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A TWO-STAGE LITTORAL WARFARE SHIP SYSTEM DESIGN

by

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A Systems Engineering approach to the development of a flexible warship system intended for littoral warfare is presented, followed by a description of the preliminary design of the ship shown by analysis to the most cost-effective. The requirements for the project reported were to consider the need to diversify the Navy's current blue water fleet by adding a number of affordable vessels which can be tailored to accomplish specific objectives, as deemed necessary. The ships are to provide flexible response in littoral areas, under an Aegis-ship area air defense umbrella. A "two-stage" approach consisting of a "mother" ship carrying other surface and air craft was considered most effective. In this approach, the flexible, tailored nature of the response is provided by various kinds of "daughter" craft, permitting changing the loadout of the mother ship to respond to current or anticipated needs. The nature of the various daughter craft was arrived at in a previous course; this report concentrates primarily on the definition, feasibility studies and preliminary design of the "mother" ship.

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A Two Stage Littoral Warfare Ship System Design

(Specialized Tactical Response and Engagement System: SPECTRE)

This report documents a systems engineering and design capstone project undertaken by students in the Total Ship Systems Engineering (TSSE) program at the Naval Postgraduate School and performed over two academic quarters. The project was under the direction of Prof. C. N. Calvano. (The officer students who comprised the design team were: LCDR Gene Blaylock; LT Robert Burger; LT Eric Hoy; LT Rick Thiel; LT Dave Wagnon; LT Curtis Vejvoda, all U.S. Navy Officers).

ABSTRACT

The Mission Needs Statement given to the design team recognized that future Naval forces would find themselves operating in littoral areas, intervening in regional conflicts and needing to respond to varying kinds of mission demands with flexible forces. It had earlier been agreed by the design team and faculty that a two-stage system, consisting of a "mother" ship which carried numbers of surface and air craft of varying kinds and capabilities offered the most promise for an affordable system that was rapidly re-configurable (by changing the load of carried "2nd stage" craft) to meet unpredictable tactical needs. The mother ship was dubbed the "Carrier Multi-Mission Dock (CMD) and the carried craft, whether air or surface, were called Tactical Patrol Craft (PTX). The combination is referred to as the SPECTRE system. The nature of the PTXs had been examined in an earlier design exercise and craft capable in performing in six warfare areas had been preliminarily defined.

This document reports on the examination of seven potential scenarios for employment of the SPECTRE system, develops the Required Operational Capabilities for the PTX and for the CMD and discusses and justifies a design philosophy to be used to guide the subsequent design effort. The design focus the became primarily the nature of the CMD. A significant effort in threat assessment using the postulated scenarios resulted in a choice of combat system suite alternatives for the CMD itself. In addition, various loadouts of PTXs were examined for the various employment scenarios, and finally the CMD combat system was chosen. The propulsion and other engineering major parameters were decided upon and feasibility studies of three different CMD alternatives, using the Navy's early stage design program (ASSET), were performed. The result of these feasibility studies was a decision to develop further the mid-size CMD alternative.

The second academic quarter was devoted to a preliminary design of the chosen CMD ship alternative. The design team finalized their propulsion plant selection, then defined and analyzed their combat system architecture as well as the architecture for major Hull, Mechanical and Electrical systems. A series of ship arrangements studies was conducted and the Naval Architecture aspects of the ship were examined and verified to be acceptable. The report includes a manning study and numerous drawings of the ship as preliminarily designed. The body of the report concludes with a design team-conducted analysis of their design and is followed by eight appendices giving details and results of various portions of the design investigation.

SECTION I

REQUIREMENTS PHASE

A. MISSION NEED STATEMENT

The overall navy mission has recently changed to emphasize operations in littoral areas, interventions in regional conflicts, and tactical responses with flexible forces. These revised missions reflect the fact that major blue water engagements with other large, technologically advanced navies continue to be considered unlikely, while constrained budgets and scrutinized program costs are a certainty. Consequently, the number of major battle groups will almost definitely decrease, and the number of "low level" conflicts is expected to increase. With respect to specific assets, Aegis-class ships already completed or under contract are expected to provide all the state-of-the-art area AAW warfare capability that the Navy will need until well into the 21st century. However, current ship platforms do not possess the unique abilities to meet the demands of the littoral environment within the constraint of limited financial resources. Thus, diversifying the blue water fleet with a number of affordable vessels tailored to accomplish a specific objective is deemed necessary. The purpose of these specialized ships is to provide a flexible response in littoral areas, under an Aegis umbrella.

B. OPERATIONAL REQUIREMENTS DOCUMENT (ORD)

1. Description of Operational Capability.

In support of the mission need statement, the Chief of Naval Operations (CNO) and the Joint Requirements Oversight Council (JROC) have decided to explore the viability of a "mother ship/scout fighter" combination as the backbone of a Specialized Tactical Response and Engagement (SPECTRE) system. The idea is to deploy a large, simple Carrier Multi-Mission Dock (CMD) ship to a littoral area where a regional conflict is to be deterred or a regional enemy defeated. The CMD would carry a number of smaller Tactical Patrol Craft (PTX), which may be either surface or airborne. The CMD provides long-range, ocean-crossing capability, while the PTX platforms provide most of the combat capability for the combination.

The SPECTRE system consists of a number of PTX platforms, deployed from the CMD, which are configured for a single warfare area only, and have no facilities for a permanent crew. Potential PTX mission areas are: AAW, ASUW, ASW, NGFS, Anti-mine Warfare, and shallow water operations. By placing various mixes of the PTX platforms in the CMD, different capabilities that are tailored to a specific conflict can be provided at the operating area. The CMD will provide all support activities required by the PTXs and their crews, including processing of data and coordination of operations.

Some possible CMD/PTX operational scenarios include:

a. Support of amphibious landings. The CMD will stay over the horizon with the amphibious ships while the PTXs operate to the coast conducting mine clearance operations, coastal surveillance operations, gun fire support operations and anti-air coverage.

b. Protection of anchorages. For an amphibious force anchored off shore, the CMD/PTX system will provide a defensive screen against third world level air, surface, and undersea attacks.

c. Blockading of harbors and restricted waterways. The CMD/PTX combination will maintain patrols and board suspect vessels to enforce embargoes and control shipping.

d. Area mine clearance operations. The CMD/PTX system will provide a deployable mine clearance capability which can operate independently or in support of major operations.

e. Escorting of amphibious or logistics forces. The CMD/PTX, as a secondary mission, will provide protection for such forces in littoral or restricted waterways.

f. Independent PTX operations. This option involves the deployment of PTXs from secure shore facilities vice operating from the CMD. These operations will be primarily police actions such as drug interdiction and smuggling prevention.

2. Threat Summary.

The threat envisioned for this system is primarily from third world nations possessing both modern and capable weapon systems. The majority of these weapons are purchased from nations with significant technological ability such as the United States, China and former members of the Soviet Union. Specifically these threats include:

A. Anti-ship missiles
   1. air launched
   2. ship launched
   3. submarine launched
   4. shore launched

B. Torpedoes

C. Mines

D. Gunfire (small and medium caliber)
   1. ships/boats
   2. shore

E. Chemical, Biological and Nuclear weapons

F. Special Forces

3. Shortcomings of Existing Systems.

Current systems are capable of supporting the Navy's mission against the previously mentioned threats, however there are numerous drawbacks:

A. Cost. Acquisition costs of current ships are enormous (CG47, DDG51, LHD). The loss of a single vessel in a low intensity conflict results in excessive loss of life and financial expense.

B. Inability of present units to provide tailored response in littorals for a specific scenario.
C. Current unit availability does not provide for sufficient area coverage.
D. Currently only the new patrol craft (PC-1) is capable of performing shallow water operations.

4. Range of Capabilities Required.

The proposed CMD/PTX system shall provide the following capabilities:

A. Transit all major waterways.
B. Sustain a 6-month deployment with 3 week UNREP cycle.
C. Sustain combat operations for 3 weeks (same as UNREP cycle).
D. Conduct aircraft operations in sea state 4, boat operations in sea state 3 and UNREP operations in sea sate 5.
E. Provide for interoperability with any Joint Task Force.
F. Operate in mine infested waters.
G. Operate in a CBR environment.
H. Designed for reduced signature (underwater acoustic, airborne acoustic, IR, and electromagnetic).
I. Provide medical capabilities (1 medical surgery, 1 dental chair).
J. Require a maximum of 1000 officers and enlisted personnel.
K. A 50 year life cycle.
L. CMD must have point air defense capability.
M. CMD minimum sustained speed will be 24 kts with a goal of 28 kts.
N. CMD minimum range will be 6000 nm with a goal of 8000 nm at a minimum endurance speed of 16 kts with a goal of 18 kts.
O. CMD displacement will not exceed 40000 tons.
P. CMD will provide Command and Control of PTX operations.
Q. CMD will receive and transmit intelligence data (satellite, RF, HUMINT).
R. CMD will be capable of exchanging tactical information with all joint and allied forces and aircraft.
S. CMD will maintain communication with higher authority at all times.
T. CMD will not exceed $600 million in "first ship" cost (FY 94 dollars).
U. CMD will provide space and accommodations for a small embarked Task Force Commander staff with minimum impact on overall ship volume.

V. CMD will transport and support 4 to 8 PTX surface craft and 2 to 10 PTX aircraft.

W. CMD will not require unusual port / repair / support facilities.

X. Each PTX platform must be capable of supporting one of the following mission areas: AAW, ASW, ASUW, NGFS, mine clearance or coastal surveillance missions.

Y. Surface borne PTX platforms will have only passive ASMD.

Z. Surface borne PTX will have a nominal mission profile of 2 hours transit from CMD to mission area, 8 hours on station, and 2 hours return to CMD transit time.

AA. PTX combat system suite modules shall be airliftable via current assets, and the feasibility of airlifting complete PTX platforms must be explored.

5. Integrated Logistic Support (ILS).

The key factors determining the logistics support requirements for the CMD/PTX system are the required deployment cycle, number of ships in the force, and the ability of the CMD to perform preventive and corrective maintenance on the PTXs. A few of the more important ILS requirements are provided below:

A. CMD must provide full support for PTXs and embarked aircraft for a 6 month deployment (less fuel).

B. CMD will be in phased maintenance: 18 month cycle (90 day duration) with minor overhaul every 12.5 years (9 month duration), and major overhaul every 25 years (18 month duration).

C. Equipment is to be arranged to facilitate ease of maintenance/removal.

D. Minimal crew size is to be achieved.

E. Equipment commonality is required where possible.

F. A high level of onboard training capability is required.

6. Infrastructure Support.

The infrastructure required to operate, maintain and support the CMD/PTX combination will utilize existing systems to the maximum extent possible. This will minimize additional costs incurred due to the "irregularity" of this proposed combat capability. Some of the required support services are:

A. To provide intelligence reports (photo reconnaissance, etc.), charts and maps of projected operational areas to allow for safe navigation and the conduction of mission operations.

B. That ports must provide a means of HAZMAT and trash removal.

7. Force Structure.

The force structure of 10 CMDs total, 5 per coast is envisioned. The CMD/PTX system must be able to be forward deployed.

8. Schedule Considerations.

A preliminary target for ship delivery is dependent upon the availability of ship building assets and technology, however a timeline is provided:

A. The first SPECTRE system must be deployable within 5 years from congressional authorization with an IOC no later than 2007.

B. Follow-on units must be delivered at 1 year intervals thereafter, with an FOC of 2017.

9. Cost Considerations.

The primary consideration for the development of the CMD/PTX concept shall be a system which provides the required warfare capabilities at a competitive cost when compared to current fleet assets.

C. SCENARIOS AND ASSOCIATED THREATS

1. Support of Amphibious Landings (1 Battalion Landing Team).

Situations require an amphibious landing assault onto an opposed beach head. In preparation for the assault, surveillance of potential landing sites, positive location of defense forces and strength assessment is required. Once the primary landing site is identified, mine clearance assets are to be employed to clear the way for boat lanes. During the assault, strike assets are to be available when called to support ground forces and maintain constant patrol of the boat lane perimeter defending against small boat attack on the troop carriers.

A. Threats
1. Mincs
2. Shore launched anti-ship missiles
3. Shore gun batteries
4. Air launched anti-ship missiles
5. Surface launched anti-ship missiles

B. Current Operating Force
1. (1) LHD/LPD
2. (2-3) LSD
3. (2-4) surface combatants
4. (0-1) submarines
5. Landing Preparation (mine hunting)
6. Little ASW support

C. Proposed SPECTRE Operating Force
1. (1) LHD/LPD
2. (2-3) LSD
3. (1) AEGIS combatant
4. (1-2) CMD with appropriate PTX mix to perform:
    a. SPEC OPS PATROL (area reconnaisance)
    b. MIW
    c. STRIKE (ASUW and NGFS)
    d. ASW

2. Support of Small Amphibious Landing (Personnel Evacuation, Peacekeeping, etc).

Situations require an amphibious operation for the landing of security forces or the evacuation of personnel. While the landing is not directly opposed with defense forces, some elements of resistance or deterrence can be expected. Surveillance of the landing site and reconnaissance is required. Mine clearance assets may be employed to verify safety of the operations area and landing site. Strike assets are to be available when called to support shore positions and maintain constant patrol of the boat lane perimeter defending against possible terrorist attack.

A. Threats

1. Mines
2. Shore launched anti-ship missiles
3. Shore gun batteries
4. Air launched anti-ship missiles
5. Surface launched anti-ship missiles

B. Current Operating Force

1. (1) LHD and/or LSD
2. (0-1) surface combatants (if air threat is expected)
3. (0-1) submarines
4. Landing Preparation (mine hunting)
5. Little ASW support

C. Proposed SPECTRE Operating Force

1. (1) LHD/LSD
2. (1-2) CMD with appropriate PTX mix to perform:
    a. SPEC OPS PATROL (area reconnaissance)
    b. MIW
    c. STRIKE (AAW, ASUW, NGFS)
    d. ASW

3. Conduct Harbor Blockade (Boarding, Search and Seizure, etc).

Situations require implementing a unilaterally agreed upon sanction against a government by conducting a specific harbor or island nation blockade. Opposition to the embargo is expected in the form of small, isolated organized action and high potential for convert or terrorist activity; thus, the type of threat will be variable. The ability to identify potential blockade runners, conduct boardings for inspection while maintaining cohesive coverage in the operating area will directly impact effectivenss of the mission. Maintaining a high naval presence with many varied platforms will further enhance the embargo's effectiveness but increase opportunity for retalliation. Assets dedicated to actively aquire intelligence will support all facets of the mission.

A. Threats
1. Mines
2. Shore launched anti-ship missiles
3. Shore gun batteries
4. Air launched anti-ship missiles
5. Surface launched anti-ship missiles
6. Sub surface launched anti-ship missiles
7. Sub surface launched torpedoes

B. Current Operating Force
1. (1-4) Surface combatants (depending on area of coverage)
2. (1-2) Coast Guard vessels or detachments
3. (0-1) submarines

C. Proposed SPECTRE Operating Force
1. (1-2) CMD with appropriate PTX mix to perform:
   a. SPEC OPS PATROL (area reconnaissance)
   b. STRIKE (AAW, ASUW, NGFS)
   c. MIW
   d. ASW

4. Conduct Area Mine Clearance.

Situations require dedicated mine clearance operation of shipping channel, port or amphibious operating area in short notice. Objective clearance area is located a significant distance from availabe MIW assets, while their slow speed delays all operations. Once on station, MIW assets require protection in order to conduct their mission efficiently.

A. Threats

1. Mines
2. Shore launched anti-ship missles
3. Shore gun batteries
4. Air launched anti-ship missiles

B. Current Operating Force

1. (1-2) Surface combatants (depending on area of coverage)
2. (1) LHD or LSD to provide support and command and control
3. Heavy lift or tow a specified number of mine sweepers/mine hunters to the area.

