adhered to the maximum extend feasible. This includes any Fiber Optic Local Area Network and its communications protocols, standardization of processor configuration permitting wide use of interchangeable, up-gradable electronic card assemblies (processors, memories, etc.) System design should allow evolution to the Next Generation Computer Resource (NGCR) program standard.

i. (U) Mapping, Charting, and Geodesy Support. No special mapping, charting or geodesy support will be required beyond that provided normally for ships with an amphibious warfare mission. Standard military data, including digital nautical chart displays appropriate for amphibious assault ships, will be provided by the Defense Mapping Agency.

j. (U) Environmental Support. No unique weather, oceanographic or astrophysical support is required for MPF 2010. Meteorological and Oceanographic (METOC) forecast products will be used to support MPF 2010 and MAGTF operations via JMCIS.

6. (U) Force Structure. The USMC Operational Maneuver From the Sea concept for the year 2010 and beyond will require three squadrons of MPF ships. Each squadron shall be comprised of 5 MPF ships (for a total of 15 ships). Each MPF ship shall be of the same design and shall incorporate modular design concepts to allow the greatest degree of flexibility possible. The modular design features will be

incorporated in such a manner as to allow small degrees of specialization of each ship, while still maintaining the maximum flexibility of the squadron.

7. (U) Schedule Considerations.

a. (U) IOC for the MPF will occur after lead MPS Post Shakedown Availability. At that time, the MPS should have completed Post Delivery Tests and Trials, and deficiencies, including warranty items, should have been corrected. Full operational capability will occur upon delivery of last ship of class. The material support date should coincide with the IOC date.

b. (U) The new MPF Program, which replaces existing MPF ships should be completed by 2010 in order to support *Marine Corp MPF 2010 and Beyond* concepts of *Operational Maneuver From the Sea* and *Ship-To-Objective Maneuver*.

APPENDIX B. AVIATION LOAD OUT

A. ASSUMPTIONS

The aviation combat element of the MPF 2010 was modeled after information provided by the CNA study. The aircraft complement assumed by CNA is as follows, [4]:

60 JSF	5 EA-6B
12 KC-130	36 MV-22
8 CH-53E	18 AH-1W
6 UH-1N	

For reasons described below, the assumptions made by CNA were slightly modified by our design team, table. We deviated from the CNA study in three respects:

Ship 1	30 JSFs	4 SH-60			
Ship 2	30 JSFs	4 SH-60			
Ship 3	12 MV22	4 SH-60	3 CH53	6 AH-1W	2 UH1
Ship 4	12 MV22	4 SH-60	3 CH53	6 AH-1W	2 UH1
Ship 5	12 MV22	4 SH-60	3 CH53	6 AH-1W	2 UH1

1. EA-6B Aircraft

MPF 2010 will not support EA-6B aircraft. Although these aircraft (or their future equivalent) may be assigned to the MAGTF ACE, they will not be able to operate from MPF 2010. The current variant of electronic warfare aircraft, the EA-6B, is not capable of short take-off or landing without catapults and arresting wires, neither of which is provided by MPF 2010. We assume that during MPF 2010 operations, electronic warfare support will either be provided by a Carrier Battle Group or by shore based support. MPF 2010 will support a STOVL electronic warfare aircraft, should one be developed.

2. KC-130 Aircraft

Similarly, MPF 2010 will not support KC-130 aircraft. KC-130 aircraft assigned to the ACE are provided to refuel aircraft. KC-130 aircraft will operate from nearby friendly airfields, if available. If a friendly airfield is not available, refueling support will be provided by the carrier air wing.

3. SH-60 Aircraft

Finally, four SH-60s are assigned to each MPF 2010 ship. None of the aircraft included in the CNA study are capable of conducting all weather search and rescue (SAR) missions. In order to conduct aircraft launch and recovery operations, at least one SAR aircraft must be airborne and another on standby. We assumed that at any one time at least one of the SAR aircraft will be inoperable and that another may be otherwise occupied. Due to its considerable versatility, the SH-60 was chosen as the SAR aircraft. In addition to SAR, it is assumed that the SH-60 will support visual mine detection. The hangar is large enough to accommodate each ship's assumed load out of aircraft (including the additional SH-60s).

B. AIRCRAFT LOAD OUT

1. Joint Strike Fighter (Variant A) Load-out

Two of the MPF 2010 ships will carry the 60 Joint Strike Fighters. Each of these ships shall be referred to as the "JSF load-out." The JSF and rotary wing aircraft (with the exception of the SH-60s) were split into two separate load-outs due to the different missions and characteristics of the aircraft. The JSFs shall be primarily used to provide direct fire support to the elements of the MAGTF which are ashore. Further, simultaneous JSF and rotary wing aircraft operation from a single MPF 2010 require excessive coordination. Hence the segregation of JSF and MAGTF rotary wing aircraft throughout the MPF 2010 squadron. JSFs will be able to operate from the MPF 2010 ships on a continuous basis to conduct operations in support the MPF 2010 mission.

2. Rotary Wing-Aircraft (Variant B) Load-out

The majority of the rotary wing aircraft will be carried aboard three ships in the MPF 2010 squadron. Each of these ships shall be referred to as the “rotary wing aircraft load-out.” The primary criterion of concern for defining the rotary wing load-out was that all MAGTF MV-22s would be able to debark in a nearly simultaneous fashion. During the initial phases of the STOM, it will be necessary to insert a battalion of Marines via MV-22s and a battalion of Marines via AAAVs into the objective area, nearly simultaneously. It was determined that in order to debark the air battalion in an expeditious manner while minimizing the airborne loitering time of the MV-22s, it would be prudent to provided the capability for all 36 MV-22s to take off either simultaneously or nearly simultaneously. Therefore, deck space has been provided on each of the 3 rotary wing load-out MPF 2010 ships so that all 12 MV-22s may be operating on the deck at the same time. This will support the rapid, simultaneous deployment of one infantry battalion by air.

C. CONCLUSION

Although specific aircraft load-outs have been assumed for this design of MPF 2010, nothing would prevent a MAGTF commander from reconfiguring the aircraft load-out to suit the needs of his particular mission. Due to the commonality in ship design, any MPF 2010 ship can accommodate any aircraft supported by the MPF 2010 squadron. This provides the MAGTF commander with an unlimited number of aircraft load-out options, to include the mixing of both JSF and rotary-wing aircraft on one MPF 2010 ship.

APPENDIX C ASSET REPORT

ASSET/MONOCV VERSION 4.2.0 - HULL GEOM MODULE - 11/22/98 16:10.12

PRINTED REPORT NO. 1 - HULL GEOMETRY SUMMARY

HULL OFFSETS IND-GENERATE		MIN BEAM, FT	130.00
HULL DIM IND-B		MAX BEAM, FT	140.00
MARGIN LINE IND-CALC		HULL FLARE ANGLE, DEG	.00
HULL STA IND-OPTIMUM		FORWARD BULWARK, FT	.00
HULL BC IND-LHA			
FAST SHIP PARENT IND-			

HULL PRINCIPAL DIMENSIONS (ON DWL)

LBP, FT	950.00	PRISMATIC COEF	.720
LOA, FT	985.89	MAX SECTION COEF	.955
BEAM, FT	140.00	WATERPLANE COEF	.853
BEAM @ WEATHER DECK, FT	140.00	LCB/LCP	.518
DRAFT, FT	35.00	HALF SIDING WIDTH, FT	1.00
DEPTH STA 0, FT	106.00	BOT RAKE, FT	.00
DEPTH STA 3, FT	106.00	RAISED DECK HT, FT	.00
DEPTH STA 10, FT	106.00	RAISED DECK FWD LIM, STA	
DEPTH STA 20, FT	106.00	RAISED DECK AFT LIM, STA	
FREEBOARD @ STA 3, FT	71.00	BARE HULL DISPL, LTON	1458.64
STABILITY BEAM, FT	152.94	AREA BEAM, FT	78.52

BARE HULL DATA ON LWL		STABILITY DATA ON LWL	
LGTH ON WL, FT	948.94	KB, FT	18.27
BEAM, FT	140.03	BMT, FT	53.93
DRAFT, FT	33.15	KG, FT	59.52
FREEBOARD @ STA 3, FT	72.85	FREE SURF COR, FT	1.00
PRISMATIC COEF	.709	SERV LIFE KG ALW, FT	.00
MAX SECTION COEF	.959		
WATERPLANE COEF	.849	GMT, FT	11.68
WATERPLANE AREA, FT2	112831.10	GML, FT	2158.43
WETTED SURFACE, FT2	148965.50	GMT/B AVAIL	.083
		GMT/B REQ	.130
BARE HULL DISPL, LTON	85617.77		
APPENDAGE DISPL, LTON	313.75		
FULL LOAD WT, LTON	85931.53		

PRINTED REPORT NO. 2 - HULL OFFSETS

STATION NO. 1, AT X = -35.889 FT

POINT	HALF BEAM,FT	WATERLINE,FT
1	.000	105.492
2	1.791	105.619
3	4.980	105.746
4	8.235	105.873
5	9.875	106.000

STATION NO. 2, AT X = -17.945 FT

POINT	HALF BEAM,FT	WATERLINE,FT
1	.000	77.026
2	7.100	84.269
3	23.009	91.513
4	42.707	98.756
5	60.823	106.000

STATION NO. 3, AT X = .000 FT

POINT	HALF BEAM,FT	WATERLINE,FT
1	.350	35.000
2	4.619	52.750
3	16.608	70.500
4	37.880	88.250
5	70.000	106.000

STATION NO. 4, AT X = 23.750 FT

POINT	HALF BEAM,FT	WATERLINE,FT
1	.000	5.297
2	.003	5.306
3	.023	5.351
4	.072	5.448
5	.159	5.610
6	.290	5.849
7	.467	6.175
8	.690	6.596
9	.956	7.120
10	1.259	7.756
11	1.594	8.511
12	1.951	9.391
13	2.321	10.404
14	2.696	11.555
15	3.065	12.852
16	3.423	14.299
17	3.761	15.902
18	4.076	17.668
19	4.365	19.601
20	4.626	21.706
21	4.861	23.990
22	5.072	26.456
23	5.265	29.110
24	5.445	31.957
25	5.620	35.000
26	9.065	52.750
27	19.185	70.500
28	38.617	88.250
29	70.000	106.000

STATION NO. 5, AT X = 47.500 FT

POINT	HALF BEAM,FT	WATERLINE,FT

1	.000	.000
2	.085	.011
3	.383	.064
4	.785	.178
5	1.204	.369
6	1.601	.651
7	1.962	1.035
8	2.285	1.531
9	2.580	2.149
10	2.862	2.898
11	3.153	3.787
12	3.477	4.825
13	3.858	6.018
14	4.318	7.375
15	4.874	8.902
16	5.538	10.607
17	6.310	12.497
18	7.183	14.577
19	8.136	16.855
20	9.139	19.336
21	10.150	22.027
22	11.113	24.933
23	11.963	28.060
24	12.623	31.414
25	13.005	35.000
26	15.682	52.750
27	23.888	70.500
28	40.901	88.250
29	70.000	106.000

STATION NO. 6, AT X = 96.696 FT

POINT	HALF BEAM,FT	WATERLINE,FT
1	1.000	.000
2	3.094	.028
3	3.222	.040
4	3.675	.099
5	4.318	.226
6	5.051	.439
7	5.833	.753
8	6.652	1.180
9	7.510	1.732
10	8.417	2.420
11	9.390	3.254
12	10.449	4.244
13	11.611	5.399
14	12.895	6.728
15	14.309	8.238
16	15.856	9.939
17	17.525	11.837
18	19.293	13.940
19	21.123	16.256
20	22.960	18.792
21	24.736	21.554
22	26.365	24.550
23	27.744	27.785
24	28.755	31.266
25	29.262	35.000
26	30.834	52.750
27	35.902	70.500

28	47.834	88.250
29	70.000	106.000

STATION NO. 7, AT X = 145.893 FT

POINT	HALF BEAM,FT	WATERLINE,FT
1	1.000	.000
2	10.987	.134
3	11.161	.146
4	11.791	.205
5	12.722	.332
6	13.833	.544
7	15.076	.857
8	16.428	1.283
9	17.879	1.833
10	19.419	2.519
11	21.044	3.351
12	22.745	4.338
13	24.515	5.489
14	26.343	6.814
15	28.215	8.319
16	30.114	10.015
17	32.016	11.907
18	33.894	14.004
19	35.715	16.313
20	37.438	18.841
21	39.018	21.595
22	40.400	24.581
23	41.526	27.807
24	42.325	31.277
25	42.724	35.000
26	43.647	52.750
27	46.667	70.500
28	54.535	88.250
29	70.000	106.000

STATION NO. 8, AT X = 195.089 FT

POINT	HALF BEAM,FT	WATERLINE,FT
1	1.000	.000
2	21.166	.271
3	21.389	.283
4	22.201	.341
5	23.420	.468
6	24.896	.679
7	26.568	.991
8	28.397	1.415
9	30.353	1.963
10	32.404	2.647
11	34.515	3.475
12	36.646	4.458
13	38.758	5.605
14	40.809	6.924
15	42.762	8.424
16	44.581	10.113
17	46.237	11.998
18	47.708	14.087
19	48.979	16.387
20	50.041	18.905
21	50.897	21.648
22	51.555	24.622
23	52.029	27.835

POINT	HALF BEAM,FT	WATERLINE,FT
24	52.342	31.292
25	52.522	35.000
26	53.039	52.750
27	54.780	70.500
28	59.762	88.250
29	70.000	106.000

STATION NO. 9, AT X = 244.286 FT

POINT	HALF BEAM,FT	WATERLINE,FT
1	1.000	.000
2	32.028	.417
3	32.268	.429
4	33.145	.487
5	34.468	.613
6	36.082	.824
7	37.918	1.134
8	39.929	1.556
9	42.072	2.102
10	44.299	2.783
11	46.556	3.607
12	48.784	4.586
13	50.920	5.728
14	52.906	7.042
15	54.687	8.536
16	56.220	10.217
17	57.475	12.094
18	58.435	14.174
19	59.104	16.465
20	59.501	18.972
21	59.666	21.704
22	59.656	24.666
23	59.546	27.865
24	59.428	31.308
25	59.412	35.000
26	59.680	52.750
27	60.660	70.500
28	63.664	88.250
29	70.000	106.000

STATION NO. 10, AT X = 293.482 FT

POINT	HALF BEAM,FT	WATERLINE,FT
1	1.000	.000
2	41.970	.551
3	42.208	.563
4	43.075	.620
5	44.368	.746
6	45.924	.956
7	47.668	1.265
8	49.550	1.685
9	51.526	2.229
10	53.548	2.907
11	55.563	3.729
12	57.513	4.704
13	59.341	5.842
14	60.991	7.150
15	62.417	8.638
16	63.581	10.313
17	64.458	12.183
18	65.042	14.255
19	65.343	16.536

POINT	HALF BEAM,FT	WATERLINE,FT
20	65.390	19.034
21	65.234	21.755
22	64.941	24.706
23	64.600	27.893
24	64.316	31.322
25	64.213	35.000
26	64.347	52.750
27	64.903	70.500
28	66.561	88.250
29	70.000	106.000

STATION NO. 11, AT X = 342.679 FT

POINT	HALF BEAM,FT	WATERLINE,FT
1	1.000	.000
2	49.387	.650
3	49.625	.662
4	50.472	.720
5	51.699	.845
6	53.122	1.054
7	54.658	1.362
8	56.256	1.782
9	57.877	2.324
10	59.485	3.000
11	61.044	3.819
12	62.517	4.792
13	63.871	5.926
14	65.073	7.231
15	66.097	8.714
16	66.924	10.384
17	67.544	12.249
18	67.955	14.315
19	68.170	16.590
20	68.209	19.080
21	68.108	21.793
22	67.913	24.736
23	67.682	27.913
24	67.484	31.333
25	67.402	35.000
26	67.491	52.750
27	67.833	70.500
28	68.609	88.250
29	70.000	106.000

STATION NO. 12, AT X = 391.875 FT

POINT	HALF BEAM,FT	WATERLINE,FT
1	1.000	.000
2	52.678	.695
3	52.914	.706
4	53.748	.764
5	54.928	.889
6	56.258	1.098
7	57.647	1.406
8	59.047	1.825
9	60.423	2.366
10	61.751	3.041
11	63.008	3.859
12	64.177	4.830
13	65.243	5.963
14	66.193	7.267
15	67.017	8.748

16	67.710	10.416
17	68.271	12.278
18	68.700	14.342
19	69.006	16.614
20	69.199	19.101
21	69.297	21.810
22	69.320	24.749
23	69.295	27.922
24	69.253	31.337
25	69.230	35.000
26	69.312	52.750
27	69.513	70.500
28	69.765	88.250
29	70.000	106.000

STATION NO. 13, AT X = 441.072 FT

POINT	HALF BEAM,FT	WATERLINE,FT
1	1.000	.000
2	51.510	.679
3	51.837	.686
4	52.540	.721
5	53.374	.797
6	54.291	.925
7	55.269	1.113
8	56.293	1.368
9	57.351	1.698
10	58.435	2.110
11	59.533	2.609
12	60.638	3.201
13	61.738	3.892
14	62.825	4.687
15	63.888	5.590
16	64.915	6.607
17	65.893	7.743
18	66.810	9.001
19	67.649	10.387
20	68.393	11.904
21	69.021	13.556
22	69.510	15.348
23	69.831	17.283
24	69.947	19.366
25	69.945	35.000
26	69.954	52.750
27	69.973	70.500
28	69.991	88.250
29	70.000	106.000

STATION NO. 14, AT X = 490.268 FT

POINT	HALF BEAM,FT	WATERLINE,FT
1	1.000	.000
2	50.877	.670
3	51.217	.678
4	51.946	.714
5	52.812	.793
6	53.763	.926
7	54.777	1.120
8	55.839	1.385
9	56.937	1.728
10	58.060	2.155
11	59.200	2.672

POINT	HALF BEAM,FT	WATERLINE,FT
12	60.345	3.287
13	61.487	4.003
14	62.614	4.827
15	63.717	5.765
16	64.782	6.820
17	65.797	7.998
18	66.747	9.303
19	67.618	10.740
20	68.389	12.313
21	69.041	14.027
22	69.548	15.886
23	69.881	17.893
24	70.002	20.053
25	70.000	35.000
26	70.000	52.750
27	70.000	70.500
28	70.000	88.250
29	70.000	106.000

STATION NO. 15, AT X = 539.464 FT

POINT	HALF BEAM,FT	WATERLINE,FT
1	1.000	.000
2	51.274	.676
3	51.607	.683
4	52.321	.719
5	53.168	.796
6	54.100	.926
7	55.093	1.116
8	56.133	1.376
9	57.208	1.711
10	58.308	2.129
11	59.424	2.636
12	60.546	3.238
13	61.664	3.939
14	62.768	4.746
15	63.847	5.664
16	64.890	6.697
17	65.884	7.851
18	66.815	9.129
19	67.667	10.536
20	68.423	12.077
21	69.061	13.755
22	69.558	15.575
23	69.883	17.541
24	70.002	19.656
25	70.000	35.000
26	70.000	52.750
27	70.000	70.500
28	70.000	88.250
29	70.000	106.000

STATION NO. 16, AT X = 588.661 FT

POINT	HALF BEAM,FT	WATERLINE,FT
1	1.000	.000
2	50.880	.670
3	51.117	.682
4	51.960	.740
5	53.172	.865
6	54.566	1.074

POINT	HALF BEAM,FT	WATERLINE,FT
7	56.057	1.382
8	57.597	1.801
9	59.151	2.343
10	60.687	3.019
11	62.177	3.837
12	63.594	4.809
13	64.911	5.943
14	66.106	7.247
15	67.159	8.730
16	68.055	10.399
17	68.786	12.262
18	69.349	14.327
19	69.749	16.601
20	70.000	19.090
21	70.121	21.801
22	70.142	24.742
23	70.099	27.917
24	70.034	31.335
25	70.000	35.000
26	70.000	52.750
27	70.000	70.500
28	70.000	88.250
29	70.000	106.000

STATION NO. 17, AT X = 637.857 FT

POINT	HALF BEAM,FT	WATERLINE,FT
1	1.000	.000
2	37.674	.493
3	37.907	.505
4	38.791	.563
5	40.200	.688
6	42.027	.899
7	44.220	1.208
8	46.737	1.630
9	49.520	2.174
10	52.497	2.853
11	55.574	3.676
12	58.647	4.653
13	61.605	5.793
14	64.338	7.103
15	66.746	8.594
16	68.749	10.272
17	70.290	12.145
18	71.342	14.220
19	71.911	16.505
20	72.040	19.007
21	71.806	21.733
22	71.321	24.688
23	70.734	27.881
24	70.223	31.316
25	70.000	35.000
26	70.000	52.750
27	70.000	70.500
28	70.000	88.250
29	70.000	106.000

STATION NO. 18, AT X = 687.054 FT

POINT	HALF BEAM,FT	WATERLINE,FT
1	1.000	.000
2	18.120	.230

POINT	HALF BEAM,FT	WATERLINE,FT
3	18.315	.242
4	19.127	.300
5	20.621	.427
6	22.821	.639
7	25.737	.951
8	29.346	1.375
9	33.574	1.924
10	38.299	2.608
11	43.357	3.438
12	48.553	4.422
13	53.673	5.570
14	58.502	6.891
15	62.842	8.393
16	66.526	10.083
17	69.431	11.971
18	71.490	14.062
19	72.698	16.365
20	73.115	18.886
21	72.868	21.632
22	72.149	24.610
23	71.212	27.826
24	70.372	31.288
25	70.000	35.000
26	70.000	52.750
27	70.000	70.500
28	70.000	88.250
29	70.000	106.000

STATION NO. 19, AT X = 736.250 FT

POINT	HALF BEAM,FT	WATERLINE,FT
1	1.000	.000
2	3.243	.030
3	3.397	.042
4	4.083	.101
5	5.451	.228
6	7.588	.441
7	10.540	.755
8	14.303	1.182
9	18.819	1.734
10	23.973	2.422
11	29.606	3.256
12	35.521	4.246
13	41.497	5.401
14	47.310	6.729
15	52.746	8.240
16	57.618	9.940
17	61.779	11.838
18	65.133	13.942
19	67.638	16.257
20	69.312	18.793
21	70.236	21.555
22	70.547	24.550
23	70.437	27.785
24	70.153	31.266
25	69.989	35.000
26	70.007	52.750
27	70.009	70.500
28	70.004	88.250
29	70.000	106.000

STATION NO. 20, AT X = 789.688 FT

POINT	HALF BEAM,FT	WATERLINE,FT
1	1.000	2.428
2	1.103	2.438
3	1.556	2.487
4	2.443	2.593
5	3.816	2.771
6	5.713	3.034
7	8.152	3.391
8	11.127	3.852
9	14.605	4.427
10	18.533	5.125
11	22.833	5.952
12	27.415	6.918
13	32.174	8.028
14	37.002	9.291
15	41.791	10.712
16	46.435	12.299
17	50.838	14.058
18	54.916	15.994
19	58.594	18.113
20	61.811	20.422
21	64.519	22.926
22	66.676	25.631
23	68.254	28.541
24	69.228	31.663
25	69.578	35.000
26	69.740	52.750
27	69.875	70.500
28	69.966	88.250
29	70.000	106.000

STATION NO. 21, AT X = 843.125 FT

POINT	HALF BEAM,FT	WATERLINE,FT
1	1.000	10.573
2	1.069	10.581
3	1.369	10.618
4	1.955	10.697
5	2.862	10.831
6	4.125	11.028
7	5.771	11.295
8	7.819	11.642
9	10.279	12.073
10	13.149	12.596
11	16.416	13.217
12	20.059	13.941
13	24.042	14.773
14	28.319	15.720
15	32.834	16.786
16	37.515	17.976
17	42.282	19.295
18	47.038	20.747
19	51.674	22.336
20	56.066	24.068
21	60.071	25.946
22	63.534	27.974
23	66.277	30.156
24	68.105	32.497
25	68.802	35.000

26	69.197	52.750
27	69.586	70.500
28	69.882	88.250
29	70.000	106.000

STATION NO. 22, AT X = 896.563 FT

POINT	HALF BEAM,FT	WATERLINE,FT
1	1.000	22.592
2	1.037	22.596
3	1.210	22.615
4	1.581	22.655
5	2.196	22.723
6	3.094	22.823
7	4.313	22.959
8	5.886	23.135
9	7.842	23.354
10	10.205	23.619
11	12.992	23.935
12	16.210	24.302
13	19.857	24.725
14	23.913	25.206
15	28.343	25.748
16	33.090	26.352
17	38.077	27.022
18	43.200	27.760
19	48.332	28.567
20	53.315	29.447
21	57.963	30.401
22	62.063	31.431
23	65.367	32.540
24	67.597	33.729
25	68.442	35.000
26	68.991	52.750
27	69.493	70.500
28	69.859	88.250
29	70.000	106.000

STATION NO. 23, AT X = 950.000 FT

POINT	HALF BEAM,FT	WATERLINE,FT
1	1.000	29.753
2	1.022	29.754
3	1.144	29.762
4	1.448	29.779
5	1.998	29.808
6	2.842	29.850
7	4.021	29.908
8	5.570	29.982
9	7.520	30.075
10	9.892	30.187
11	12.704	30.321
12	15.959	30.476
13	19.652	30.655
14	23.760	30.858
15	28.245	31.087
16	33.049	31.343
17	38.089	31.626
18	43.261	31.938
19	48.434	32.280
20	53.451	32.652
21	58.124	33.055

22	62.239	33.491
23	65.547	33.960
24	67.771	34.462
25	68.600	35.000
26	69.167	52.750
27	69.610	70.500
28	69.897	88.250
29	70.000	106.000

PRINTED REPORT NO. 3 - HULL BOUNDARY CONDITIONS

HULL OFFSETS IND-GENERATE
HULL BC IND-LHA   HULL STA IND-OPTIMUM

LBP, FT	950.00	LCB/LBP	.518
BEAM, FT	140.00	LCF/LBP	.565
DRAFT, FT	35.00	HALF SIDING WIDTH, FT	1.00
DEPTH STA 0, FT	106.00	BOT RAKE, FT	.00
DEPTH STA 3, FT	106.00	FWD RAISED DECK LIMIT	
DEPTH STA 10, FT	106.00	AFT RAISED DECK LIMIT	
DEPTH STA 20, FT	106.00	RAISED DECK HT, FT	.00
PRISMATIC COEF	.720	WATERPLANE COEF	.853
MAX SECTION COEF	.955		

NO POINTS BELOW DWL	25.	FWD KEEL/BL LIMIT	.050
NO POINTS ABOVE DWL	4.	AFT KEEL/BL LIMIT	.775
POINT DIST FAC ABOVE DWL	2.540	BOW ANGLE, DEG	73.00
POINT DIST FAC BELOW DWL	1.000	BOW SHAPE FAC	.000
BOW OVERHANG	.038	STA 20 SECTION COEF	.650
STERN OVERHANG	.000	HULL FLARE ANGLE, DEG	

SECTIONAL AREA AND DWL CURVES

	AREA	DWL
STA 0 ORDINATE	.000	.005
STA 0 SLOPE	-.750	-1.000
STA 20 ORDINATE	.100	.980
STA 20 SLOPE	.000	.050
PARALLEL MID LGTH	.000	.278
STA MAX ORDINATE	10.500	12.500
STA MAX AREA SLOPE	.000	.000
TENSOR NO 1	.000	.000
TENSOR NO 2	.000	.000
TENSOR NO 3	.000	.000
TENSOR NO 4	.000	.000
TENSOR/POLY SWITCH	-1.000	-1.000