C. Proposed SPECTRE Operating Force

1. (1-2) CMD with appropriate PTX mix to perform:
    a. MIW
    b. Command and control with MH-53
    c. STRIKE (ASUW, NGFS, AAW)
    d. SPEC OPS PATROL (area reconnaissance)

5. Conduct Escort Operations in Restricted Waterways.

Situations require protection of merchant shipping traffic in providing safe passage through shipping channel choke point within restricted waterways. Sufficient forces to safely maintain the continuous flow of traffic are necessary. The ability to defend the merchant ships from terrorist attack at any potential vantage point requries capabilities to effectively counter the threats. Continuous survellaince will be important to readily identify and counter opposition.

A. Threats

1. Mines
2. Shore launched anti-ship missiles
3. Shore gun batteries
4. Air launched anti-ship missiles

5. Surface launched anti-ship missiles

B. Current Operating Force
   1. (2) Non-AEGIS surface combatants for several escorted ships
   2. (1) AEGIS surface combatant to provide area AAW support
   3. Continuous mine countermeasure operations to ensure safe path

C. Proposed SPECTRE Operating Force
   1. (1) CMD with appropriate PTX mix to perform:
      a. STRIKE (ASUW, AAW, NGFS)
      b. MIW
      c. SPEC OPS PATROL
      d. ASW
   2. (1) AEGIS surface combatant to provide area AAW support

6. Conduct Independent PTX Operations.

Situations require deployment of a variety of platforms with specific missions to regions where support services will be provided by existing shore facilities. The means to provide maintenance and supply facilities for the operating platforms is requried.

A. Threats
   1. Air launched anti-ship missiles
   2. Surface launched anti-ship missiles

B. Current Operating Force
   1. (1) Surface combatant or Coast Guard vessel

C. Proposed SPECTRE Operating Force
   1. Appropriate PTX mix to perform:
      a. ASUW (surface patrol)
      b. AAW (against aircraft only)

7. Conduct Special Operations (INTEL, RECON, SPECOPS).

Situations require extensive survey and gathering of intelligence of locations that are not easily accessible, except by sea. Operations will include insertion and extraction of reconnaissance forces at a moments notice, continuous monitoring of all electronic activity and survellance along coastal regions in inland waterways.

A. Threats

1. Shore launched anti-ship missiles
2. Shore gun batteries
3. Air launched anti-ship missiles

B. Current Operating Force

1. (1-2) Special Boat Unit (SBU) or (1-2) patrol craft (PC)
2. Shore facilities required to support craft and personnel
3. Lift or tow a specified number of vessels to the area.

C. Proposed SPECTRE Operating Force

1. (1) CMD with appropriate PTX mix to perform:
    a. ASUW (surface patrol)
    b. AAW (close aircraft only)
    c. Strike capability to destroy shore batteries
    d. Personnel and PTX support operations

D. REQUIRED OPERATIONAL CAPABILITIES (ROCs)

The required operational capabilities for the Specialized Tactical Response and Engagement (SPECTRE) system have been segregated into PTX and CMD ROCs. Each platform is designed to accomplish its own set of operational capabilities to ensure that the total system operates to its optimum ability.

1. Tactical Patrol Craft (PTX)

The primary and secondary ROCs for the airborne PTX craft are contained in table 1-1 while those for the surface PTX craft are contained in table 1-2. The ROCs have been seperated to facilitate combat system assessment. Each PTX must perform the capabilities specified under its primary mission area. For example, the AAW designated PTX must provide all the listed capabilities under the AAW ROCs.

The Amphibious Warfare (AMW) ROCs were included to provide for integrated operations between amphibious forces and the SPECTRE system. The SPECTRE concept is not to be used primarily as an amphibious operation platform.

The Mine Warfare (MIW) ROCs MIW 5 and MIW 7 were included to provide the flexibility to lay mines as well as conduct mine countermeasures if the tactical situation determines that mine laying capability is required. In this sense the mine laying ROCs (MIW 5 and MIW 7) are secondary.

2. Carrier Multi-Mission Dock (CMD)

The primary and secondary ROCs for the CMD are contained in table 1-3. It is envisioned that the primary mission of the CMD is to provide the necessary support services to the PTX platforms such as PTX craft maintenance, medical facilities, command and control, haven facilities, and administrative services. The CMD will also carry the necessary ordnance to replenish the PTX craft in the mission they are assigned.

The CMD will be equipped to provide for self defense capability to include the use of decoys. The primary and secondary ROCs for the CMD will fluctuate depending on the assigned mission of the SPECTRE system. ROCs may be primary in one scenario but may be secondary in a different scenario.

TABLE 1-1

AIRBORNE PTX PRIMARY AND SECONDARY REQUIRED OPERATIONAL CAPABILITIES

Reference: OPNAVINST C3501.2H, Naval Warfare Mission Areas and Require Operational Capability/Projected Operational Environment (ROC/POE)

ANTI-AIR WARFARE (AAW). the destruction or neutralization of enemy air platforms and airborne weapons, whether launched from air, surface, subsurface or land platforms.

AAW 1 Provide anti-air defense in cooperation with other forces.
- AAW 1.2 Provide self-defense.
- AAW 1.5 Support area defense for amphibious forces in transit and in Amphibious Objective Area (AOA).
- AAW 1.6 Support area defense for a Surface Action Group (SAG).

AAW 2 Provide anti-air defense of a geographic area (zone) in cooperation with other forces.

AAW 3 Engage air targets in cooperation with other forces.

AAW 5 Conduct airborne anti-air operations.
- AAW 5.1 Conduct airborne anti-air cyclic operations.
- AAW 5.3 Employ defensive tactics against air attack.
- AAW 5.5 See Reference.

AAW 6 Detect, identify and track air targets.
- AAW 6.2 Recognize by sight, friendly/enemy aircraft which may be encountered in expected operating areas.

AAW 8 Engage air targets using installed air-to-air weapons systems.
- AAW 8.1 Engage air targets using all weather intercept system.
- AAW 8.3 Engage air targets using SIDEWINDER system.
- AAW 8.5 Engage air targets using guns.

AMPHIBIOUS WARFARE (AMW). Attacks, launched from the sea by naval forces and by landing forces embarked in ships or craft, designed to achieve a landing on a hostile shore. This includes fire support of troops in contact with enemy forces through the use of close air support or shore bombardment.

AMW 6 Conduct helicopter operations in support of amphibious assault.
- AMW 6.1 Conduct day helo flight operations.
- AMW 6.2 Conduct night helo flight operations.
- AMW 6.5 Conduct helo flight operations during all EMCON conditions.
- AMW 6.6 Conduct helo hot and cold refueling operations.

AMW 8 Provide for surface/subsurface defense of an AOA.

AMW 9 Conduct pre-assault cover and diversionary actions.

ANTI-SURFACE WARFARE (ASU). The destruction or neutralization of enemy surface combatants and merchant ships.

ASU 1 Engage surface threats with anti-surface weapons.
- ASU 1.2 Engage surface ships with medium range cruise missiles.
- ASU 1.6 Engage surface ships with minor caliber gunfire. (i.e. 25mm, 20mm, .50 cal)
- ASU 1.7 Illuminate surface ships with guns.
- ASU 1.8 Engage surface ships with medium range missiles.
- ASU 1.9 Engage surface ships with small arms gunfire.

ASU 2 Engage surface targets during BG operations in cooperation with other forces.
- ASU 2.2 Operate in direct support of surface forces.
- ASU 2.4 Operate in coordination with land and sea based air forces in conducting long range surface actions.

ASU 3 Support anti-surface ship defense of a geographical area (e.g. zone or barrier) in cooperation with other forces.

ASU 4 Detect, identify, localize and track surface targets.

ASU 4.4 Detect and track surface contacts visually.
ASU 4.5 Detect, identify, localize and track surface targets with infrared.
ASU 4.6 Detect, identify, localize and track surface targets by ESM.
ASU 4.7 Identify surface contacts.
ASU 4.11 Prosecute attack using Link 4A targeting information.

ASU 6 Disengage, evade and avoid surface attack.
ASU 6.1 Employ countermeasures.
ASU 6.2 Employ evasion techniques.
ASU 6.3 Employ EMCON procedures.

ASU 9 Conduct attacks on surface ships using air launched armament.
ASU 9.1 Attack surface ships using nuclear or conventional armament in an all weather environment.
ASU 9.2 Attack surface ships using nuclear or conventional armament in day visual environment.
ASU 9.3 Attack surface ships using nuclear or conventional armament in night visual environment.
ASU 9.4 Attack surface ships using air-to-surface guided missiles or anti-radiation weapons systems.
ASU 9.6 Attack surface ships using guided or unguided free fall weapon systems.
ASU 9.8 Evade hostile surface-to-air threats.

ASU 10 Conduct airborne operations in support of anti-surface attack operations.
ASU 10.3 Conduct defense suppression in support of air attack operations.
ASU 10.4 Conduct flight operations during all EMCON conditions.
ASU 10.5 Provide over-the-horizon (OTH) targeting information in support of air attack operations.

ASU 12 Support and conduct independent ASU operations.
ASU 12.1 Conduct ASU operations while escorting a convoy and/or URG.
ASU 12.2 Conduct ASU operations while escorting ATF or protecting an AOA.
ASU 12.3 Conduct ASU self-defense operations.

ASU 13 Conduct pre-attack deception operations.

ANTI-SUBMARINE WARFARE (ASW). The destruction or Neutralization of enemy submarines.

ASW 1 Provide ASW defense against submarines for surface forces, groups and units.
ASW 1.1 Screen a convoy (military or mercantile).
ASW 1.3 Screen transitting amphibious forces or an underway replenishment group.
ASW 1.4 Operate in direct support of surface forces.
ASW 1.5 Operate in associated support of surface forces.

ASW 2 Provide ASW defense of a geographic area.
ASW 2.1 Operate as a choke point ASW search/barrier unit.
ASW 2.2 Operate as an inshore harbor defense ASW barrier.
ASW 2.3 Operate as an AOA ASW defense barrier.
ASW 2.5 Sanitize an area of threat submarines in preparation for use by surface forces.

ASW 3 Conduct independent ASW operations.
ASW 3.1 See Reference.
ASW 3.2 See Reference.

ASW 4 Conduct airborne anti-submarine operations.
ASW 4.1 Conduct day and night, all-weather, airborne anti-submarine cyclic operations.
ASW 4.3 Provide information to surface units utilizing data link.
ASW 4.4 Provide information to other ASW aircraft utilizing data link.
ASW 4.6 Conduct long-range ASW operations.

ASW 6 Engage submarines in cooperation with other forces.
ASW 6.3 Operate in direct support of surface forces.
ASW 6.4 See Reference.

ASW 6.5 See Reference.
ASW 6.6 See Reference.
ASW 6.7 See Reference.
ASW 6.8 See Reference.
ASW 6.10 See Reference.
ASW 6.12 See Reference.
ASW 6.14 See Reference.
ASW 6.15 See Reference.

ASW 7 Engage submarines with anti-submarine armament.
ASW 7.6 See Reference.
ASW 7.7 Attack with air launched missiles.
ASW 7.9 Attack with guns.
ASW 7.11 Attack with conventional air-to-surface ordnance.

ASW 8 Disengage, evade, avoid, and deceive submarines.
ASW 8.4 Conduct deception operations in support of ASW operations.

COMMAND, CONTROL AND COMMUNICATIONS (CCC). Providing communications and related facilities for coordination and control of external organizations or forces and control of unit's own facilities.

CCC 3 Provide own unit's command and control functions.
CCC 3.3 Provide all necessary personnel services, programs, and facilities to safeguard classified material and information.
CCC 3.4 Carry out emergency destruction of classified matter and equipment rapidly and efficiently.
CCC 3.5 Employ Identification Friend or Foe/Selective Identification Feature (IFF/SIF) secure IFF mode 4.

CCC 4 Maintain Navy Tactical Data System (NTDS) or data link capability.
CCC 4.3 Transmit/receive and support Link 11.
CCC 4.10 Transmit/receive and correlate targeting information with Link 4A.

CCC 6 Provide communications for own unit.
CCC 6.1 Provide tactical voice communications.
CCC 6.12 Provide internal communications systems.
CCC 6.16 Provide tactical, secure, anti-jam Ultra-High Frequency (UHF) voice communications.
CCC 6.17 Provide tactical, secure, anti-jam Very-High Frequency (VHF) voice communications.
CCC 6.18 Provide tactical, secure, anti-jam HF voice communications.
CCC 6.19 Provide tactical, secure voice or data communications.

CCC 7 Implement Operations Security (OPSEC) measures and conduct military deception actions.
CCC 7.1 Plan, coordinate and control implementation of OPSEC measures.
CCC 7.2 Execute OPSEC measures.
CCC 7.3 Plan, coordinate and control Navy operational deception operations.
CCC 7.4 Execute Navy operational deception actions using tactics, operations, exercises or physical means.

CCC 9 Relay Naval communications with visual and electronic means.
CCC 9.3 Relay electronic communications.

CCC 13 Provide communications support for tactical surface, submarine and air units.
CCC 13.22 Provide Search and Rescue (SAR) communications support.

ELECTRONIC WARFARE (ELW). The effective use by friendly forces of the electromagnetic spectrum for detection and targeting while deterring, exploiting, reducing or denying its use by the enemy.

ELW 1 See Reference.
ELW 1.1 See Reference.
ELW 1.2 See Reference.
ELW 1.3 See Reference.

ELW 1.4 See Reference.
ELw 1.5 See Reference.

ELW 2 See Reference.
ELW 2.2 See Reference.
ELW 2.4 See Reference.
ELW 2.6 See Reference.
ELW 2.7 See Reference.
ELW 2.10 See Reference.

ELW 3 See Reference.
ELW 3.1 See Reference.
ELW 3.2 See Reference.

ELW 4 See Reference.
ELW 4.1 See Reference.
ELW 4.2 See Reference.
ELW 4.3 See Reference.

ELW 5 See Reference.

ELW 6 See Reference.
ELW 6.1 See Reference.

ELW 7 See Reference.
ELW 7.1 See Reference.

ELW 8 Conduct Electronic Warfare Support Measures operations in support of integrated strike training.

ELW 9 Conduct Electronic Countermeasure operations in support of integrated strike training.

ELW 10 Conduct Electronic Counter-Countermeasure operations in support of integrated strike training.

INTELLIGENCE (INT). The collection, processing, and evaluation of information to determine location, identification and capability of hostile forces through the employment of reconnaisance, surveillance, and other means.

INT 1 See Reference.
INT 1.1 See Reference.
INT 1.4 See Reference.
INT 1.5 See Reference.

MINE WARFARE (MIW). The use of mines for control/denial of sea or harbor areas, and mine countermeasures to destroy or neutralize enemy mines.

MIW 1 See Reference.
MIW 1.1 See Reference.
MIW 1.2 See Reference.
MIW 1.3 See Reference.
MIW 1.6 See Reference.

MIW 2 Conduct influence mine countermeasures.
MIW 1.1 Sweep magnetic mines.
MIW 2.2 Sweep acoustic mines.
MIW 2.3 Sweep pressure mines.
MIW 2.4 Sweep underwater electrical potential mines.
MIW 2.5 Sweep magnetic/acoustic combination influence mines.
MIW 2.6 Sweep magnetic/pressure combination influence mines.
MIW 2.7 Sweep acoustic/pressure combination influence mines.
MIW 2.8 Sweep magnetic/pressure/acoustic combination influence mines.

MIW 3 Conduct mine neutralization/destruction.
MIW 3.2 Destroy floating mines.

MIW 4 Conduct mine countermeasures (MCM).
MIW 4.1 Detect, classify and plot sea mines.
MIW 4.2 Vector small craft to mark locataed mine like objects.

MIW 4.7 Conduct trawl sweep operations to clear/neutralize bottom mines.

MIW 5 Support/conduct offensive/defensive service and exercise mine-laying operations.

MIW 5.2 Support/conduct mine laying operations by aircraft in a hostile environment.

MIW 9 Conduct airborne mine countermeasures.

MIW 9.1 Conduct day helo AMCM flight operations.

MIW 9.2 See Reference.

MIW 9.4 Provide MCM gear to support MCM operations.

MIW 11 Conduct Route Survey Operations.

MIW 11.2 Conduct RSO by AMCM rotary aircraft.

MIW 11.3 Provide capability to collect, store, retrieve, and process MIW contact information.

MOBILITY (MOB). The ability of naval forces to move and to maintain themselves in all situations over, under or upon the surface.

MOB 3 Prevent and control damage.

Mob 3.2 Counter and control CBR contamination/agents.

Mob 3.3 Maintain security against unfriendly acts.

MOB 7 Perform seamanship, airmanship and navigation tasks.

MOB 7.9 Operate day and night and under all weather conditions.

MOB 7.15 Operate in a chemically contaminated environment

MOB 8 Operate from a ship.

MOB 8.2 Operate from a ship with a helicopter platform.

STRIKE WARFARE (STW). Support the destruction or neutralization of enemy targets ashore through the use of conventional weapons.

STW 3 Support/conduct multiple cruise missile strikes either independently or in support of other strike forces.

STW 3.2 Support/conduct conventionally armed cruise missile strikes.

TABLE 1-2

SURFACE PTX PRIMARY AND SECONDARY REQUIRED OPERATIONAL CAPABILITIES

Reference: OPNAVINST C3501.2H, Naval Warfare Mission Areas and Require Operational Capability/Projected Operational Environment (ROC/POE)

ANTI-AIR WARFARE (AAW). the destruction or neutralization of enemy air platforms and airborne weapons, whether launched from air, surface, subsurface or land platforms.

AAW 1 Provide anti-air defense in cooperation with other forces.

- AAW 1.2 Provide self-defense.
- AAW 1.5 Support area defense for amphibious forces in transit and in Amphibious Objective Area (AOA).
- AAW 1.6 Support area defense for a Surface Action Group (SAG).

AAW 2 Provide anti-air defense of a geographic area (zone) in cooperation with other forces.

AAW 3 Engage air targets in cooperation with other forces.

AAW 6 Detect, identify and track air targets.

- AAW 6.2 Recognize by sight, friendly/enemy aircraft which may be encountered in expected operating areas.
- AAW 6.5 Detect, identify and track air targets with radar.
- AAW 6.6 Acquire and track targets with Gun Fire Control System/Missile Fire Control System (GFCS/MFCS).

AAW 9 Engage airborne threats using surface-to-air armament.

- AAW 9.5 Engage airborne threats using installed anti-air weapons.
- AAW 9.6 See reference.
- AAW 9.7 Engage airborne threats using portable missile systems.

AMPHIBIOUS WARFARE (AMW). Attacks, launched from the sea by naval forces and by landing forces embarked in ships or craft, designed to achieve a landing on a hostile shore. This includes fire support of troops in contact with enemy forces through the use of close air support or shore bombardment.

AMW 6 Conduct helicopter operations in support of amphibious assault.

- AMW 6.1 Conduct day helo flight operations.
- AMW 6.2 Conduct night helo flight operations.
- AMW 6.5 Conduct helo flight operations during all EMCON conditions.
- AMW 6.6 Conduct helo hot and cold refueling operations.

AMW 8 Provide for surface/subsurface defense of an AOA.

AMW 9 Conduct pre-assault cover and diversionary actions.

AMW 14 Support/conduct Naval Gunfire Support (NGFS) against designated targets in support of an amphibious operation.

- AMW 14.1 Conduct shore bombardment with conventional weapons
- AMW 14.3 Conduct direct fire.
- AMW 14.4 Conduct indirect fire
- AMW 14.5 Conduct simultaneous illumination and destructive fire.

AMW 18 Conduct Inshore Undersea Warfare (IUW) operations.

ANTI-SURFACE WARFARE (ASU). The destruction or neutralization of enemy surface combatants and merchant ships.

ASU 1 Engage surface threats with anti-surface weapons.

- ASU 1.2 Engage surface ships with medium range cruise missiles.
- ASU 1.5 Engage surface ships with intermediate caliber gunfire. (i.e. 3"/75, 76mm)
- ASU 1.6 Engage surface ships with minor caliber gunfire. (i.e. 25mm, 20mm, .50 cal)
- ASU 1.7 Illuminate surface ships with guns.
- ASU 1.8 Engage surface ships with medium range missiles.
- ASU 1.9 Engage surface ships with small arms gunfire.

ASU 2 Engage surface targets during BG operations in cooperation with other forces.
- ASU 2.1 Operate as a member of a multi-ship SAG.
- ASU 2.2 Operate in direct support of surface forces.
- ASU 2.4 Operate in coordination with land and sea based air forces in conducting long range surface actions.

ASU 3 Support anti-surface ship defense of a geographical area (e.g. zone or barrier) in cooperation with other forces.

ASU 4 Detect, identify, localize and track surface targets.
- ASU 4.1 Detect, identify, localize and track surface targets with radar.
- ASU 4.4 Detect and track surface contacts visually.
- ASU 4.5 Detect, identify, localize and track surface targets with infrared.
- ASU 4.6 Detect, identify, localize and track surface targets by ESM.
- ASU 4.7 Identify surface contacts.
- ASU 4.11 Prosecute attack using Link 4A targeting information.

ASU 6 Disengage, evade and avoid surface attack.
- ASU 6.1 Employ countermeasures.
- ASU 6.2 Employ evasion techniques.
- ASU 6.3 Employ EMCON procedures.

ASU 10 Conduct airborne operations in support of anti-surface attack operations.
- ASU 10.3 Conduct defense suppression in support of air attack operations.
- ASU 10.4 Conduct flight operations during all EMCON conditions.
- ASU 10.5 Provide over-the-horizon (OTH) targeting information in support of air attack operations.

ASU 12 Support and conduct independent ASU operations.
- ASU 12.1 Conduct ASU operations while escorting a convoy and/or URG.
- ASU 12.2 Conduct ASU operations while escorting ATF or protecting an AOA.
- ASU 12.3 Conduct ASU self-defense operations.

ASU 13 Conduct pre-attack deception operations.

ANTI-SUBMARINE WARFARE (ASW). The destruction or Neutralization of enemy submarines.

ASW 1 Provide ASW defense against submarines for surface forces, groups and units.
- ASW 1.1 Screen a convoy (military or mercantile).
- ASW 1.3 Screen transitting amphibious forces or an underway replenishment group.
- ASW 1.4 Operate in direct support of surface forces.
- ASW 1.5 Operate in associated support of surface forces.
- ASW 1.6 Operate as a member of a multi-platform search and attack unit (SAU).

ASW 2 Provide ASW defense of a geographic area.
- ASW 2.1 Operate as a choke point ASW search/barrier unit.
- ASW 2.2 Operate as an inshore harbor defense ASW barrier.
- ASW 2.3 Operate as an AOA ASW defense barrier.
- ASW 2.5 Sanitize an area of threat submarines in preparation for use by surface forces.

ASW 3 Conduct independent ASW operations.
- ASW 3.1 See Reference.
- ASW 3.2 See Reference.

ASW 6 Engage submarines in cooperation with other forces.
- ASW 6.1 Operate as a member of a multi-ship Search and Attack Unit (SAU).
- ASW 6.2 Operate as a member of a combined surface and aviation SAU.
- ASW 6.4 See Reference.
- ASW 6.5 See Reference.
- ASW 6.6 See Reference.
- ASW 6.7 See Reference.
- ASW 6.8 See Reference.
- ASW 6.10 See Reference.

ASW 6.12 See Reference.
ASW 6.14 See Reference.
ASW 6.15 See Reference.

ASW 7 Engage submarines with anti-submarine armament.
ASW 7.6 See Reference.

ASW 8 Disengage, evade, avoid, and deceive submarines.
ASW 8.1 Employ torpedo countermeasures and evasion techniques.
ASW 8.4 Conduct deception operations in support of ASW operations.

COMMAND, CONTROL AND COMMUNICATIONS (CCC). Providing communications and related facilities for coordination and control of external organizations or forces and control of unit's own facilities.

CCC 3 Provide own unit's command and control functions.
CCC 3.3 Provide all necessary personnel services, programs, and facilities to safeguard classified material and information.
CCC 3.4 Carry out emergency destruction of classified matter and equipment rapidly and efficiently.
CCC 3.5 Employ Identification Friend or Foe/Selective Identification Feature (IFF/SIF) secure IFF mode 4.

CCC 4 Maintain Navy Tactical Data System (NTDS) or data link capability.
CCC 4.3 Transmit/receive and support Link 11.
CCC 4.4 Receive data link information from airborne ASW aircraft.

CCC 6 Provide communications for own unit.
CCC 6.1 Provide tactical voice communications.
CCC 6.2 Provide visual communications.
CCC 6.12 Provide internal communications systems.
CCC 6.16 Provide tactical, secure, anti-jam Ultra-High Frequency (UHF) voice communications.
CCC 6.17 Provide tactical, secure, anti-jam Very-High Frequency (VHF) voice communications.
CCC 6.18 Provide tactical, secure, anti-jam HF voice communications.
CCC 6.19 Provide tactical, secure voice or data communications.

CCC 7 Implement Operations Security (OPSEC) measures and conduct military deception actions.
CCC 7.1 Plan, coordinate and control implementation of OPSEC measures.
CCC 7.2 Execute OPSEC measures.
CCC 7.3 Plan, coordinate and control Navy operational deception operations.
CCC 7.4 Execute Navy operational deception actions using tactics, operations, exercises or physical means.
CCC 7.6 Execute military deception actions using technical means (electronic, acoustic, visual, Electrical/Optical (E/O)).

CCC 9 Relay Naval communications with visual and electronic means.
CCC 9.1 Relay visual communications.
CCC 9.3 Relay electronic communications.

CCC 13 Provide communications support for tactical surface, submarine and air units.
CCC 13.12 Provide Harbor Common voice net support.
CCC 13.22 Provide Search and Rescue (SAR) communications support.

ELECTRONIC WARFARE (ELW). The effective use by friendly forces of the electromagnetic spectrum for detection and targeting while deterring, exploiting, reducing or denying its use by the enemy.

ELW 1 See Reference.
ELW 1.1 See Reference.
ELW 1.2 See Reference.
ELW 1.3 See Reference.
ELW 1.4 See Reference.
ELw 1.5 See Reference.

ELW 2 See Reference.

ELW 2.2 See Reference.
ELW 2.4 See Reference.
ELW 2.6 See Reference.
ELW 2.7 See Reference.
ELW 2.10 See Reference.

ELW 3 See Reference.

ELW 3.1 See Reference.
ELW 3.2 See Reference.

ELW 4 See Reference.

ELW 4.1 See Reference.
ELW 4.2 See Reference.
ELW 4.3 See Reference.

ELW 5 See Reference.

ELW 6 See Reference.

ELW 6.1 See Reference.

ELW 7 See Reference.

ELW 7.1 See Reference.

ELW 8 Conduct Electronic Warfare Support Measures operations in support of integrated strike training.

ELW 9 Conduct Electronic Countermeasure operations in support of integrated strike training.

ELW 10 Conduct Electronic Counter-Countermeasure operations in support of integrated strike training.

FLEET SUPPORT OPERATIONS (FSO). Naval forces and designated shore facilities providing supporting services other than logistics replenishment to fleet units.

FSO 7 Provide explosive ordnance disposal (EOD) services.

FSO 7.8 Recover and conduct initial technical evaluation of ordnance encountered underwater.
FSO 7.9 Conduct ordnance disposal and demolition operations.
FSO 7.11 Detect the presence of chemical agents.
FSO 7.21 Conduct small craft operations in support of EOD missions.

INTELLIGENCE (INT). The collection, processing, and evaluation of information to determine location, identification and capability of hostile forces through the employment of reconnaisance, surveillance, and other means.

INT 1 See Reference.

INT 1.1 See Reference.
INT 1.4 See Reference.
INT 1.5 See Reference.

INT 3 Conduct surveillance and reconnaissance.

INT 3.1 See Reference.
INT 3.2 Conduct overt surveillance and reconnaissance operations.
INT 3.3 See Reference.

INT 6 Conduct surface reconnaissance.

INT 6.1 Conduct surface patrols or barriers.
INT 6.2 Conduct strike reconnaissance on hostile shore lines.
INT 6.5 Conduct inshore harbor defense patrols.

MINE WARFARE (MIW). The use of mines for control/denial of sea or harbor areas, and mine countermeasures to destroy or neutralize enemy mines.

MIW 1 See Reference.

MIW 1.1 See Reference.
MIW 1.2 See Reference.
MIW 1.3 See Reference.
MIW 1.6 See Reference.

MIW 2 Conduct influence mine countermeasures.
- MIW 1.1 Sweep magnetic mines.
- MIW 2.2 Sweep acoustic mines.
- MIW 2.3 Sweep pressure mines.
- MIW 2.4 Sweep underwater electrical potential mines.
- MIW 2.5 Sweep magnetic/acoustic combination influence mines.
- MIW 2.6 Sweep magnetic/pressure combination influence mines.
- MIW 2.7 Sweep acoustic/pressure combination influence mines.
- MIW 2.8 Sweep magnetic/pressure/acoustic combination influence mines.

MIW 3 Conduct mine neutralization/destruction.
- MIW 3.1 Neutralize located mines.
- MIW 3.2 Destroy floating mines.
- MIW 3.3 Destroy subsurface mines.
- MIW 3.4 Recover enemy mines.
- MIW 3.6 Provide support for embarked EOD/SEAL.

MIW 4 Conduct mine countermeasures (MCM).
- MIW 4.1 Detect, classify and plot sea mines.
- MIW 4.3 Neutralize moored sea mines.
- MIW 4.4 Neutralize bottom sea mines.
- MIW 4.7 Conduct trawl sweep operations to clear/neutralize bottom mines.

MIW 5 Support/conduct offensive/defensive service and exercise mine-laying operations.
- MIW 5.1 Support/conduct service and exercise mine-laying operations by surface ships.
- MIW 5.5 Conduct min-laying ooperations with SEAL team.

MIW 6 Conduct magnetic silencing (degaussing, deperming, etc).
- MIW 6.7 Maintain magnetic signature limits.

MIW 8 Conduct precise navigation.
- MIW 8.2 Navigate precisely in MCM environment.
- MIW 8.3 Navigate precisely in mine laying environment.
- MIW 8.5 Safely navigate minefields.

MIW 11 Conduct Route Survey Operations.
- MIW 11.1 Conduct RSO by SMCM ships/craft.
- MIW 11.3 Provide capability to collect, store, retrieve, and process MIW contact information.

MOBILITY (MOB). The ability of naval forces to move and to maintain themselves in all situations over, under or upon the surface.

MOB 3 Prevent and control damage.
- Mob 3.1 Control fire, flooding, electrical, structural, propulsion and hull casualties.
- Mob 3.2 Counter and control CBR contamination/agents.
- Mob 3.3 Maintain security against unfriendly acts.
- Mob 3.5 Provide DC security and surveillance.
- Mob 3.8 Provide emergency breathing devices per ship's allowance.

MOB 5 Maneuver in formation.

MOB 7 Perform seamanship, airmanship and navigation tasks.
- MOB 7.1 Navigate under all conditions of geographic location, weather, and visibility.
- MOB 7.6 Abandon/scuttle ship rapidly
- MOB 7.7 Provide life boat/raft capacity IAW unit's allowance
- MOB 7.8 Tow or be towed.
- MOB 7.9 Operate day and night and under all weather conditions.
- MOB 7.14 Moor alongside ATF shipping or docks.
- MOB 7.15 Operate in a chemically contaminated environment

MOB 8 Operate from a ship.
- MOB 8.8 Operate from a well deck equipped amphibious ship.

MOB 12 Maintain the health and well-being of the crew.

MOB 12.2 Ensure the operation of the potable water system in a manner consistent with approved sanitary procedures and standards.

MOB 12.3 Maintain the environment to ensure the protection of personnel from overexposure to hazardous levels of radiation, temperature, noise, vibration, and toxic substances per current instructions.

MOB 12.6 Ensure operation and maintenance of all phases of shipboard environmental protection systems do not create a health hazardand are consistent with other naval directives pertaining to the prevention of pollution of the environment.