DECK AT EDGE CURVE
FLAT OF BOTTOM CURVE

STATION 0 OFFSET	1.000	STA OF TRANS START	1.500
STA 0 SLOPE	.000	SLOPE-STA OF TRANS START	-.550
STA 10 OFFSET	1.000	STA OF START OF MID	8.688
STA 10 SLOPE	.000	STA OF END OF MID	12.000
STATION 20 OFFSET	1.000	STA OF TRANS END	16.000
STA 20 SLOPE	.000	SLOPE-STA OF TRANS END	.000
PARALLEL MID LGTH	.900	FLAT OF BOT ANGLE, DEG	.770
STA OF PARALLEL MID	10.000	ELLIPSE RATIO	1.000

SLOPES AT SECTION CURVES

	BOT	DWL	DAE
STA 0 ORDINATE, DEG	8.000	87.000	25.000

STA 0 SLOPE	21.500	5.000	16.000
STA 10 ORDINATE, DEG	1.897	90.000	90.000
STA 10 SLOPE	1.375	.000	.000
STA 20 ORDINATE, DEG	3.750	88.000	90.000
STA 20 SLOPE	20.000	.000	.000
PARALLEL MID LGTH	.400	.350	.250
STA OF PARALLEL MID	8.750	11.337	11.250

PRINTED REPORT NO. 4 - MARGIN LINE

MARGIN LINE IND-CALC
MIN FREEBOARD MARGIN, FT .25

DIST FROM FP FT	HT ABOVE BL FT
-35.89	105.75
-17.94	105.75
.00	105.75
23.75	105.75
47.50	105.75
96.70	105.75
145.89	105.75
195.09	105.75
244.29	105.75
293.48	105.75
342.68	105.75
391.88	105.75
441.07	105.75
490.27	105.75
539.46	105.75
588.66	105.75
637.86	105.75
687.05	105.75
736.25	105.75
789.69	105.75
843.13	105.75
896.56	105.75
950.0	105.75

PRINTED REPORT NO. 5 - HULL SECTIONAL AREA CURVE

STATION	LOCATION,FT	AREA,FT2
1	-35.89	.00
2	-17.94	.00
3	.00	.00
4	23.75	233.93
5	47.50	564.81
6	96.70	1436.91
7	145.89	2381.71
8	195.09	3235.33
9	244.29	3901.02
10	293.48	4345.88
11	342.68	4588.78
12	391.88	4682.87
13	441.07	4695.54
14	490.27	4687.74
15	539.46	4694.45
16	588.66	4709.33
17	637.86	4680.87
18	687.05	4527.76
19	736.25	4151.32
20	789.69	3398.35

21	843.13	2300.18
22	896.56	1105.82
23	950.00	467.95

ASSET/MONOCV VERSION 4.2.0 - HULL SUBDIV MODULE - 11/22/98 16:10.13

PRINTED REPORT NO. 1 - SUMMARY

HULL SUBDIV IND-GIVEN		INNER BOT IND-NONE	
LBP, FT	950.00	HULL AVG DECK HT, FT	19.79
DEPTH STA 10, FT	106.00		
TOTAL HULL VOLUME, FT3	11689610.	NO. OF DECKS	9
		NO. OF TRANS BHDS	9
MR VOLUME, FT3	663753.	NO. OF LONG BHDS	0
OP TANKAGE ALLOCATED, FT3	1078149.	NO. OF MACHY RMS	4
OP TANKAGE UTILIZED, FT3	1078149.	NO. OF LARGE OBJECT SPACES	9
OP TANKAGE REQ, FT3	793133.		
SHAFT ALLEY VOL, FT3	8713.		
LARGE OBJECT VOL, FT3	5995216.		
HULL ARR AREA AVAIL, FT2	486999.5		

PRINTED REPORT NO. 2 - TRANSVERSE BULKHEADS

HULL SUBDIV IND-GIVEN
NO TRANS BHDS 9

BULKHEAD NO	DISTANCE FROM FP,FT	DISTANCE FROM FP/LBP	MR FWD BHD LOC
1	70.00	.074	
2	170.00	.179	OMR
3	270.00	.284	
4	370.00	.389	
5	470.00	.495	
6	570.00	.600	
7	670.00	.705	MMR
8	730.00	.768	AMR
9	800.00	.842	OMR

PRINTED REPORT NO. 3 - LONGITUDINAL BULKHEADS

NO. OF LONG BHDS 0

PRINTED REPORT NO. 4 - INTERNAL DECKS AND INNER BOTTOM

HULL SUBDIV IND-GIVEN		INNER BOT IND-NONE	
NO. INTERNAL DECKS	8	--------- INNER BOTTOM ----------	
DEPTH STA 10, FT	106.00	CVK HT, FT	
HULL AVG DECK HT, FT	19.79	HORZ OFFSET HT, FT	
RAISED DECK HT, FT	.00	HORZ OFFSET, FT	
MAIN DECK HT, FT	106.00	FLAT FWD LOC, FT	

FLAT AFT LOC, FT
OFFSET FWD LOC, FT
OFFSET AFT LOC, FT

INT DECK NO.	DIST FROM BL AT .5 LBP,FT	DECK SHEER FRAC	DECK TYPE	ARRANGEABLE AREA FT2	ARRANGEABLE VOL FT3
2	97.00	.0	PLATFORM	9786.6	98009.
3	86.00	.0	PLATFORM	28561.4	579669.
4	66.00	.0	CONTINUOUS	116502.2	3927541.
5	48.00	.0	PLATFORM	83592.4	1519758.
6	38.00	.0	PLATFORM	29825.5	851189.
7	35.00	.0	PLATFORM	74536.8	972486.
8	25.00	.0	PLATFORM	74059.1	743163.
9	12.00	.0	PLATFORM	70135.6	945159.
		DECK TOTALS		486999.5	9636972.
		MR VOLUME, FT3			663753.
		SHAFT VOLUME, FT3			8713.
		OP TANKAGE ASSIGNED, FT3			1078149.
		BALLAST TANKAGE, FT3			297721.
		CARGO VOLUME, FT3			0.
		PROTECT SYS, FT3			0.
		VOID VOLUME, FT3			0.
		HOLD (UNASSIGNED), FT3			4300.
		TOTAL HULL VOLUME, FT3			11689610.

PRINTED REPORT NO. 5 - MACHINERY ROOMS AND LARGE OBJECT SPACES

MACHINERY ROOMS:
MR AFT BHD POS, FT 800.00

MR NO.	TYPE	FWD BHD ID	UPR DECK ID	OUTER BHD ID P/S	LGTH AVL FT	LGTH RQD FT	HT AVL FT	HT RQD FT	MR VOL FT3
1	OMR	2	1	SH SH					
2	MMR	7	5	SH SH	60.00	55.00	48.00	34.56	373973.
3	AMR	8	6	SH SH	70.00	44.83	38.00	23.01	289780.
4	OMR	9	7	SH SH					
								TOTAL	663753.

LARGE OBJECT SPACES:

LG OBJ	TRANS BHD ID	DECK ID	OUTER BHD ID	AREA	VOLUME	LG OBJ	COMPARTMENT ID

NO.	FWD/AFT	UPR/LWR	P/S	FT2	FT3		TYPE	(LOWER-FWD)
===	=======	=======	======	========	========		==========	===========
1	1 2	1 3	SH SH	9914.7	237308.			3- 70-0
2	1 3	3 4	SH SH	19330.9	411575.		CARGO DECK	4- 70-0
3	2 3	1 3	SH SH	12203.3	261146.			3- 170-0
4	3 7	1 4	SH SH	55150.6	2219583.		CARGO DECK	4- 270-0
5	7 TR	1 2	SH SH	39186.5	352751.			2- 670-0
6	7 TR	2 4	SH SH	39033.9	1212739.		CARGO DECK	4- 670-0
7	7 8	4 5	SH SH	8400.1	151204.		WELL DECK	5- 670-0
8	8 TR	4 6	SH SH	29825.5	851189.		WELL DECK	6- 730-0
9	9 TR	6 HB	SH SH		297721.	*	BALLAST	HB- 800-0
				-------	-------			
			TOTALS	213045.6	5995216.			

- SHAFT ALLEY VOLUME HAS BEEN REMOVED FROM THIS LARGE OBJECT SPACE

PRINTED REPORT NO. 6 - ARRANGEABLE HULL COMPARTMENTS AREA/VOLUME

HULL ARR AREA AVAIL, FT2 486999.5
HULL ARR VOLUME AVAIL, FT3 9636972.
NUMBER OF INTERNAL DECKS - 8
NUMBER OF TRANSVERSE BULKHEADS - 9
NUMBER OF LONGITUDINAL BULKHEADS - 0
INNER BOTTOM INDICATOR - NONE
MAIN DECK HT, FT - 106.0

COMPARTMENT NO.	AREA FT2	AREA CENTER X	AREA CENTER Y	AREA CENTER Z	VOLUME FT3	VOLUME CENTER X	VOLUME CENTER Y	VOLUME CENTER Z
2- FPK-0	9786.6	25.6	.0	97.0	98009.	27.3	.0	101.8
3- FPK-0	6443.3	28.6	.0	86.0	81216.	30.9	.0	91.9
3- 70-0	9914.7	122.4	.0	86.0	237308.	121.0	.0	96.6
3- 170-0	12203.3	221.2	.0	86.0	261146.	220.6	.0	96.2
4- FPK-0	2986.8	36.3	.0	66.0	83643.	35.0	.0	77.3
4- 70-0	19330.9	182.1	.0	66.0	411575.	179.5	.0	76.2
4- 270-0	55150.6	472.4	.0	66.0	2219583.	471.4	.0	86.1
4- 670-0	39033.9	809.7	.0	66.0	1212739.	809.9	.0	81.5
5- FPK-0	1748.2	42.8	.0	48.0	38593.	41.3	.0	57.8
5- 70-0	7211.5	126.0	.0	48.0	135225.	125.4	.0	57.1
5- 170-0	11177.1	222.1	.0	48.0	202981.	222.0	.0	57.0
5- 270-0	13153.2	320.8	.0	48.0	237329.	320.8	.0	57.0
5- 370-0	13904.4	420.2	.0	48.0	250437.	420.2	.0	57.0
5- 470-0	13998.0	520.0	.0	48.0	251990.	520.0	.0	57.0
5- 570-0	14000.0	620.0	.0	48.0	252000.	620.0	.0	57.0
5- 670-0	8400.1	700.0	.0	48.0	151204.	700.0	.0	57.0
6- 730-0	29825.5	839.0	.0	38.0	851189.	839.6	.0	52.1
7- FPK-0	1371.6	46.8	.0	35.0	19507.	45.8	.0	41.7
7- 70-0	7017.3	126.4	.0	35.0	92487.	126.2	.0	41.5
7- 170-0	11116.4	222.2	.0	35.0	144908.	222.1	.0	41.5
7- 270-0	13135.5	320.8	.0	35.0	170876.	320.8	.0	41.5
7- 370-0	13898.3	420.2	.0	35.0	180718.	420.2	.0	41.5
7- 470-0	13997.7	520.0	.0	35.0	181991.	520.0	.0	41.5
7- 570-0	14000.0	620.0	.0	35.0	182000.	620.0	.0	41.5
8- FPK-0	1133.2	48.6	.0	25.0	12434.	48.0	.0	30.2
8- 70-0	6562.5	127.1	.0	25.0	68433.	126.7	.0	30.1
8- 170-0	11036.0	222.5	.0	25.0	110847.	222.3	.0	30.0
8- 270-0	13238.5	320.8	.0	25.0	131742.	320.8	.0	30.0
8- 370-0	13906.6	420.2	.0	25.0	139015.	420.2	.0	30.0
8- 470-0	14006.5	520.0	.0	25.0	140002.	520.0	.0	30.0
8- 570-0	14175.8	620.2	.0	25.0	140689.	620.1	.0	30.0
9- FPK-0	619.8	51.2	.0	12.0	11187.	50.3	.0	19.2
9- 70-0	4947.2	129.3	.0	12.0	76060.	128.0	.0	18.8
9- 170-0	10254.1	223.6	.0	12.0	139951.	223.0	.0	18.6
9- 270-0	13101.0	320.9	.0	12.0	172295.	320.8	.0	18.5
9- 370-0	13648.5	420.1	.0	12.0	180151.	420.1	.0	18.5
9- 470-0	13672.2	520.0	.0	12.0	181152.	520.0	.0	18.5
9- 570-0	13892.7	620.1	.0	12.0	184362.	620.3	.0	18.5

PRINTED REPORT NO. 7 - HULL TANKAGE COMPARTMENTS AREA/VOLUME

******************************* NOTE ******************************
THESE COMPARTMENT AREAS ARE NOT INCLUDED IN HULL ARR AREA AVAIL
****

OPERATIONAL TANKAGE

TOTAL ALLOCATED, FT3 1078149.
TOTAL UTILIZED, FT3 1078149.
XCG, FT 544.3, VCG, FT 37.6

COMPARTMENT NO.	AREA FT2	AREA CENTER X	AREA CENTER Y	AREA CENTER Z	VOLUME FT3	VOLUME CENTER X	VOLUME CENTER Y	VOLUME CENTER Z
2- 670-0	39186.5	810.0	.0	97.0	352751.	810.0	.0	101.5
HB- 70-0					43728.	130.6	.0	6.8
HB- 170-0					102747.	224.3	.0	6.6
HB- 270-0					140536.	321.3	.0	6.4
HB- 370-0					148449.	419.9	.0	6.4
HB- 470-0					147852.	520.1	.0	6.4
HB- 570-0					142084.	618.9	.0	6.5

BALLAST TANKAGE
(TRIM AND FUNCTIONAL)

TOTAL ALLOCATED, FT3 297721.
XCG, FT 857.9, VCG, FT 28.5

COMPARTMENT NO.	AREA FT2	AREA CENTER X	AREA CENTER Y	AREA CENTER Z	VOLUME FT3	VOLUME CENTER X	VOLUME CENTER Y	VOLUME CENTER Z
HB- 800-0					297721. *	857.9	.0	28.5

* SHAFT ALLEY VOLUME HAS BEEN REMOVED FROM THIS COMPARTMENT

HOLD VOLUME (UNASSIGNED)

TOTAL AVAILABLE, FT3 4300.
XCG, FT 53.2, VCG, FT 7.4

COMPARTMENT NO.	AREA FT2	AREA CENTER X	AREA CENTER Y	AREA CENTER Z	VOLUME FT3	VOLUME CENTER X	VOLUME CENTER Y	VOLUME CENTER Z
HB- FPK-0					4300.	53.2	.0	7.4

PRINTED REPORT NO. 8 - ARRANGEABLE LARGE OBJECT SPACE COMPARTMENTS ASSIGNED

CARGO DECK COMPARTMENTS

AREA/VOLUME SUMMARY

COMPARTMENT NO.	AREA FT2	AREA CENTER X	AREA CENTER Y	AREA CENTER Z	VOLUME FT3	VOLUME CENTER X	VOLUME CENTER Y	VOLUME CENTER Z
4- 70-0	19330.9	182.1	.0	66.0	411575.	179.5	.0	76.2
4- 270-0	55150.6	472.4	.0	66.0	2219583.	471.4	.0	86.1
4- 670-0	39033.9	809.7	.0	66.0	1212739.	809.9	.0	81.5
DECK # 4	-------	------	-----	-----	-------	------	-----	-----
TOTAL --	113515.4	538.9	.0	66.0	3843898.	547.0	.0	83.6

TOTAL SHIP AREA AND VOLUME DESIGNATED AS CARGO COMPARTMENTS:

AREA = 113515.4 FT2 X-CG= 538.9 FT Y-CG= .0 FT Z-CG= 66.0 FT

VOLUME = 3843898. FT3 X-CG= 547.0 FT Y-CG= .0 FT Z-CG= 83.6 FT

ASSET/MONOCV VERSION 4.2.0 - AVIATION SUPPORT MODULE - 11/22/98 16:10.1

PRINTED REPORT NO. 1 - SUMMARY

BALLISTIC PROT IND -	NONE
BLAST RESIST IND -	3 PSI
DAMAGE PREV PANEL SYS IND -	DPPS
DESIGN STDS IND -	CURRENT
HAB STD IND -	NAVY
VAST IND -	NONE

LBP,FT	950.0	HULL VOLUME,FT3	11689610.
BEAM,FT	140.0	DKHS VOLUME,FT3	2496258.
DRAFT,FT	35.0	SPONSON VOLUME,FT3	2665165.
LOA,FT	1000.0	TOTAL VOLUME,FT3	16851030.
FLT DK HT,FT	106.0	SPONSON DECK AREA,FT2	248354.5
USABLE FLT DK AREA,FT2	143962.0	MAX SHP,HP	177300.
HANGAR LENGTH,FT	.0		
HANGAR WIDTH REQ,FT	.0	TOTAL ACCOM	4332.0
HANGAR HT,FT	.0	MAGAZINE AREA,FT2	.0
HANGAR AREA,FT2	.0	SPS VOLUME,FT3	.0
TOTAL AIRCRAFT	21.0	SPS DEPTH,FT	.0
DEPLOYMENT TIME,DAYS	90.0	SPS OFFSET REQ,FT	.0
		SPS OFFSET,FT	.0

PRINTED REPORT NO. 2 - FLIGHT DECK

FLIGHT DECK LENGTH,FT	1000.0
MAX BEAM AT FLIGHT DECK,FT	220.0
HEIGHT TO FLIGHT DECK,FT	106.0
USABLE FLIGHT DECK AREA,FT2	143962.0
FLIGHT DECK ISLAND DECK AREA,FT2	76038.0
FLIGHT DECK ELEVATOR DECK AREA,FT2	.0
FLIGHT DECK SAFE PARKING AREA,FT2	143962.0
FLIGHT DECK SAFE PARKING SPOTS (F/A-18 Std. @ 1,092 Sq-Ft)	132.
FLIGHT DECK CATAPULT AREA,FT2	.0
FLIGHT DECK LANDING ZONE AREA,FT2	.0
FLIGHT DECK INTERFERENCE AREA,FT2	.0
C-13-1 AIRCRAFT CATAPULTS	0.
C-13-2 AIRCRAFT CATAPULTS	0.
ELEC MAG AIRCRAFT CATAPULTS	0.
TOTAL AIRCRAFT CATAPULTS	0.
ARRESTING GEAR ENG. TYPE	NONE
ARRESTING GEAR ENGINES	0.

FLIGHT DECK KNUCKLE OFFSETS

	PORT		STARBOARD	
	LONG.	TRANS.	LONG.	TRANS.
FT	-50.00	.00	-50.00	.00
FT	-50.00	120.00	-50.00	100.00
FT	950.00	120.00	950.00	100.00
FT	950.00	.00	950.00	.00
FT	.00	.00	950.00	.00

PRINTED REPORT NO. 3 - HANGAR

HANGAR REQUIRED AREA,FT2	.0
HANGAR MINIMUM WIDTH REQUIRED,FT	.0
HANGAR AFT BULKHEAD LOC,FT	.0
HANGAR FWD BULKHEAD LOC,FT	.0
HANGAR LOS AREA,FT2	.0
HANGAR LOS LENGTH,FT	.0
HANGAR LOS WIDTH,FT	.0
HANGAR LOS HEIGHT,FT	.0
HANGAR LOS VOLUME,FT3	.0

MAIN DECK HEIGHT,FT	106.0

HANGAR SAFE PARKING AREA,FT2	.0
HANGAR ELEVATOR DECK AREA,FT2	.0
HANGAR SAFE PARKING SPOTS	0.
(F/A-18 Std. = 1,192 Sq-Ft)	
HANGAR DIVISION DOOR NO	.0
HANGAR SIDEWALL DECK WIDTH,FT	.0

PRINTED REPORT NO. 4 - SPONSONS

SPONSON LOW RCS IND -	NONE

NUMBER OF SPONSONS	2.0
SPONSON DEPTH,FT	59.0
SPONSON DECK AREA,FT2	248354.5
SPONSON VOLUME,FT3	2665165.
SPONSON VOLUME (NO ELEV),FT3	2665165.

SPONSON INPUT DATA

LOC	X FWD FT	X AFT FT	FWD ANGLE DEG	AFT ANGLE DEG	SPONSON WIDTH AT UPPER FT	MID FT	LOWER FT
PORT	100.0	850.0	135.0	45.0	110.0	90.0	80.0
STBD	100.0	850.0	135.0	45.0	90.0	80.0	75.0

SPONSON AREAS AND VOLUME

DECK ID	DECK AREA FT2	VOLUME FT3
2	171026.90	1539242.00
3	43013.89	473152.80
4	22028.98	440579.60
5	11167.90	201022.10

PRINTED REPORT NO. 5 - ELEVATORS

TOTAL ELEVATORS	3.
FLIGHT DECK ELEVATOR DECK AREA,FT2	.0
HANGAR ELEVATOR DECK AREA,FT2	.0

AVIATION ELEVATORS	
STARBOARD	0.
PORT	0.
STERN	0.
INTERNAL	0.

WEAPON ELEVATORS	
UPPER-STAGE WEAPON ELEVATORS	0.
LOWER-STAGE WEAPON ELEVATORS	0.

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SPONSON WEAPON ELEVATORS                 0.

CARGO ELEVATORS                          3.
CARGO CONVEYORS                          0.

ELEVATOR INPUT DATA
    ELEV TYPE    LENGTH   WIDTH   X LOC   Y LOC  UPPER LOWER
                    FT      FT      FT      FT   DK ID DK ID
LIFT SYS   LIFT CAP      ELEVATOR AREA LOCATION
PRESSURE     LTON     HULL   HNGR     PS     SS    GAL    SPC
     CARGO         20.0    10.0   190.0   -10.0******    4.
          *******      1.0     .0     .0     .0     .0     .0
     CARGO         20.0    10.0   350.0   -10.0******    4.
          *******      1.0     .0     .0     .0     .0     .0
     CARGO         20.0    10.0   550.0   -10.0******    4.
          *******      1.0     .0     .0     .0     .0     .0
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PRINTED REPORT NO. 6 - AIRCRAFT COMPLEMENT

VAST IND -                              NONE

TOTAL AIRCRAFT                           21.
TOTAL SQUADRONS                           4.
TOTAL AIRCRAFT TYPES                      3.
AERO SERVICE LOAD,KW                     63.0
EMPTY WEIGHT OF AIRCRAFT,LTON           225.8
WEIGHT OF AIRCRAFT/SHIP AMMO,LTON          .0
WEIGHT OF AIRCRAFT FUEL (JP-5),LTON     3000.0
VOLUME OF AIRCRAFT FUEL (JP-5),FT3    132283.5
                        US Gallons     19285.8

AIRCRAFT
                SQUADRONS   PLANES/SQUADRON
MV-22               1.         12.
SH-60               2.          3.
SH-3H               1.          3.
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PRINTED REPORT NO.  7 - MAGAZINES

HULL SUBDIVISION IND -          GIVEN
MAGAZINE LOC IND -

MAGAZINE LOS AREA,FT2               .0
MAGAZINE FWD LENGTH,FT        ********
MAGAZINE AFT LENGTH,FT        ********
TOTAL LENGTH MAGAZINES,FT           .0
MAGAZINE HEIGHT,FT                  .0
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 PRINTED REPORT NO.  8 - PROTECTION

 BALLISTIC PROT IND -        NONE
 DAMAGE PREV PANEL SYS IND - DPPS

 SPS DEPTH,FT                     .0
 SPS VOLUME,FT3                   .0
 SPS OFFSET REQ,FT                .0
 SPS OFFSET,FT                    .0




    ASSET/MONOCV VERSION 4.2.0 - DECKHOUSE MODULE -  11/22/98 16:10.14

 PRINTED REPORT NO.  1 - DECKHOUSE SUMMARY

 DKHS GEOM IND-GIVEN                  BLAST RESIST IND-3 PSI
 DKHS SIZE IND-                       DKHS MTRL TYPE IND-STEEL
 BEAM LINK IND-NO

 LBP, FT                    950.00   DKHS LENGTH OA, FT
634.41
 BEAM, FT                   140.00   DKHS MAX WIDTH, FT
120.00
 AREA BEAM, FT               78.52   DKHS HT (W/O PLTHS), FT
50.00

 DKHS FWD LIMIT-          STA   3.8   OTHER ARR AREA REQ, FT2
508797.
 DKHS AFT LIMIT-          STA  17.1   HULL ARR AREA AVAIL, FT2
487000.
 DKHS AVG DECK HT, FT         10.00   SPONSON ARR AREA AVAIL, FT2
248354.
 DKHS NO LVLS                         DKHS ARR AREA REQ, FT2
12960.
 DKHS MIN SIDE CLR, FT                HANGAR ARR AREA REQ, FT2
0.
 DKHS AVG SIDE ANG, DEG               PLTHS ARR AREA REQ, FT2
953.
 DKHS OUTBOARD SIDE LOC,FT
 DKHS NO PRISMS                   4   DKHS MAX ARR AREA, FT2
252160.
 DKHS ARR AREA DERIV, FT2   2323.32   DKHS ARR AREA AVAIL, FT2
252160.
 DKHS MIN ALW BEAM, FT       120.00   DKHS VOLUME, FT3
2496258.
 BRIDGE L-O-S OVER BOW, FT   435.11
                                      DKHS WEIGHT, LTON
4301.16
 DKHS SIDE CLR OFFSET, FT             DKHS VCG, FT
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123.08
DKHS SIDE ANG OFFSET, DEG
DKHS DECK HT OFFSET, FT

PRINTED REPORT NO. 2 - SUPERSTRUCTURE DECKHOUSES

NO OF SS DECKHOUSE BLKS 4
DKHS VOLUME, FT3 2496258.
DKHS ARR AREA AVAIL, FT2 252160.4

	DECKHOUSE NUMBER			
	1	2	3	4
DIST FROM BOW, FT	179.36	178.60	627.00	675.45
LENGTH, FT	633.65	31.64	115.90	63.65
DIST FROM CL, FT				
FWD/PORT/BTM	-20.00	-20.00	.00	-20.00
AFT/PORT/BTM	-20.00	-20.00	.00	-20.00
FWD/STBD/BTM	100.00	100.00	60.00	.00
AFT/STBD/BTM	100.00	100.00	60.00	.00
FWD/PORT/TOP	-20.00	-20.00	.00	-20.00
AFT/PORT/TOP	-20.00	-20.00	.00	-20.00
FWD/STBD/TOP	100.00	100.00	60.00	.00
AFT/STBD/TOP	100.00	100.00	60.00	.00
DIST ABV BASELINE FWD, FT	106.00	136.00	136.00	136.00
DIST ABV BASELINE AFT, FT	106.00	136.00	136.00	136.00
HEIGHT, FT	30.00	15.00	20.00	15.00
VOLUME, FT3	2281140.	56943.	139080.	19095.
ARR AREA, FT2	228114.0	7592.4	13908.0	2546.0

PRINTED REPORT NO. 3 - DECKHOUSE STRUCTURE WEIGHT SUMMARY

DKHS MTRL TYPE IND-STEEL DKHS STRUCT DENSITY, LBM/FT3 3.86
HANGAR VOL, FT3 0. BLAST RESIST IND-3 PSI

	WT-LTON	VCG-FT	LCG-FT
	=======	======	======
CALCULATED SWBS150	4301.2	123.08	501.43

DECK HOUSE	VOLUME FT3	VCG FROM BL FT
=====	======	=======
NO. 1	2281140.	121.00
NO. 2	56943.	143.50
NO. 3	139080.	146.00
NO. 4	19095.	143.50
	---------	-------

2496258.   123.08

ASSET/MONOCV VERSION 4.2.0 - APPENDAGE MODULE - 11/22/98 16:10.14

PRINTED REPORT NO. 1 - SUMMARY

APPENDAGE DISP, LTON	313.8
SHELL DISP, LTON	98.4

SKEG IND	PRESENT
SKEG DISP, LTON	42.5
SKEG AFT LIMIT/LBP	.9161
SKEG THK, FT	2.00
SKEG PROJECTED AREA, FT2	742.9
BILGE KEEL IND	PRESENT
BILGE KEEL DISP, LTON	55.8
BILGE KEEL LGTH, FT	313.50
SHAFT SUPPORT TYPE IND	OPEN STRUT
SHAFT SUPPORT DISP, LTON	50.9
SHAFT DISP, LTON	11.0
PROP TYPE IND	CP
PROP BLADE DISP, LTON	6.4
NO PROP SHAFTS	2
PROP DIA, FT	23.00
SONAR DOME IND	NONE
SONAR DISP, LTON	.0

RUDDER TYPE IND	SPADE
NO RUDDERS	2
AVG RUDDER CHORD, FT	21.11
RUDDER THK, FT	2.36
RUDDER SPAN, FT	25.68
RUDDER PROJECTED AREA, FT2	542.0
RUDDER DISP, LTON	48.7
FIN SIZE IND	
NO FIN PAIRS	0
FWD FIN	
CHORD, FT	
THK, FT	
SPAN, FT	
PROJECTED AREA, FT2	
DISP, LTON (PER PAIR)	
AFT FIN	
CHORD, FT	
THK, FT	
SPAN, FT	
PROJECTED AREA, FT2	
DISP, LTON (PER PAIR)	

PRINTED REPORT NO. 2 - APPENDAGE BUOYANCY AND WEIGHT

APPENDAGE	DISP, LTON	----CENTER OF BUOYANCY---- X, FT	Y, FT	Z, FT
SHELL	98.4	476.08	.00	31.89
SKEG	42.5	838.22	.00	5.22
BILGE KEELS*	55.8	475.00	69.98	21.20
OPEN STRUTS*	50.9	905.79	.00	10.73
PROPULSION SHAFTS*	11.0	880.98	.00	11.53
PROP BLADES*	6.4	915.39	17.25	9.08
RUDDERS*	48.7	937.45	.00	16.14
TOTAL, LTON	313.8			

* TRANSVERSE C.B. PER SIDE IS SHOWN

SWBS114, SHLL APNDG, LTON 197.24

SWBS565, ROLL FINS, LTON .00

ASSET/MONOCV VERSION 4.2.0 - RESISTANCE MODULE - 11/22/98 16:10.14

PRINTED REPORT NO. 1 - SUMMARY

RESID RESIST IND	REGR	BILGE KEEL IND	PRESENT
FRICTION LINE IND	ITTC	SHAFT SUPPORT TYPE IND	OPEN STRUT
ENDUR DISP IND	FULL LOAD	PRPLN SYS RESIST IND	CALC
PROP TYPE IND	CP	RUDDER TYPE IND	SPADE
SONAR DRAG IND		SONAR DOME IND	NONE
SKEG IND	PRESENT		
FULL LOAD WT, LTON	85931.5	CORR ALW	.00022
AVG ENDUR DISP, LTON	85931.5	DRAG MARGIN FAC	.040
USABLE FUEL WT, LTON	9814.0		
NO FIN PAIRS	0.	PRPLN SYS RESIST FRAC	
NO RUDDERS	2.	MAX SPEED	.122
NO PROP SHAFTS	2.	SUSTN SPEED	.121
PROP DIA, FT	23.00	ENDUR SPEED	.131

CONDITION	SPEED	------------EFFECTIVE HORSEPOWER, HP------------						DRAG
	KT	FRIC	RESID	APPDG	WIND	MARGIN	TOTAL	LBF
MAX	27.51	41558.	35783.	15004.	2441.	3791.	98577.	1167835.
SUSTN	25.00	31498.	29905.	11757.	1832.	3000.	77993.	1016611.
ENDUR	20.00	16492.	15524.	6455.	938.	1576.	40985.	667783.