STRIKE WARFARE (STW). Support the destruction or neutralization of enemy targets ashore through the use of conventional weapons.

STW 3 Support/conduct multiple cruise missile strikes either independently or in support of other strike forces.

STW 3.2 Support/conduct conventionally armed cruise missile strikes.

TABLE 1-3

CMD PRIMARY AND SECONDARY REQUIRED OPERATIONAL CAPABILITIES

Reference: OPNAVINST C3501.2H, Naval Warfare Mission Areas and Require Operational Capability/Projected Operational Environment (ROC/POE)

ANTI-AIR WARFARE (AAW). the destruction or neutralization of enemy air platforms and airborne weapons, whether launched from air, surface, subsurface or land platforms.

AAW 1 Provide anti-air defense in cooperation with other forces.

AAW 1.2 Provide self-defense.

AAW 4 Provide for air operations in support of airborne anti-air operations.

AAW 4.1 Launch fixed wing and/or rotary wing aircraft involved in anti-air operations.

AAW 4.2 Recover fixed wing and/or rotary wing aircraft involved in anti-air operations.

AAW 4.5 Provide required conventional ordnance to support anti-air operations.

AAW 4.7 Load/unload ordnance compatible with required aircraft turnaround times.

AAW 6 Detect, identify and track air targets.

AAW 6.2 Recognize by sight, friendly/enemy aircraft which may be encountered in expected operating areas.

AAW 6.3 Maintain accurate air plot.

AAW 6.4 Measure aircraft altitude by radar.

AAW 6.5 Detect, identify and track air targets with radar.

AAW 6.6 Acquire and track targets with Gun Fire Control System/Missile Fire Control System (GFCS/MFCS).

AAW 6.7 See Reference.

AAW 6.8 See Reference.

AAW 6.10 See Reference.

AAW 9 Engage airborne threats using surface-to-air armament.

AAW 9.5 Engage airborne threats using installed anti-air weapons.

AAW 9.6 See reference.

AMPHIBIOUS WARFARE (AMW). Attacks, launched from the sea by naval forces and by landing forces embarked in ships or craft, designed to achieve a landing on a hostile shore. This includes fire support of troops in contact with enemy forces through the use of close air support or shore bombardment.

AMW 6 Conduct helicopter operations in support of amphibious assault.

AMW 6.1 Conduct day helo flight operations.

AMW 6.2 Conduct night helo flight operations.

AMW 6.4 Provide required conventional ordnance to support amphibious operations.

AMW 6.5 Conduct helo flight operations during all EMCON conditions.

AMW 6.6 Conduct helo hot and cold refueling operations.

AMW 6.7 Serve as helo haven.

AMW 6.8 Provide electric power for helo starting, testing, etc.

AMW 12 Provide air control and coordination of air operations in an AOA.

AMW 12.2 Provide coordination of AAW, ASU, and ASW air assets for protection of the force in an AOA.

AMW 12.3 Control air search and rescue operations in an AOA.

AMW 12.4 Coordinate air assets in the AOA with supporting arms to provide safe, coordinated action.

ANTI-SURFACE WARFARE (ASU). The destruction or neutralization of enemy surface combatants and merchant ships.

ASU 1 Engage surface threats with anti-surface weapons.

ASU 1.6 Engage surface ships with minor caliber gunfire. (i.e. 25mm, 20mm, .50 cal)

ASU 2 Engage surface targets during BG operations in cooperation with other forces.

ASU 2.1 Operate as a member of a multi-ship SAG.
ASU 2.2 Operate in direct support of surface forces.
ASU 4 Detect, identify, localize and track surface targets.
ASU 4.1 Detect, identify, localize and track surface targets with radar.
ASU 4.4 Detect and track surface contacts visually.
ASU 4.6 Detect, identify, localize and track surface targets by ESM.
ASU 4.7 Identify surface contacts.
ASU 4.8 Detect and track surface contacts by Radio Direction Finding (OUTBOARD or Combat DF).
ASU 6 Disengage, evade and avoid surface attack.
ASU 6.1 Employ countermeasures.
ASU 6.2 Employ evasion techniques.
ASU 6.3 Employ EMCON procedures.
ASU 8 Provide for air operations in support of anti-surface attack operations.
ASU 8.1 Launch fixed and/or rotary wing aircraft in support of anti-surface operations.
ASU 8.2 Recover fixed and/or rotary wing aircraft in support of anti-surface operations.
ASU 8.5 Provide required conventional ordnance to support anti-surface attack operations.
ASU 8.8 Control aircraft under all condtions of active jamming.
ASU 8.9 Load/unload ordnance compatible with required aircraft turnaround times.
ASU 8.10 Provide air strike control to direct or assist attack aircraft.
ASU 10 Conduct airborne operations in support of anti-surface attack operations.
ASU 10.4 Conduct flight operations during all EMCON conditions.
ASU 12 Support and conduct independent ASU operations.
ASU 12.3 Conduct ASU self-defense operations.
ASU 13 Conduct pre-attack deception operations.

ANTI-SUBMARINE WARFARE (ASW). The destruction or Neutralization of enemy submarines.
ASW 1 Provide ASW defense against submarines for surface forces, groups and units.
ASW 1.4 Operate in direct support of surface forces.
ASW 1.5 Operate in associated support of surface forces.
ASW 3 Conduct independent ASW operations.
ASW 3.1 See Reference.
ASW 3.2 See Reference.
ASW 5 Provide for air operations in support of airborne anti-submarine operations.
ASW 5.1 Launch fixed wing and/or rotary wing aircraft involved in anti-submarine operations.
ASW 5.2 Recover fixed wing and/or rotary wing aircraft involved in anti-submarine operations.
ASW 5.4 Provide required conventional ordnance to support anti-submarine operations.
ASW 5.6 Conduct operations during all EMCON conditions.
ASW 5.7 Load/unload ordnance compatible with required aircraft turnaround times.
ASW 5.8 See Reference.
ASW 5.9 Control fixed wing and/or rotary wing ASW aircraft in conjunction with coordinated search and/or attack operations.
ASW 5.10 Control helicopter screen.
ASW 5.11 Provide positive and/or advisory control of ASW aircraft.
ASW 7 Engage submarines with anti-submarine armament.
ASW 7.9 Attack with guns.
ASW 8 Disengage, evade, avoid, and deceive submarines.
ASW 8.1 Employ torpedo countermeasures and evasion techniques.
ASW 8.2 Employ ACM against submarines.
ASW 8.4 Conduct deception operations in support of ASW operations.

COMMAND, CONTROL AND COMMUNICATIONS (CCC). Providing communications and related facilities for coordination and control of external organizations or forces and control of unit's own facilities.

CCC 1 Provide command and control facilities for a task organization commander and staff.

CCC 1.1 Adequately support (spaces, facilities, and equipment only) embarked Warfare Commander or Coordinator (other than own unit Commanding Officer).

CCC 1.2 Provide adequate command and control facilities for embarked Warfare Commander or Coordinator (other than own unit Commanding Officer).

CCC 1.5 Provide a Tactical Air Control Center (TACC) or Tactical Air Direction Center (TADC), as appropriate, with facilities for the tactical air officer and/or tactical air controller and his staff. Facilities are required for the control and coordination of AAW, ASW, and MIW and multi-deck helicopter operations.

CCC 1.9 Provide a signal/electronic warfare coordination center with facilities for operations and intelligence personnel.

CCC 1.10 Provide a Helicopter Logistic Support Center with facilities for the Helicopter Logistic Coordinator (HLC) and supporting personnel.

CCC 1.14 Provide a Combat Information Center (CIC) with facilities for a Staff Watch Officer (SWO).

CCC 2 Coordinate and control the operations of the task organization or functional force to carry out assigned missions.

CCC 2.1 Coordinate the reconnaissance of multiple surface, subsurface, and/or air contacts.

CCC 2.2 Function as AAWC for force or sector.

CCC 2.3 Function as ASWC for force or sector.

CCC 2.4 Function as SAU or SAG commander.

CCC 2.5 Operate as contact area commander to coordinate multi-type search and attack operations.

CCC 2.8 Function as on-scene commander for a Search and Rescue (SAR) operation.

CCC 2.13 Plan, coordinate, control, and analyze the effectiveness of a Surface Mine Countermeasures/Airborne Mine Countermeasures (SMCM/AMCM) operation.

CCC 2.15 Function as one or more of the following coordinators for force or sector.

(1) Air Element Coordinator (AREC)
(2) LAMPS Element Coordinator (LEC)
(4) Screen Coordinator (SC)
(5) Electronic Warfare Coordinator (EWC)
(6) Force Air Track Coordinator
(7) Force Surface Track Coordinator
(8) Force Track Coordinator

CCC 2.16 Assist in the planning of AAW, ASU, and ASW for the coordination of air operations in the AOA.

CCC 2.18 Function as an Anti-surface Warfare Commander (ASUWC) for force or sector.

CCC 3 Provide own unit's command and control functions.

CCC 3.1 Maintain a CIC capable of collecting, processing, displaying, evaluating, and disseminating tactical information.

CCC 3.3 Provide all necessary personnel services, programs, and facilities to safeguard classified material and information.

CCC 3.4 Carry out emergency destruction of classified matter and equipment rapidly and efficiently.

CCC 3.5 Employ Identification Friend or Foe/Selective Identification Feature (IFF/SIF) secure IFF mode 4.

CCC 3.7 Maintain a CIC capable of supporting a TAO.

CCC 3.8 Establish voice communications with US. Marine Corps (USMC) evacuation and command nets and Naval Support Activity (NSA) net.

CCC 4 Maintain Navy Tactical Data System (NTDS) or data link capability.

CCC 4.2 Provide continuous Link 14 information to non-NTDS units.

CCC 4.3 Transmit/receive and support Link 11.

CCC 4.4 Receive data link information from airborne ASW aircraft.
CCC 4.5 Receive and process data link information from Satellite Communication (SATCOM).
CCC 4.6 Receive and process data link information from High Frequency (HF) systems.
CCC 4.7 Receive Link 14 information.
CCC 4.10 Transmit/receive and correlate targeting information with Link 4A.

CCC 6 Provide communications for own unit.

CCC 6.1 Provide tactical voice communications.
CCC 6.2 Provide visual communications.
CCC 6.3 Provide multi-channel cryptographically covered teletype send and receive circuits.
CCC 6.4 Provide uncovered Radio-Teletype/Continuous Wave communications.
CCC 6.5 Provide full duplex cryptographically covered HF teletype circuits.
CCC 6.6 Process message traffic.
CCC 6.9 Maintain multi-channel crytographically covered teletype send and receive circuits (single channel for Mine Hunter Ships (MSHs)).
CCC 6.10 Provide voice/teletype/computer data cryptographically covered satellite communication circuits.
CCC 6.11 Establish and provide fixed combat communications and relay support for NSW operations.
CCC 6.12 Provide internal communications systems.
CCC 6.16 Provide tactical, secure, anti-jam Ultra-High Frequency (UHF) voice communications.
CCC 6.17 Provide tactical, secure, anti-jam Very-High Frequency (VHF) voice communications.
CCC 6.18 Provide tactical, secure, anti-jam HF voice communications.
CCC 6.19 Provide tactical, secure voice or data communications.
CCC 6.21 Provide OTCIXS.
CCC 6.22 Provide TADIXS.
CCC 6.23 Provide TADIXS B.

CCC 7 Implement Operations Security (OPSEC) measures and conduct military deception actions.

CCC 7.1 Plan, coordinate and control implementation of OPSEC measures.
CCC 7.2 Execute OPSEC measures.
CCC 7.3 Plan, coordinate and control Navy operational deception operations.
CCC 7.4 Execute Navy operational deception actions using tactics, operations, exercises or physical means.
CCC 7.6 Execute military deception actions using technical means (electronic, acoustic, visual, Electrical/Optical (E/O)).

CCC 9 Relay Naval communications with visual and electronic means.

CCC 9.1 Relay visual communications.
CCC 9.3 Relay electronic communications.

CCC 13 Provide communications support for tactical surface, submarine and air units.

CCC 13.12 Provide Harbor Common voice net support.
CCC 13.13 Provide High Command (HICOM) voice net support.
CCC 13.22 Provide Search and Rescue (SAR) communications support.

ELECTRONIC WARFARE (ELW). The effective use by friendly forces of the electromagnetic spectrum for detection and targeting while deterring, exploiting, reducing or denying its use by the enemy.

ELW 1 See Reference.

ELW 1.1 See Reference.
ELW 1.2 See Reference.
ELW 1.3 See Reference.
ELW 1.4 See Reference.
ELw 1.5 See Reference.

ELW 2 See Reference.

ELW 2.2 See Reference.
ELW 2.4 See Reference.

ELW 2.6 See Reference.
ELW 2.7 See Reference.
ELW 2.10 See Reference.

ELW 3 See Reference.
ELW 3.1 See Reference.
ELW 3.2 See Reference.

ELW 4 See Reference.
ELW 4.1 See Reference.
ELW 4.2 See Reference.
ELW 4.3 See Reference.

ELW 5 See Reference.

ELW 6 See Reference.
ELW 6.1 See Reference.

ELW 7 See Reference.
ELW 7.1 See Reference.

ELW 8 Conduct Electronic Warfare Support Measures operations in support of integrated strike training.

ELW 9 Conduct Electronic Countermeasure operations in support of integrated strike training.

ELW 10 Conduct Electronic Counter-Countermeasure operations in support of integrated strike training.

FLEET SUPPORT OPERATIONS (FSO). Naval forces and designated shore facilities providing supporting services other than logistics replenishment to fleet units.

FSO 7 Provide explosive ordnance disposal (EOD) services.
FSO 7.9 Conduct ordnance disposal and demolition operations.
FSO 7.11 Detect the presence of chemical agents.
FSO 7.21 Conduct small craft operations in support of EOD missions.

FSO 9 Provide routine health care.
FSO 9.1 Conduct daily sick call.
FSO 9.2 Conduct physical examinations.
FSO 9.4 Conduct basic ward care.
FSO 9.5 Conduct sanitation and safety inspections and provide preventive medicine instruction.
FSO 9.6 Conduct appropriate industrial hygiene/environmental health monitoring and occupational safety and health training.
FSO 9.10 Conduct on-site emergency medical treatment during hazardous evolutions including flight quarters, underway replenishment/refueling, and amphibious boat operations.
FSO 9.12 Conduct x-ray diagnostic services.

FSO 10 Provide first aid assistance.
FSO 10.1 Identify, equip, and maintain appropriate first aid spaces.
FSO 10.2 Train assigned personnel in first aid, self, and buddy procedures.
FSO 10.3 Train stretcher bearers.

FSO 11 Provide triage.
FSO 11.1 Identify, equip, and maintain suitable triage spaces.
FSO 11.2 Train assigned medical/dental personnel in triage care.
FSO 11.3 Povide for augmentation by specialized personnel and equipment.

FSO 12 Provide resuscitation.
FSO 12.1 Identify, equip, and maintain suitable resuscitation spaces.
FSO 12.2 Train assigned medical/dental personnel in resuscitation.
FSO 12.3 Povide for augmentation by specialized personnel and equipment.

FSO 13 Provide definitive care.
FSO 13.1 Provide emergency minor surgery by hospitalman.
FSO 13.2 Provide for care beds.
FSO 13.7 Provide surgery by Medical Officer (MO).
FSO 13.13 Provide care by MO trained in sick call, triage, and resuscitation.

FSO 14 Provide medical regulation of casualties.

FSO 14.2 Train medical personnel in medical regulation.
FSO 14.4 Provide for transfer/evacuation of patients.

FSO 16 Provide routine and emergency dental care.
FSO 16.1 Conduct daily sick call.
FSO 16.2 Conduct examinations (including x-ray diagnostics).
FSO 16.3 Conduct a preventive dentistry program.

FSO 17 Provide definitive dental care.
FSO 17.1 Provide restorative treatment and minor oral surgery including tooth extraction.

INTELLIGENCE (INT). The collection, processing, and evaluation of information to determine location, identification and capability of hostile forces through the employment of reconnaisance, surveillance, and other means.

INT 1 See Reference.
INT 1.1 See Reference.
INT 1.4 See Reference.
INT 1.5 See Reference.

INT 3 Conduct surveillance and reconnaissance.
INT 3.2 Conduct overt surveillance and reconnaissance operations.

INT 8 Process surveillance and reconnaissance information.

INT 9 Disseminate surveillance and reconnaissance information.

LOGISTICS (LOG). The resupply of combat consumables to combatant forces in the theater of operations.

LOG 1 Conduct underway replenishment.
LOG 1.1 Transfer ammunition underway.
LOG 1.3 Transfer cargo underway.
LOG 1.5 Transfer missiles underway.
LOG 1.15 Transfer torpedoes underway.
LOG 1.17 Transfer mines underway.

LOG 2 Transfer/receive cargo and personnel.
LOG 2.2 Provide facilities and personnel for material, mail, and passenger handling.
LOG 2.3 Act as transient personnel receiving station.
LOG 2.4 Transfer and receive personnel by helo.

LOG 3 Provide sealift for cargo and personnel.
LOG 3.1 Provide stowage and berthing spaces for equipment and personnel during transit.

MINE WARFARE (MIW). The use of mines for control/denial of sea or harbor areas, and mine countermeasures to destroy or neutralize enemy mines.

MIW 3 Conduct mine neutralization/destruction.
MIW 3.2 Destroy floating mines.
MIW 3.6 Provide support for embarked EOD/SEAL.

MIW 4 Conduct mine countermeasures (MCM).
MIW 4.2 Vector small craft to mark locataed mine like objects.

MIW 5 Support/conduct offensive/defensive service and exercise mine-laying operations.
MIW 5.1 Support/conduct service and exercise mine-laying operations by surface ships.
MIW 5.2 Support/conduct mine laying operations by aircraft in a hostile environment.

MIW 6 Conduct magnetic silencing (degaussing, deperming, etc).
MIW 6.7 Maintain magnetic signature limits.

MIW 8 Conduct precise navigation.
MIW 8.2 Navigate precisely in MCM environment.
MIW 8.3 Navigate precisely in mine laying environment.
MIW 8.5 Safely navigate minefields.

MIW 10 Provide for air operations in support of mine warfare operations.

MIW 10.1 Launch fixed wing and/or rotary wing aircraft involved in mine warfare operations.
MIW 10.2 Recover fixed wing and/or rotary wing aircraft involved in mine warfare operations.
MIW 10.5 Provide required conventional ordnance to support mine warfare operations.
MIW 10.7 Load/unload mine warfare ordnance compatible with required aircraft turnaround time.

MIW 11 Conduct Route Survey Operations.
MIW 11.3 Provide capability to collect, store, retrieve, and process MIW contact information.

MOBILITY (MOB). The ability of naval forces to move and to maintain themselves in all situations over, under or upon the surface.

MOB 1 Steam to designed capability and in most fuel efficient manner.
MOB 1.1 Steam at full power.
MOB 1.2 Steam with split plant.
MOB 1.5 Steam at sustained BG/SAG speeds.
MOB 1.6 Maintain necessary machinery redundancy to enhance survival in high threat areas.
MOB 1.7 Transit at high speed.

MOB 2 Support/provide safe, flyable aircraft for all-weather operations.

MOB 3 Prevent and control damage.
Mob 3.1 Control fire, flooding, electrical, structural, propulsion and hull casualties.
Mob 3.2 Counter and control CBR contamination/agents.
Mob 3.3 Maintain security against unfriendly acts.
Mob 3.5 Provide DC security and surveillance.
Mob 3.8 Provide emergency breathing devices per ship's allowance.

MOB 5 Maneuver in formation.

MOB 7 Perform seamanship, airmanship and navigation tasks.
MOB 7.1 Navigate under all conditions of geographic location, weather, and visibility.
MOB 7.2 Conduct precision anchoring
MOB 7.3 Get underway, moor, anchor, and sortie with duty section in a safe manner
MOB 7.5 Utilize programmed evasive steering.
MOB 7.6 Abandon/scuttle ship rapidly
MOB 7.7 Provide life boat/raft capacity IAW unit's allowance
MOB 7.8 Tow or be towed.
MOB 7.9 Operate day and night and under all weather conditions.
MOB 7.14 Moor alongside ATF shipping or docks.
MOB 7.15 Operate in a chemically contaminated environment

MOB 10 Replenish at sea.
MOB 10.1 Receive VERTREP.
MOB 10.2 Receive fuel while underway.
MOB 10.3 Receive munitions and provisions while underway.
MOB 10.4 Receive potable and/or feed water while underway.

MOB 12 Maintain the health and well-being of the crew.
MOB 12.1 Ensure all phases of food service operations are conducted consistent with approved sanitary procedures and standards.
MOB 12.2 Ensure the operation of the potable water system in a manner consistent with approved sanitary procedures and standards.
MOB 12.3 Maintain the environment to ensure the protection of personnel from overexposure to hazardous levels of radiation,
temperature, noise, vibration, and toxic substances per current instructions.
MOB 12.5 Monitor to ensure that habitability is consistent with approved habitability procedures and standards.
MOB 12.6 Ensure operation and maintenance of all phases of shipboard environmental protection systems do not create a health hazardand are consistent with other naval

directives pertaining to the prevention of pollution of the environment.

NONCOMBAT OPERATIONS (NCO). Selected operations of a noncombat nature not clearly catagorized in any other warfare mission area. Included in this catagory are the necessary support requirements and/or special missions that are required of a unit but not directly related to the other Warfare Mission Areas.

NCO 2 Provide administrative and supply support for own unit.
- NCO 2.1 Provide supply support services.
- NCO 2.2 Provide clerical Support services.
- NCO 2.3 Provide disbursing services.
- NCO 2.4 Provide post office services.
- NCO 2.5 Provide messing facilities.
- NCO 2.6 Provide ships service facilities.

NCO 3 Provide upkeep and maintenance of own unit.
- NCO 3.1 Provide organizational level maintenance.
- NCO 3.2 Repair own unit's equipment.
- NCO 3.3 Provide small arms storage area.

STRIKE WARFARE (STW). Support the destruction or neutralization of enemy targets ashore through the use of conventional weapons.

STW 8 Provide for air operations in support of air strike operations.
- STW 8.1 Launch fixed and/or rotary winged aircraft involved in air strike operations.
- STW 8.2 Recover fixed and/or rotary winged aircraft involved in air strike operations.
- STW 8.5 Provide required conventional ordnance to support strike operations.
- STW 8.7 Load/unload ordnance compatible with required aircraft turnaround times.

E. DESIGN PHILOSOPHY

Throughout the design process, specific issues and systems to be incorporated in the SPECTRE design need to be considered and trade-offs made. In order to ensure this to be a logical process, a prioritized list of the major design issues is required. This document, known as the Design Philosophy, is employed to provide consistency to all trade-offs and design decisions. This section outlines and provides justification of the issues considered important enough to be incorporated in the Design Philosophy, and their relative ranking, for the SPECTRE System. This philosophy is therefore also conveyed to the design of the CMD platform itself.

In order to develop the Design Philosophy an assessment of the many factors that steer the design of a ship is required. This list includes fundamental military and technical issues as well as those military and political issues that are currently in the spotlight, affecting design acceptance. These issues are then weighed against the mission need and the ORD to establish which are a high, medium or low priority.

1. Priority of Design Considerations

The following are those concerns that will hold the highest priority throughout the design process. Note that there is no relative ranking. These considerations are treated with equal significance and are weighted as such.

Cost

Mission Effectiveness

Mission Flexibility

The next list contains those considerations that are assigned a mid level priority. Since this list is longer than those of the highest priority and cover a wider range of concerns, a numerical ranking has been assigned to assist making trade-off decisions within this category

(1) Survivability

(2) R, M & A

(3) Affordability Through Commonality (ATC)

(4) Commercial Off The Shelf (COTS)

The remaining issues evaluated as important enough to affect the design are given the lowest priority (also ranked), as follows:

(1) Producibility

(2) Habitability (including Bi-Gender allowances)

(3) Reduced Manning

(4) Environmental

(5) Future Growth

(6) Fuel Economy

(7) Size

The final group is provided for completeness, and includes those considerations determined to be of minor concern. Some of these will manifest themselves in the design, but only to the point that they are requirements that must be included.

Appearance

Automation

Political / Societal

2. Discussion / Justification:

Mission effectiveness is an obvious priority in the design of any ship and should not require any discussion here. But the fact that mission effectiveness is given equal weighting to *cost*, may draw significant discussion and criticism. This is a recognition of the current fiscal environment within which the Navy must operate, requiring cost effective platforms that "do more with less."

Mission flexibility is given a high priority since the CMD must operate in diverse situations with varying mission requirements, and therefore varying payloads. This directly affects the foundation of the SPECTRE concept as a tailored force, as outlined in the ORD.

Survivability is broken out of mission effectiveness and listed as a separate priority to ensure that related issues are addressed with appropriate emphasis and not lost in the tendency to treat offensive capabilities or specific systems as the only elements within mission effectiveness. Such related issues that directly affect survivability of the CMD include reduced signatures to lower susceptibility to a hit, and enclaving to reduce the CMD's vulnerability.

Reliability, Maintainability and Availability (RM&A) are considered important due to the significant impact these issues have on all the previous higher priority issues.

Affordability Through Commonality (ATC) & Commercial Off The Shelf (COTS) are listed separately as they are current programs that directly affect RM&A, platform costs and mission flexibility.

Producibility is listed as a low priority due to the potential cost savings derived from designing a ship for given production methods and ease of construction. Although listed here, designing for production cannot be allowed to have a negative effect on any of the higher priority issues.

Habitability improvements are to be considered primarily as a morale consideration, without compromising previously discussed issues.

Operational, maintenance and damage control *manning requirements* will be reduced to an optimal point in order to reduce O&S costs.

Environmental impact issues are considered so as to meet regulatory requirements, with a low priority placed on exceeding those requirements or predicting future environmental issues.

Design considerations and margins for improving *future growth* potential are given a low priority in view of the CMD's probable size, and that a majority of the SPECTRE's combat system suite is contained in the PTX craft.

Fuel economy considerations drive the need for efficient propulsion and power generation plants in order to reduce costs and support the extended independent operating requirements of the ORD.

Optimization of *size* below the navigational requirements detailed in the ORD is given a low priority, since size inevitability has an impact on fuel consumption and platform costs.

SECTION II

COMBAT SYSTEM DEFINITION PHASE

A. PTX CAPABILITIES, EQUIPMENT AND SIZE

1. Anti-Submarine Warfare (ASW)

The ASW platform(s) must be capable of accomplishing all ASW Required Operational Capabilities (ROCs). Two possible platforms have been chosen to fullfill this mission area, One is a surface PTX craft and the other is an airborne PTX, namely the SH-60B.

A. SURFACE PTX

1. EQUIPMENT

a. Passive only towed array sonar (depths greater than 400 ft)
b. Active and passive sonobouys with tethered balloon (any depth)
c. Two twin-tube torpedo launchers (Mk 50 torpedoes)
d. Small caliber gun for close aboard small craft engagement.
e. Link 11 and link 4A data transmission/receive equipment
f. LAMPS shipboard equipment (LSE).
g. Passive Anti-Ship Missile Defense (ASMD) - CHAFF, ECM, etc.
h. UHF/HF/VHF secure and nonsecure communications.

2. SIZE/RANGE

a. Displacement: 120 tons
b. Length: 100 ft
c. Beam: 25 ft
d. Draft: 5 ft
e. Total height: 36 ft
f. Manning: 10-12 total
g. Speed: 40+ kts
h. Endurance: 8-12 hrs

B. SH-60B PTX (Seahawk LAMPS-III)

b. One quad missile launcher or 2 twin tube missle launchers with long range missiles capable of engaging surface or shore targets at ranges to 80 nm using off hull targeting data.

c. 76mm gun for engagement of medium range surface and shore targets.

d. Small caliber gun for close aboard small craft engagement.

e. Passive Anti-Ship Missile Defense (ASMD) - CHAFF, ECM, etc.

f. SAT/UHF/HF secure and nonsecure communications.

g. LAMPS shipboard equipment (LSE).

2. SIZE/RANGE

a. Displacement: 130 tons

b. Length: 100 ft

c. Beam: 25 ft

d. Draft: 6 ft

e. Total height: 36 ft

f. Manning: 10-12 total

g. Speed: 40+ kts

h. Endurance: 8-12 hrs

B. AH-1W PTX (COBRA)

1. EQUIPMENT

a. Search radar

b. 20mm gun

c. Rocket pods

d. (8) TOW or (8) HELLFIRE

2. SIZE/RANGE

a. Weight: 2 tons

b. Length: 60 ft

c. Width: 15 ft (50 ft diameter rotor)

e. Total height: 18 ft

1. EQUIPMENT

a. Active and passive sonobouys (25)
b. AQS-13 dipping sonar
c. Two Mk 50 torpedoes
d. Link 11 data equipment
e. ALQ-142 ESM equipment
f. ASQ-811(V)2 MAD

2. SIZE/RANGE

a. Weight: 10 tons
b. Length: 60 ft
c. Width: 15 ft (50 ft diameter rotor)
e. Total height: 18 ft
f. Manning: 2
g. Speed: 130 kts cruise
h. Endurance: 4.5 hrs

2. Anti-Surface Warfare (ASU)

The ASU platform(s) must be capable of accomplishing all ASU and STW Required Operational Capabilities (ROCs). There are four possible platforms that fullfill this mission area, One is a surface PTX craft and the other three are airborne PTX craft, namely the AH-1W COBRA, AH-64A APACHE, and AV-8B HARRIER II. This platform is also designated as a Strike Warfare platform since the ASU weapons load-out is similar to a STW load-out.

A. SURFACE PTX

1. EQUIPMENT

a. Long range (60 nm) surface and air search/fire control radar.

f. Manning: 2
g. Speed: 190 kts cruise
h. Range: 250 nm
h. Endurance: 2.5 hrs

C. AH-64A PTX (APACHE)

1. EQUIPMENT

a. Search radar
b. 30mm gun
c. 16 HELLFIRE or (76) 70mm rockets

2. SIZE/RANGE

a. Weight: 8 tons
b. Length: 60 ft
c. Width: 15 ft (50 ft diameter rotor)
e. Total height: 18 ft
f. Manning: 2
g. Speed: 220 kts cruise
h. Range: 300 nm
h. Endurance: 2.5 hrs

D. AV-8B PTX (HARRIER II)

1. EQUIPMENT

a. APG-65 radar
b. (2) 30mm gun
c. (14) 500lbs bombs or (6) 1000lb bombs or (4) MAVERICK air-to-surface missiles

2. SIZE/RANGE

a. Weight: 9 tons

b. Length: 45 ft
c. Width: 30 ft
e. Total height: 20 ft
f. Manning: 1
g. Speed: 615 kts cruise
h. Range: 172 nm
h. Endurance: 1.0 hrs

3. Mine Warfare (MIW)

The MIW platform(s) must be capable of accomplishing all MIW Required Operational Capabilities (ROCs). There are two possible platforms that fullfill this mission area, One is a surface PTX craft and the other is an airborne PTX craft, namely the MH-53E. The surface PTX will be capable of both mine sweeping and mine hunting. The MH-53E will be easily converted from either sweeping or hunting. An EOD or SEAL team will be carried to provide for mine identification, handling and destruction.

A. SURFACE PTX

1. EQUIPMENT

a. Double "O" sweep gear (500 yd wide path at 10 kts).
b. Mk 5(A) straight tail sweep for influence mines.
c. Mk 4(V) or Mk 6(B) acoustic noise maker sweep for influence mines.
d. AN/SQQ-32 Variable Depth Sonar (VDS) to detect and classify.
e. AN/SLQ-48 Mine Neutralization System (MNS) remotely operated vehicle or EOD detachment.
f. Passive Anti-Ship Missile Defense (ASMD) - CHAFF, ECM, etc.
g. SAT/UHF/HF secure and nonsecure communications.