PRINTED REPORT NO. 2 - SPEED-POWER MATRIX

RESID RESIST IND	REGR
ENDUR DISP IND	FULL LOAD

SPEED AND POWER FOR FULL LOAD DISP
====================================

FULL LOAD WT, LTON 85931.5

SPEED	------------EFFECTIVE HORSEPOWER, HP------------						DRAG
KT	FRIC	RESID	APPDG	WIND	MARGIN	TOTAL	LBF
2.00	21.	15.*	14.	1.	2.	53.	8691.
4.00	157.	120.*	88.	8.	15.	387.	31504.
6.00	506.	404.*	257.	25.	48.	1240.	67337.
8.00	1162.	957.*	553.	60.	109.	2841.	115726.
10.00	2215.	1870.*	1002.	117.	208.	5413.	176378.
12.00	3755.	3231.*	1631.	203.	353.	9173.	249086.
14.00	5867.	5131.*	2464.	322.	551.	14336.	333690.
16.00	8638.	7659.*	3526.	480.	812.	21116.	430061.
18.00	12152.	10905.*	4838.	684.	1143.	29723.	538090.
20.00	16492.	15524.	6455.	938.	1576.	40985.	667783.
22.00	21741.	21328.	8381.	1249.	2108.	54806.	811799.
24.00	27981.	27047.	10563.	1621.	2688.	69901.	949098.
26.00	35294.	32275.	12997.	2061.	3305.	85933.	1077020.
28.00	43759.	41478.	15939.	2574.	4150.	107901.	1255754.
30.00	53458.	87650.	21102.	3166.	6615.	171992.	1868210.

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* DENOTES EXTRAPOLATED VALUE.

PRINTED REPORT NO. 3 - SHIP GEOMETRIC DATA FOR RESISTANCE COMPUTATIONS

RESID RESIST IND REGR
ENDUR DISP IND FULL LOAD

	FULL LOAD	AVE ENDUR DISP
BARE HULL DISP, LTON	85618.4	85618.4
APPENDAGE DISP, LTON	313.1	313.1
TOTAL DISP, LTON	85931.5	85931.5
LBP, FT	950.00	950.00
WL LENGTH, FT	948.94	948.94
BEAM AT MAX AREA STA, FT	140.03	140.03
DRAFT AT MAX AREA STA, FT	33.15	33.15
TAYLOR WETTED SURF AREA, FT2	148965.5	148965.5
SHIP WETTED SURF AREA, FT2	148965.5	148965.5
SKEG WETTED SURF AREA, FT2	1485.9	1485.9
WIND FRONT AREA, FT2	16117.8	16117.8
FROUDE WETTED SURF COEF	7.1700	7.1700
LENGTH-BEAM RATIO	6.7767	6.7767
BEAM-DRAFT RATIO	4.2245	4.2245
PRISMATIC COEF	.7091	.7091
MAX SECTION COEF	.9588	.9588
DISP-LENGTH RATIO	100.1974	100.1974
LCB-LENGTH RATIO	.5135	.5135
HALF ANG ENTRANCE, DEG	14.08	14.08
HALF ANG RUN, DEG	8.10	8.10
TRANSOM BUTTOCK ANG, DEG	5.52	5.52
BOW SECT AREA COEF	.0000	.0000
TRANSOM SECT AREA COEF	.0507	.0507
TRANSOM BREADTH COEF	.8438	.8438
TRANSOM DEPTH COEF	.1024	.1024

PRINTED REPORT NO. 4 - APPENDAGE DATA

SKEG IND PRESENT
SKEG AREA, FT2 742.9

BILGE KEEL IND PRESENT

SHAFT SUPPORT TYPE IND OPEN STRUT

		MAIN	INTMD
NO STRUTS PER SHAFT	1.		
STRUT DIMENSIONS		------	--------
STRUT CHORD, FT		4.78	
STRUT THICKNESS, FT		.96	
BARREL LENGTH, FT		18.40	
BARREL DIA, FT		7.56	

NO PROP SHAFTS 2.
INBOARD SHAFT PAIR:
WET SHAFT LGTH (PORT), FT 50.43
WET SHAFT LGTH (STBD), FT 50.43
INTRMDT SHAFT DIA, FT 2.17

PROP TYPE IND CP

PROP DIA, FT	23.00
SONAR DOME IND	NONE
SONAR DRAG IND	
SONAR SECT AREA, FT2	
NO RUDDERS	2.
RUDDER AREA, FT2	542.0
NO FIN PAIRS	0.
ROLL FIN AREA, FT2	

ASSET/MONOCV VERSION 4.2.0 - PROPELLER MODULE - 11/22/98 16:10.14

PRINTED REPORT NO. 1 - SUMMARY

PROP TYPE IND	CP	PROP SERIES IND	TROOST
PROP DIA IND	GIVEN	PROP LOC IND	CALC
PROP AREA IND	GIVEN	PROP ID IND	
SHAFT SUPPORT TYPE IND	OPEN STRUT		

MAX SPEED, KT	27.51	ENDUR SPEED, KT	20.00
MAX EHP (/SHAFT), HP	49289.	ENDUR EHP (/SHAFT), HP	20493.
MAX SHP (/SHAFT), HP	74525.	ENDUR SHP (/SHAFT), HP	31324.
MAX PROP RPM	135.7	ENDUR PROP RPM	100.5
MAX PROP COEF	.661	ENDUR PROP COEF	.654

SUSTN SPEED, KT	25.00	PROP DIA, FT	23.00
SUSTN EHP (/SHAFT), HP	38997.	NO BLADES	5.
SUSTN SHP (/SHAFT), HP	59387.	PITCH RATIO	1.21
SUSTN PROP RPM	124.8	EXPAND AREA RATIO	.800
SUSTN PROP COEF	.657	CAVITATION NO	1.70
NO PROP SHAFTS	2.0		

TOTAL PROPELLER WT, LTON 138.09

PRINTED REPORT NO. 2 - PROPELLER CHARACTERISTICS

PROP ID IND	
NO PROP SHAFTS	2.
PROP DIA, FT	23.00
NO BLADES	5.
PITCH RATIO	1.21
EXPAND AREA RATIO	.800
THRUST DED COEF	.000
TAYLOR WAKE FRAC	.000
HULL EFFICIENCY	1.000
REL ROTATE EFF	.980

	----------- CONDITIONS ----------		
CHARACTERISTICS	MAXIMUM	SUSTAINED	ENDURANCE
SPEED, KT	27.51	25.00	20.00
RPM	135.7	124.8	100.5
THRUST/SHAFT, LBF	583925.	508312.	333896.
EHP/SHAFT, HP	49289.	38997.	20493.
TORQUE/SHAFT, FT-LBF	2828065.	2449043.	1604651.
SHP/SHAFT, HP	74525.	59387.	31324.
ADVANCE COEF (J)	.893	.882	.876
THRUST COEF (KT)	.205	.211	.214
TORQUE COEF (10KQ)	.432	.442	.447
OPEN WATER EFFY	.675	.670	.668
PC	.661	.657	.654

PRINTED REPORT NO. 3 - CAVITATION CHARACTERISTICS

MAX SPEED OF ADV, KT	27.51
MAX THRUST, LBF	583925.
MAX PROP RPM	135.7
PROP DIA, FT	23.00
SHALLOW HUB DEPTH, FT	24.07
STD CAV NO	1.70
LOCAL CAV NO (.7R)	.24
MEAN THRUST LOADING COEF	.15
EXPAND AREA RATIO	.800
MIN EAR REQUIRED	.810
BACK CAV ALLOWED, PERCENT	10.0

THRUST LOADING EXCEEDS BURRILL'S CRITERIA

PRINTED REPORT NO. 4 - PROPELLER ARRANGEMENT

FULL LOAD DRAFT, FT 33.15

	INBOARD PAIR
PROP DIA, FT	23.00
HUB DEPTH FROM DWL, FT	24.07
LONG LOC FROM AP, FT	34.61
HUB POS FROM CL, FT	17.25
TIP CLR FROM BL, FT	-2.42
TIP CLR FROM MAX HB, FT	44.37
TIP CLR FROM HULL BOT, FT	5.75

TOTAL PROPELLER WT, LTON 138.09

ASSET/MONOCV VERSION 4.2.0 - MACHINERY MODULE - 11/22/98 16:10.15

PRINTED REPORT NO. 1 - SUMMARY

TRANS TYPE IND	ELECT	MAX SPEED, KT	27.51
ELECT PRPLN TYPE IND	AC-AC	SUSTN SPEED IND	GIVEN
SHAFT SUPPORT TYPE IND	OPEN STRUT	SUSTN SPEED, KT	25.00
NO PROP SHAFTS	2.	SUSTN SPEED POWER FRAC	.800
SEC ENG USAGE IND	AND	ENDUR SPEED IND	GIVEN
SS SYS TYPE IND	PD	ENDUR SPEED, KT	20.00
PD SS TYPE IND	SOLID ST	DESIGN MODE IND	ENDURANCE
MAX MARG ELECT LOAD, KW	13703.	ENDURANCE, NM	12000.
AVG 24-HR ELECT LOAD, KW	9953.	USABLE FUEL WT, LTON	9814.0
SWBS 200 GROUP WT, LTON	4811.9	SWBS 300 GROUP WT, LTON	1672.1
NO BOILERS PER SHAFT	0.	NO RESERVE BOILERS	0.
AUX STEAM FAC	.000		

ARRANGEMENT OR SS SYSTEM	TYPE	NO INSTALLED	NO ONLINE MAX+SUSTN	NO ONLINE ENDURANCE
ELECT PG ARR 1 IND	M-PG	4	4	3
ELECT PG ARR 2 IND	S-SPG	3	3	2
ELECT DL ARR IND	MTR	2	2	2
SEP SHIP-SERVICE SYSTEM	KW	0	0	0
PD SHIP-SERVICE SYSTEM	3000. KW	7	7	6

	MAIN ENG	SEC ENG	SS ENG
ENG SELECT IND	GIVEN	GIVEN	GIVEN
ENG MODEL IND	SEMT PC4/10	GE LM5000	GM 16-645E5
ENG TYPE IND	F DIESEL	GT	D DIESEL
ENG SIZE IND	GIVEN	GIVEN	GIVEN
NO INSTALLED	4	3	0
ENG PWR AVAIL, HP	15000.	39100.	3070.
ENG RPM	400.0	3600.0	900.0
ENG SFC, LBM/HP-HR	.305	.387	.380
ENG LOAD FRAC	1.014	1.014	

PRINTED REPORT NO. 2 - MACHINERY EQUIPMENT LIST

NO EACH	ITEM	WEIGHT LTON	LENGTH FT	WIDTH FT	HEIGHT FT
	PROPULSION PLANT				
4	MAIN ENGINE (BARE)	196.4	30.25	14.67	20.47
0	MAIN ENGINE ENCLOSURE MODULE				
0	MAIN ENGINE INTERCOOLER				
3	SEC ENGINE (BARE)	4.8	19.67	6.50	6.50
3	SEC ENGINE ENCLOSURE MODULE	11.7	33.32	10.00	9.30
0	SEC ENGINE INTERCOOLER				
0	RACER STEAM TURBINE				
0	RACER CONDENSER				
0	GEAR (01)				
0	EPIC REV PINION GEAR (02)				
0	FRANCO TOSI REV GEAR (03)				
0	VSCF COMB/STEP-UP GEAR (04)				
0	RACER REDUCTION GEAR (05)				
0	2 SPD SOLAR EPIC GEAR (06)				
0	OFFSET GEAR (07)				
0	OFFSET COMB (2-1) GEAR (08)				
0	OFFSET COMB (3-2) GEAR (09)				
0	CR EPIC GEAR (10)				
0	Z DRIVE SPIRAL BVL GEAR (11)				
0	PLANETARY REDUCTION GEAR(12)				
0	CR BI-COUPLED EPIC GEAR (13)				
0	STAR EPIC REV GEAR (14)				
0	STAR EPIC REDUCTION GEAR(15)				
0	COMBINING STEP-UP GEAR (16)				
0	SEC COMB STEP-UP GEAR (18)				
4	PROPULSION GENERATOR	231.5	7.04	31.68	31.68
3	SEC PROPULSION GENERATOR	50.4	22.67	8.13	8.13
2	PROPULSION MOTOR	637.7	37.42	2.67	3.22
2	THRUST BEARING	28.4	5.15	7.21	7.21
2	PROPELLER SHAFT				
	ELECTRIC PLANT				
0	SS ENGINE (BARE)				
0	SS ENGINE ENCLOSURE MODULE				
0	SS REDUCTION GEAR (17)				
0	SEPARATE SS GENERATOR				
0	VSCF SS GENERATOR				
0	VSCF SS CYCLOCONVERTER				
7	PD SS FREQUENCY CHANGER	26.8	29.00	4.00	7.50
7	PD SS TRANSFORMER	10.7	24.00	4.00	7.50
0	PD SS MG-SET MOTOR				
0	PD SS MG-SET GENERATOR				
0	PD SS DC-BUS RECTIFIER				
0	PD SS DC-BUS .25MW INVERTER				
0	PD SS STEAM TURBINE/COND				
0	PD SS STEAM TURB DRIVEN GEN				

PRINTED REPORT NO. 3 - ENGINES

	MAIN ENG	SEC ENG	SS ENG
ENG SELECT IND	GIVEN	GIVEN	GIVEN
ENG TYPE IND	F DIESEL	GT	D DIESEL
ENG MODEL IND	SEMT PC4/10	GE LM5000	GM 16-645E5
ENG SIZE IND	GIVEN	GIVEN	GIVEN
NO INSTALLED	4	3	0
ENG BARE WT, LTON	196.4	4.8	16.8
ENG LENGTH, FT	30.25	19.67	17.64
ENG WIDTH, FT	14.67	6.50	5.64
ENG HEIGHT, FT	20.47	6.50	9.25
ENG PWR AVAIL, HP	15000.	39100.0	3070.0
ENG RPM	400.0	3600.0	900.0
ENG MASS FL, LBM/SEC	54.8	247.0	8.3
ENG EXH TEMP, DEGF	675.0	885.0	725.0
ENG SFC EQN IND	DIESEL	OTHER	DIESEL
ENG SFC, LBM/HP-HR	.305	.387	.380
MAX SPEED CONDITION			
NO OPERATING	4	3	0
ENG PWR, HP	15207.	39639.5	
ENG RPM	400.0	3600.0	
ENG MASS FL, LBM/SEC	55.1	248.3	
ENG EXH TEMP, DEGF	679.2	888.1	
ENG SFC, LBM/HP-HR	.306	.385	
SUSTN SPEED CONDITION			
NO OPERATING	4	3	0
ENG PWR, HP	12493.	32564.7	
ENG RPM	368.1	3312.6	
ENG MASS FL, LBM/SEC	51.1	230.2	
ENG EXH TEMP, DEGF	630.1	845.1	
ENG SFC, LBM/HP-HR	.301	.402	
ENDUR SPEED CONDITION			
NO OPERATING	3	2	0
ENG PWR, HP	10861.	28310.9	
ENG RPM	296.3	2666.6	
ENG MASS FL, LBM/SEC	48.4	218.1	
ENG EXH TEMP, DEGF	605.7	821.7	
ENG SFC, LBM/HP-HR	.304	.420	

NOTE - ENGINE OPERATING DATA ARE BASED ON USE OF DFM FUEL.

PRINTED REPORT NO. 4 - GEARS

NO EACH	ITEM	WEIGHT LTON	LENGTH FT	WIDTH FT	HEIGHT FT
	2-STAGE REDUCTION GEARS				
0	LTDR GEAR (01)				
0	CR BI-COUPLED EPIC GEAR (13)				
	1ST STAGE REDUCTION GEARS				
0	HOSR GEAR (01)				
0	OFFSET GEAR (07)				
0	OFFSET COMB (2-1) GEAR (08)				
0	OFFSET COMB (3-2) GEAR (09)				
0	STAR EPIC REDUCTION GEAR(15)				
	2ND STAGE REDUCTION GEARS				
0	CR EPIC GEAR (10)				
0	PLANETARY REDUCTION GEAR(12)				
	SPECIAL GEARS				
0	EPIC REV PINION GEAR (02)				
0	FRANCO TOSI REV GEAR (03)				
0	VSCF COMB/STEP-UP GEAR (04)				
0	RACER REDUCTION GEAR (05)				
0	2 SPD SOLAR EPIC GEAR (06)				
0	Z DRIVE SPIRAL BVL GEAR (11)				
0	STAR EPIC REV GEAR (14)				
0	COMBINING STEP-UP GEAR (16)				
0	SS REDUCTION GEAR (17)				
0	SEC COMB STEP-UP GEAR (18)				

REDUCTION GEAR DESIGN FACTORS AND DIMENSIONS	1ST STAGE	2ND STAGE	SS
REDUCTION RATIO			
K FACTOR			
FACE WIDTH RATIO			
CASING WT FACTOR			
GEAR FACE WIDTH, FT			
PINION GEAR DIA, FT			
REDUCTION GEAR DIA, FT			
SUN GEAR DIA, FT			
PLANET GEAR DIA, FT			
RING GEAR DIA, FT			
RING GEAR THK, FT			
NO PLANETS			

PRINTED REPORT NO. 5 - ELECTRIC PROPULSION AND PD SHIP-SERVICE EQUIPMENT

TRANS TYPE IND - ELECT
ELECT PRPLN TYPE IND - AC-AC
ELECT PRPLN RATING IND - CALC

TRANS LINE NODE PT IND - CALC
SS SYS TYPE IND - PD
PD SS TYPE IND - SOLID ST

MOTORS AND GENERATORS

	MAIN PRPLN GENERATOR	SEC PRPLN GENERATOR	PRPLN MOTOR	VSCF GENERATOR
INSTALLED NUMBER	4	3	2	0
TYPE	AC	AC	AC	
FREQUENCY CONTROL	NO	NO		
DRIVE			DIRECT	
ROTOR COOLING	AIR	AIR	AIR	
ROTOR TIP SPEED, FT/MIN	28500.	28500.	28500.	
STATOR COOLING	LIQUID	LIQUID	LIQUID	
ARM ELECT LOAD, AMP/IN	2400.	2400.	2400.	
POWER RATING, MW	25.83	48.93	62.46	3.00
ROTATIONAL SPEED, RPM	400.	3600.	136.	.
NUMBER OF POLES	2.	2.	6.	
LENGTH, FT	7.0	22.7	37.4	
WIDTH, FT	31.7	8.1	2.7	
HEIGHT, FT	31.7	8.1	3.2	
WEIGHT, LTON	231.5	50.4	637.7	

OTHER ELECTRIC PROPULSION AND PD SHIP-SERVICE EQUIPMENT

ELECTRIC PROPULSION:	TOTAL WEIGHT LTON	PD SHIP-SERVICE:	TOTAL WEIGHT LTON
CONTROLS	2.8	VSCF CYCLOCONVERTERS	
BRAKING RESISTORS	25.0	PD SS FREQUENCY CHANGERS	187.5
EXCITERS	29.4	PD SS TRANSFORMERS	75.0
SWITCHGEAR	33.7	PD SS MG-SET MOTORS	
POWER CONVERTERS	.0	PD SS MG-SET GENERATORS	
DEIONIZED COOL WATER SYS	48.7	PD SS DC-BUS RECTIFIERS	
PRPLN TRANS LINE	133.4	PD SS DC-BUS IPCCS	
RECTIFIERS	.0	PD SS STEAM TURB/COND	
HELIUM REFRIGERATION SYS	.0	PD SS STEAM DRIVEN SS GEN	

PROPULSION TRANSMISSION LINE

TRANS LINE NODE PT X, FT 705.77
TRANS LINE NODE PT Y, FT -6.75
TRANS LINE NODE PT Z, FT 17.17

	MAIN GENS TO NODE	SEC GENS TO NODE	MOTORS TO NODE
TRANS LINE TOTAL LENGTH, FT	136.73	1848.70	176.68
TRANS LINE DIAMETER , FT	1.00	1.00	1.00
TRANS LINE TOTAL WEIGHT, LTON	4.5	114.9	14.0

PRINTED REPORT NO. 6 - SHIP SERVICE SYSTEMS

SS SYS TYPE IND - PD
SS PWR CONV EFF IND - CALC

PD SS TYPE IND - SOLID ST
GEN SIZE IND - STD

ELECT LOAD DES MARGIN FAC .000
ELECT LOAD SL MARGIN FAC .000
ELECT LOAD IMBAL FAC .900
MAX MARG ELECT LOAD, KW 13702.9
MAX STANDBY LOAD, KW 12730.5
24-HR AVG ELECT LOAD, KW 9953.2

SEP ENG/GEN SET PWR CONV EFF
PD SS SYS PWR CONV EFF,BATTLE .950
PD SS SYS PWR CONV EFF,CRUISE .950

PROPULSION DERIVED SHIP SERVICE SYSTEMS

CONDITION	NO INSTALL	NO ONLINE	REQ KW/PDSYS	AVAIL KW/PDSYS	LOADING FRAC
WINTER BATTLE	7	7	1958.	3000.	.653
WINTER CRUISE	7	6	2284.	3000.	.761
SUMMER CRUISE	7	6	2146.	3000.	.715
ENDURANCE(24-HR AVG)	7	6	1659.	3000.	.553

SEPARATE SHIP-SERVICE SYSTEMS

CONDITION	NO INSTALL	NO ONLINE	REQ KW/GEN	AVAIL KW/GEN	LOADING FRAC
WINTER BATTLE	0	0			.000
WINTER CRUISE	0	0			.000
SUMMER CRUISE	0	0			.000
ENDURANCE(24-HR AVG)	0	0			.000

TOTALS

CONDITION	REQ KW	AVAIL KW	LOADING FRAC
WINTER BATTLE	13703.	21000.	.653
WINTER CRUISE	13703.	18000.	.761
SUMMER CRUISE	12878.	18000.	.715
ENDURANCE(24-HR AVG)	9953.	18000.	.553

PRINTED REPORT NO. 7 - INTAKE DUCTS

INLET TYPE IND - PLENUM   DUCT SILENCING IND - BOTH
GT ENG ENCL IND - 90 DBA

MAIN DUCT DESIGN VELOCITY, FT/SEC 20.00
SECONDARY DUCT DESIGN VELOCITY, FT/SEC 20.00

ASSOCIATION >>	MAIN ENG	SEC ENG	SS ENG
ENGINE TYPE	F DIESEL	GT	D DIESEL
INLET DUCT XSECT AREA,FT2	35.5	182.5	.0
INLET DUCT XSECT LTH, FT	6.72	18.3	.0
INLET DUCT XSECT WID, FT	6.72	10.0	.0

MAIN PROPULSION ENGINES

LOCATION	MMR1		MMR1	
ENGINE #	1		2	
	WT,LTON	VCG,FT	WT,LTON	VCG,FT
INLET	.3	152.00	.3	152.00
INLET DUCTING	3.4	94.78	3.4	94.78
INLET SILENCER	.6	40.00	.6	40.00
GT COOLING SUPPLY	.0	.00	.0	.00
GT BLEED AIR SUPPLY	.0	.00	.0	.00

MAIN PROPULSION ENGINES

LOCATION	MMR1		MMR1	
ENGINE #	3		4	
	WT,LTON	VCG,FT	WT,LTON	VCG,FT
INLET	.3	152.00	.3	152.00
INLET DUCTING	3.4	94.78	3.4	94.78
INLET SILENCER	.6	40.00	.6	40.00
GT COOLING SUPPLY	.0	.00	.0	.00
GT BLEED AIR SUPPLY	.0	.00	.0	.00

SECONDARY PROPULSION ENGINES

LOCATION	OMR1		OMR1	
ENGINE #	1		2	
	WT,LTON	VCG,FT	WT,LTON	VCG,FT
INLET	1.6	102.00	1.6	147.00
INLET DUCTING	.6	101.43	3.4	123.93
INLET SILENCER	7.0	95.00	7.0	130.04
GT COOLING SUPPLY	.6	97.32	3.5	113.97
GT BLEED AIR SUPPLY	7.1	95.80	7.1	107.50

SECONDARY PROPULSION ENGINES

LOCATION	OMR1	
ENGINE #	3	
	WT,LTON	VCG,FT

INLET	1.6	147.00
INLET DUCTING	3.4	123.93
INLET SILENCER	7.0	130.04
GT COOLING SUPPLY	3.5	113.97
GT BLEED AIR SUPPLY	7.1	107.50

NOTE - NUMERIC DATA PRESENTED ABOVE ARE ON A PER ENGINE OR PER BOILER ROOM BASIS.