2. SIZE/RANGE

a. Displacement: 130 tons
b. Length: 100 ft
c. Beam: 25 ft

d. Draft: 6 ft

e. Total height: 36 ft

f. Manning: 10-12 total

g. Speed: 40+ kts

h. Endurance: 8-12 hrs

B. MH-53E PTX (Sea Dragon)

1. EQUIPMENT

a. Mk 103 double wire sweep gear (100 yd wide path at 25 kts).

b. Mk 104 or ALQ-160 or ALQ-141 acoustic noise maker sweep for influence mines.

c. Mk 105 or ALQ-166 hydrofoil sled to sweep magnetic mines.

d. AQS-14 sonar

2. SIZE/RANGE

a. Weight: 33 tons

b. Length: 100 ft

c. Width: 25 ft (80 ft diameter rotor)

e. Total height: 25 ft

f. Manning: 3

g. Speed: 150 kts cruise

h. Range: 230 nm

h. Endurance: 4.0 hrs

4. Intelligence (INT)

The INT platform must be capable of accomplishing a large portion of the INT Required Operational Capabilities (ROCs). The only platform able to fullfill this mission area is a surface PTX craft. This PTX is smaller than the other surface PTX craft and will be utilized primary in clandestine and intelligence gathering operations. This vessel may also be configured to provide for covert incursion operations and combat Search and Rescue (SAR).

A. SURFACE PTX

1. EQUIPMENT

a. VAMPIR IR surveillance and target designator ESM system.
b. Radar and communication Direction Finding (DF).
c. Gyro stabilized weapons platform with one of the following:
   1). GIAT 20mm machine gun
   2). Bushwacker 25 mm gun system
   3). STINGER missile system
   4). JAVELIN SAM launcher
   5). Portable rocket launcher
d. Night vision equipment
c. Passive Anti-Ship Missile Defense (ASMD) - RBOC and TORCH.
f. SAT/UHF/HF secure and nonsecure communications.

2. SIZE/RANGE

a. Displacement: 40 tons
b. Length: 60 ft
c. Beam: 15 ft
d. Draft: 3 ft
e. Total height: 15 ft
f. Manning: 6-8 total
g. Speed: 40+ kts
h. Endurance: 8-12 hrs

5. Anti-Air Warfare (AAW)

The AAW platform(s) must be capable of accomplishing all AAW Required Operational Capabilities (ROCs). The only feasible platform to accomplish this mission area is an airborne PTX, namely the same aircraft designated as ASU platforms but configured with AAW weapons systems. The ASU surface PTX has AAW capability built-in with the installed 76mm dual purpose gun. The AAW platforms are to provide defense against incoming aircraft not missiles. Each PTX and the CMD must be provided with point ASMD individually.

A. AH-1W PTX (COBRA)

1. EQUIPMENT

a. Search radar
b. 20mm gun
c. (2) SIDEWINDER air-to-air missiles

2. SIZE/RANGE

a. Weight: 2 tons
b. Length: 60 ft
c. Width: 15 ft (50 ft diameter rotor)
e. Total height: 18 ft
f. Manning: 2
g. Speed: 190 kts cruise
h. Range: 250 nm
h. Endurance: 2.5 hrs

B. AH-64A PTX (APACHE)

1. EQUIPMENT

a. Search radar
b. 30mm gun
c. (2) SIDEWINDER air-to-air missiles

2. SIZE/RANGE

a. Weight: 8 tons
b. Length: 60 ft
c. Width: 15 ft (50 ft diameter rotor)
e. Total height: 18 ft

f. Manning 2

g. Speed: 220 kts cruise

h. Range: 300 nm

h. Endurance: 2.5 hrs

C. AV-8B PTX (HARRIER II)

1. EQUIPMENT

a. APG-65 radar

b. (2) 30mm gun

c. (2) SIDEWINDER air-to-air missiles

2. SIZE/RANGE

a. Weight: 9 tons

b. Length: 45 ft

c. Width: 30 ft

e. Total height: 20 ft

f. Manning: 1

g. Speed: 615 kts cruise

h. Range: 172 nm

h. Endurance: 1.0 hrs

B. CMD COMBAT SYSTEM ALTERNATIVES

The combat system alternatives were generated in order to provide a selection list from which to choose appropriate systems which support the ROCs for the CMD. The following is a compilation of the proposed combat system equipment. Each particular combat system element has numerous equipment selection possibilities to provide a specific combat capability.

1. Detection Elements

Detection elements include surface search radars, air search radars, aviation control radars, navigation equipment, electronic warfare equipment and sonar equipment.

A. Surface Search
1. SPS-63
2. SPS-64
3. SPS-67
4. SPS-55
5. LN-66
6. Radiant Mist

B. Air Search
1. 2-D
    a) SPS-49
    b) SPS-65
    c) SPS-40E
2. 3-D
    a) SPS-48E
    b) SPS-52C
    c) SPY-1B
    d) FAST
    e) FLEXAR

C. Navigation
1. WRN-6 (GPS)
2. SRN-25 (OMEGA)
3. WSN-5 (INS)

4. WQN-1 (FATHOMETER)
5. LORAN
6. SATNAV

D. Electronic Warfare
1. SLQ-32(V2)
2. SLQ-32(V3)
3. SLQ-54 (AIEWS/MATES)
4. SHIELDS V2
5. ALR-66A
6. LOCATOR 2000
7. APR-39A V2/SIEWS

E. Sonar
1. SQS-26
2. SQS-53
3. SQS-56
4. SQQ-28 (LAMPS III Data Link)
5. SQR-18 (FFG TACTAS)
6. SQR-19 (DD TACTAS)
7. SQQ-89 (SQS-53,SQR-19,SQQ-28)
8. Mine Detection / Evasion

2. Command, Control, Communication Elements

A. NTDS
B. ACDS
C. OTCIXS
D. LINK 11, 14, 16
E. TADIXS
F. CUDIXS
G. INCS
H. AEGIS Display System

3. CMD Passive Self Defense Elements

A. SLQ-25/36 NIXIE
B. MK 36 SRBOC DLS
C. SEAGNAT
D. AN/SSQ-25
E. SSTDS
F. ALEX DLS

4. CMD Engagement Elements

A. ASUW
1. 20mm BUSHMASTER
2. HARPOON
3. TOMAHAWK
4. 50 cal M2
5. 5" 54 cal
6. 76mm
7. SM-2
8. PTX

B. ASW
1. MK 32 SVTT (MK46/50 Torpedoes)
2. ASROC
3. PTX

C. AAW
1. SM-2
2. RAM
3. CIWS
4. SEA SPARROW
5. 76mm
6. 5" 54 cal
7. STINGER
8. PTX

D. STRIKE
1. TOMAHAWK

2. ATACM
3. 5" 54 cal
4. PTX

E. Mine Warfare

1. PTX

C. CMD LOAD-OUT FOR SCENARIOS

The CMD will be required to carry different mixes of PTX craft for each scenario it is engaged in. This section describes the anticipated PTX craft needed to carry out a specific mission scenario. The PTX craft are broken down into surface and airborne. The numbers of PTX craft delineated in the following section will be sufficient to control the operating area and meet all required capabilities for the given scenario. For each scenario the previously determined threats were prioritized, the PTX craft capabilities were compared and a suitable number of PTXs required was determined.

1. Support of Amphibious Landings (1 Battalion Landing Team).

Using the scenario previously stated and assuming three boat lanes for the landing, the following PTXs are required:

A. Surface PTX
1. (4) MIW
2. (4) Strike
3. (2) Surface Patrol

B. Airborne PTX
1. (4) MIW
2. (2) Strike

2. Support of Small Amphibious Landing (Personnel Evacuation, Peacekeeping, etc).

Using the scenario previously developed for semi-covert small actions the following PTXs are required:

A. Surface PTX
1. (4) Surface Patrol
2. (4) Strike (configured with AAW weapons)

B. Airborne PTX
1. (4) Strike

2. (2) MIW
3. (2) ASW

3. Conduct Harbor Blockade (Boarding, Search and Seizure, etc).

Using the scenario previously developed and assuming a harbor the size of Monterey Bay the following PTXs are required:

A. Surface PTX
1. (6) Strike
2. (4) Surface Patrol

B. Airborne PTX
1. (6) Strike
2. (2) AAW
3. (2-4) ASW (some may be configured for MIW)

4. Conduct Area Mine Clearance.

For area mine clearance (20 sq nm) the following PTXs are required:

A. Surface PTX
1. (8) MIW
2. (2-4) Strike (some may be configured for AAW)

B. Airborne PTX
1. (8) MIW
2. (2-4) AAW
3. (4) Strike

5. Conduct Escort Operations in Restricted Waterways.

For escort operations in previously mine sanitized waters the following PTXs are required:

A. Surface PTX

1. (6) Strike

B. Airborne PTX
   1. (4) Strike
   2. (4) AAW
   3. (2) MIW

6. Conduct Independent PTX Operations.

For independent PTX operations the mix of PTX craft will depend entirely on the specific situation and will either be forward deployed or transported to the area and operated from a safe shore station.

7. Conduct Special Operations (INTEL, RECON, SPECOPS).

Using the scenario previously developed for covert special operations the following PTXs are required:

A. Surface PTX
   1. (6) Strike
   2. (6) Surface Patrol

B. Airborne PTX
   1. (4) AAW
   2. (4) Strike

D. CMD COMBAT SYSTEM SELECTION

A decision matrix was generated for each of the combat systems proposed in the combat system alternatives section. The matrix utilized weighted values from the design philosophy and specific combat system capabilities. The decision matrices are enclosed as appendix A.

1. Detection Elements

A. Surface Search

Based on the decision matrix the SPS-64 and SPS-67 combination was chosen for the CMD platform. Both radars are currently in use on numerous naval surface craft and thus do not require any additional research and development or operational testing. The combination of these two radars provides for excellent navigation functions and target resolution. It is envisioned that the two radar systems will be located separately on the ship. The redundancy provided by two separate radars will improve the ships survivability characteristics.

B. Air Search

The SPS-49 (2-D) air search radar was chosen based on the decision matrix and a ship visit. It was determined that a 3-D radar is not necessary for the purposes of the CMD platform. The SPS-49 provides excellent target resolution for low flying aircraft, which is the anticipated threat.

C. Aviation Control

For aviation control the SPN-35/43 combination was chosen. This radar selection provides for azimuth and elevation illumination for aircraft control and target designation. The SPN-35/43 combination can also be used for elevation information on enemy aircraft targets. TACAN was deemed necessary for the CMD mission and will be included in the combat system suite.

D. Navigation

The navigation system chosen consists of the WRN-6 Global Positioning System (GPS), SRN-25 (OMEGA), WQN-1 (fathometer), and LORAN C. This combination will provide real-time navigation capability and will be used to direct PTX craft to suspected enemy platforms. Each of these is currently being used on naval surface craft.

E. Electronic Warfare

The SLQ-32 (V3) was chosen for the CMD design. A modification to the SLQ-32 (V3) is envisioned which would include an Infrared (IR) and laser detection and jamming capability. Infrared and laser detection and jamming technology is currently available and incorporation into the SLQ-32 (V3) system seems feasible. This capability will enhance the CMD survivability characteristics and improve passive point defense.

F. Sonar

Based on projected operational scenarios, a sonar system was deemed unnecessary. A small mine avoidance sonar was proposed for inclusion but was rejected for various reasons. The PTX platforms will be required to peform underwater search and destruction.

2. Command, Control, Communication Elements

The following command, control and communication equipment was selected to provide the CMD with the capabilities required in the ROCs:

A. ACDS (Advanced Combat Direction System)

The ACDS replaces obsolescent NTDS (Navy Tactical Data System) hardware, introduces a program compatible with NTDS, but with some improvements, and features a new computer program architecture. The system is a family of computers, software packages, consoles and data links that process real-time strategic and tactical information from platforms in a task force. Information is communicated using either link 11, link 14, link 4A, or link 16. The processing system for the CMD ACDS will replace the AN/UYK-43 computers with compatible state-of-the-art COTS (Commercial Off The Shelf) computers. The data storage capability will be expandable and graphical display consoles will be compatible with emerging commercial standards.

B. LINK 11

Link 11 is a two-way real-time encrypted data link between the CMD, PTX and other ships and aircraft operating at HF or UHF bands. It is used to exchange track and tactical data, and is the primary integrating element in unified task force operations. Link

11 model five (LEMF) is the next generation which will possess greater data handling capability and increased security.

C. LINK 16

Link 16 will connect the CMD to the Joint Tactical Information Data System (JTIDS). It is designed to provide secure, jam-resistant, real-time information transfer among dispersed units which are within line of sight. This link will be the primary means of communication between the CMD, PTX and other joint forces.

D. LINK 14

Link 14 is a one-way HF or UHF data link which enables the ACDS equipped CMD to provide tactical information to non-ACDS equipped craft.

E. LINK 4A

Link 4A is a one-way UHF data link that the CMD will use to control strike platforms and interceptor aircraft.

F. CUDIXS

The Common User Digital Information System will carry two-way general service messages via satellite.

G. OTCIXS

The Officer-In-Tactical-Command Information Exchange System provides two-way secure satellite communications (voice or teletype) for the task group and for transmission of information to shore establishments.

H. IVCS

A fiber optic Interior Virtual Communication System will provide the CMD multiplexed integrated interior communications. The fiber optic cables will be redundantly routed throughout the ship to improve survivability.

I. KSQ-1

The amphibious boat control transceiver system will be used to control surface PTX craft from the CMD. The system utilizes PTX GPS locations which are satellite linked to the CMD. The CMD can then provide steering information to the PTX to vector toward a specific search area.

J. JOTS II (Joint Operational Tactical System II)

JOTS II is a battle management software system that can interface with any supporting command, control and communication system. JOTS II plots in NTDS symbology on a dynamic, high resolution color map which is used in much the same way as a paper navigation chart. The data displayed on the map can be precisely controlled by the user.

JOTS II is written in C and works within the UNIX operating system. Virtually any modern UNIX work station is compatible with JOTS II. The software consists of five main subsystems: communications, message processing, track management, tactical display, and validated applications. These subsystems form a system which can be expanded or customized for specific battle management needs. JOTS II can communicate with computers resident on ships or in shore mode with the Naval Tactical Command System through OTCIXS, the DDN, LINK 11 or LINK 14.

K. GENERAL

The CMD will maintain sufficient antennas, handsets, teletypes, switchgears, patch panels, etc. to provide for HF, UHF, VHF, SHF and satellite communications to forces afloat and ashore.

3. CMD Passive Self Defense Elements

A. SSTDS

The Surface Ship Torpedo Defense System consists of a noise making towed body, similar to SLQ-25 (NIXIE), with improved on-board signal processing.

B. ALEX

A shipboard decoy (CHAFF or IR) system made by Hycor. The 130.2 mm caliber twenty launcher system will be used on the CMD. The launchers have automatic round selection and sequencing and use current navy cartridges, as well as, Chafstar, Gemini, HIRAM and LORAC series. The ALEX system will be incorporated into the SLQ-32(V3) detection system.

4. CMD Engagement Elements

A. ASUW

For anti-surface actions the CMD will use (8) 25mm BUSHMASTER chain guns located at various stations around the ship, and (1) or (2) 76mm rapid fire automatic guns.

B. ASW

The CMD will only have passive anti-submarine weapons. Active anti-submarine actions will be performed by the ASW PTX.

C. AAW

For anti-air actions the CMD will employ (2) Rolling Airframe Missile (RAM) launchers carrying 21 rounds each and (2) Close In Weapon Systems (CIWS). The RAM is a fire-and-forget weapon, homing either on infrared or electromagnetic emissions with a range of 5nm. The CIWS fires 20mm rounds at a rate of 1000-3000 rounds per minute with an effective range of 1.5nm.

D. Strike

Strike missions will be carried out by the strike PTX.

SECTION III

PROPULSION PLANT DEFINITION PHASE

A. CMD PROPULSION PLANT ALTERNATIVES

There are numerous propulsion plant alternatives to provide the necessary power to propel the CMD at the desired speed and maintain endurance limits prescribed by the Operational Requirements Document. The most feasible alternatives are described below and are sub-catagorized into power generation, transmission and propulsor.

1. Power Generation

Power generation can be sub-divided into two broad catagories: nuclear and conventional.

A. Nuclear

Consists of the nuclear reactor, associated main machinery equipment and steam turbines.

B. Conventional

1. Steam power (S)

   Consists of boilers, steam turbines and associated auxiliary equipment.

2. Gas Turbine power (GT)

   Utilizes gas turbines as prime movers for generators and/or main engines.

3. Diesel power (D)

   Utilizes diesel engines as the prime movers for generators and/or main engines.

4. Fuel Cells (FC)

   Fuel cells generate ship's service electricity directly using the chemical reaction between gaseous hydrogen and oxygen.

2. Transmission

Power transmission is defined as the manner in which the power generated is transmitted to the propulsor which in turn drives the ship. Included in power transmission is the method by which ship's service electricity is generated.

A. Mechanical Drive (MD)

There are separate prime movers for main propulsion and ship's service electricity. The main engines are mechanically coupled to the propulsor shafts.

B. Integrated Electric Drive (IED)

The propulsion and ship's service generators are driven by the same prime mover.

C. Advanced Integrated Electric Drive (AIED)

The same concept as IED, but with advanced technology generators and motors.

D. Propulsion Derived Ship Service (PDSS)

The main engines are mechanically coupled to the propulsor shafts, and the ship's service generators are driven by the same prime mover as the main engines.

E. Power Off the Main Bus (POMS)

The propulsion motors and ships service electric distribution system recieve power from the same bus.

3. Propulsor

The propulsor is the device which imparts energy to the surrounding medium producing thrust which causes the ship to move.

A. Fixed Pitch propeller (FP)
B. Controllable/Reversible Pitch propeller (CRP)
C. Waterjet (WJ)
D. Counter-Rotating propeller (CR)
E. Vertical axis propellor (VP)

B. CMD PROPULSION PLANT SELECTION

The combat effectiveness is the prime concern in considering possible propulsion plants to incorporate into the CMD. The hull form necessary to carry out the previously discussed missions will drive the propulsion plant selection. Many alternatives were disregarded due to the high cost involved, weight and volume requirements and political considerations.

1. Power Generation

A. Nuclear Power

Nuclear power is not feasible for the SPECTRE concept due to the high cost involved in procurement, the increased weight to support reactor shielding and hull form restrictions.

B. Conventional power

Steam power (using a conventionally powered boiler to generate steam) is not feasible due to the hull form restrictions and political considerations.

Fuel cells are considered feasible but current technology does not provide for the high power requirements needed to propel the CMD.

Gas turbines and diesel engines are the primary source of power generation considered for the CMD. The low maintenance required on these systems coupled with the increased machinery arrangement alternatives provides for a durable propulsion plant.

2. Transmission

Mechanical drive, integrated electric drive and advanced integrated electric drive are all viable options for the CMD. Mechanical drive has advantages in that the technology is rather simple and the cost is low. Electric drive provides for increased machinery arrangement flexibility but is more expensive.

PDSS and POMS are considered not feasible for this design since the ships service electric power requirements will be minimal and the added cost for incorporation of these systems would not be economically feasible.

3. Propulsor

Fixed pitch propellers, controllable-reversible pitch propellers, and waterjet propulsors will be considered as possible choices in the preliminary design phase. The selection of the propulsor is closely tied to the transmission selection.

Counter-rotating propellers do not provide any added capability which affects the mission effectiveness and would increase acquisition costs.

4. Summary

To facilitate the generation of ASSET design models three different hull forms and ship sizes will be considered to provide for the needed combat capability for a given scenario. In each hull a gas turbine power plant with mechanical drive transmission and controllable-reversible pitch propellers will be considered. This provides a baseline for hull form and size selection which will be used to determine the type of platform desired for the Multi-mission Dock (CMD) platform. Propulsion plant selection and arrangements will be determined after a hull form is finalized.

SECTION IV

FEASIBILITY STUDIES

A. ASSET DESIGN MODEL ALTERNATIVES

Three ASSET design models were developed and are discussed in this section. To aid in the ship design processes a design program provided by the Decision Engineering was also used. As previously stated, all of the designs generated are conventionally powered with gas turbines, mechanically driven and have CRP propellers. Numerous assumptions were made for these models.

1. Design Model Assumptions

The unique mission of the CMD is to deliver and provide command and control of the PTXs as well as logistic support. All offensive warfare capabilities are to reside with the different PTXs while the CMD is to only have point defense capabilities. Careful consideration and evaluation of the mission of the CMD resulted in the decision that all design alternatives would have the same basic capabilities, i.e. C & C, point defense, etc. The major variation between the different design alternatives would be the number of PTXs that the CMD could carry. Evaluation of the design would be based on three different sizes of the CMD corresponding to three PTX carrying capacity options. The following is a list of the basic design assumptions used in the development of the three ASSET design models:

A. The smallest CMD was based on the smallest number of PTXs needed to form an operating unit within a particular warfare area. An example would be four mine warfare units are needed to adequately perform the mine hunting mission. The largest CMD was based on the minimum number of PTXs needed to satisfy the mission requirements of the many scenarios envisioned for the CMD. The three sizes decided upon are:

- i) Small - 4 surface PTXs and 2 air PTXs.
- ii) Medium - 6 surface PTXs and 6 air PTXs.
- iii) Large - 8 surface PTXs and 10 air PTXs.

B. Well deck size resulted from assuming that the largest surface PTX would fit inside of a box with the dimensions of 100' x 25' x 34'. The well deck configuration would accommodate two PTXs side by side. Allowing for adequate clearance between hulls of three feet, the well deck width for all three design alternatives was set at 60'. The required length of the well deck was set according to the number of PTXs to be carried end to end and allowing for adequate clearance between hulls. This resulted in minimum well deck lengths of 210', 315', and 420'. The forward bulkhead of the well deck was then moved forward to correspond to the standard location of a hull transverse bulkhead.

C. Hangars were sized to house approximately 50 percent of the embarked aircraft. The largest airframe to be carried by the CMD was used in determining hanger space requirements. The CH-53E was the largest airframe considered for this purpose. Square foot estimates were provided by the Decision Engineering design program. Airframe dimensions were taken from Navy pub. NWP-42.

D. Flight deck size was based on the number of launch and recover spots needed to adequately support the embarked aircraft and on the operating area required for each airframe. Three launch and recover spots were selected and labeled 1, 2, and 3. Each launch and recover spot is sized to allow simultaneous air operations by any of the embarked aircraft. Allowance was also made for equipment staging on the flight deck. Flight deck dimensions selected are 100', 305' and 410'. The width of the flight decks is designed to be at the full beam of the ship. Aircraft operating requirements were obtained from Air Capable Ship Aviation Facilities Bulletin No. 1G.

E. The hull form used was from the LSD-41 class and was modified for each of the three design alternatives considered.

F. In order to simplify the analysis, all three design alternatives were given the same propulsion design of gas turbine main engines, mechanical drive, and controllable reversible pitch propellers. Ship service generators are diesel electric generators sized to meet the required emergency electric load.

G. The deck house was sized to fill the remaining deck area from the hangar to the foc'sle. Current level of evaluation is unable to adequately determine the required area of deck house required.

H. Defensive enhancement modifications, such as angled hull and deck house to reduce radar cross section, were not employed in the ASSET modeling for the feasibility studies but were incorporated in preliminary design.

I. Weight and stability calculations were based on actual ASSET design model configurations and on modified weight statements. Weight statement data was provided from LSD-41 class full load weight statements which were scaled to the design model hull dimensions.

2. CMD Model One (CMD(S))

The first model developed is a small version of the LSD-41 class amphibious assault platform. The ASSET design model and the Decision Engineering design model characteristics are contained in appendix B. The major characteristics of this design are tabulated in table 4-1.

TABLE 4-1

Ship Displacement (full load):	16,782 long tons
Ship Volume:	2,431,533 cubic feet
Ship Length (LBP):	480 feet
Ship Length (LOA):	496 feet
Ship Beam:	88 feet
Ship Draft:	26.3 feet
Ship Range:	6000NM @ 16 kts
Ship Speed (max):	27.2 kts
Ship Speed (sustained):	26.0 kts
Main Engines:	(2) LM-2500 gas turbines
Generators:	(4) Diesel @ 1500 kW
Power Transmission:	Mechanical drive
Propulsors:	(2) CRP propellers (20 ft diameter)
Surface PTX Capacity:	(4) surface craft in well deck
Airborne PTX Capacity:	(2) MH-53E sized helos
Command and Control:	Level II (50 men)
Self Defense:	(2) CIWS, (2) RAM, small caliber guns
Average First Cost:	$ 491 million
Operating and Support Cost:	$ 25 million/year
Total Manning:	365 men (28 officer/337 enlisted)

3. CMD Model Two (CMD(M))

The medium sized CMD ASSET model characteristics are contained in appendix C. The major characteristics of this design are tabulated in table 4-2.

TABLE 4-2

Ship Displacement (full load):	19,410 long tons
Ship Volume:	3,137,190 cubic feet
Ship Length (LBP):	600 feet
Ship Length (LOA):	620 feet
Ship Beam:	90 feet
Ship Draft:	23.8 feet
Ship Range:	6000NM @ 16 kts
Ship Speed (max):	27.6 kts
Ship Speed (sustained):	26.0 kts
Main Engines:	(4) LM-2500 gas turbines
Generators:	(4) Diesel @ 2000 kW
Power Transmission:	Mechanical drive
Propulsors:	(2) CRP propellers (17.5 ft diameter)
Surface PTX Capacity:	(6) surface craft in well deck
Airborne PTX Capacity:	(6) MH-53E sized helos
Command and Control:	Level II (50 men)
Self Defense:	(2) CIWS, (2) RAM, small caliber guns
Average First Cost:	$ 560 million
Operating and Support Cost:	$ 30.5 million/year
Total Manning:	468 men (49 officer/419 enlisted)

4. CMD Model Three (CMD(L))

The ASSET design model output for the large CMD is contained in appendix D. The major characteristics of this design are tabulated in table 4-3.

TABLE 4-3

Ship Displacement (full load):	23,037 long tons
Ship Volume:	3,964,348 cubic feet
Ship Length (LBP):	720 feet
Ship Length (LOA):	745 feet
Ship Beam:	92 feet
Ship Draft:	23.7 feet
Ship Range:	6000NM @ 16 kts
Ship Speed (max):	28.0 kts
Ship Speed (sustained):	26.0 kts
Main Engines:	(4) LM-2500 gas turbines
Generators:	(4) Diesel @ 2000 kW
Power Transmission:	Mechanical drive
Propulsors:	(2) CRP propellers (17.7 ft diameter)
Surface PTX Capacity:	(8) surface craft in well deck
Airborne PTX Capacity:	(10) MH-53E sized helos
Command and Control:	Level II (50 men)
Self Defense:	(2) CIWS, (2) RAM, small caliber guns
Average First Cost:	$ 623 million
Operating and Support Cost:	$ 41.2 million/year
Total Manning:	672 men (60 officer/612 enlisted)

5. ASSET Design Comparison

Based on the projected necessary operating forces previously identified in the CMD load-out section table 4-4 was constructed. The number of CMD platforms required to perform each scenario are tabulated.

TABLE 4-4

SCENARIO	# of CMD(S)	# of CMD(M)	# of CMD(L)
Scenario #1	3	2	1
Scenario #2	3	1	1
Scenario #3	3	1	1
Scenario #4	6	2	2
Scenario #5	3	1	1
Scenario #6	N/A	N/A	N/A
Scenario #7	3	2	1

By identifying the requirements for each scenario and knowing the capabilities of each of the ASSET model CMD platforms a Measure of Effectiveness program can be used to aid in the selection of the most feasible platform.

B. MEASURE OF EFFECTIVENESS STUDIES

Some methods for measuring the effectiveness of combat systems are derived in [1]. The basic definition is:

$$\text{measure of effectiveness} = \frac{\text{fraction of mission completed}}{\text{system cost}}$$

In this analysis, the fraction of mission completed (FOMC) will be the fraction of the combat system remaining after the mission. The term 'combat system' will take on a variety of meanings. In its simplest form it will be a single weapons platform, ship or aircraft, but it will also be used to describe an entire task force.

1. Single Platform Type vs. Single Threat Type

For a single combat system engaging a single threat, the proposed measure of effectiveness (MOE) is

$$MOE = \frac{A(1-(1-DE)PL)}{C}$$

where

A = Availability of the combat system
DE = defense efficiency of the combat system against the threat
PL = loss probability of the combat system if hit by the threat
C = cost of the combat system

For multiple combat systems of the same type engaging multiple threats of the same type, the definition is extended to

$$MOE = \frac{A(1-(NT/NS)(1-DE)PL)}{NS \cdot C}$$

where

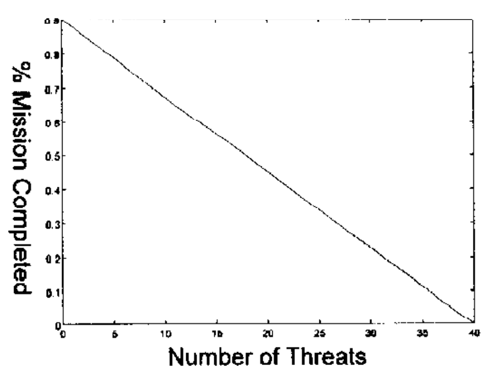
NS = number of combat system platforms
NT = number of threats

This definition includes the simplification that the threat will split evenly so that each combat system will see the same threat magnitude. At any particular instant in time this assumption is probably false. However, over the course of the entire mission, it is likely that same type combat system platforms will be performing similar tasks. So on a time average basis, the same type combat system platforms will be exposed to an equivalent threat.

Another simplification is the use of single threat defense efficiency and loss probability parameters for multiple threats. Accurately predicting the manner in which these parameters change for different threat levels would require simulations with detailed physical models of the combat systems and threats. It is reasonable to assume that an increasing threat level will correspond to a decreasing combat system defense efficiency and an increasing loss probability. It is also likely that there is a saturation threat level above which the fraction of mission completion is zero. Using the single threat defense efficiency and loss probability parameters and the saturation threat level results in a linearly decreasing fraction of mission completion. As an example, consider a combat system with the following parameters:

Availability (A) = 0.9
Defense Efficiency (DE) = 0.9
Loss Probability (PL) = 0.25
Platform Number (NS) = 1

The fraction of mission completion is shown in the graph below. These parameters result in threat saturation level, NT = 40. Depending on the particular combat system and threat, this saturation level may or may not be reasonable. If the saturation threat level seems unreasonable, different values for defense efficiency and loss probability can be selected until the desired fraction of mission completion curve is obtained.



The next step is to develop a measure of effectiveness for a task force with multiple different combat systems engaging multiple different threats. The approach taken will be to determine an MOE for each type of combat system platform and then use a weighted average to determine the task force MOE.

2. Combined Task Force vs. Combined Threat

The MOE for the individual combat system platforms will be calculated from the following equation:

$$MOE = \frac{A}{NS \cdot C}\prod_{i=1}^{T}[1-(NT(i)/NS)(1-DE(i))PL(i)]$$

In the equation, T is defined as the number of different types of threats. If there are five different types of threats then T will be 5. Essentially, a fraction of mission completion for each threat type is calculated in the same manner as the MOE for multiple combat systems of the same type engaging multiple threats of the same type. From these calculations, the product is calculated and used in the overall combat system platform MOE calculation.

For a specific threat type, a percentage of the threat is assigned to each platform type on a value basis. This assumes that an enemy will apportion his weapons in proportion to the value of the targets. For calculations, the value of the platform is proportional to the cost of the platform. This is consistent with the assumption made for a task force composed of a single type of platform. In that situation, each platform has the same value and the threat is split equally among the platforms.