TRUNK AREA AND VOLUME REQUIREMENTS

INTAKE ASSOCIATION	AREA,FT2 HULL	AREA,FT2 DKHS	VOLUME,FT3 HULL	VOLUME,FT3 DKHS
MAIN ENGINES/BOILERS	569.3	948.8	11006.	9488.
SEC ENGINES/BOILERS	1257.1	2095.2	0.	18857.
SHIP-SERVICE ENGINES	.0	.0	0.	0.
TOTALS	1826.4	3044.0	11006.	28345.

PRINTED REPORT NO. 8 - EXHAUST DUCTS
EXHAUST IR SUPPRESS IND-PRESENT
DUCT SILENCING IND-BOTH
GT ENG ENCL IND-90 DBA

EXHAUST STACK TEMP, DEGF	350.0
EDUCTOR DESIGN FAC	1.000

	MAIN ENG	SEC ENG	SS ENG
ENG TYPE	F DIESEL	GT	D DIESEL
ENG EXH TEMP, DEGF	679.	888.	
ENG MASS FL, LBM/SEC	55.1	248.3	
EXH DUCT GAS TEMP, DEGF	679.	794.	
EXH DUCT GAS DEN, LBM/FT3	.0343	.0312	
EXH DUCT MASS FL, LBM/SEC	55.1	283.1	
EXH DUCT AREA, FT2	14.9	84.5	

MAIN PROPULSION ENGINES

LOCATION	MMR1		MMR1	
ENGINE #	1		2	
	WT,LTON	VCG,FT	WT,LTON	VCG,FT
EXH DUCT (TO BOILER/REG)	.0		.0	
EXH BOILER (RACER)	.0		.0	
EXH REGENERATOR	.0		.0	
EXH DUCT (TO STACK)	13.1	94.78	13.1	94.78
EXH SILENCER	1.8	42.95	1.8	42.95
EXH STACK	.8	162.30	.8	162.30
EXH SPRAY RING	.7	112.22	.7	112.22
EXH EDUCTOR	1.3	160.43	1.3	160.43

MAIN PROPULSION ENGINES

LOCATION	MMR1		MMR1	
ENGINE #	3		4	
	WT,LTON	VCG,FT	WT,LTON	VCG,FT
EXH DUCT (TO BOILER/REG)	.0		.0	
EXH BOILER (RACER)	.0		.0	
EXH REGENERATOR	.0		.0	
EXH DUCT (TO STACK)	13.1	94.78	13.1	94.78
EXH SILENCER	1.8	42.95	1.8	42.95
EXH STACK	.8	162.30	.8	162.30
EXH SPRAY RING	.7	112.22	.7	112.22
EXH EDUCTOR	1.3	160.43	1.3	160.43

SECONDARY PROPULSION ENGINES

LOCATION	OMR1		OMR1	
ENGINE #	1		2	
	WT,LTON	VCG,FT	WT,LTON	VCG,FT
EXH DUCT (TO BOILER/REG)	.0		.0	
EXH BOILER (RACER)	.0		.0	
EXH REGENERATOR	.0		.0	
EXH DUCT (TO STACK)	2.3	101.43	13.8	123.93
EXH SILENCER	24.0	103.00	24.0	138.92
EXH STACK	4.7	112.30	4.7	157.30
EXH SPRAY RING	1.0	101.45	1.0	131.60
EXH EDUCTOR	22.9	117.66	22.9	162.66

SECONDARY PROPULSION ENGINES

LOCATION	OMR1	
ENGINE #	3	
	WT,LTON	VCG,FT
EXH DUCT (TO BOILER/REG)	.0	
EXH BOILER (RACER)	.0	
EXH REGENERATOR	.0	
EXH DUCT (TO STACK)	13.8	123.93
EXH SILENCER	24.0	138.92
EXH STACK	4.7	157.30
EXH SPRAY RING	1.0	131.60
EXH EDUCTOR	22.9	162.66

NOTE - NUMERIC DATA PRESENTED ABOVE ARE ON A PER ENGINE OR PER BOILER ROOM BASIS.

TRUNK AREA AND VOLUME REQUIREMENTS

	-----AREA,FT2----		---VOLUME,FT3----	
EXHAUST ASSOCIATION	HULL	DKHS	HULL	DKHS
MAIN ENGINES/BOILERS	874.6	1457.6	16908.	14576.
SEC ENGINES/BOILERS	1333.9	2223.1	0.	20008.
SHIP-SERVICE ENGINES	.0	.0	0.	0.
TOTALS	2208.4	3680.7	16908.	34584.

PRINTED REPORT NO. 9 - PROPELLERS AND SHAFTS

SHAFT SUPPORT TYPE IND-OPEN STRUT
SHAFT SYS SIZE IND-CALC
PROP TYPE IND-CP

PROP DIA, FT	23.00
HUB DIA, FT	7.56
PROP BLADE WT, LTON	24.9
PROP HUB WT, LTON	44.1
BEND STRESS CON FAC	1.700
OVRHG PROP MOM ARM RATIO	.340
EQUIV FP PROP WT, LTON	54.7
ALLOW BEND STRESS, LBF/IN2	6000.
FATIGUE LIMIT, LBF/IN2	47500.
YIELD POINT, LBF/IN2	75000.
TORQUE MARGIN FAC	1.200
OFF-CENTER THRUST FAC	1.000
NO STRUTS PER SHAFT	1

INBOARD PORT SHAFT

	PROP SECTION	INTERMED SECTION	LINE SECTION
ANGLE, DEG	4.07	4.07	4.07
LENGTH, FT	19.55	66.98	26.28
MAX DIAMETER (OD), FT	3.63	2.17	1.90
BORE RATIO	.550	.667	.667
TOTAL WEIGHT, LTON	41.5	40.2	10.2
LCG, FT	901.51	858.36	811.85
TCG, FT	-17.25	-17.25	-17.25
VCG, FT	10.07	13.14	16.45
FACTOR OF SAFETY		2.00	1.75

INBOARD STBD SHAFT

	PROP SECTION	INTERMED SECTION	LINE SECTION
ANGLE, DEG	4.07	4.07	4.07
LENGTH, FT	19.55	66.98	26.28
MAX DIAMETER (OD), FT	3.63	2.17	1.90
BORE RATIO	.550	.667	.667
TOTAL WEIGHT, LTON	41.5	40.2	10.2
LCG, FT	901.51	858.36	811.85
TCG, FT	17.25	17.25	17.25
VCG, FT	10.07	13.14	16.45
FACTOR OF SAFETY		2.00	1.75

PRINTED REPORT NO. 10 - STRUTS, PODS, AND RUDDERS

SHAFT SUPPORT TYPE IND-OPEN STRUT
SHAFT SYS SIZE IND-CALC

PROP DIA, FT	23.00
NO STRUTS PER SHAFT	1
NO SHAFTS	2
OVRHG PROP MOM ARM RATIO	.340

STRUTS

	MAIN STRUT	INTERMED STRUT
WALL THICKNESS, FT	.35	
CHORD, FT	4.78	
THICKNESS, FT	.96	
BARREL LTH, FT	18.40	
BARREL DIA, FT	7.56	

PODS

STRUT WALL THICKNESS, FT
STRUT CHORD, FT
STRUT THICKNESS, FT
BARREL LTH, FT
BARREL DIA, FT

RUDDERS

RUDDER TYPE IND-SPADE
RUDDER SIZE IND-CALC

NO RUDDERS	2.
RUDDER WT (PER), LTON	141.2
RUDDER DISP (PER), LTON	24.4

	CHORD,FT	THICK,FT	SPAN,FT
SPADE RUDDER	21.11	2.36	25.68

PRINTED REPORT NO. 11 - ELECTRIC LOADS

ELECT LOAD DES MARGIN FAC	.000	ELECT LOAD SL MARGIN FAC	.000
400-HZ ELECT LOAD FAC	.100	MAX 400-HZ ELEC LOAD	39.158
24-HR AVG ELECT LOAD	9953.2	TOTAL SUMMER CRUISE LOAD	12877.6
CONNECTED ELECT LOAD	36312.8	TOTAL WINTER CRUISE LOAD	13702.9
MAX MARG ELEC LOAD	13702.9	TOTAL SUMMER LAUNCH LOAD	10840.5
MAX STBY ELECT LOAD	12730.5	TOTAL WINTER LAUNCH LOAD	11271.3
VITAL ELECT LOAD	4939.0	TOTAL ANCHOR LOAD	12730.5
		TOTAL EMERGENCY LOAD	5493.2

SWBS COMPONENT	CRUISE SUMMER	CRUISE WINTER	LAUNCH SUMMER	LAUNCH WINTER	ANCHOR	EMERG.
200 PROPULSION PLANT	416.1	667.5	612.5	896.7	171.3	171.7
230 PROPULSION UNITS	17.6	17.6	17.6	17.6	30.0	17.6
233 DIESEL ENGINES	10.0	10.0	10.0	10.0	.0	10.0
234 GAS TURBINES	7.7	7.7	7.7	7.7	30.0	7.7
240 TRANSMISSION+PROPULSORS	2.6	2.6	35.0	35.0	4.0	16.2
241 REDUCTION GEARS	.0	.0	.0	.0	4.0	.0
243 SHAFTING	2.6	2.6	2.6	2.6	.0	.0
245 PROPULSORS	.0	.0	32.4	32.4	.0	16.2
250 SUPPORT SYSTEMS	356.5	564.2	487.7	684.5	114.7	137.9
251 COMBUSTION AIR SYSTEM	109.3	317.0	240.5	437.3	.0	.0
252 PROPULSION CONTROL SYS	28.5	28.5	28.5	28.5	5.4	28.5
256 CIRC + COOL SEA WATER	218.6	218.6	218.6	218.6	109.3	109.3
260 PROPUL FUEL & LUBE OIL	39.4	83.1	72.2	159.6	22.5	.0
261 FUEL SERVICE SYSTEM	38.4	82.1	71.2	158.6	22.3	.0
264 LUBE OIL HANDLING	1.0	1.0	1.0	1.0	.3	.0
300 ELECTRIC PLANT, GENERAL	3323.0	3323.0	2635.8	2635.8	3320.5	1755.2
310 ELECTRIC POWER GENERATIO	4.6	4.6	5.6	5.6	2.1	.8
313 BATTERIES+SERVICE FACIL	3.0	3.0	4.0	4.0	1.5	.0
314 POWER CONVERSION EQUIPM	1.6	1.6	1.6	1.6	.6	.8
330 LIGHTING SYSTEM	3318.4	3318.4	2630.3	2630.3	3318.4	1754.4
400 COMMAND+SURVEILLANCE	342.6	342.6	391.6	391.6	333.3	47.7
430 INTERIOR COMMUNICATIONS	46.7	46.7	95.5	95.5	37.3	47.7
470 COUNTERMEASURES	206.4	206.4	206.4	206.4	206.4	.0
475 DEGAUSSING	206.4	206.4	206.4	206.4	206.4	.0
490 SPECIAL PURPOSE SYS	89.6	89.6	89.7	89.7	89.6	.0
491 ELCTRNC TEST,CHKOUT,MON	5.3	5.3	5.4	5.4	5.3	.0
493 NON-COMBAT DATA PROCESS	84.3	84.3	84.3	84.3	84.3	.0
500 AUXILIARY SYSTEMS	7903.3	8330.7	6967.0	6967.0	8071.9	3514.6
510 CLIMATE CONTROL	6387.1	6814.4	5498.4	5498.4	6814.4	2642.0
511 COMPARTMENT HEATING SYS	427.3	854.7	581.1	581.1	854.7	.0
512 VENTILATION SYSTEM	3790.2	3790.2	2747.8	2747.8	3790.2	549.6
514 AIR CONDITIONING SYSTEM	2092.4	2092.4	2092.4	2092.4	2092.4	2092.4
516 REFRIGERATION SYSTEM	77.1	77.1	77.1	77.1	77.1	.0
520 SEA WATER SYSTEMS	119.4	119.4	126.3	126.3	117.2	126.3
521 FIREMAIN+SEA WATER FLUS	114.9	114.9	126.3	126.3	114.9	126.3
529 DRAINAGE+BALLASTING SYS	4.5	4.5	.0	.0	2.2	.0
530 FRESH WATER SYSTEMS	277.5	277.5	277.5	277.5	277.5	226.5
531 DISTILLING PLANT	223.1	223.1	223.1	223.1	223.1	223.1

532 COOLING WATER	6.8	6.8	6.8	6.8	6.8	3.4
533 POTABLE WATER	47.7	47.7	47.7	47.7	47.7	.0
540 FUELS/LUBRICANTS,HANDLIN	559.4	559.4	504.8	504.8	559.4	75.4
541 SHIP FUEL+COMPENSATING	483.9	483.9	429.3	429.3	483.9	.0
542 AVIATION+GENERAL PURPOS	37.7	37.7	37.7	37.7	37.7	37.7
543 AVIATION+GENERAL PURPOS	37.7	37.7	37.7	37.7	37.7	37.7
550 AIR,GAS+MISC FLUID SYSTE	96.1	96.1	96.1	96.1	96.1	96.1
551 COMPRESSED AIR SYSTEMS	58.4	58.4	58.4	58.4	58.4	58.4
553 O2 N2 SYSTEM	37.6	37.6	37.6	37.6	37.6	37.6
560 SHIP CNTL SYS	279.7	279.7	279.7	279.7	.0	279.7
561 STEERING+DIVING CNTL SY	279.7	279.7	279.7	279.7	.0	279.7
580 MECHANICAL HANDLING SYST	68.7	68.7	68.7	68.7	68.7	68.7
586 AIRCRAFT RECOVERY SUPPO	1.0	1.0	1.0	1.0	1.0	1.0
587 AIRCRAFT LAUNCH SUPPORT	67.7	67.7	67.7	67.7	67.7	67.7
590 SPECIAL PURPOSE SYSTEMS	115.5	115.5	115.5	115.5	138.6	.0
593 ENVIRONMENTAL POLLUTION	115.5	115.5	115.5	115.5	138.6	.0
600 OUTFIT+FURNISHING,GENERAL	892.6	1039.1	233.6	380.2	833.6	4.0
620 HULL COMPARTMENTATION	78.1	224.7	78.1	224.7	62.5	.0
625 AIRPORTS,FIXED PORTLIGH	78.1	224.7	78.1	224.7	62.5	.0
630 PRESERVATIVES+COVERINGS	44.0	44.0	33.4	33.4	44.0	.0
633 CATHODIC PROTECTION	44.0	44.0	33.4	33.4	44.0	.0
650 SERVICE SPACES	477.4	477.4	71.8	71.8	434.1	4.0
651 COMMISSARY SPACES	402.1	402.1	2.6	2.6	402.1	.0
652 MEDICAL SPACES	43.3	43.3	43.3	43.3	.0	4.0
655 LAUNDRY SPACES	20.7	20.7	25.9	25.9	20.7	.0
656 TRASH DISPOSAL SPACES	11.2	11.2	.0	.0	11.2	.0
660 WORKING SPACES	293.0	293.0	50.3	50.3	293.0	.0
665 WORKSHOPS,LABS,TEST ARE	293.0	293.0	50.3	50.3	293.0	.0
TOTAL LOADS	12878.	13703.	10840.	11271.	12731.	5493.
TOTAL MARGINED LOADS	12878.	13703.	10840.	11271.	12731.	5493.

PRINTED REPORT NO. 12 - POWERING

SUSTN SPEED IND - GIVEN
ENDUR SPEED IND - GIVEN
TRANS EFF IND - CALC

SUSTN SPEED POWER FRAC .800

100 PCT POWER TRANS EFF .9320*
25 PCT POWER TRANS EFF .9100*
* VALUES DO NOT INCLUDE CP PROP TRANSMISSION EFFICIENCY MULTIPLIER

	MAX SPEED	SUSTN SPEED	ENDUR SPEED
SHIP SPEED, KT	27.51	25.00	20.00
PROP RPM	135.7	124.8	100.5
NO OP PROP SHAFTS	2	2	2
EHP (/SHAFT), HP	49289.	38997.	20493.

PROPULSIVE COEF	.661	.657	.654
ENDUR PWR ALW	1.0	1.0	1.1
SHP (/SHAFT), HP	74524.	59386.	34456.
TRANS EFFY	.932	.928	.920
CP PROP TRANS EFFY MULT	.997	.997	.997
PROPUL PWR (/SHAFT), HP	80202.	64161.	37577.
PD SS PWR (/SHAFT), HP	9672.	9672.	7025.
BHP (/SHAFT), HP	89873.	73833.	44602.

PRINTED REPORT NO. 13 - HULL STRUCTURE AND MISCELLANEOUS WEIGHT

SWBS	COMPONENT	WT,LTON	LCG,FT	VCG,FT
====	=========	=======	======	======
160	SPECIAL STRUCTURES			
161	CASTINGS, FORGINGS, AND WELDMENTS	365.8	476.28	27.40
162	STACKS AND MASTS	17.3	280.93	145.92
180	FOUNDATIONS			
182	PROPULSION PLANT FOUNDATIONS	1601.8	703.18	18.70
183	ELECTRIC PLANT FOUNDATIONS	52.5	487.97	52.06

* DENOTES INCLUSION OF PAYLOAD OR ADJUSTMENTS

PRINTED REPORT NO. 14 - PROPULSION PLANT WEIGHT

SWBS	COMPONENT	WT,LTON	LCG,FT	VCG,FT
200	PROPULSION PLANT	4811.9	666.72	29.42
210	ENERGY GENERATING SYSTEM (NUCLEAR)	.0	.00	.00
212	NUCLEAR STEAM GENERATOR	.0	.00	.00
213	REACTORS	.0	.00	.00
214	REACTOR COOLANT SYSTEM	.0	.00	.00
215	REACTOR COOLANT SERVICE SYSTEM	.0	.00	.00
216	REACTOR PLANT AUXILIARY SYSTEM	.0	.00	.00
217	NUCLEAR POWER CONTROL AND INSTRUMENTATIO	.0	.00	.00
218	RADIATION SHIELDING (PRIMARY)	.0	.00	.00
219	RADIATION SHIELDING (SECONDARY)	.0	.00	.00
220	ENERGY GENERATING SYSTEM (NON-NUCLEAR)	.0	.00	.00
221	PROPULSION BOILERS	.0	.00	.00
230	PROPULSION UNITS	3777.4	681.67	23.93
231	PROPULSION STEAM TURBINES	.0	.00	.00
233	PROPULSION INTERNAL COMBUSTION ENGINES	1060.7	686.12	20.41
234	PROPULSION GAS TURBINES	93.9	182.66	89.36
235	ELECTRIC PROPULSION	2622.8	697.72	23.01
240	TRANSMISSION AND PROPULSOR SYSTEMS	452.8	821.31	11.06
241	PROPULSION REDUCTION GEARS	.0	.00	.00
242	PROPULSION CLUTCHES AND COUPLINGS	.0	.00	.00
243	PROPULSION SHAFTING	183.6	872.69	12.12
244	PROPULSION SHAFT BEARINGS	96.6	834.19	14.86
245	PROPULSORS	172.7	759.50	7.81
250	PRPLN SUPPORT SYS (EXCEPT FUEL+LUBE OIL)	430.8	398.42	101.94
251	COMBUSTION AIR SYSTEM	79.2	295.07	109.07
252	PROPULSION CONTROL SYSTEM	43.8	645.19	68.90
253	MAIN STEAM PIPING SYSTEM	.0	.00	.00
254	CONDENSERS AND AIR EJECTORS	.0	.00	.00
255	FEED AND CONDENSATE SYSTEM	.0	.00	.00
256	CIRCULATING AND COOLING SEA WATER SYSTEM	66.7	598.50	38.16
258	H.P. STEAM DRAIN SYSTEM	.0	.00	.00
259	UPTAKES (INNER CASING)	241.2	332.28	123.22
260	PRPLN SUPPORT SYS (FUEL+LUBE OIL)	64.2	637.26	14.15
261	FUEL SERVICE SYSTEM	9.4	597.69	20.01
262	MAIN PROPULSION LUBE OIL SYSTEM	39.2	645.19	12.00
264	LUBE OIL FILL, TRANSFER, AND PURIF	15.7	641.19	16.00
290	SPECIAL PURPOSE SYSTEMS	86.5	562.73	15.55
298	OPERATING FLUIDS	75.5	570.00	8.00
299	REPAIR PARTS AND SPECIAL TOOLS	11.0	513.00	67.20

* DENOTES INCLUSION OF PAYLOAD OR ADJUSTMENTS

PRINTED REPORT NO. 15 - ELECTRIC PLANT WEIGHT

SWBS	COMPONENT	WT,LTON	LCG,FT	VCG,FT
300	ELECTRIC PLANT	1672.1	498.26	71.44
310	ELECTRIC POWER GENERATION	409.7	466.24	62.85
311	SHIP SERVICE POWER GENERATION	262.5	487.97	54.06
312	EMERGENCY GENERATORS	.0	.00	.00
313	BATTERIES AND SERVICE FACILITIES	.0	.00	.00
314	POWER CONVERSION EQUIPMENT	147.2	427.50	78.53
320	POWER DISTRIBUTION SYSTEMS	698.0	504.56	56.65
321	SHIP SERVICE POWER CABLE	588.9	503.50	53.00
322	EMERGENCY POWER CABLE SYSTEM	.0	.00	.00
323	CASUALTY POWER CABLE SYSTEM	70.3	503.50	75.58
324	SWITCHGEAR AND PANELS	38.9	522.50	77.70
330	LIGHTING SYSTEM	529.1	497.96	99.76
331	LIGHTING DISTRIBUTION	220.8	503.50	94.40
332	LIGHTING FIXTURES	308.3	494.00	103.59
340	POWER GENERATION SUPPORT SYSTEMS	.0	.00	.00
342	DIESEL SUPPORT SYSTEMS	.0	.00	.00
343	TURBINE SUPPORT SYSTEMS	.0	.00	.00
390	SPECIAL PURPOSE SYSTEMS	35.2	750.50	39.22
398	OPERATING FLUIDS	.0	.00	.00
399	REPAIR PARTS AND SPECIAL TOOLS	35.2	750.50	39.22

* DENOTES INCLUSION OF PAYLOAD OR ADJUSTMENTS

PRINTED REPORT NO. 16 - MACHINERY ROOMS

NO MAIN MACHINERY ROOMS 1
NO AUX MACHINERY ROOMS 1
NO OTHER MACHINERY ROOMS 2

BULKHEAD LOCATIONS

MR NO	MR ID	FWD BHD BHD NO	FWD BHD X, FT	FWD BHD X/LBP	AFT BHD BHD NO	AFT BHD X, FT	AFT BHD X/LBP
1	OMR1	2.	170.00	.179	3.	270.00	.284
2	MMR1	7.	670.00	.705	8.	730.00	.768
3	AMR1	8.	730.00	.768	9.	800.00	.842
4	OMR2	9.	800.00	.842		950.00	1.000

DIMENSIONS

MR NO	MR ID	LENGTH, FT AVAIL	LENGTH, FT REQ	WIDTH, FT AVAIL	WIDTH, FT REQ	HEIGHT, FT AVAIL	HEIGHT, FT REQ
1	OMR1	100.00	37.00	140.00	57.99	106.00	97.87
2	MMR1	60.00	55.00	140.00	152.73	48.00	34.56
3	AMR1	70.00	44.83	139.65	42.71	38.00	23.01
4	OMR2	150.00	.00	137.05	.00	35.00	.00

ARRANGEMENTS

MR NO	MR ID	ROTATION ANGLE,DEG
1	OMR1	90.00
2	MMR1	.00
3	AMR1	.00
4	OMR2	.00

PRINTED REPORT NO. 17 - MACHINERY ARRANGEMENTS

CLEARANCES (MACHINERY TO MACHINERY)

ENG TO ENG CLR, FT	1.00
ENG TO GEAR CLR, FT OR ENG TO GEN CLR OR GEAR TO GEN CLR	1.00
MTR TO GEAR CLR, FT	2.50
PRPLN ARR TO SS ARR CLR, FT	6.00
AISLE WIDTH CLR, FT	2.50
PORT/CL TB TO GEAR CLR, FT	.00
STBD TB TO GEAR CLR, FT	.00

SEPARATIONS (BETWEEN HULL AND MACHINERY)

LONG (TO BHD), FT	1.00
TRANS (TO SIDE SHELL), FT	1.00
VERT (TO HULL BOT), FT	1.00
RADIAL (TO POD), FT	1.00

ARRANGEMENTS

ARRANGEMENT	TYPE	NO INSTALLED	NO ONLINE MAX+SUSTN	NO ONLINE ENDURANCE
ELECT PG ARR 1 IND	M-PG	4	4	3
ELECT PG ARR 2 IND	S-SPG	3	3	2
ELECT DL ARR IND	MTR	2	2	2
SHIP SERVICE ARR	DIESEL	0	0	0

MACHINERY COMPONENT LOCATIONS

COMPONENT	MR ID	CG LOC, FT X	Y	Z
MAIN ENG	MMR1	686.12	-58.02	23.32
MAIN ENG	MMR1	686.12	-23.84	23.32
MAIN ENG	MMR1	686.12	10.34	23.32
MAIN ENG	MMR1	686.12	44.52	23.32
SEC ENG	OMR1	176.00	-11.83	92.22
SEC ENG	OMR1	188.50	-11.83	92.22
SEC ENG	OMR1	201.00	-11.83	92.22
PRPLN MTR	AMR1	774.95	-17.25	19.08
PRPLN MTR	AMR1	774.95	17.25	19.08

SHAFTING

SHAFT TYPE	END POINT LOC, FT X	Y	Z	SHAFT ANGLE, DEG
INBRD PORT	798.74	-17.25	17.39	4.07
INBRD STBD	798.74	17.25	17.39	4.07

PRINTED REPORT NO. 18 - MACHINERY SPACE REQUIREMENTS

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            MACHINERY ROOM VOLUME REQUIREMENTS
            ========= ==== ====== ============
  VOLUME CATEGORY                                VOLUME, FT3
  ---------------                                -----------
SWBS GROUP 200                                   361375.
  PROPULSION POWER GENERATION                      232971.
    PROPULSION ENGINES                               182999.
    PROPULSION REDUCTION GEARS AND GENERATORS         49972.
  DRIVELINE MACHINERY                               20438.
    REDUCTION AND BEVEL GEARS WITH Z-DRIVE               0.
    ELECTRIC PROPULSION MOTORS AND GEARS              20438.
    REMOTELY-LOCATED THRUST BEARINGS                     0.
  PROPELLER SHAFT                                     143.
  ELECTRIC PROPULSION MISCELLANEOUS EQUIPMENT       26297.
    CONTROLS                                           2763.
    BRAKING RESISTORS                                  3089.
    MOTOR AND GENERATOR EXCITERS                       5302.
    SWITCHGEAR                                         6708.
    POWER CONVERTERS                                     0.
    DEIONIZED COOLING WATER SYSTEMS                    8436.
    RECTIFIERS                                           0.
    HELIUM REFRIGERATION SYSTEMS                         0.
  PROPULSION AUXILIARIES                            81526.
    PROPULSION LOCAL CONTROL CONSOLES                  3406.
    CP PROP HYDRAULIC OIL POWER MODULES                5947.
    FUEL OIL PUMPS                                    40549.
    LUBE OIL PUMPS                                     5341.
    LUBE OIL PURIFIERS                                14441.
    ENGINE LUBE OIL CONDITIONERS                       2967.
    SEAWATER COOLING PUMPS                             8876.

SWBS GROUP 300                                    36050.
  ELECTRIC PLANT POWER GENERATION                   14430.
    SHIP SERVICE POWER GENERATION                     14430.
      SEPARATE SS ENGINES                                  0.
      SEPARATE SS GENERATORS/GEAR                          0.
      PD SS VSCF CYCLOCONVERTERS                           0.
      PD SS TRANSFORMERS & FREQUENCY CHANGERS          14430.
      PD SS STEAM TURBINES/CONDENS/GENERATORS              0.
      PD SS MOTOR - GENERATORS                             0.
      PD SS DC-BUS RECTIFIERS                              0.
      PD SS DC-BUS INTEG PWR CONV CTRS (IPCCS)             0.
  SHIP SERVICE SWITCHBOARDS                         21619.

SWBS GROUP 500                                    97956.
  AUXILIARY MACHINERY                               97956.
    AIR CONDITIONING PLANTS                           18899.
    AUXILIARY BOILERS                                    0.
    FIRE PUMPS                                        12354.
    DISTILLING PLANTS                                 40162.
    AIR COMPRESSORS                                   20911.
    ROLL FIN PAIRS                                       0.
    SEWAGE PLANTS                                      5632.

            ARRANGEABLE AREA REQUIREMENTS
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SSCS	GROUP NAME	FT2 HULL/DKHS	FT2 DKHS ONLY
4.31	AUXILIARY MACHINERY DELTA	-16837.3	.0
4.3311	SHIP SERVICE POWER GENERATION	1261.3	.0
	SEP SS ENGINES/GENERATORS	.0	.0
	PD SS VSCF CYCLOCONVERTERS	.0	.0
	PD SS TRANS. & FREQ. CHANGERS	1261.3	.0
	PD SS STEAM TURBS/CONDS/GENS	.0	.0
	PD SS MOTOR - GENERATORS	.0	.0
	PD SS DC-BUS RECTIFIERS	.0	.0
	PD SS DC-BUS IPCCS	.0	.0
4.131	INT COMB ENG ENERGY GENERATION	.0	.0
4.141	GAS TURB ENG ENERGY GENERATION	2258.5	.0
	MAIN PROPULSION ENGINES	.0	.0
	MAIN PROPUL GEN/GEAR/ETC	.0	.0
	SEC PROPULSION ENGINES	1339.6	.0
	SEC PROPUL GEN/GEAR/ETC	918.9	.0
4.132	INTERNAL COMB ENGINE COMB AIR	569.3	948.8
4.133	INTERNAL COMB ENGINE EXHAUST	874.6	1457.6
4.142	GAS TURBINE ENGINE COMB AIR	1257.1	2095.2
4.143	GAS TURBINE ENGINE EXHAUST	1333.9	2223.1
4.112	BOILER COMBUSTION AIR INTAKE	.0	.0
4.113	BOILER COMBUSTION EXHAUST	.0	.0

NOTE: * DENOTES INCLUSION OF PAYLOAD OR ADJUSTMENTS

PRINTED REPORT NO. 19 - SURFACE SHIP ENDURANCE CALCULATION FORM

DESIGN MODE IND-ENDURANCE
ENDUR DISP IND-FULL LOAD
ENDUR DEF IND-USN
SHIP FUEL TYPE IND-JP-5

SHIP FUEL LHV, BTU/LBM 18300.
DFM FUEL LHV, BTU/LBM 18360.

(1)	ENDURANCE REQUIRED, NM	12000.
(2)	ENDURANCE SPEED, KT	20.00
(3)	FULL LOAD DISPLACEMENT, LTON	85931.5
(3A)	AVERAGE ENDURANCE DISPLACEMENT, LTON	85931.5
(4)	RATED FULL POWER SHP, HP	149047.
(5)	DESIGN ENDURANCE POWER SHP @ (2)&(3A), HP	62647.
(6)	AVERAGE ENDURANCE POWER (SHP), HP (5) X 1.10	68912.
(7)	RATIO, AVG END SHP/RATED F.P. SHP (6)/(4)	.46235
(8)	AVERAGE ENDURANCE BHP, HP (8A)+(8B) OR (8A) WITH STEAM PDSS	89205.
(8A)	AVERAGE PRPLN ENDURANCE BHP, HP (6)/TRANSMISSION EFFICIENCY	75155.
(8B)	SHIP SERV PWR SUPPLIED BY PRPLN ENG, HP	14050.
(9)	24-HOUR AVERAGE ELECTRIC LOAD, KW	9953.
(9A)	24-HOUR AVERAGE ELECTRIC LOAD PORTION SUPPLIED BY SS ENG, KW	0.
(10)	CALCULATED PROPULSION FUEL RATE @(8), LBM/HP-HR	.378

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(11) CALC PRPLN FUEL CONSUMPTION, LBM/HR              33693.3
     (10)X(8)
(12) CALC SS GEN FUEL RATE @ (9A), LBM/KW-HR             .000
(13) CALC SS GEN FUEL CONSUMPTION, LBM/HR                  .0
     (12)X(9A)
(14) CALC FUEL CONSUMPTION, STEAM PD SS,       LBM/HR      .0
     1.115 * (10) * (8B)
(15) TOTAL CALC ALL-PURPOSE FUEL CONSUMPTION, LBM/HR  33693.3
     (11)+(13)+14)
(16) CALC ALL-PURPOSE FUEL RATE, LBM/HP-HR               .489
     (15)/(6)
(17) FUEL RATE CORRECTION FACTOR BASED ON (7)          1.0323
(18) SPECIFIED FUEL RATE, LBM/HP-HR                      .505
     (16)X(17)
(19) AVG ENDURANCE FUEL RATE, LBM/HP-HR                  .530
     (18)X1.05
(20) ENDURANCE FUEL (BURNABLE), LTON                   9814.0 *
     (1)X(6)X(19)/(2)X2240
(21) TAILPIPE ALLOWANCE FACTOR                            .95
(22) ENDURANCE FUEL LOAD, LTON                        10330.5
     (20)/(21)


ENG ENDUR RPM IND-      130
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PRINTED REPORT NO. 20 - MACHINERY MARGINS

PROPULSION PLANT

MAIN ENG MAX LOAD FRAC	1.014
SEC ENG MAX LOAD FRAC	1.014
TORQUE MARGIN FAC	1.200

ELECTRIC PLANT

SS ENG MAX LOAD FRAC	
ELECT LOAD DES MARGIN FAC	.000
ELECT LOAD SL MARGIN FAC	.000
ELECT LOAD IMBAL FAC	.900

ASSET/MONOCV VERSION 4.2.0 - WEIGHT MODULE - 11/22/98 16:10.16

PRINTED REPORT NO. 1 - SUMMARY

		W E I G H T		LCG	VCG
SWBS	G R O U P	LTON	PER CENT	FT	FT
100	HULL STRUCTURE	33253.3	38.7	488.42	70.51
200	PROPULSION PLANT	4811.9	5.6	666.72	29.42
300	ELECTRIC PLANT	1672.1	1.9	498.26	71.44
400	COMMAND + SURVEILLANCE	1072.1	1.2	352.14	84.18
500	AUXILIARY SYSTEMS	2909.9	3.4	256.90	61.57
600	OUTFIT + FURNISHINGS	4236.2	4.9	474.73	75.79
700	ARMAMENT	5.1	.0	691.83	81.90
	L I G H T S H I P	47960.7	55.8	488.37	66.65
M21	PD MARGIN				
M22	CD MARGIN				
M11	D & B MARGIN				
M23	CON MOD MARGIN				
M24	GFM MARGIN				
	LIGHT SHIP WITH MARGINS	47960.7	55.8	488.37	66.65
F00	FULL LOADS	37970.8	44.2	475.29	50.51
F10	SHIPS FORCE + EFFECTS	14.9		452.27	95.22
F20	MISSION RELATED EXPENDABLES	382.1		475.00	102.63
F30	SHIPS STORES	925.3		475.00	86.61
F40	FUELS + LUBRICANTS	13376.2		498.85	32.60
F50	LIQUIDS + GASES (NON FUEL)	1028.5		475.00	37.56
F60	CARGO	22243.7		461.17	59.46
	F U L L L O A D W T	85931.5	100.0	482.59	59.52

PRINTED REPORT NO. 2 - HULL STRUCTURES WEIGHT

SWBS	COMPONENT	WT-LTON	VCG-FT	LCG-FT
100	HULL STRUCTURES	33253.3	70.51	488.42
110	SHELL + SUPPORTS	8544.6	31.89	476.08
111	PLATING	5053.7	40.49	475.00
113	INNER BOTTOM	773.4		475.00
114	SHELL APPENDAGES	197.2	19.14	521.72
115	STANCHIONS			
116	LONGIT FRAMING	2520.3	25.44	475.00
117	TRANSV FRAMING			
120	HULL STRUCTURAL BULKHDS	2257.3	60.29	475.00
121	LONGIT STRUCTURAL BULKHDS	752.6	62.54	475.00
122	TRANSV STRUCTURAL BULKHDS	1058.9	62.54	475.00
123	TRUNKS + ENCLOSURES	445.8	51.13	475.00
124	BULKHEADS, TORPEDO PROTECT SYS			
130	HULL DECKS	3280.0	91.33	475.00
131	MAIN DECK	2086.1	105.89	475.00
132	2ND DECK	1193.9	65.87	475.00
133	3RD DECK			
134	4TH DECK			
135	5TH DECK+DECKS BELOW			
136	01 HULL DECK			
137	02 HULL DECK			
138	03 HULL DECK			
139	04 HULL DECK			
140	HULL PLATFORMS/FLATS	3107.9	66.82	475.00
141	1ST PLATFORM	877.6	96.90	475.00
142	2ND PLATFORM	511.8	85.91	475.00
143	3RD PLATFORM	1497.9	47.95	475.00
144	4TH PLATFORM			
145	5TH PLAT+PLATS BELOW			
149	FLATS	220.6	31.01	475.00
150	DECK HOUSE STRUCTURE	4301.2	123.08	501.43
151	DECKHOUSE STRUCT TO FIRST LEVEL			
152	1ST DECKHOUSE LEVEL			
153	2ND DECKHOUSE LEVEL			
154	3RD DECKHOUSE LEVEL			
155	4TH DECKHOUSE LEVEL			
156	5TH DECKHOUSE LEVEL			
157	6TH DECKHOUSE LEVEL			
158	7TH DECKHOUSE LEVEL			
159	8TH DECKHOUSE LEVEL			
160	SPECIAL STRUCTURES	8553.5	88.10	474.66
161	CASTINGS+FORGINGS+EQUIV WELDMT	365.8	27.40	476.28
162	STACKS AND MACKS	17.3	145.92	280.93
163	SEA CHESTS	68.0	5.80	475.00
164	BALLISTIC PLATING			
165	SONAR DOMES			
166	SPONSONS	7880.9	92.22	475.00
167	HULL STRUCTURAL CLOSURES	199.8	61.67	475.00
168	DKHS STRUCTURAL CLOSURES			
169	SPECIAL PURPOSE CLOSURES+STRUCT	21.6	68.90	475.00
170	MASTS+KINGPOSTS+SERV PLATFORM	43.7	178.50	495.80
171	MASTS,TOWERS,TETRAPODS	43.7	178.50	495.80
172	KINGPOSTS AND SUPPORT FRAMES			

179 SERVICE PLATFORMS			
180 FOUNDATIONS	2006.8	28.99	629.52
181 HULL STRUCTURE FOUNDATIONS			
182 PROPULSION PLANT FOUNDATIONS	1601.8	18.70	703.18
183 ELECTRIC PLANT FOUNDATIONS	52.5	52.06	487.97
184 COMMAND+SURVEILLANCE FDNS	94.8	101.50	475.00
185 AUXILIARY SYSTEMS FOUNDATIONS	257.2	61.57	256.90
186 OUTFIT+FURNISHINGS FOUNDATIONS			
187 ARMAMENT FOUNDATIONS	.5	69.96	475.00
190 SPECIAL PURPOSE SYSTEMS	1158.4	69.07	488.12
191 BALLAST+BOUYANCY UNITS			
196 MILL TOLERANCE	644.0	70.56	488.43
197 WELDING AND RIVETS	487.8	70.56	488.43
198 FREE FLOODING LIQUIDS	26.6	5.50	475.00
199 HULL REPAIR PARTS+SPECIAL TOOLS			

* DENOTES INCLUSION OF PAYLOAD OR ADJUSTMENTS

PRINTED REPORT NO. 3 - PROPULSION PLANT WEIGHT

SWBS COMPONENT	WT-LTON	VCG-FT	LCG-FT
200 PROPULSION PLANT	4811.9	29.42	666.72
210 ENERGY GEN SYS (NUCLEAR)			
212 NUCLEAR STEAM GENERATOR			
213 REACTORS			
214 REACTOR COOLANT SYSTEM			
215 REACTOR COOLANT SERVICE SYSTEM			
216 REACTOR PLANT AUXILIARY SYSTEMS			
217 NUCLEAR POWER CONTROL+INSTRUM			
218 RADIATION SHIELDING (PRIMARY)			
219 RADIATION SHIELDING (SECONDARY)			
220 ENERGY GENERATING SYSTEM (NONNUC)			
221 PROPULSION BOILERS			
222 GAS GENERATORS			
223 MAIN PROPULSION BATTERIES			
224 MAIN PROPULSION FUEL CELLS			
230 PROPULSION UNITS	3777.4	23.93	681.67
231 STEAM TURBINES			
232 STEAM ENGINES			
233 DIESEL ENGINES	1060.7	20.41	686.12
234 GAS TURBINES	93.9	89.36	182.66
235 ELECTRIC PROPULSION	2622.8	23.01	697.72
236 SELF-CONTAINED PROPULSION SYS			
237 AUXILIARY PROPULSION DEVICES			
240 TRANSMISSION+PROPULSOR SYSTEMS	452.8	11.06	821.31
241 REDUCTION GEARS			
242 CLUTCHES + COUPLINGS			
243 SHAFTING	183.6	12.12	872.69
244 SHAFT BEARINGS	96.6	14.86	834.19
245 PROPULSORS	172.7	7.81	759.50
246 PROPULSOR SHROUDS AND DUCTS			
247 WATER JET PROPULSORS			

250 SUPPORT SYSTEMS	430.8	101.94	398.42
251 COMBUSTION AIR SYSTEM	79.2	109.07	295.07
252 PROPULSION CONTROL SYSTEM	43.8	68.90	645.19
253 MAIN STEAM PIPING SYSTEM			
254 CONDENSERS AND AIR EJECTORS			
255 FEED AND CONDENSATE SYSTEM			
256 CIRC + COOL SEA WATER SYSTEM	66.7	38.16	598.50
258 H.P. STEAM DRAIN SYSTEM			
259 UPTAKES (INNER CASING)	241.2	123.22	332.28
260 PROPUL SUP SYS- FUEL, LUBE OIL	64.2	14.15	637.26
261 FUEL SERVICE SYSTEM	9.4	20.01	597.69
262 MAIN PROPULSION LUBE OIL SYSTEM	39.2	12.00	645.19
264 LUBE OIL HANDLING	15.7	16.00	641.19
290 SPECIAL PURPOSE SYSTEMS	86.5	15.55	562.73
298 OPERATING FLUIDS	75.5	8.00	570.00
299 REPAIR PARTS + TOOLS	11.0	67.20	513.00

* DENOTES INCLUSION OF PAYLOAD OR ADJUSTMENTS

PRINTED REPORT NO. 4 - ELECTRIC PLANT WEIGHT

SWBS	COMPONENT	WT-LTON	VCG-FT	LCG-FT
300	ELECTRIC PLANT, GENERAL	1672.1	71.44	498.26
310	ELECTRIC POWER GENERATION	409.7	62.85	466.24
311	SHIP SERVICE POWER GENERATION	262.5	54.06	487.97
312	EMERGENCY GENERATORS			
313	BATTERIES+SERVICE FACILITIES			
314	POWER CONVERSION EQUIPMENT	147.2	78.53	427.50
320	POWER DISTRIBUTION SYS	698.0	56.65	504.56
321	SHIP SERVICE POWER CABLE	588.9	53.00	503.50
322	EMERGENCY POWER CABLE SYS			
323	CASUALTY POWER CABLE SYS	70.3	75.58	503.50
324	SWITCHGEAR+PANELS	38.9	77.70	522.50
330	LIGHTING SYSTEM	529.1	99.76	497.96
331	LIGHTING DISTRIBUTION	220.8	94.40	503.50
332	LIGHTING FIXTURES	308.3	103.59	494.00
340	POWER GENERATION SUPPORT SYS			
341	SSTG LUBE OIL			
342	DIESEL SUPPORT SYS			
343	TURBINE SUPPORT SYS			
390	SPECIAL PURPOSE SYS	35.2	39.22	750.50
398	ELECTRIC PLANT OP FLUIDS			
399	REPAIR PARTS+SPECIAL TOOLS	35.2	39.22	750.50

* DENOTES INCLUSION OF PAYLOAD OR ADJUSTMENTS

PRINTED REPORT NO. 5 - COMMAND+SURVEILLANCE WEIGHT

	SWBS	COMPONENT	WT-LTON	VCG-FT	LCG-FT
	400	COMMAND+SURVEILLANCE	1072.1	84.18	352.14
	410	COMMAND+CONTROL SYS	144.7	100.14	167.90
*	411	DATA DISPLAY GROUP	136.4	100.50	152.00
	412	DATA PROCESSING GROUP	7.1	93.21	475.00
*	413	DIGITAL DATA SWITCHBOARDS	1.2	100.50	152.00
	414	INTERFACE EQUIPMENT			
	415	DIGITAL DATA COMMUNICATIONS			
	417	COMMAND+CONTROL ANALOG SWBD			
	420	NAVIGATION SYS	75.1	99.42	461.82
	421	NON-ELECT NAVIGATION AIDS			
*	422	ELECTRICAL NAVIGATION AIDS	5.7	108.60	108.00
	423	ELECTRONIC NAVIG AIDS, RADIO	67.4	101.00	495.80
	424	ELECTRONIC NAVIG AIDS, ACOUSTIC			
	426	ELECTRICAL NAVIGATION SYS			
*	427	INERTIAL NAVIGATION SYS	2.0	20.00	325.00
	428	NAVIGATION CONTROL MONITORING			
	430	INTERIOR COMMUNICATIONS	246.5	77.12	475.92
*	431	SWITCHBOARDS FOR I.C. SYSTEMS	3.1	100.50	152.00
	432	TELEPHONE SYSTEMS	224.1	76.32	475.00
	433	ANNOUNCING SYSTEMS			
*	434	ENTERTAINMENT + TRAINING SYS	5.8	100.50	775.00
	435	VOICE TUBES+MESSAGE PASSING SYS			
*	436	ALARM, SAFETY, WARNING SYSTEMS	13.5	75.00	437.00
	437	INDICATING, ORDER, METERING SYS			
	438	INTEGRATED CONTROL SYSTEMS			
	439	RECORDING + TELEVISION SYSTEMS			
	440	EXTERIOR COMMUNICATIONS	346.2	100.50	267.00
*	441	RADIO SYSTEMS	346.2	100.50	267.00
	442	UNDERWATER SYSTEMS			
	443	VISUAL + AUDIBLE SYSTEMS			
	444	TELEMETRY SYSTEMS			
	445	TTY + FACSIMILE SYSTEMS			
	446	SECURITY EQUIPMENT SYSTEMS			
	450	SURF SURV SYS (RADAR)	3.7	100.50	100.00
	451	SURFACE SEARCH RADAR			
	452	AIR SEARCH RADAR (2D)			
	453	AIR SEARCH RADAR (3D)			
	454	AIRCRAFT CONTROL APPROACH RADAR			
*	455	IDENTIFICATION SYSTEMS (IFF)	3.7	100.50	100.00
	456	MULTIPLE MODE RADAR			
	459	SPACE VEHICLE ELECTRONIC TRACKG			
	460	UNDERWATER SURVEILLANCE SYSTEMS			
	461	ACTIVE SONAR			
	462	PASSIVE SONAR			
	463	MULTIPLE MODE SONAR			
	464	CLASSIFICATION SONAR			
	465	BATHYTHERMOGRAPH			
	466	MISC ELECTRONICS			
	470	COUNTERMEASURES	219.0	47.54	461.43
*	471	ACTIVE + ACTIVE/PASSIVE ECM	12.6	106.00	450.00
*	472	PASSIVE ECM	1.2	106.00	450.00
	473	TORPEDO DECOYS			
	474	DECOYS (OTHER)			

*	475 DEGAUSSING	205.2	43.61	462.20
	476 MINE COUNTERMEASURES			
	480 FIRE CONTROL SYS	36.9	100.50	200.00
	481 GUN FIRE CONTROL SYSTEMS			
*	482 MISSILE FIRE CONTROL SYSTEMS	36.9	100.50	200.00
	483 UNDERWATER FIRE CONTROL SYSTEMS			
	484 INTEGRATED FIRE CONTROL SYSTEMS			
	489 WEAPON SYSTEM SWITCHBOARDS			
	490 SPECIAL PURPOSE SYS			
	491 ELCTRNC TEST,CHKOUT,MONITR EQPT			
	492 FLIGHT CNTRL+INSTR LANDING SYS			
	493 NON-COMBAT DATA PROCESSING SYS			
	494 METEOROLOGICAL SYSTEMS			
	495 SPEC PURPOSE INTELLIGENCE SYS			
	496 OPERATION SPACE ITEMS			
	498 C+S OPERATING FLUIDS			
	499 REPAIR PARTS+SPECIAL TOOLS			

* DENOTES INCLUSION OF PAYLOAD OR ADJUSTMENTS

PRINTED REPORT NO. 6 - AUXILIARY SYSTEMS WEIGHT

SWBS COMPONENT	WT-LTON	VCG-FT	LCG-FT
500 AUXILIARY SYSTEMS, GENERAL	2909.9	61.57	256.90
510 CLIMATE CONTROL	1181.3	72.96	65.62
* 511 COMPARTMENT HEATING SYSTEM	144.9	68.90	475.00
512 VENTILATION SYSTEM	1018.1	74.20	
513 MACHINERY SPACE VENT SYSTEM			
514 AIR CONDITIONING SYSTEM			
516 REFRIGERATION SYSTEM	18.3	36.04	475.00
517 AUX BOILERS+OTHER HEAT SOURCES			
520 SEA WATER SYSTEMS	404.8	61.48	475.00
521 FIREMAIN+SEA WATER FLUSHING SYS	404.8	61.48	475.00
522 SPRINKLING SYSTEM			
523 WASHDOWN SYSTEM			
524 AUXILIARY SEAWATER SYSTEM			
526 SCUPPERS+DECK DRAINS			
527 FIREMAIN ACTUATED SERV, OTHER			
528 PLUMBING DRAINAGE			
529 DRAINAGE+BALLASTING SYSTEM			
530 FRESH WATER SYSTEMS	100.4	17.15	475.00
531 DISTILLING PLANT			
532 COOLING WATER			
533 POTABLE WATER	65.0	9.15	475.00
534 AUX STEAM + DRAINS IN MACH BOX	35.5	31.80	475.00
535 AUX STEAM + DRAINS OUT MACH BOX			
536 AUXILIARY FRESH WATER COOLING			
540 FUELS/LUBRICANTS,HANDLING+STORAGE			
541 SHIP FUEL+COMPENSATING SYSTEM			
542 AVIATION+GENERAL PURPOSE FUELS			
543 AVIATION+GENERAL PURPOSE LUBO			
544 LIQUID CARGO			
545 TANK HEATING			475.00
546 AUXILIARY LUBE SYS			
549 SPEC FUEL+LUBRICANTS HANDL+STOW			
550 AIR,GAS+MISC FLUID SYSTEM			
551 COMPRESSED AIR SYSTEMS			
552 COMPRESSED GASES			
553 O2 N2 SYSTEM			
554 LP BLOW			
555 FIRE EXTINGUISHING SYSTEMS			
556 HYDRAULIC FLUID SYSTEM			
557 LIQUID GASES, CARGO			
558 SPECIAL PIPING SYSTEMS			
560 SHIP CNTL SYS			
561 STEERING+DIVING CNTL SYS			
562 RUDDER			
565 TRIM+HEEL SYSTEMS			
568 MANEUVERING SYSTEMS			
570 UNDERWAY REPLENISHMENT SYSTEMS			
571 REPLENISHMENT-AT-SEA SYSTEMS			
572 SHIP STORES+EQUIP HANDLING SYS			
573 CARGO HANDLING SYSTEMS			
574 VERTICAL REPLENISHMENT SYSTEMS			
575 VEHICLE HANDLING+STOWAGE SYSTEMS			
580 MECHANICAL HANDLING SYSTEMS	999.4	53.28	323.86

	581 ANCHOR HANDLING+STOWAGE SYSTEMS	622.4	62.54	10.00
	582 MOORING+TOWING SYSTEMS			
*	583 BOATS,HANDLING+STOWAGE SYSTEMS	377.0	38.00	842.00
	584 MECH OPER DOOR,GATE,RAMP,TTBL SYS			
	585 ELEVATING + RETRACTING GEAR			
	586 AIRCRAFT RECOVERY SUPPORT SYS			
	587 AIRCRAFT LAUNCH SUPPORT SYSTEM			
	588 AIRCRAFT HANDLING,SERVICE,STOWAGE			
	589 MISC MECH HANDLING SYSTEMS			
	590 SPECIAL PURPOSE SYSTEMS	224.0	58.58	475.00
	591 SCIENTIFIC+OCEAN ENGINEERING SYS			
	592 SWIMMER+DIVER SUPPORT+PROT SYS			
	593 ENVIRONMENTAL POLLUTION CNTL SYS			
	594 SUBMARINE RESC+SALVG+SURVIVE SYS			
	595 TOW,LAUNCH,HANDLE UNDERWATER SYS			
	596 HANDLING SYS FOR DIVER+SUBMR VEH			
	597 SALVAGE SUPPORT SYSTEMS			
	598 AUX SYSTEMS OPERATING FLUIDS	224.0	58.58	475.00
	599 AUX SYSTEMS REPAIR PARTS+TOOLS			

* DENOTES INCLUSION OF PAYLOAD OR ADJUSTMENTS

PRINTED REPORT NO. 7 - OUTFIT+FURNISHINGS WEIGHT

SWBS	COMPONENT	WT-LTON	VCG-FT	LCG-FT
600	OUTFIT+FURNISHING,GENERAL	4236.2	75.79	474.73
610	SHIP FITTINGS	87.5	83.26	487.04
611	HULL FITTINGS	52.2	76.32	475.00
612	RAILS,STANCHIONS+LIFELINES	28.6	94.34	475.00
613	RIGGING+CANVAS	6.6	90.10	633.33
620	HULL COMPARTMENTATION	788.2	69.33	475.00
621	NON-STRUCTURAL BULKHEADS	515.1	84.80	475.00
622	FLOOR PLATES+GRATING	76.3	45.79	475.00
623	LADDERS	188.7	33.32	475.00
624	NON-STRUCTURAL CLOSURES			
625	AIRPORTS,FIXED PORTLTS, WINDOWS	8.1	146.25	475.00
630	PRESERVATIVES+COVERINGS	1841.1	76.75	475.00
631	PAINTING	289.1	60.42	475.00
632	ZINC COATING			
633	CATHODIC PROTECTION	6.1	28.62	475.00
634	DECK COVERINGS	446.6	76.32	475.00
635	HULL INSULATION	791.4	81.62	475.00
636	HULL DAMPING			
637	SHEATHING	272.9	86.92	475.00
638	REFRIGERATION SPACES	35.0	36.04	475.00
639	RADIATION SHIELDING			
640	LIVING SPACES	47.1	92.81	280.66
641	OFFICER BERTHING+MESSING	15.6	101.66	475.00
642	NON-COMM OFFICER B+M	1.6	94.83	475.00
643	ENLISTED PERSONNEL B+M	8.9	96.86	475.00
644	SANITARY SPACES+FIXTURES	1.0	98.53	436.47
645	LEISURE+COMMUNITY SPACES	20.0	83.68	20.02
650	SERVICE SPACES	187.3	98.55	512.08
651	COMMISSARY SPACES	100.5	100.00	475.00
652	MEDICAL SPACES	21.7	101.00	380.00

653 DENTAL SPACES	1.7	89.00	380.00
654 UTILITY SPACES			
655 LAUNDRY SPACES	62.8	95.50	617.50
656 TRASH DISPOSAL SPACES	.6	111.00	807.50
660 WORKING SPACES	396.1	103.20	475.00
661 OFFICES	109.6	84.80	475.00
662 MACH CNTL CENTER FURNISHING			
663 ELECT CNTL CENTER FURNISHING			
664 DAMAGE CNTL STATIONS			
665 WORKSHOPS,LABS,TEST AREAS	286.4	110.24	475.00
670 STOWAGE SPACES	853.9	60.45	475.00
671 LOCKERS+SPECIAL STOWAGE			
672 STOREROOMS+ISSUE ROOMS	853.9	60.45	475.00
673 CARGO STOWAGE			
690 SPECIAL PURPOSE SYSTEMS	35.1	72.21	72.21
698 OPERATING FLUIDS	1.4	75.26	475.00
699 REPAIR PARTS+SPECIAL TOOLS	33.7	72.08	475.00

* DENOTES INCLUSION OF PAYLOAD OR ADJUSTMENTS

PRINTED REPORT NO. 8 - ARMAMENT WEIGHT

SWBS	COMPONENT	WT-LTON	VCG-FT	LCG-FT
700	ARMAMENT	5.1	81.90	691.83
710	GUNS+AMMUNITION			
711	GUNS			
712	AMMUNITION HANDLING			
713	AMMUNITION STOWAGE			
720	MISSLES+ROCKETS			
721	LAUNCHING DEVICES			
722	MISSILE+ROCKET,GUID CAP HAND SYS			
723	MISSILE+ROCKET STOWAGE			
724	MISSILE HYDRAULICS			
725	MISSILE GAS			
726	MISSILE COMPENSATING			
727	MISSILE LAUNCHER CONTROL			
728	MISSILE HEAT,COOL,TEMP CNTRL			
729	MISSILE MONITOR,TEST,ALINEMENT			
730	MINES			
731	MINE LAUNCHING DEVICES			
732	MINE HANDLING			
733	MINE STOWAGE			
740	DEPTH CHARGES			
741	DEPTH CHARGE LAUNCHING DEVICES			
742	DEPTH CHARGE HANDLING			
743	DEPTH CHARGE STOWAGE			
750	TORPEDOES			
751	TORPEDO TUBES			
752	TORPEDO HANDLING			
753	TORPEDO STOWAGE			
760	SMALL ARMS+PYROTECHNICS	5.0	82.83	698.20
761	SMALL ARMS+PYRO LAUNCHING DEV	2.4	100.50	475.00
762	SMALL ARMS+PYRO HANDLING	.2	24.79	475.00
763	SMALL ARMS+PYRO STOWAGE	2.4	70.00	940.00
770	CARGO MUNITIONS			
772	CARGO MUNITIONS HANDLING			
773	CARGO MUNITIONS STOWAGE			
780	AIRCRAFT RELATED WEAPONS			
782	AIRCRAFT RELATED WEAPONS HANDL			
783	AIRCRAFT RELATED WEAPONS STOW			
784	AIRCRAFT RELATED WPNS ELEV, US			
785	AIRCRAFT RELATED WPNS ELEV, LS			
786	AIRCRAFT RELATED WEAPONS, HYD			
790	SPECIAL PURPOSE SYSTEMS	.1	50.25	475.00
791	SPECIAL WEAPONS SYSTEMS			
792	SPECIAL WEAPONS HANDLING			
793	SPECIAL WEAPONS STOWAGE			
797	MISC ORDINANCE SPACES			
798	ARMAMENT OPERATING FLUIDS	.0	55.12	475.00
799	ARMAMENT REPAIR PART+TOOLS	.1	49.82	475.00

* DENOTES INCLUSION OF PAYLOAD OR ADJUSTMENTS

PRINTED REPORT NO. 9 - LOADS WEIGHT (FULL LOAD CONDITION)

	SWBS	COMPONENT	WT-LTON	VCG-FT	LCG-FT
	F00	LOADS	37970.8	50.51	475.29
	F10	SHIPS FORCE	14.9	95.22	452.27
	F11	OFFICERS	8.0	93.27	407.29
	F12	NON-COMMISSIONED OFFICERS	.3	89.55	572.37
	F13	ENLISTED MEN	2.1	88.43	451.72
	F14	MARINES			
	F15	TROOPS			
	F16	AIR WING PERSONNEL			
	F19	OTHER PERSONNEL	4.5	102.15	524.70
	F20	MISSION RELATED EXPENDABLES+SYS	382.1	102.63	475.00
	F21	SHIP AMMUNITION	35.7	15.50	475.00
	F22	ORD DEL SYS AMMO			
	F23	ORD DEL SYS (AIRCRAFT)	225.8	113.00	475.00
	F24	ORD REPAIR PARTS (SHIP)			
	F25	ORD REPAIR PARTS (ORD)			
	F26	ORD DEL SYS SUPPORT EQUIP	120.6	109.01	475.00
	F29	SPECIAL MISSION RELATED SYS			
	F30	STORES	925.3	86.61	475.00
	F31	PROVISIONS+PERSONNEL STORES	762.9	93.54	475.00
	F32	GENERAL STORES	162.4	54.06	475.00
	F33	MARINES STORES (SHIPS COMPLEM)			
	F39	SPECIAL STORES			
	F40	LIQUIDS, PETROLEUM BASED	13376.2	32.60	498.85
	F41	DIESEL FUEL MARINE	10330.5	37.56	544.26
*	F42	JP-5	3000.0	16.00	350.00
	F43	GASOLINE	.2	109.00	902.50
	F44	DISTILLATE FUEL			
	F45	NAVY STANDARD FUEL OIL (NSFO)			
	F46	LUBRICATING OIL	45.4		
	F49	SPECIAL FUELS AND LUBRICANTS			
	F50	LIQUIDS, NON-PETRO BASED	1028.5	37.56	475.00
	F51	SEA WATER			
	F52	FRESH WATER	965.2	37.56	475.00
	F53	RESERVE FEED WATER			
	F54	HYDRAULIC FLUID			
	F55	SANITARY TANK LIQUID	63.3	37.56	475.00
	F56	GAS (NON FUEL TYPE)			
	F59	MISC LIQUIDS, NON-PETROLEUM			
	F60	CARGO	22243.7	59.46	461.17
*	F61	CARGO, ORDINANCE + DELVRY SYS	243.0	114.00	470.00
	F62	CARGO, STORES			
*	F63	CARGO, FUELS + LUBRICANTS	3000.0	16.00	350.00
	F64	CARGO, LIQUIDS, NON-PETROLEUM			
	F65	CARGO, CRYOGENIC+LIQUEFIED GAS			
*	F66	CARGO, AMPHIBIOUS ASSAULT SYS	6214.0	40.82	350.00
	F67	CARGO, GASES			
*	F69	CARGO, MISCELLANEOUS	12786.7	77.67	541.10

* DENOTES INCLUSION OF PAYLOAD OR ADJUSTMENTS

PRINTED REPORT NO. 10 - WEIGHT AND KG MODIFICATION SUMMARY

ROW	WT KEY	P+A NAME	WT - LTON ORIGINAL	WT - LTON CHANGE	WT - LTON RESULT.	VCG - FT ORIG.	VCG - FT CHANGE	VCG - FT RESULT.	LCG -FT ORIG.	LCG -FT CHANGE	LCG -FT RESULT.
33	W411	COMBAT SYSTEMS	.0	136.4	136.4	UNKNOWN	100.5	100.5	UNKNOWN	152.0	152.0
34	W413	COMBAT SYSTEMS	.0	1.2	1.2	UNKNOWN	100.5	100.5	UNKNOWN	152.0	152.0
35	W422	COMBAT SYSTEMS	.0	5.7	5.7	UNKNOWN	108.6	108.6	UNKNOWN	108.0	108.0
36	W427	COMBAT SYSTEMS	.0	2.0	2.0	UNKNOWN	20.0	20.0	UNKNOWN	325.0	325.0
37	W431	COMBAT SYSTEMS	.0	3.1	3.1	UNKNOWN	100.5	100.5	UNKNOWN	152.0	152.0
38	W434	COMBAT SYSTEMS	.0	5.8	5.8	UNKNOWN	100.5	100.5	UNKNOWN	775.0	775.0
39	W436	COMBAT SYSTEMS	.0	13.5	13.5	UNKNOWN	75.0	75.0	UNKNOWN	437.0	437.0
40	W441	COMBAT SYSTEMS	.0	346.2	346.2	UNKNOWN	100.5	100.5	UNKNOWN	267.0	267.0
41	W455	COMBAT SYSTEMS	.0	3.7	3.7	UNKNOWN	100.5	100.5	UNKNOWN	100.0	100.0
42	W471	COMBAT SYSTEMS	.0	12.6	12.6	UNKNOWN	106.0	106.0	UNKNOWN	450.0	450.0
43	W472	COMBAT SYSTEMS	.0	1.2	1.2	UNKNOWN	106.0	106.0	UNKNOWN	450.0	450.0
44	W475	COMBAT SYSTEMS	100.1	105.1	205.2	71.0	17.5	43.6	475.0	450.0	462.2
45	W482	COMBAT SYSTEMS	.0	36.9	36.9	UNKNOWN	100.5	100.5	UNKNOWN	200.0	200.0
7	W511	REDUCE GR 511 (HEATING) ELECTRIC LOAD	144.9	.0	144.9	68.9	.0	68.9	475.0	.0	475.0
32	W583	WELLDECK VESSELS	.0	377.0	377.0	UNKNOWN	38.0	38.0	UNKNOWN	842.0	842.0
30	WF42	JP5 PROPULSION	.0	3000.0	3000.0	UNKNOWN	16.0	16.0	UNKNOWN	350.0	

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350.0
  31   WF61   HANGAR
       .0    243.0    243.0   UNKNOWN   114.0   114.0   UNKNOWN   470.0
470.0
  29   WF63   JP5 FUEL CARGO
       .0   3000.0   3000.0   UNKNOWN    16.0    16.0   UNKNOWN   350.0
350.0
  11   WF66   VEHICLE DECK 1A
       .0    205.9            UNKNOWN    29.5           UNKNOWN   100.0
  12           1B
             305.0                       29.0                     200.0
  13           1C
             305.0                       29.0                     300.0
  14           1D
             305.0                       29.0                     400.0
  15           1E
             305.0                       29.0                     500.0
  16           1F
             205.9                       29.5                     600.0
  17           VEHICLE DECK 2A
             213.5                       40.5                     100.0
  18           2B
             625.8                       39.8                     200.0
  19           2C
             625.8                       39.8                     300.0
  20           2D
             625.8                       39.8                     400.0
  21           2E
             625.8                       39.8                     500.0
  22           2F
             213.5                       40.5                     600.0
  23           VEHICLE DECK 3A
             100.0                       54.0                     100.0
  24           3B
             100.0                       54.0                     200.0
  25           3C
             625.8                       54.0                     300.0
  26           3D
             625.8                       54.0                     400.0
  27           3E
             100.0                       54.0                     500.0
  28           3F
             100.0   6214.0              54.0    40.8             600.0
350.0
   8   WF69   FWD CARGO SPACE (LRG OB 1)
       .0   1183.2            UNKNOWN    76.0           UNKNOWN   140.0
   9           MIS CARGO SPACE (LRG OB 2)
            6707.5                       80.5                     438.5
  10           AFT CARGO SPACE (LRG OB 3)
            4896.0  12786.7              74.2    77.7             778.6
541.1
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PRINTED REPORT NO. 11 - P+A WEIGHTS AND VCGS

ROW / WT KEY	PAYLOAD NAME / WEIGHT ADD,LTON	WEIGHT FAC	VCG KEY	VCG ADD,FT	VCG FAC	LCG KEY	LCG ADD,FT	LCG FAC
33	COMBAT SYSTEMS							
W411	136.40	.00	BL	100.50	1.00	FPRP	152.00	1.00
34	COMBAT SYSTEMS							
W413	1.20	.00	BL	100.50	1.00	FPRP	152.00	1.00
35	COMBAT SYSTEMS							
W422	5.70	.00	BL	108.60	1.00	FPRP	108.00	1.00
36	COMBAT SYSTEMS							
W427	2.00	.00	BL	20.00	1.00	FPRP	325.00	1.00
37	COMBAT SYSTEMS							
W431	3.10	.00	BL	100.50	1.00	FPRP	152.00	1.00
38	COMBAT SYSTEMS							
W434	5.80	.00	BL	100.50	1.00	FPRP	775.00	1.00
39	COMBAT SYSTEMS							
W436	13.50	.00	BL	75.00	1.00	FPRP	437.00	1.00
40	COMBAT SYSTEMS							
W441	346.20	.00	BL	100.50	1.00	FPRP	267.00	1.00
41	COMBAT SYSTEMS							
W455	3.70	.00	BL	100.50	1.00	FPRP	100.00	1.00
42	COMBAT SYSTEMS							
W471	12.60	.00	BL	106.00	1.00	FPRP	450.00	1.00
43	COMBAT SYSTEMS							
W472	1.20	.00	BL	106.00	1.00	FPRP	450.00	1.00
44	COMBAT SYSTEMS							
W475	105.10	.00	BL	17.50	1.00	FPRP	450.00	1.00
45	COMBAT SYSTEMS							
W482	36.90	.00	BL	100.50	1.00	FPRP	200.00	1.00
7	REDUCE GR 511 (HEATING) ELECTRIC LOAD							
W511	.00	.00	NONE	.00	1.00	NONE	.00	1.00
32	WELLDECK VESSELS							
W583	377.00	.00	BL	38.00	1.00	FPRP	842.00	1.00
30	JP5 PROPULSION							
WF42	3000.00	.00	D20	-90.00	1.00	FPRP	350.00	1.00
31	HANGAR							
WF61	243.00	.00	D20	8.00	1.00	FPRP	470.00	1.00

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 29   JP5 FUEL CARGO
WF63   3000.00       .00   D20     -90.00      1.00   FPRP    350.00    1.00

 11   VEHICLE DECK 1A
WF66    205.90       .00   D20     -76.50      1.00   FPRP    100.00    1.00

 12   1B
WF66    305.04       .00   D20     -77.00      1.00   FPRP    200.00    1.00

 13   1C
WF66    305.04       .00   D20     -77.00      1.00   FPRP    300.00    1.00

 14   1D
WF66    305.04       .00   D20     -77.00      1.00   FPRP    400.00    1.00

 15   1E
WF66    305.04       .00   D20     -77.00      1.00   FPRP    500.00    1.00

 16   1F
WF66    205.90       .00   D20     -76.50      1.00   FPRP    600.00    1.00

 17   VEHICLE DECK 2A
WF66    213.50       .00   D20     -65.50      1.00   FPRP    100.00    1.00

 18   2B
WF66    625.84       .00   D20     -66.20      1.00   FPRP    200.00    1.00

 19   2C
WF66    625.84       .00   D20     -66.20      1.00   FPRP    300.00    1.00

 20   2D
WF66    625.84       .00   D20     -66.20      1.00   FPRP    400.00    1.00

 21   2E
WF66    625.84       .00   D20     -66.20      1.00   FPRP    500.00    1.00

 22   2F
WF66    213.50       .00   D20     -65.50      1.00   FPRP    600.00    1.00

 23   VEHICLE DECK 3A
WF66    100.00       .00   D20     -52.00      1.00   FPRP    100.00    1.00

 24   3B
WF66    100.00       .00   D20     -52.00      1.00   FPRP    200.00    1.00

 25   3C
WF66    625.84       .00   D20     -52.00      1.00   FPRP    300.00    1.00

 26   3D
WF66    625.84       .00   D20     -52.00      1.00   FPRP    400.00    1.00

 27   3E
WF66    100.00       .00   D20     -52.00      1.00   FPRP    500.00    1.00

 28   3F
WF66    100.00       .00   D20     -52.00      1.00   FPRP    600.00    1.00
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8 FWD CARGO SPACE (LRG OB 1)

WF69	1183.20	.00	D20	-30.00	1.00	FPRP	140.00	1.00

9 MIS CARGO SPACE (LRG OB 2)

WF69	6707.52	.00	D20	-25.50	1.00	FPRP	438.50	1.00

10 AFT CARGO SPACE (LRG OB 3)

WF69	4896.00	.00	D20	-31.80	1.00	FPRP	778.60	1.00

ASSET/MONOCV VERSION 4.2.0 - SPACE MODULE - 11/22/98 16:10.18

PRINTED REPORT NO. 1 - SUMMARY

SHIP TYPE-AMPHIB
COLL PROTECT SYSTEM-NONE
SONAR DOME-NONE

AVIATION FACILITY-MAJOR AVN
HAB STANDARD-NAVY
EMBARKED COMMANDER-FLAG CMDR

FULL LOAD WT, LTON	85931.5		
TOTAL CREW ACC	4332.	PASSWAY MARGIN FAC	.000
HULL AVG DECK HT, FT	19.79	AC MARGIN FAC	.200
MR VOLUME, FT3	663753.	SPACE MARGIN FAC	.000
TANK VOL REQ,FT3	793131.	TANK MARGIN FAC	.000
SHAFT ALLEY VOLUME,FT3	8713.		

	AREA FT2			VOL FT3
	PAYLOAD REQUIRED	TOTAL REQUIRED	TOTAL AVAILABLE	TOTAL ACTUAL
DKHS ONLY	0.	12960.	252160.	2496258.
HULL OR DKHS	114462.	508797.	487000.	11689610.
SPONSON			248354.	2665165.
TOTAL	114462.	521758.	987514.	16851030.

SSCS GROUP	TOTAL AREA FT2	DKHS AREA FT2	PERCENT TOTAL AREA
1. MISSION SUPPORT	294147.	13628.	56.4
2. HUMAN SUPPORT	187991.	3162.	36.0
3. SHIP SUPPORT	-30581.	-17823.	-5.9
4. SHIP MOBILITY SYSTEM	70201.	13994.	13.5
5. UNASSIGNED			.0
TOTAL	521758.	12960.	100.0

PRINTED REPORT NO. 2 - MISSION SUPPORT AREA

SSCS	GROUP	VOLUME FT3	AREA FT2	LOC	SD
*1.	MISSION SUPPORT	141693.3	294147.4	T	0
			13628.0	D	
			280519.5	E	
1.1	COMMAND,COMMUNICATION+SURV		8178.0	D	0
			16.2	E	
1.11	EXTERIOR COMMUNICATIONS		64.0	D	0
1.111	RADIO			E	0
1.112	UNDERWATER SYSTEMS			E	0
1.113	VISUAL COM		64.0	D	0
1.12	SURVEILLANCE SYS			E	0
1.121	SURFACE SURV (RADAR)			E	0
1.122	UNDERWATER SURV (SONAR)			E	0
1.13	COMMAND+CONTROL		953.3	D	0
1.131	COMBAT INFO CENTER			E	0
1.132	CONNING STATIONS		953.3	D	0
1.13201	PILOT HOUSE		873.2	D	0
1.13202	CHART ROOM		80.1	D	0
1.14	COUNTERMEASURES			E	0
1.141	ELECTRONIC			E	0
1.142	TORPEDO			E	0
1.143	MISSILE			E	0
1.15	INTERIOR COMMUNICATIONS		7160.7	D	0
1.16	ENVIORNMENTAL CNTL SUP SYS		16.2	E	0
1.2	WEAPONS			E	0
1.21	GUNS			E	0
1.22	MISSILES			E	0
1.23	ROCKETS			E	0
1.24	TORPEDOS			E	0
1.25	DEPTH CHARGES			E	0
1.26	MINES			E	0
1.27	MULT EJECT RACK STOW			E	0
1.28	WEAP MODULE STA & SERV INTER			E	0
1.3	AVIATION	141693.3		E	0
1.31	AVIATION LAUNCH+RECOVERY			E	0
1.311	LAUNCHING+RECOVERY AREAS			E	0
1.31102	HELICOPTER LANDING AREA			E	0
1.312	LAUNCHING+RECOVERY EQUIP			E	0
1.3123	HELICOPTER RECOVERY			E	0
1.32	AVIATION CONTROL			E	0
1.323	OPERATIONS			E	0
1.33	AVIATION HANDLING			E	0
1.34	AIRCRAFT STOWAGE			E	0
1.34002	HELICOPTER HANGAR			E	0
1.35	AVIATION ADMINISTRATION			E	0
1.36	AVIATION MAINTENANCE			E	0
1.37	AIRCRAFT ORDINANCE			E	0
1.372	CONTROL			E	0
1.373	HANDLING			E	0
1.374	STOWAGE			E	0
1.38	AVIATION FUEL SYS	141693.3		E	0
1.381	JP-5 SYSTEM	141693.3		E	0

1.3811	JP-5 TRANSFER						E	0
1.3812	JP-5 HANDLING						E	0
1.3813	AVIATION FUEL	141693.3					E	0
1.39	AVIATION STORES						E	0
1.391	AVIATION CONSUMABLES						E	0
1.4	AMPHIBIOUS		172655.5				E	0
1.41	AMPHIB OPS						E	0
1.42	AMPHIB CONTROL						E	0
1.43	AMPHIB HANDLING			1650.0			E	0
1.43007	STERN GATE OP GR RM					1200.0	E	0
1.43008	INHAUL MACH RM					450.0	E	0
1.44	AMPHIB STOWAGE			168033.0			E	0
*1.44001	VEHICLE STOWAGE					129807.4	E	0
1.44002	WELL DECK					38225.6	E	0
1.45	AMPHIB ADMIN			2372.6			E	0
1.451	LANDING FORCE CMDR ADMIN				1635.0		E	0
1.452	BATTALION ADMIN				875.0		E	0
1.453	TROOP ADMIN				-357.4		E	0
1.45401	COMBAT CARGO OFFICE					220.0	E	0
1.46	AMPHIB MAINTANENCE			600.0			E	0
1.46001	CANVAS & RUBBER SKRT SHP					600.0	E	0
1.47	AMPHIB ORDINANCE						E	0
1.48	AMPHIB FUEL						E	0
1.49	AMPHIB STORES						E	0
1.5	CARGO						E	0
1.6	INTERMEDIATE MAINT FAC						E	0
1.7	FLAG FACILITIES		5400.0				D	0
1.71	OPERATIONS						E	0
1.72	CONTROL			900.0			D	0
1.73	HANDLING						E	0
1.74	STOWAGE						E	0
1.75	ADMIN			4500.0			D	0
1.8	SPECIAL MISSIONS						E	0
1.9	SM ARMS,PYRO+SALU BAT		50.0				D	0
			11247.8				E	
1.91	SM ARMS (LOCKER)			291.7			E	0
1.92	PYROTECHNICS			50.0			D	0
1.93	SALUTING BAT (MAGAZINE)			40.0			E	0
1.94	ARMORY			12063.2			E	0
1.95	SECURITY FORCE EQUIP			-1147.1			E	0

PRINTED REPORT NO. 3 - HUMAN SUPPORT AREA

HAB STD = NAVY

SSCS	GROUP	VOLUME FT3	AREA FT2	LOC	SD
*2.	HUMAN SUPPORT		187991.1	T	0
			3161.6	D	
			184829.6	E	
2.1	LIVING		2344.0	D	0
			120284.5	E	
2.11	OFFICER LIVING		2319.0	D	0
			35071.0	E	
2.111	BERTHING		2101.0	D	0
			31718.0	E	
2.1111	SHIP OFFICER		863.0	D	0
			3325.0	E	
2.1111101	COMMANDING OFFICER CABIN		513.0	D	1
2.1111104	COMMANDING OFFICER STATEROOM		200.0	D	1
2.1111206	EXECUTIVE OFFICER STATEROOM		150.0	D	1
2.1111230	DEPARTMENT HEAD STATEROOM		625.0	E	5
2.1111302	OFFICER STATEROOM (DBL)		2700.0	E	0
2.1113	TROOP OFFICER		28393.0	E	0
2.1113103	TROOP COMMANDER CABIN		513.0	E	1
2.1113104	TROOP COMMANDER STATEROOM		200.0	E	1
2.1113301	TROOP OFFICER STATEROOM		10250.0	E	0
2.1113302	TROOP OFFICER STATEROOM		17430.0	E	166
2.1114	AVIATION OFFICER			E	0
2.1115	FLAG OFFICER		1238.0	D	0
2.1115101	FLAG CABIN		513.0	D	1
2.1115104	FLAG STATEROOM		200.0	D	1
2.1115301	FLAG STAFF OFFICER STTRM		525.0	D	5
2.112	SANITARY		218.0	D	0
			3353.0	E	
2.1121	SHIP OFFICER		80.0	D	0
			399.0	E	
2.1121101	COMMANDING OFFICER BATH		50.0	D	1
2.1121201	EXECUTIVE OFFICER BATH		30.0	D	1
2.1121202	OFFICER SEMI-PRIVATE BATH		37.5	E	1
2.1121203	OFFICER BATH		22.5	E	2
2.1121303	OFFICER WR, WC & SH		339.0	E	3
2.1123	TROOP OFFICER		2954.0	E	0
2.1123101	TROOP COMMANDER BATH		50.0	E	1
2.1123302	TROOP OFFICER WR, WC & SH		2904.0	E	13
2.1124	AVIATION OFFICER			E	0
2.1125	FLAG OFFICER		138.0	D	0
2.1125101	FLAG OFFICER BATH		50.0	D	1
2.1125302	FLAG STF OFF WR, WC & SH		88.0	D	1
2.12	CPO LIVING		1645.5	E	0
2.121	BERTHING		1347.5	E	0
2.1211	SHIP CPO		220.0	E	0
2.121101	LIVING SPACE		220.0	E	1
2.1212	MARINE MASTER SGT			E	0
2.1213	SENIOR TROOP NCO		1127.5	E	0
2.121301	LIVING SPACE		1127.5	E	2
2.1215	FLAG CPO			E	0

2.1217	SPECIAL MISSION CPO		E	0
2.122	SANITARY	298.0	E	0
2.1221	SHIP CPO	72.0	E	0
2.122101	SANITARY	72.0	E	1
2.1222	MARINE MASTER SGT		E	0
2.1223	SENIOR TROOP NCO	226.0	E	0
2.122301	SANITARY	226.0	E	2
2.1225	FLAG CPO		E	0
2.1227	SPECIAL MISSION CPO		E	0
2.13	CREW LIVING	82628.2	E	0
2.131	BERTHING	57453.0	E	0
2.1311	SHIP CREW	903.0	E	0
2.131101	LIVING SPACE	903.0	E	2
2.1312	MARINE		E	0
2.1313	TROOP	56550.0	E	0
2.131301	LIVING SPACE	56550.0	E	79
2.1315	FLAG CREW		E	0
2.1317	SPECIAL MISSION CREW		E	0
2.132	SANITARY	20770.0	E	0
2.1321	SHIP CREW	169.0	E	0
2.132101	SANITARY	169.0	E	2
2.1322	MARINE		E	0
2.1323	TROOP	20601.0	E	0
2.132301	SANITARY	20601.0	E	79
2.1325	FLAG CREW		E	0
2.1327	SPECIAL MISSION CREW		E	0
2.133	RECREATION	4405.2	E	0
2.13301	RECREATION ROOM	1906.0	E	0
2.13302	LIBRARY	1906.0	E	0
2.13304	HOBBY SHOP	160.0	E	1
2.13305	PHOTOGRAPHIC DARK ROOM	433.2	E	1
2.13306	CREW LOUNGE		E	0
2.14	GENERAL SANITARY FACILITIES	25.0	D	0
		170.0	E	
2.14001	LADIES RETIRING ROOM	120.0	E	2
2.14002	BRIDGE WASHRM & WC	25.0	D	1
2.14003	DECK WASHRM & WC	25.0	E	1
2.14004	ENGINEERING WR & WC	25.0	E	1
2.15	SHIP RECREATION FAC	734.8	E	0
2.151	MUSIC		E	0
2.15102	FM RADIO STATION		E	0
2.15103			E	0
2.152	MOTION PIC FILM+EQUIP	20.0	E	0
2.15201	PROJECTION EQUIP RM	20.0	E	0
2.153	PHYSICAL FITNESS	619.8	E	0
2.15301	PHYSICAL FITNESS RM	100.0	E	0
2.15302	ATHLETIC GEAR STRM	12.8	E	0
2.15303	TROOP ATHLETIC GR STRM	507.0	E	0
2.154	TV ROOM	95.0	E	0
2.16	TRAINING	35.0	E	0
2.16002	RECOGNITION TRAINING LKR	35.0	E	0
2.2	COMMISSARY	34222.7	E	0
2.21	FOOD SERVICE	17503.8	E	0
2.211	OFFICER	6243.0	E	0
2.21102	WARDROOM MESSR00M	4418.0	E	0
2.21103	WARDROOM LOUNGE	1825.0	E	0
2.212	CPO	600.0	E	0
2.21201	CPO MESSROOM AND LOUNGE	600.0	E	0

2.213	CREW	9136.0	E	0
2.21301	1ST CLASS MESSROOM	1370.4	E	0
2.21303	CREW MESSROOM	7765.6	E	0
2.214	MESS MANAGEMENT SPLST	1524.8	E	0
2.21401	MESS MNGMNT SPLST MESSRM	1524.8	E	0
2.215	FLAG OFFICER		E	0
2.22	COMMISSARY SERVICE SPACES	5018.3	E	0
2.221	FOOD PREPARATION SPACES	777.3	E	0
2.22101	MEAT PREPARATION ROOM	267.0	E	0
2.22103	BAKERY		E	0
2.22104	BREAD ROOM		E	0
2.22105	VEGETABLE PREPARATION ROOM	308.0	E	0
2.22107	THAW ROOM	202.3	E	0
2.222	GALLEY	3809.0	E	0
2.22201	COMMANDING OFFICER GALLEY	115.0	E	0
2.22202	WARD ROOM GALLEY	660.0	E	0
2.22203	CPO GALLEY	152.0	E	0
2.22204	CREW GALLEY	2882.0	E	0
2.223	PANTRIES	82.0	E	0
2.22303	CPO PANTRY	82.0	E	0
2.224	SCULLERY	350.0	E	0
2.22401	WARDROOM SCULLERY		E	0
2.22403	CREW SCULLERY	350.0	E	0
2.225	GARBAGE DISPOSAL		E	0
2.22501	GARBAGE DISPOSAL ROOM		E	0
2.226	PREPARED FOOD HANDLING		E	0
2.23	FOOD STORAGE+ISSUE	11700.6	E	0
2.231	CHILL PROVISIONS	2988.7	E	0
2.232	FROZEN PROVISIONS	2072.9	E	0
2.233	DRY PROVISIONS	5527.6	E	0
2.234	ISSUE	1111.4	E	0
2.23401	PROVISION ISSUE ROOM	738.8	E	0
2.23402	WARDROOM PROVISION ISSUE	372.6	E	0
2.3	MEDICAL+DENTAL (MEDICAL)	5051.9	E	0
2.31	MEDICAL FACILITIES	3828.5	E	0
2.31002	AUDIOMETRIC BOOTH		E	0
2.31003	AVIATION EXAMINING ROOM		E	0
2.31004	BACTERIOLOGICAL LAB		E	0
2.31007	DIET PANTRY	90.4	E	0
2.31009	EYE EXAMINATION RANGE RM	180.0	E	0
2.3101	INTENSIVE CARE QUIET RM		E	0
2.31011	MEDICAL LINEN ISSUE RM		E	0
2.31012	MEDICAL TREATMENT ROOM	2885.1	E	0
2.31013	MEDICAL X-RAY DARK ROOM	32.0	E	0
2.31014	MEDICAL X-RAY EXPOSURE RM	104.0	E	0
2.31016	PHARMACY		E	0
2.31023	MEDICAL UTILITY RM	56.0	E	0
2.31024	WARD	50.0	E	0
2.31025	WARD BATH	431.0	E	0
2.31026	WARD NURSING CENTER		E	0
2.31027	MORGUE		E	0
2.33	BATTLE DRESSING	250.0	E	0
2.331	AUX BATTLE DRESSING	25.0	E	0
2.33101	FWD AUX BATTLE DRESS ST	25.0	E	0
2.33102	AFT AUX BATTLE DRESS ST		E	0
2.332	MAIN BATTLE DRESSING	225.0	E	0
2.33201	FWD BATTLE DRESSING STA	75.0	E	0
2.33202	MID BATTLE DRESSING STA	75.0	E	0

2.33203	AFT BATTLE DRESSING STA	75.0	E	0
2.34	MEDICAL & DENTAL STOWAGE	973.5	E	0
2.341	MEDICAL	973.5	E	0
2.34101	MEDICAL STOREROOM	853.5	E	2
2.34102	PHARMACY STOREROOM		E	0
2.34104	BATTLE DRESSING STRM	120.0	E	2
2.342	DENTAL		E	0
2.35	MEDICAL & DENTAL ADMIN		E	0
2.352	DENTAL ADMIN		E	0
2.4	GENERAL SERVICES	16061.7	E	0
2.41	SHIP STORE FACILITIES	7171.7	E	0
2.41001	SHIP STORE	7171.7	E	0
2.41002	CLOTHING & SMALL STRS ISSUE RM		E	0
2.41003	SNACK BAR		E	0
2.41005	VENDING MACHINE AREA		E	0
2.42	LAUNDRY FACILITIES	5446.8	E	0
2.42001	LAUNDRY	4407.1	E	0
2.42002	LAUNDRY ISSUE ROOM	433.2	E	0
2.42003	LAUNDRY RECEIVING ROOM	606.5	E	0
2.43	DRY CLEANING	302.0	E	0
2.44	BARBER SERVICE	1275.0	E	0
2.44001	OFFICER BARBER SHOP	225.0	E	0
2.44002	BARBER SHOP	75.0	E	0
2.44003	TROOP BARBER SHOP	975.0	E	0
2.46	POSTAL SERVICE	966.7	E	0
2.46001	POST OFFICE	924.7	E	0
2.46002	MAILBAG STOREROOM	42.0	E	0
2.47	BRIG	422.0	E	0
2.47001	BRIG - CELL LOBBY	80.0	E	0
2.47002	DETENTION CELL	176.0	E	0
2.47003	BRIG - SENTRY VESTIBULE	96.0	E	0
2.47004	BRIG - SOLITARY CELL	70.0	E	0
2.48	RELIGIOUS	477.5	E	0
2.48001	CHAPLAIN OFFICE	140.0	E	0
2.48002	CHAPLAIN OFFICE LOBBY	100.0	E	0
2.48003	CHAPLAIN LOCKER	12.5	E	0
2.48004	CHAPEL	225.0	E	0
2.5	PERSONNEL STORES	817.6	D	0
		3057.8	E	
2.51	BAGGAGE STOREROOMS	2449.9	E	0
2.51001	OFFICER BAGGAGE STRM	114.0	E	0
2.51002	CPO BAGGAGE STRM	49.0	E	0
2.51003	CREW BAGGAGE STRM	1906.0	E	0
2.51005	TROOP OFF BAGGAGE STRM	380.9	E	0
2.52	MESSROOM STORES	471.0	D	0
		118.0	E	
2.52001	WARDROOM STOREROOM	471.0	D	0
2.52002	CPO STOREROOM	98.0	E	0
2.52003	COMMANDING OFFICER STRM	20.0	E	0
2.55	FOUL WEATHER GEAR	346.6	D	0
		80.0	E	
2.55001	FOUL WEATHER GEAR LOCKER	346.6	D	0
2.55002	DRYING ROOM	80.0	E	0
2.56	LINEN STOWAGE	150.0	E	0
2.57	FOLDING CHAIR STOREROOM	259.9	E	0
2.6	CBR PROTECTION	23630.9	E	0
2.61	CBR DECON STATIONS	3249.0	E	0
2.62	CBR DEFENSE EQUIPMENT	20381.9	E	0

*2.62001	CBR DEFENSE EQP STRMS	20381.9	E	0
2.62002	GAS MASK STOREROOM		E	1
2.63	CPS AIRLOCKS		E	0
2.7	LIFESAVING EQUIPMENT	20.0	E	0
2.71	LIFEJACKET LOCKER	20.0	E	0

PRINTED REPORT NO. 4 - SHIP SUPPORT AREA

SSCS	GROUP	VOLUME FT3	AREA FT2	LOC	SD
*3.	SHIP SUPPORT	949158.5	-30581.4	T	0
			-17823.2	D	
			-12758.1	E	
3.1	SHIP CNTL SYS(STEERING&DIVING)		6987.2	E	0
3.11	STEERING GEAR		6987.2	E	0
3.12	ROLL STABILIZATION			E	0
3.15	STEERING CONTROL			E	0
3.2	DAMAGE CONTROL		4706.9	E	0
3.21	DAMAGE CNTRL CENTRAL		6987.2	E	0
3.22	REPAIR STATIONS		690.7	E	0
3.25	FIRE FIGHTING		-2971.0	E	0
3.3	SHIP ADMINISTRATION		4203.4	E	0
3.301	GENERAL SHIP		107.3	E	0
3.302	EXECUTIVE DEPT		246.2	E	0
3.303	ENGINEERING DEPT		151.1	E	0
3.304	SUPPLY DEPT		2270.3	E	0
3.305	DECK DEPT		65.2	E	0
3.306	OPERATIONS DEPT		1363.3	E	0
3.307	WEAPONS DEPT			E	0
3.308	REACTOR DEPT			E	0
3.309	MARINES			E	0
3.31	SHIP PHOTO/PRINT SVCS			E	0
3.5	DECK AUXILIARIES		1552.4	E	0
3.51	ANCHOR HANDLING		1552.4	E	0
3.52	LINE HANDLING			E	0
3.53	TRANSFER-AT-SEA			E	0
3.54	SHIP BOATS STOWAGE			E	0
3.6	SHIP MAINTENANCE		4029.8	E	0
3.61	ENGINEERING DEPT		2146.8	E	0
3.611	AUX (FILTER CLEANING)		305.3	E	0
3.612	ELECTRICAL		719.4	E	0
3.613	MECH (GENERAL WK SHOP)		1012.1	E	0
3.614	PROPULSION MAINTENANCE		110.0	E	0
3.62	OPERATIONS DEPT (ELECT SHOP)		1047.8	E	0
3.63	WEAPONS DEPT (ORDINANCE SHOP)		168.0	E	0
3.64	DECK DEPT (CARPENTER SHOP)		667.2	E	0
3.7	STOWAGE		34696.1	E	0
3.71	SUPPLY DEPT		27090.1	E	0
3.711	HAZARDOUS MATL (FLAM LIQ)		5000.0	E	0
3.712	SPECIAL CLOTHING		462.2	E	0
3.713	GEN USE CONSUM+REPAIR PART		17370.2	E	0
3.714	SHIP STORE STORES		1299.6	E	0
3.715	STORES HANDLING		2958.0	E	0
3.72	ENGINEERING DEPT		1478.8	E	0
3.73	OPERATIONS DEPT		1636.0	E	0
3.74	DECK DEPT (BOATSWAIN STORES)		4274.7	E	0
3.75	WEAPONS DEPT			E	0
3.76	EXEC DEPT (MASTER-AT-ARMS STOR)		216.6	E	0
3.78	CLEANING GEAR STOWAGE			E	0
3.8	ACCESS (INTERIOR-NORMAL)		-17823.2	D	0
			-83463.5	E	

3.82	INTERIOR		-17823.2	D	0
			-83463.5	E	
3.821	NORMAL ACCESS		-18813.4	D	0
			-88100.5	E	
3.822	ESCAPE ACCESS		990.2	D	0
			4637.0	E	
3.9	TANKS	949158.5	1959.5	E	0
3.91	SHIP PROP SYS TNKG	487922.4		E	0
3.911	SHIP ENDUR FUEL TNKG	487922.4		E	0
3.91101	ENDUR FUEL TANK	487922.4		E	0
3.91104	CLEAN BALLAST TANK			E	0
3.914	FEEDWATER TNKG			E	0
3.92	BALLAST TANK	297720.7		E	0
3.93	FRESH WATER TNKG	35441.0		E	0
3.94	POLLUTION CNTRL TNKG		1959.5	E	0
3.941	SEWAGE TANKS		886.1	E	0
3.942	OILY WASTE TANKS		1073.4	E	0
3.95	VOIDS	128074.4		E	0
3.96	COFFERDAMS			E	0
3.97	CROSSFLOODING DUCTS			E	0

PRINTED REPORT NO. 5 - SHIP MACHINERY SYSTEM AREA

SSCS	GROUP	VOLUME FT3	AREA FT2	LOC	SD
*4.	SHIP MACHINERY SYSTEM	8712.8	70200.5	T	0
			13994.1	D	
			56206.4	E	
4.1	PROPULSION SYSTEM		6724.7	D	0
			7773.3	E	
4.13	INTERNAL COMBUSTION		2406.4	D	0
			1983.8	E	
4.131	ENERGY GENERATION			E	0
4.132	COMBUSTION AIR		948.8	D	0
			569.3	E	
4.133	EXHAUST		1457.6	D	0
			874.6	E	
4.134	CONTROL		540.0	E	0
4.14	GAS TURBINE		4318.3	D	0
			5789.5	E	
4.141	ENERGY GENERATION		2258.5	E	0
4.142	COMBUSTION AIR		2095.2	D	0
			1257.1	E	
4.143	EXHAUST		2223.1	D	0
			1333.9	E	
4.144	CONTROL		940.0	E	0
4.17	AUX PROPULSION SYSTEMS			E	0
4.2	PROPULSOR & TRANSMISSION SYST	8712.8		E	0
4.21	SCREW PROPELLER	8712.8		E	0
4.21001	PROP SHAFT ALLEY	8712.8		E	0
4.22	CYCLOIDAL PROPELLER ROOMS			E	0
4.23	WATERJET ROOMS			E	0
4.24	AIR FAN ROOMS			E	0
4.3	AUX MACHINERY		7269.4	D	0
			41933.0	E	
4.31	GENERAL (AUX MACH DELTA)		-16837.3	E	0
4.32	A/C & REFRIGERATION		624.1	E	0
4.321	A/C (INCL VENT)		379.7	E	0
4.322	REFRIGERATION		244.5	E	0
4.33	ELECTRICAL		9767.6	E	0
4.331	POWER GENERATION		2209.5	E	0
4.3311	SHIP SERVICE PWR GEN		1261.3	E	0
4.3313	BATTERIES			E	0
4.3314	400 HERTZ		948.2	E	0
4.332	PWR DIST & CNTRL		6820.9	E	0
4.334	DEGAUSSING		737.2	E	0
4.34	POLLUTION CONTROL SYSTEMS		32945.3	E	0
4.341	SEWAGE		29241.2	E	0
4.342	TRASH		3704.1	E	0
4.35	MECHANICAL SYSTEMS		10587.0	E	0
4.36	VENTILATION SYSTEMS		7269.4	D	0
			4846.3	E	

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    ASSET/MONOCV VERSION 4.2.0 - DESIGN SUMMARY -  11/22/98 16:10.19

PRINTED REPORT NO. 1 - SUMMARY

SHIP COMMENT TABLE
     MPF 2010 MODEL STARTED BY RAJAN AND TOM
     DATE STARTED: 27 AUG 1998
     STOPPED AT HULL GROUP ITEM 44
     CALLED PAT H CONCERNING UNDERRATING OF PD GENS AND OVER LOADING
     OF SEP GEN PAT SAYS THIS IS A FLAW OF THE PROGRAM AND SHOULD
     IGNORED PAT ALSO COMMENTED THAT THE FAILURE IN THE AVIATION MODULE
     WITH REFERENCE TO THE SWBS COULD BE A BUG IN THE PROGRAM AND
     REFERED US TO THE ASSET HELP PAGE

  PRINCIPAL CHARACTERISTICS - FT           WEIGHT SUMMARY - LTON
LBP                          950.0    GROUP 1 - HULL STRUCTURE  33253.3
LOA                          985.9    GROUP 2 - PROP PLANT       4811.9
BEAM, DWL                    140.0    GROUP 3 - ELECT PLANT      1672.1
BEAM, WEATHER DECK           140.0    GROUP 4 - COMM + SURVEIL   1072.1
DEPTH @ STA 10               106.0    GROUP 5 - AUX SYSTEMS      2909.9
DRAFT TO KEEL DWL             35.0    GROUP 6 - OUTFIT + FURN    4236.2
DRAFT TO KEEL LWL             33.1    GROUP 7 - ARMAMENT            5.1
FREEBOARD @ STA 3             72.9    ----------------------------------
GMT                           11.7    SUM GROUPS 1-7            47960.7
CP                            .720    DESIGN MARGIN                  .0
CX                            .955    ----------------------------------
                                      LIGHTSHIP WEIGHT          47960.7
SPEED(KT):  MAX= 27.5  SUST= 25.0     LOADS                     37970.8
ENDURANCE: 12000.0 NM AT 20.0 KTS     ----------------------------------
                                      FULL LOAD DISPLACEMENT    85931.5
TRANSMISSION TYPE:           ELECT    FULL LOAD KG:  FT            59.5
MAIN ENG: 4 F DIESEL @ 15000.0 HP
SEC ENG:  3 GT       @ 39100.0 HP     MILITARY PAYLOAD WT - LTON25887.0
SHAFT POWER/SHAFT:     74523.6 HP     USABLE FUEL WT - LTON      9814.0
PROPELLERS: 2 - CP  - 23.0 FT DIA

PD GEN:   7 SOLID ST @  3000.0 KW
                                                OFF  CPO   ENL    TOTAL
24-HR LOAD                  9953.2    MANNING   465   46  3780     4291
MAX MARG ELECT LOAD        13702.9    ACCOM     471   49  3812     4332

     AREA SUMMARY - FT2                    VOLUME SUMMARY - FT3
HULL AREA             -    487000.    HULL VOLUME           -  11689610.
SPONSON AREA          -    248354.    SPONSON VOLUME        -   2665165.
SUPERSTRUCTURE AREA   -    252160.    SUPERSTRUCTURE VOLUME -   2496258.
-----------------------------------   ----------------------------------
TOTAL AREA            -    987514.    TOTAL VOLUME          -  16851030.
```

PRINTED REPORT NO. 2 - MANNING AND ACCOMMODATION SUMMARY

CREW ACCOM MARGIN FAC .01

	SHIPS CREW	MARINES	TROOPS	AVIATION	FLAG	TRANS	SPECIAL MISSION
OFFICERS	45	0	410	0	10	0	0
CPO	2	0	40	0	4	0	0
OEM	20	0	3740	0	20	0	0
TOTAL	67	0	4190	0	34	0	0

	TOTALS	ACCOMMODATION
OFFICES	465	471
CPO	46	49
OEM	3780	3812
TOTAL	4291	4332

PRINTED REPORT NO. 3 - INDICATORS

```
MISSION
   SHIP TYPE IND               = AMPHIB
   DESIGN MODE IND             = ENDURANCE
   ENDUR DISP IND              = FULL LOAD
   ENDUR DEF IND               = USN
   SUSTN SPEED IND             = GIVEN
   ENDUR SPEED IND             = GIVEN
   AVIATION FACILITIES IND     = MAJOR AVN
   EMBARKED COMMANDER IND      = FLAG CMDR
HULL
   HULL OFFSETS IND            = GENERATE
   HULL DIM IND                = B
   FAST SHIP PARENT IND        =
   STABILITY IND               = 2/3
HULL BOUNDARY CONDITIONS
   HULL BC IND                 = LHA
   HULL STA IND                = OPTIMUM
SHELL APPENDAGES
   BILGE KEEL IND              = PRESENT
   SKEG IND                    = PRESENT
MARGIN LINE
   MARGIN LINE IND             = CALC
HULL SUBDIVISION
   HULL SUBDIV IND             = GIVEN
INNER BOTTOM
   INNER BOT IND               = NONE
HULL LOADS
   HULL LOADS IND              = CALC
STRUCTURAL ARRANGEMENT
   BOT PLATE LIMIT IND         = CALC
   STIFFENER SHAPE IND         =
DECKHOUSE
   DKHS GEOM IND               = GIVEN
   DKHS SIZE IND               =
   DKHS BEAM LINK IND          = NO
DKHS MATERIALS
   DKHS MTRL TYPE IND          = STEEL
DKHS LOADS
   BLAST RESIST IND            = 3 PSI
   ARRESTING GEAR TYPE IND     = NONE
   SPONSON LOW RCS IND         = NONE
   VAST IND                    = NONE
   MAGAZINE LOC IND            =
   DAMAGE PREV PANEL SYS IND   = DPPS
MISCELLANEOUS SYSTEMS
   AIR COND SYS TYPE IND       = CENTRAL
   BALLISTIC PROTECTION IND    = NONE
   DEGAUSSING SYSTEM IND       = STANDARD
   STOWAGE TYPE IND            = VIDMAR
   O2/N2 PLANT TYPE IND        = LOW PRESS
   DESIGN STDS IND             = CURRENT
PROPULSION PLANT
   MECH CL/PORT ARR IND        =
   MECH STBD ARR IND           =
   ELECT PG ARR 1 IND          = M-PG
```

```
   ELECT PG ARR 2 IND          = S-SPG
   ELECT DL ARR IND            = MTR
ARRANGEMENT CG
   MACHY KG IND                = GIVEN
PROPULSION UNITS
   ENG ENDUR RPM IND           = CALC
   SEC ENG USAGE IND           = AND
   GT ENG ENCL IND             = 90 DBA
   SS ENG ENCL IND             = PRESENT
   DIESEL ENG MOUNT IND        = COMPOUND
   MAIN ENG SELECT IND         = GIVEN
   MAIN ENG MODEL IND          = SEMT PC4/10
   MAIN ENG TYPE IND           = F DIESEL
   MAIN ENG SFC EQN IND        = DIESEL
   MAIN ENG SIZE IND           = GIVEN
   SEC ENG SELECT IND          = GIVEN
   SEC ENG MODEL IND           = GE LM5000
   SEC ENG TYPE IND            = GT
   SEC ENG SFC EQN IND         = OTHER
   SEC ENG SIZE IND            = GIVEN
TRANSMISSION
   TRANS TYPE IND              = ELECT
   TRANS EFF IND               = CALC
ELECTRICAL TRANSMISSION
   ELECT PRPLN TYPE IND        = AC-AC
   ELECT PRPLN RATING IND      = CALC
   AC SYNC ROTOR COOLING IND   = AIR
   TRANS LINE NODE PT IND      = CALC
GEARS
   SEC ENG TWO SPD GEAR IND    = NONE
   SHAFT SUPPORT TYPE IND      = OPEN STRUT
   SHAFT SYS SIZE IND          = CALC
PROPULSION SHAFT BEARINGS
   THRUST BRG LOC IND          = CALC
PROPELLER FACTORS
   PROP TYPE IND               = CP
   PROP SERIES IND             = TROOST
   PROP DIA IND                = GIVEN
   PROP AREA IND               = GIVEN
   PROP LOC IND                = CALC
   PITCH RATIO IND             = GIVEN
OPEN WATER PROP DATA
   PROP ID IND                 =
PROPULSION SUPPORT SYS
   INLET TYPE IND              = PLENUM
   DUCT SILENCING IND          = BOTH
   EXHAUST IR SUPPRESS IND     = PRESENT
   FUEL SYS TYPE IND           = COMP
SS GENERATORS
   SS SYS TYPE IND             = PD
   PD SS TYPE IND              = SOLID ST
   SS PWR CONV EFF IND         = CALC
SS GENERATOR SIZE
   SS GEN SIZE IND             = STD
   SS ENG SELECT IND           = GIVEN
   SS ENG MODEL IND            = GM 16-645E5
   SS ENG TYPE IND             = D DIESEL
   SS ENG SFC EQN IND          = DIESEL
```

```
   SS ENG SIZE IND             = GIVEN
EMERGENCY SS GENERATORS
   EMER SS ENG TYPE IND        =
COMMAND AND SURVEILLANCE
   SONAR DOME IND              = NONE
   SONAR DRAG IND              =
AUXILIARY SYSTEMS
   COMP HEATING TYPE IND       = ELECTRIC
   COLL PROTECT SYS IND        = NONE
AUXILIARY BOILERS
   AUX BOILER TYPE IND         = NONE
SHIP CONTROL SYSTEMS
   RUDDER SIZE IND             = CALC
   RUDDER TYPE IND             = SPADE
ROLL FINS
   FIN SIZE IND                =
SPECIAL PURPOSE SYSTEMS
   POLLUTION CNTL IND          = GRAV SEWG
   HAB STD IND                 = NAVY
   SHIP FUEL TYPE IND          = JP-5
RESISTANCE FACTORS
   FRICTION LINE IND           = ITTC
   RESID RESIST IND            = REGR
   WORM CURVE IND              = LHA1
   PRPLN SYS RESIST IND        = CALC
   PARENT SHIP OUTPUT IND      = YES
PERFORMANCE FACTORS
   PERF DISP IND               =
   TOWED BODY IND              = NONE
HYDROSTATIC FACTORS
   APPENDAGE IND               = WITH
   HYSTAT IND                  = WT LCG
HYDROSTATIC COMPARTMENTS
   COMP DEF IND                = GIVEN
EXPORT FACTORS
   EXPORT FILE NAME IND        =
   EXPORT TARGET IND           =
```

PRINTED REPORT NO. 4 - MARGINS

HULL	
MIN FREEBOARD MARGIN, FT	.25
HULL MARGIN STRESS, KSI	
PROPULSION PLANT	
TORQUE MARGIN FAC	1.200
ELECTRIC PLANT	
ELECT LOAD DES MARGIN FAC	.000
ELECT LOAD SL MARGIN FAC	.000
AUXILIARY SYSTEMS	
AC MARGIN FAC	.200
OUTFIT AND FURNISHINGS	
CREW ACCOM MARGIN FAC	.008
WEIGHT MARGINS	
D+B WT MARGIN FAC	.000
D+B KG MARGIN FAC	.000
PD WT MARGIN FAC	.000
PD KG MARGIN FAC	.000
CD WT MARGIN FAC	.000
CD KG MARGIN FAC	.000
CON MOD WT MARGIN FAC	.000
CON MOD KG MARGIN FAC	.000
GFM WT MARGIN FAC	.000
GFM KG MARGIN FAC	.000
GROWTH WT MARGIN, LTON	.0
GROWTH KG MARGIN FAC	.000
RESISTANCE FACTORS	
DRAG MARGIN FAC	.040
SPACE FACTORS	
SPACE MARGIN FAC	.000
PASSWAY MARGIN FAC	.000
TANKAGE MARGIN FAC	.000

PRINTED REPORT NO. 5 - PAYLOAD AND ADJUSTMENTS

ROW	PAYLOAD AND ADJUSTMENT NAME
1	ADD VEHICLE DECK
2	GENERAL SSCS GR 1 CORRECTION
3	ADJUST FAULTY CBR ALGORITHM
4	GENERAL SSCS GR 2 CORRECTION
5	GENERAL SSCS GR 3 CORRECTION
6	GENERAL SSCS GR 4 CORRECTION
7	REDUCE GR 511 (HEATING) ELECTRIC LOAD
8	FWD CARGO SPACE (LRG OB 1)
9	MIS CARGO SPACE (LRG OB 2)
10	AFT CARGO SPACE (LRG OB 3)
11	VEHICLE DECK 1A
12	1B
13	1C
14	1D
15	1E
16	1F
17	VEHICLE DECK 2A
18	2B
19	2C
20	2D
21	2E
22	2F
23	VEHICLE DECK 3A
24	3B
25	3C
26	3D
27	3E
28	3F
29	JP5 FUEL CARGO
30	JP5 PROPULSION
31	HANGAR
32	WELLDECK VESSELS
33	COMBAT SYSTEMS
34	COMBAT SYSTEMS
35	COMBAT SYSTEMS
36	COMBAT SYSTEMS
37	COMBAT SYSTEMS
38	COMBAT SYSTEMS
39	COMBAT SYSTEMS
40	COMBAT SYSTEMS
41	COMBAT SYSTEMS
42	COMBAT SYSTEMS
43	COMBAT SYSTEMS
44	COMBAT SYSTEMS
45	COMBAT SYSTEMS

ROW	WT KEY	WT ADD LTON	WT FAC	VCG KEY	VCG ADD FT	VCG FAC
1	NONE	.00	.000	NONE	.00	1.000
2	NONE	.00	.000	NONE	.00	1.000
3	NONE	.00	.000	NONE	.00	1.000
4	NONE	.00	.000	NONE	.00	1.000

5	NONE	.00	.000	NONE	.00	1.000
6	NONE	.00	.000	NONE	.00	1.000
7	W511	.00	.000	NONE	.00	1.000
8	WF69	1183.20	.000	D20	-30.00	1.000
9	WF69	6707.52	.000	D20	-25.50	1.000
10	WF69	4896.00	.000	D20	-31.80	1.000
11	WF66	205.90	.000	D20	-76.50	1.000
12	WF66	305.04	.000	D20	-77.00	1.000
13	WF66	305.04	.000	D20	-77.00	1.000
14	WF66	305.04	.000	D20	-77.00	1.000
15	WF66	305.04	.000	D20	-77.00	1.000
16	WF66	205.90	.000	D20	-76.50	1.000
17	WF66	213.50	.000	D20	-65.50	1.000
18	WF66	625.84	.000	D20	-66.20	1.000
19	WF66	625.84	.000	D20	-66.20	1.000
20	WF66	625.84	.000	D20	-66.20	1.000
21	WF66	625.84	.000	D20	-66.20	1.000
22	WF66	213.50	.000	D20	-65.50	1.000
23	WF66	100.00	.000	D20	-52.00	1.000
24	WF66	100.00	.000	D20	-52.00	1.000
25	WF66	625.84	.000	D20	-52.00	1.000
26	WF66	625.84	.000	D20	-52.00	1.000
27	WF66	100.00	.000	D20	-52.00	1.000
28	WF66	100.00	.000	D20	-52.00	1.000
29	WF63	3000.00	.000	D20	-90.00	1.000
30	WF42	3000.00	.000	D20	-90.00	1.000
31	WF61	243.00	.000	D20	8.00	1.000
32	W583	377.00	.000	BL	38.00	1.000
33	W411	136.40	.000	BL	100.50	1.000
34	W413	1.20	.000	BL	100.50	1.000
35	W422	5.70	.000	BL	108.60	1.000
36	W427	2.00	.000	BL	20.00	1.000
37	W431	3.10	.000	BL	100.50	1.000
38	W434	5.80	.000	BL	100.50	1.000
39	W436	13.50	.000	BL	75.00	1.000
40	W441	346.20	.000	BL	100.50	1.000
41	W455	3.70	.000	BL	100.50	1.000
42	W471	12.60	.000	BL	106.00	1.000
43	W472	1.20	.000	BL	106.00	1.000
44	W475	105.10	.000	BL	17.50	1.000
45	W482	36.90	.000	BL	100.50	1.000

	AREA	---AREA ADD, FT2--		-----AREA FAC-----	
ROW	KEY	HULL/SS	SS/ONLY	HULL/SS	SS/ONLY
1	A14400	16292.00	.00	.000	.000
2	A1000	96600.00	.00	.000	.000
3	A26200	********	.00	.000	.000
4	A2000	********	.00	.000	.000
5	A3000	12570.00	.00	.000	.000
6	A4000	6500.00	.00	.000	.000
7	NONE	.00	.00	.000	.000
8	NONE	.00	.00	.000	.000
9	NONE	.00	.00	.000	.000
10	NONE	.00	.00	.000	.000
11	NONE	.00	.00	.000	.000
12	NONE	.00	.00	.000	.000
13	NONE	.00	.00	.000	.000

14	NONE	.00	.00	.000	.000
15	NONE	.00	.00	.000	.000
16	NONE	.00	.00	.000	.000
17	NONE	.00	.00	.000	.000
18	NONE	.00	.00	.000	.000
19	NONE	.00	.00	.000	.000
20	NONE	.00	.00	.000	.000
21	NONE	.00	.00	.000	.000
22	NONE	.00	.00	.000	.000
23	NONE	.00	.00	.000	.000
24	NONE	.00	.00	.000	.000
25	NONE	.00	.00	.000	.000
26	NONE	.00	.00	.000	.000
27	NONE	.00	.00	.000	.000
28	NONE	.00	.00	.000	.000
29	NONE	.00	.00	.000	.000
30	NONE	.00	.00	.000	.000
31	NONE	.00	.00	.000	.000
32	NONE	.00	.00	.000	.000
33	NONE	.00	.00	.000	.000
34	NONE	.00	.00	.000	.000
35	NONE	.00	.00	.000	.000
36	NONE	.00	.00	.000	.000
37	NONE	.00	.00	.000	.000
38	NONE	.00	.00	.000	.000
39	NONE	.00	.00	.000	.000
40	NONE	.00	.00	.000	.000
41	NONE	.00	.00	.000	.000
42	NONE	.00	.00	.000	.000
43	NONE	.00	.00	.000	.000
44	NONE	.00	.00	.000	.000
45	NONE	.00	.00	.000	.000

	KW	------KW ADD------		------KW FAC------	
ROW	KEY	CRUISE	BATTLE	CRUISE	BATTLE
1	NONE	.00	.00	.000	.000
2	NONE	.00	.00	.000	.000
3	NONE	.00	.00	.000	.000
4	NONE	.00	.00	.000	.000
5	NONE	.00	.00	.000	.000
6	NONE	.00	.00	.000	.000
7	W511	.00	.00	-.900	-.900
8	WF69	.00	.00	.000	.000
9	WF69	.00	.00	.000	.000
10	WF69	.00	.00	.000	.000
11	WF66	.00	.00	.000	.000
12	WF66	.00	.00	.000	.000
13	WF66	.00	.00	.000	.000
14	WF66	.00	.00	.000	.000
15	WF66	.00	.00	.000	.000
16	WF66	.00	.00	.000	.000
17	WF66	.00	.00	.000	.000
18	WF66	.00	.00	.000	.000
19	WF66	.00	.00	.000	.000
20	WF66	.00	.00	.000	.000
21	WF66	.00	.00	.000	.000
22	WF66	.00	.00	.000	.000

23	WF66	.00	.00	.000	.000
24	WF66	.00	.00	.000	.000
25	WF66	.00	.00	.000	.000
26	WF66	.00	.00	.000	.000
27	WF66	.00	.00	.000	.000
28	WF66	.00	.00	.000	.000
29	WF63	.00	.00	.000	.000
30	WF42	.00	.00	.000	.000
31	WF61	.00	.00	.000	.000
32	W583	.00	.00	.000	.000
33	W411	.00	.00	.000	.000
34	W413	.00	.00	.000	.000
35	W422	.00	.00	.000	.000
36	W427	.00	.00	.000	.000
37	W431	.00	.00	.000	.000
38	W434	.00	.00	.000	.000
39	W436	.00	.00	.000	.000
40	W441	.00	.00	.000	.000
41	W455	.00	.00	.000	.000
42	W471	.00	.00	.000	.000
43	W472	.00	.00	.000	.000
44	W475	.00	.00	.000	.000
45	W482	.00	.00	.000	

APPENDIX D COST ESTIMATION

This cost model was provided by the project supervisors to estimate the MPF 2010 lead ship acquisition cost. Values chosen for the MPF 2010 ship are shown in the attached work sheet.

The cost factors shown below are based on the algorithms formerly used in the ASSET computer program and the MIT Math Model, used in the MIT XIII-A program. They use a series of factors to operate on weights of the various weight groups, as well as factors for non-weight-related items.

The weight group equations take the form of Equation Eq. 2 with values of x and y as in Table 16.

$$C_i = x * K_i * (W_{i00})^y \qquad \text{Eq. 2}$$

i	x	y
1	0.03395	0.772
2	0.00185	0.808
3	0.07505	0.910
4	0.10857	0.617
5	0.09487	0.782
6	0.09859	0.784
7	0.00838	0.987

Table 16. Cost Factors

The values for K are taken from the following:

K_1 = 1.0 Mild steel displacement hull with aluminum deckhouse

1.57 Mild steel plus 25% HY-80 monohull with aluminum deckhouse
2.292 Conventional aluminum hull
5.588 HT aluminum hull

K_2 = 1.0 CODOG/CODAG plant, high speed marine propulsors and straight drive train
1.502 GT/CODAG plant, high speed marine propulsors, right-angled drive train
1.979 Steam turbine power plant, low speed CP propeller and long shafts
2.345 GT power plant, low speed CP propeller with reduction gears and special arrangements problem, such as in a SWATH
3.280 GT plant with complex drives
3.436 Nuclear steam pressurized water plant

K_3 = 1.0 Conventional 60 HZ power, steam or diesel generator
2.036 Conventional 60 HZ power, light diesel or GT generators
12.68 All 40 HZ, GT generators

K_4 = 1.0 Simple control systems, minimal electronics
3.163 Modest control systems, sophisticated electronics
6.906 Complex control systems, sophisticated electronics, weight critical ship

K_5 = 1.0 Steam propelled displacement ship
1.525 GT propelled displacement ship
4.161 Fully submerged hydofoils
5.370 Air cushion vehicle

K_6 = 1.0 Conventional displacement ship
1.857 Weight critical ship

K_7 = 1.0 Conventional displacement ship
3.401 Weight critical ship, light armament

$K_8 =$ 2.882 Follow ship
12.888 Lead ship, unsophisticated weapons
26.06 Lead ship, sophisticated weapons

$K_9 =$ 1.0 Simple tools, limited trials
4.254 Complex tooling, extensive trials

To estimate the cost of margin use equation :

$$C_M = (W_M/(W_{LS} - W_M))(C_1 + C_2 + C_3 \ldots\ldots + C_7)$$

For engineering costs:

$$C_8 = (0.034K_8)(C_1 + C_2 + C_3 \ldots\ldots + C_7)^{1.099}$$

Construction and assembly costs

$$C_9 = (0.135K_9)(C_1 + C_2 + C_3 \ldots\ldots + C_8 + C_M)^{0.839}$$

Lead ship construction cost = $C_{LS} = (C_1 + C_2 + C_3 \ldots\ldots + C_8 + C_9 + C_M)$

Profit = 0.10 (C_{LS})

Lead ship price = C_{LS} + Profit

This then yields only the shipbuilder portion of the price. Not included is the cost of changes during construction, the cost of government furnished equipment

(GFE) or the cost of growth in the program caused by changes in government requirements.

Assume all costs are from base year 1985 and use a 4% average inflation factor to carry costs forward to 1999.

WORK SHEET FOR LEAD SHIP ACQUISITION COST FOR MPF 2010 SHIP USING MIT MATH MODEL

I	x	y	K	W	C
1	0.03395	0.772	1.000	33787.2	106.4232
2	0.00185	0.808	1.000	4889.4	1.770477
3	0.07505	0.91	1.000	1698.9	65.2835
4	0.10857	0.617	1.000	1089.4	8.12184
5	0.09487	0.782	1.525	2956.6	74.91323
6	0.09859	0.784	1.000	4304.2	69.63131
7	0.00838	0.987	1.000	5.2	0.042652
					326.1862
Wm = 10%					
Cm =	36.24292				
K_8	12.888				
C_8	253.4914				
K_9	4.254				
C_9	125.76				
C_{LS}	741.68				
Profit	74.17				
Total	815.85				

Table. 17 MIT Cost Calculations

APPENDIX E SIGNATURE ANALYSIS

Reduction of the overall ship signature was not considered a design priority for MPF 2010. Nonetheless, it is important to know the magnitude of the ship's signature and to minimize the signature whenever possible and practical.

A. RADAR CROSS SECTION

Upon first approximation, our MPF 2010 design is very box-like in shape. The sides of the hull are very nearly vertical for much of the length. The sides of the hangar are vertical from every aspect. Of the various aspects considered, the beam and stern presents the largest concern for radar cross section (RCS). These two aspects will be analyzed for radar guided sea skimming cruise missiles. We looked at a radar wavelength of 0.1 meter, noting that RCS increases at the inverse square of the radar wavelengths.

In order to conduct our analysis it was necessary to make the following simplifying assumptions:

- The ship's surfaces is smooth and specular
- The ship is represented by a series of rectangles whose RCS are summed
- Radar wavelength of concern is 0.1 meter (3 GHz, E/F band)
- All aircraft are within the hangar
- Radar reflectivity = 100%
- Enclosed masts and advanced array antennas contribute negligible RCS compared to the rest of the ship due to their frequency selective surfaces
- Second order and multi-path effects are ignored except for dihedral or trihedral surfaces which are calculated explicitly

The normal aspect rectangular plate cross section equation is given in Equation Eq. 3, while Equation Eq. 4 gives the envelope of cross section area of an angled rectangular plate (high frequency oscillations due to diffraction lobes are ignored). The variables in these two equations are defined by the following:

L is the length along the tilted axis.
H is the length perpendicular to the tilted axis
λ is the wavelength of the radar
q is the angle the plate is tilted

$$\text{RSC} = \frac{4p\,(\text{L} * \text{H})^2}{l^2}$$

Eq. 3:

$$\text{RCS} = \frac{\text{L}^2}{p\,(\tan(q\,)^2}$$

Eq. 4:

1. Beam Aspect

Item	**Length**(ft)	**Height**(ft)	**Aveage Height**(ft)	**Angle wrt Normal**(deg)	**RCS**(ft^{2})
Pilot house	30	10	106	0	10512469
Pri-Flight	60	10	106	0	42049877
Hangar	600	30	86	0	37844888905
Hangar tilted	600	30	86	10	3685657
Sponson Top	630	22	60	0	22438234632
Sponson Bottom	630	35	35	35	257678
Hull Mid	630	20	10	0	18543995564
Hull Fwd	120	71	36	10	51609
Hull Aft	100	71	36	0	8478937110

Table 18. Major Contributors to Beam RCS

The total radar cross section for the beam is 8.74e10 ft^2 (8.12e9 m^2), the major contributors can be seen in Table 18.

For the beam aspect, the hangar contributed the largest amount to RCS. Based on this it would be desirable to tilt the hangar walls by 10 degrees relative to the vertical on the next design iteration. This reduced the hangar contribution to the Beam RCS by four orders of magnitude to a value of 49.52e9 ft^2 (4.60e9 m^2) . However, the 10-degree tilt also presented a maximum against high altitude cruise missiles. For example, a missile flying at 100,000 feet would be normal to the hangar at a range of 93 nautical miles.

The tilt angle of ten degrees results in a forty three percent reduction in total ship RCS. The largest contributors to the ship RCS then become the top portion of the sponsons and the middle portion of the hull below the sponsons. As the design progresses, these two areas should be addressed to further reduce the RCS of the MPF 2010 ship.

2. Stern aspect

The major contributors to stern aspect RCS are:

Item	**Length**(ft)	**Height**(ft)	**Aveage Height**(ft)	**Angle wrt Normal** (Deg)	**RCS**(ft^{2})
Pilot House	120	10	106	0	168199506
Hangar	120	30	86	0	1513795556
Hangar tilted	120	30	86	10	13696
Hull & Sponson	220	22	60	0	2736232190
Hull Lower	140	49	25	0	5496806586

Table 19. Major Contributors to Stern RCS

The stern radar cross section is 9.92e9 ft^2 (9.21e8 m^2), as seen in Table 19. This is one order of magnitude less than that of the beam cross section area. The largest contributor to stern aspect RCS is the lower portion of the hull where the well deck is located. Although the hangar is also tilted by the 10 degrees for this aspect, the RCS reduction for the stern aspect is not as significant as the for the beam case, only about 15 %.

These numerical results should be taken as an aid to qualitative analysis of the RCS. The assumptions made to obtain these numbers may not exactly reflect the ship's actual RCS as second order terms are ignored. This analysis does show that significant reductions can be achieved with simple geometric changes.

3. RCS Reduction Methods

In this design, two methods were used to reduce the radar cross section of the MPF 2010. These were the utilization of the enclosed mast structure and the utilization of planner phased arrays. There is, however, room to improve the RCS of these ships. One example is shown above, that of reshaping the different physical features of the ship. In latter design iterations more effort should be concentrated on reducing the RCS as much as possible.

B. INFRARED SIGNATURE

The hull size of the MPF 2010 is comparable to that of current Nimitz class aircraft carriers. Although the temperature of the hull is low compared to the exhaust of the ships engines, the large area involved magnifies the amount of infrared (IR) energy released.

The exhaust from the electrical generation systems is a primary source of infrared signature for the ship. This signature is reduced by both cooling the exhaust and the exhaust housing. The surface temperature of enclosed mast structures is also a concern because of sunlight heating. This can be mitigated by proper material selection and adequate ventilation.

Two assumptions were made during the analyses of the problem, they are that the hull temperature is a uniform 70° F and that the seawater temperature is 60° F. Additionally it was assumed that the enclosed mast structure and the Gas Turbine exhaust structures would both be cooled such that their temperature is 160° F. The black body intensity is given by equation Eq . 5, [21], where

- I = intensity (W/m^2-micron)

- h = Planck's constant (J-sec)
- C = speed of light (m/sec)
- λ= wavelength of concern (m)
- k = Boltzman's constant (J/K)
- T = temperature of concern (K)

$$I = \frac{2phc^{2}}{l^{5}\left[e^{\left(ch/lkT\right)}-1\right]}$$

Eq . 5:

An analysis was conducted for the 3-5 micron and 8-12 micron bands to evaluate the infrared signature of the items listed in Table 20. The contribution from seawater background was subtracted from ship contribution giving differential infrared signatures, seen in Table 21.

All surfaces were considered to radiate as a black body. The radiant energy was integrated over the wavelength ranges of concern, multiplied by the size of the radiating area and then divided by four times pi steradians.

Item	**Temperature** (^{0}F)	**Area** (m^2)	**3-5mm** (W/sr)	**8-12mm** (W/sr)
Hull Background	60	9290	27405	713936
Exhaust Housing background	60	21.2	62	1629
Enclosed Mast background	60	116.1	342	8922

Table 20. Inferred Contributions

Item	**Temp** (^{0}F)	**Area** (m^2)	**3-5mm** (W/sr)	**3-5mm delta** (W/sr)	**8-12mm** (W/sr)	**8-12mm delta** (W/sr)
Hull	70	9290	33444	6038	793366	79429
Exhaust Housing	160	21.2	392	329	3769	2140
Exhaust Housing	110	21.2	159	96	2565	935
Enclosed Mast	160	116.1	2148	1805	20642	11720
Enclosed Mast	110	116.1	870	528	14048	5125

Table 21. Resultant Infrared Signature

From this black body analysis, some useful conclusions can be drawn. Despite the modest temperature difference of 10 ^{0}F assumed for the hull, the hull is the greatest contributor to the ship's IR signature. The other contributors, although estimated to be at much higher temperatures, were a far smaller concern. If a cooler background is assumed, such as that of the sky or a mixture of seawater and sky, the contrast signatures would be even greater. This is because the apparent sky temperature is colder than 60 ^{0}F. As the background becomes cooler, the hull will contribute a greater percentage to the entire ship IR signature. Unless the background and the hull temperature are nearly equal, the other sources of IR energy compared to the hull will be relatively small.

APPENDIX F HYPOTHETICAL MISSILE ATTACK

The MPF 2010 has two primary active self-defense systems. The first is an electronic countermeasure system. This system, the AN/SLQ-32 (V) 4 (or future equivalent) will detect, classify and jam radar guided missiles. This system provides a soft kill capability and does not provide any defense against infrared guided threats.

The MPF 2010's hard kill self defense system is the NATO Evolved Sea Sparrow missile (ESSM) system. Each MPF 2010 ship carries four launchers (see Figure 32). The ESSM has semi-active terminal homing guidance, a range of eight nautical miles, and a speed of Mach 1. The ships multi-function arrays, as will as the future tactical data link, will be the primary search systems. Once the threat is detected, the target solution will be passed to the ESSM system, which will then schedule a launch, [10].

When the ESSM approaches the intended target one of four directors will illuminate the target for terminal homing. Each director can handle two ESSM missiles in the air at a time and illuminate one target at a time. Additionally, the MPF 2010's multi-function arrays (MFA) may be used to illuminate targets if the capacity of the ESSM directors is exceeded.

A. ENGAGEMENT TIME

Based on the following assumptions, defensive weapon engagement ranges may be estimated against launch delay time: [10], [21].

- average height of the MPF 2010 radar is 96 feet
- a 30 feet altitude sea skimmer will be detected at 25 nmi
- a 10 feet altitude sea skimmer will be detected at 21 nmi
- relative to the missiles, the ship is stationary in the water
- threat missiles travels at MACH 2.5 (0.469 nmi/sec)
- Evolved NATO Sea Sparrow travels at MACH 1.0 (0.1875 nmi/sec)

- The time it takes an ESSM to accelerate to MACH 1.0 is negligible

For the case of a 30 feet altitude sea skimmer missile traveling at MACH 2.5 (Table 22), the missile will impact the ship 53 seconds after crossing the sensor horizon. In table Delay is defined as the time of the Detect to Engage (DTE) cycle for the ESSM missiles The column ΔR represents the distance that he missile will close the MPF 2010 during the DTE cycle.

Delay (sec)	**DR** (km)	**Engage time after delay** (sec)	**Engagement Range** (nmi)
10	4.69	30.94	5.80
15	7.04	27.36	5.13
20	9.38	23.79	4.46
25	11.73	20.22	3.79
30	14.07	16.65	3.12
35	16.42	13.08	2.45
40	18.76	9.50	1.78
45	21.11	5.93	1.11
50	23.45	2.36	0.44
55	25.80	-1.21	-0.23

Table 22. Engagement Time for 30 ft missile

For the case of a 10 feet altitude sea skimmer missile traveling at MACH 2.5 (Table 23), the missile will impact the ship 44 seconds after crossing the sensor horizon. This case

Delay (sec)	**DR** (km)	**Engage time after delay** (sec)	**Engagement Range** (nmi)
10	4.69	24.84	4.66
15	7.04	21.27	3.99
20	9.38	17.70	3.32
25	11.73	14.13	2.65
30	14.07	10.56	1.98

35	16.42	6.98	1.31
40	18.76	3.41	0.64
45	21.11	-0.16	-0.03
50	23.45	-3.73	-0.70
55	25.80	-7.30	-1.37

Table 23. Engagement Time for 10 ft missile

represents approximately a nine-second reduction in reaction time from the above case of a 30 ft sea skimmer.

The results in the above tables indicate that maximum delay times cannot exceed about 45 and 35 seconds, respectively, from time of detection. Any longer delay will allow the threat to reach the ship unimpeded or the missile engagement will occur within one nautical mile from the ship. This should give enough time for the ship to react assuming the ship is in Condition III.

The speeds of the incoming missiles combined with the limited detection range and the ESSM missile 8 nmi maximum range means that there will be only one opportunity to intercept the target short of the ship.

B. ESSM ASSESSMENT

Equations 6 through 8 give the method of calculation used in Table 24. Table 24 gives the different probabilities used in determining whether or not a missile will hit the MPF 2010. The definitions of the variables used are as follows:

- i incoming threat missile
- m salvo size of threat missile
- $P_{Hit,Ship}$ is the probability that the one of the salvo will hit the MPF 2010.
- $P_{kill,i}$ is the probability that the MPF 2010 defensive systems will kill the ith incoming missile.
- $P_{ESSM,i}$ and $P_{ESM,i}$ are the probability that the weapons system will be effective against the ith missile
- P_h is the probability that the ESSM will hit the target

$$P_{Hit,Ship} = 1 - \prod_{i=1}^{m} P_{kill,i} \qquad \text{Eq. 6}$$

$$P_{kill,i} = 1 - (1 - P_{ESSM,i})(1 - P_{ECM,i}) \qquad \text{Eq. 7}$$

$$P_{ESSM,i} = 1 - (1 - P_h)^n \qquad \text{Eq. 8}$$

We can get some idea of the vulnerability of the MPF 2010 to incoming anti-ship missiles by creating a table using the above formulas for calculations. It is assumed there is enough capability from the combination of ESSM directors and MFA illuminators that it does not limit the number of ESSM missiles that can be fired at an incoming salvo. Additionally

- all defensive systems are fully available
- each i^{th} incoming threat is addressed independently
- number of ESSM launched per threat is n
- Probability of ECM effectiveness, P_{ECM} is 0.4

ENSSM Shots, n	P_H	P_{ESSM}	$P_{Kill,I}$	$P_{Hit,Ship}$			
				m = 1	m = 2	m = 3	m = 4
n = 1	0.5	0.5000	0.7000	0.3000	0.5100	0.6570	0.7599
	0.6	0.6000	0.7600	0.2400	0.4224	0.5610	0.6664
	0.7	0.7000	0.8200	0.1800	0.3276	0.4486	0.5479
	0.75	0.7500	0.8500	0.1500	0.2775	0.3859	0.4780
	0.8	0.8000	0.8800	0.1200	0.2256	0.3185	0.4003
n =2	0.5	0.7500	0.8500	0.1500	0.2775	0.3859	0.4780
	0.6	0.8400	0.9040	0.0960	0.1828	0.2612	0.3322
	0.7	0.9100	0.9460	0.0540	0.1051	0.1534	0.1991
	0.75	0.9375	0.9625	0.0375	0.0736	0.1083	0.1418
	0.8	0.9600	0.9760	0.0240	0.0474	0.0703	0.0926
n = 3	0.5	0.8750	0.9250	0.0750	0.1444	0.2085	0.2679
	0.6	0.9360	0.9616	0.0384	0.0753	0.1108	0.1450
	0.7	0.9730	0.9838	0.0162	0.0321	0.0478	0.0632
	0.75	0.9844	0.9906	0.0094	0.0187	0.0279	0.0370
	0.8	0.9920	0.9952	0.0048	0.0096	0.0143	0.0191
n = 4	0.5	0.9375	0.9625	0.0375	0.0736	0.1083	0.1418
	0.6	0.9744	0.9846	0.0154	0.0305	0.0454	0.0600
	0.7	0.9919	0.9951	0.0049	0.0097	0.0145	0.0193
	0.75	0.9961	0.9977	0.0023	0.0047	0.0070	0.0093
	0.8	0.9984	0.9990	0.0010	0.0019	0.0029	0.0038

Table 24. Assessment of Engagements

The results of this table support the tactics of shooting multiple ESSM missiles against incoming threats. As the number of missiles, n, launched against each incoming threat missile increases, the chance of the ship being hit reduces rapidly. Conversely as the number of threats, m, go up the hit probability increases.

If we consider 2 missiles leaking through external defenses to be a reasonable self-defense threat, then firing of two ESSMs per missile gives a significant increase (75-95%) in survivability. Firing four missiles each at even four "leakers" would give an even more impressive 86-99% increase in survivability.

Follow-on iterations of the design should address the possibility of increasing the number of available ESSMs through the storage of additional missiles for the ESSM system in MPF 2010 cargo loadout. Additionally, more advanced electronic systems such as advanced integrated electronic warfare system (AIEWS) and an infrared missile countermeasure system should be investigated.

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