This method of calculation is an estimate in that the threats are considered individually and joint probabilities of defense efficiency and loss probability are not considered. For each different combination of threat type and number there will be a different value for defense efficiency and loss probability. As before, accurate determination of these values would require simulations with detailed physical models of the combat systems and threats. However, it is certain that with a combined threat, the total MOE will be smaller than any single threat MOE, since defense efficiency will be smaller and the loss probability larger. If for example the individual threat fraction of mission completion's are determined to be 0.9, 0.8, 0.6, 0.5, and 0.4, the product fraction of mission completion would be 0.132.

With these individual combat system MOE's, the combined task force MOE can be calculated. The assumption is that the task force fraction of mission completion is a weighted sum of the individual platforms fraction of mission completion. The assignment of weight values to the platforms needs to correspond to the importance of that particular platform in accomplishing the mission of the task force. For different scenarios, each platform would have a different weight. In order to simplify the determination of weighting factors, a reasonable assumption is that the platform's relative capability or importance in completing a particular mission is directly proportional to the platform's cost. Using this assumption the individual platform weights could be calculated as

$$W(i) = \frac{NS(i) \cdot C(i)}{\sum_{j=1}^{PT} NS(j) \cdot C(j)}$$

The numerator is the cost of all platforms of a specific type and the denominator is the cost of the task force. The parameter PT is the number of different platform type in the task force. The task force MOE can be determined from the following equation:

$$MOE = \frac{\sum_{i=1}^{PT} FOMC(i) \cdot W(i)}{\sum_{i=1}^{PT} NS(i) \cdot C(i)}$$

The numerator represents the task force fraction of mission completion and the denominator represents the task force cost.

3. Scenario Based MOE Evaluations

Earlier in the report, seven scenarios were presented. In order to evaluate the three feasible CMD designs, six of the seven scenarios will be used to develop task force MOEs. For each of the scenarios, the SPECTRE task force composition is held constant except for the number of CMDs required. The number of large, medium, or small CMDs depends upon the number of surface and air PTX platforms required in the scenario. Using this approach, the CMD carrying capability is often under utilized.

In each scenario the potential CMD threat is determined. Baseline defense efficiency and loss probability values for each CMD threat are assumed. For each of the three feasible CMD designs, the task force MOE is calculated and the CMD with the highest MOE is selected.

To validate this selection, sensitivity analyses are performed. For each threat directed at the CMD, the threat level, defense efficiency of the CMD against the threat, and the loss probability of the CMD to the threat are varied and the task force MOE is calculated. Each parameter is varied separately while the other parameters maintain their original baseline values. The threat level is varied from zero to twice the baseline level, and the defense efficiency and loss probability are varied from 0.01 to 0.99.

The parameters are plotted against the task force MOE for each CMD. From the graphs, the CMD with the highest task force MOE is the best selection. The optimal result is for a particular CMD to produce the highest task force MOE for each parameter. This situation indicates a clear choice and validates the CMD selection based on baseline parameter values.

For the evaluations, the threat assignment probabilities and FOMC weights are directly proportional to the individual platform cost. Assumed values for defense efficiencies and loss probabilities are included in Appendix 4. The availability (A) for all platforms is assumed to be 0.90 and the platform costs (normalized) are defined below:

Platform Cost

Large CMD	0.626
Medium CMD	0.563
Small CMD	0.491
Surface Strike PTX	0.125
Surface ASW PTX	0.125
Surface MIW PTX	0.125
Surface Patrol PTX	0.040
Air Strike PTX	0.015
Air ASW PTX	0.025
Air MIW PTX	0.025
AIR AAW PTX	0.015
Aegis Combatant	1.000
LSD	0.400
LHD	0.800
Troop Carrier Surface	0.020
Troop Carrier Air	0.020

A. Scenario #1 - Support of Amphibious Landing

SPECTRE Task Force

(1) Large CMD or (2) Med. CMD or (3) Small CMD
(4) Surface Strike PTX
(4) Surface MIW PTX
(2) Surface Patrol PTX
(2) Air Strike PTX
(4) Air MIW PTX
(1) Aegis Surface Combatant
(2) LSD
(1) LHD
(14) Troop Carriers Airborne
(12) Troop Carriers Surface

Opposing Threat

(10) shore launched ASM's
(200) anti ship shore fired gun projectiles
(200) anti air shore fired gun projectiles
(10) small ship launched ASMs
(50) small ship fired anti ship gun projectiles
(10) air launched anti-air missiles
(50) mines

In this scenario, the threat potentially directed at the CMD is ship launched ASMs and ship fired projectiles. Using the baseline defense efficiency and loss probability values, the task force with the large CMD has the highest MOE. The results are tabulated in Table 4-5.

TABLE 4-5

	CMDs	Cost	DE ASM	DE Gun	PL ASM	PL Gun	TF MOE
CMD(L)	1	0.626	0.9	0.75	0.15	0.05	0.090695
CMD(M)	2	0.563	0.9	0.75	0.15	0.05	0.088529
CMD(S)	3	0.491	0.9	0.75	0.15	0.05	0.087132

The results of the sensitivity analyses are graphed in Figure 4-1. For each parameter, the large CMD produces the highest task force MOE in the range of interest. This validates the selection of the large CMD for this scenario.

A. Scenario #2 - Support of Small Amphibious Landing

SPECTRE Task Force

(1) Large CMD or (1) Med. CMD or (3) Small CMD
(4) Surface Strike PTX
(4) Surface Patrol PTX
(4) Air Strike PTX
(2) Air MIW PTX
(2) Air ASW PTX
(1) LHD
(10) Troop Carriers Airborne
(4) Troop Carriers Surface

Opposing Threat

(5) shore launched ASMs
(100) anti ship shore fired gun projectiles
(100) anti air shore fired gun projectiles
(5) small ship launched ASMs
(25) small ship fired anti ship gun projectiles
(5) air launched anti-air missiles
(25) mines

In this scenario, the threat potentially directed at the CMD is ship launched ASMs and ship fired projectiles. Using the baseline defense efficiency and loss probability values, the task force with the medium CMD has the highest MOE. The results are tabulated in Table 4-6.

TABLE 4-6

	Platforms	Cost	DE ASM	DE Gun	PL ASM	PL Gun	TF MOE
CMD(L)	1	0.626	0.9	0.75	0.15	0.05	0.202033
CMD(M)	1	0.563	0.9	0.75	0.15	0.05	0.205201
CMD(S)	3	0.491	0.9	0.75	0.15	0.05	0.178106

The results of the sensitivity analyses are graphed in Figure 4-2. For each parameter, the medium CMD produces the highest task force MOE in the range of interest. This validates the selection of the medium CMD for this scenario.

C. Scenario #3 - Blockade

SPECTRE Task Force

(1) Large CMD or (1) Med. CMD or (3) Small CMD
(6) Surface Strike PTX
(4) Surface Patrol PTX
(6) Air Strike PTX

(2) Air MIW PTX
(2) Air ASW PTX
(2) Air AAW PTX

Opposing Threat

(5) shore launched ASMs
(100) anti ship shore fired gun projectiles
(100) anti air shore fired gun projectiles
(5) small ship launched ASMs
(25) small ship fired anti ship gun projectiles
(5) air launched anti-air missiles
(25) mines
(4) submarine launched anti ship missiles
(4) submarine launched torpedoes

In this scenario, the threat potentially directed at the CMD is ship launched ASMs, ship fired projectiles, submarine launched ASMs, and submarine launched torpedoes. Using the baseline defense efficiency and loss probability values, the task force with the medium CMD has the highest MOE. The results are listed in Table 4-7.

TABLE 4-7

	CMDs	Cost	DE Ship ASM	DE Gun	DE Sub ASM	DE Sub Torpedo	PL ASM	PL Gun	PL Sub ASM	PL Sub Torpedoe	TF MOE
CMD(L)	1	0.626	0.9	0.75	0.9	0.7	0.15	0.05	0.15	0.3	0.317777
CMD(M)	1	0.563	0.9	0.75	0.9	0.7	0.15	0.05	0.15	0.3	0.332838
CMD(S)	3	0.491	0.9	0.75	0.9	0.7	0.15	0.05	0.15	0.3	0.256953

The results of the sensitivity analyses are graphed in Figures 4-3 and 4-4. For each parameter, the medium CMD produces the highest task force MOE in the range of interest. This validates the selection of the medium CMD for this scenario.

D. Scenario #4 - Mine Clearance

SPECTRE Task Force

(2) Large CMD or (2) Med. CMD or (6) Small CMD
(4) Surface Strike PTX
(8) Surface MIW PTX
(4) Air Strike PTX
(8) Air MIW PTX
(4) Air AAW PTX

Opposing Threat

(10) shore launched ASM's
(100) anti ship shore fired gun projectiles
(100) anti air shore fired gun projectiles
(10) air launched anti-air missiles
(10) air launched anti ship missiles
(50) mines

In this scenario, the threat potentially directed at the CMD is air launched ASMs. Using the baseline defense efficiency and loss probability values, the task force with the medium CMD has the highest MOE. The results are listed in Table 4-8.

TABLE 4-8

	Platforms	Cost	DE ASM	PL ASM	TF MOE
CMD(L)	2	0.626	0.9	0.15	0.229437
CMD(M)	2	0.563	0.9	0.15	0.237280
CMD(S)	6	0.491	0.9	0.15	0.162822

The results of the sensitivity analyses are graphed in Figure 4-5. For each parameter, the medium CMD produces the highest task force MOE in the range of interest. This validates the selection of the medium CMD for this scenario.

E. Scenario #5 - Escort Operations

SPECTRE Task Force

(1) Large CMD or (1) Med. CMD or (3) Small CMD
(6) Surface Strike PTX
(4) Air Strike PTX
(2) Air MIW PTX
(4) Air AAW PTX
(1) Aegis Surface Combatant

Opposing Threat

(5) shore launched ASMs
(100) anti ship shore fired gun projectiles
(100) anti air shore fired gun projectiles
(5) small ship launched ASMs
(25) small ship fired anti ship gun projectiles

(5) air launched anti-air missiles
(10) mines

In this scenario, the threat potentially directed at the CMD is ship launched ASMs and ship fired projectiles. Using the baseline defense efficiency and loss probability values, the task force with the medium CMD has the highest MOE. The results are listed in Table 4-9.

TABLE 4-9

	Platforms	Cost	DE ASM	DE Gun	PL ASM	PL Gun	TF MOE
CMD(L)	1	0.626	0.9	0.75	0.15	0.05	0.206057
CMD(M)	1	0.563	0.9	0.75	0.15	0.05	0.209211
CMD(S)	3	0.491	0.9	0.75	0.15	0.05	0.182153

The results of the sensitivity analyses are graphed in Figure 4-6. For each parameter, the medium CMD produces the highest task force MOE in the range of interest. This validates the selection of the medium CMD for this scenario.

F. Scenario #6 - Special Operations

SPECTRE Task Force

(1) Large CMD or (2) Med. CMD or (3) Small CMD
(6) Surface Strike PTX
(6) Surface Patrol PTX
(4) Air Strike PTX
(4) Air AAW PTX

Opposing Threat

(10) shore launched ASMs
(100) anti ship shore fired gun projectiles
(100) anti air shore fired gun projectiles
(10) air launched anti-air missiles
(10) air launched anti ship missiles

In this scenario, the threat potentially directed at the CMD is ship launched ASMs. Using the baseline defense efficiency and loss probability values, the task force with the large CMD has the highest MOE. The results are listed in Table 4-10.

TABLE 4-10

	Platforms	Cost	DE ASM	PL ASM	TF MOE
CMD(L)	1	0.626	0.9	0.15	0.405889
CMD(M)	2	0.563	0.9	0.15	0.334245
CMD(S)	3	0.491	0.9	0.15	0.298209

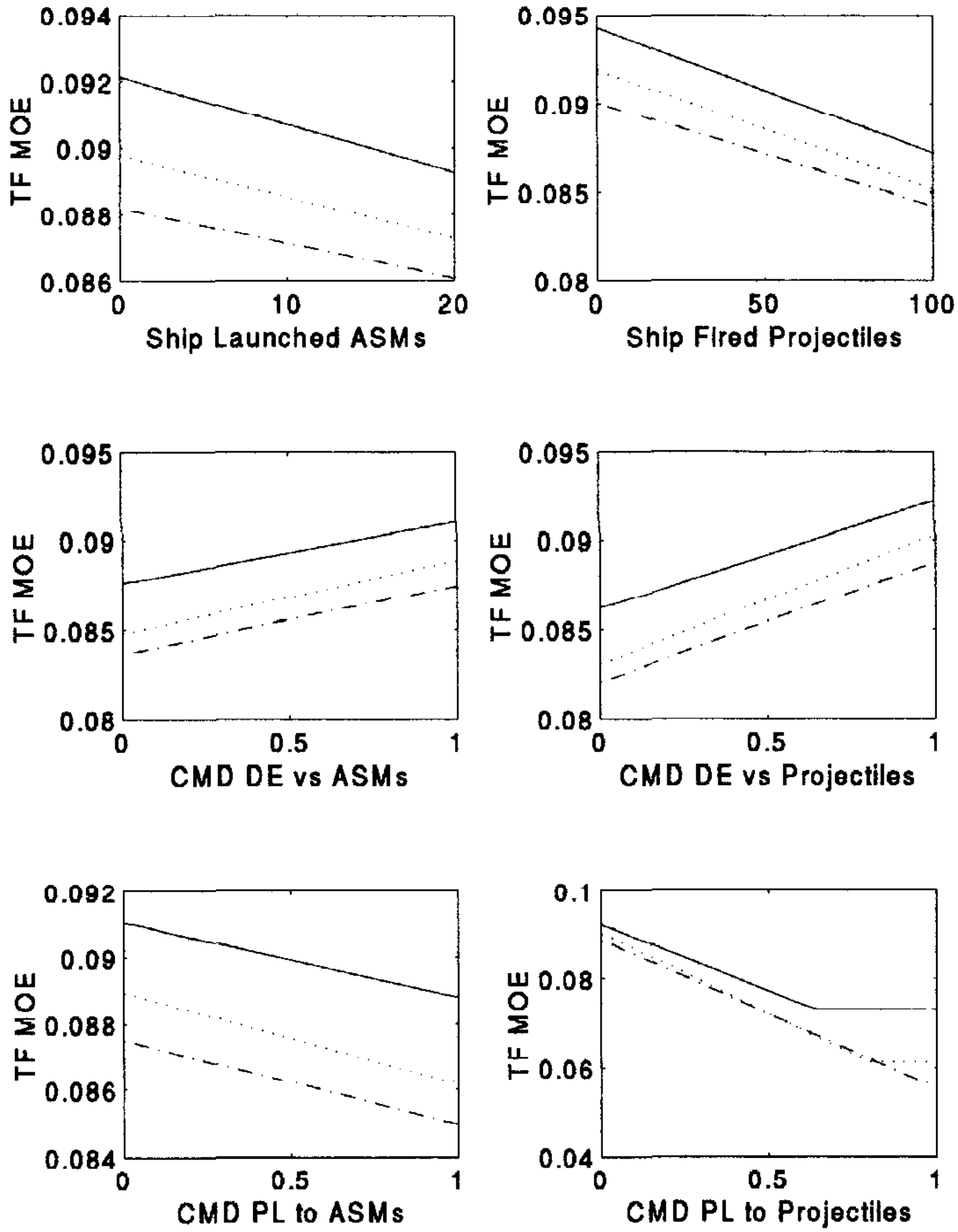
The results of the sensitivity analyses are graphed in Figure 4-7. For each parameter, the large CMD produces the highest task force MOE in the range of interest. This validates the selection of the large CMD for this scenario.

G. Conclusions

Using the baseline parmeters, the medium CMD yields the highest task force measure of effectiveness in four of the six scenarios. The sensitivity graphs show that in three of these four scenarios, the large CMD can produce a task force MOE equivalent to the medium CMD with baseline parameters, if the large CMD's defense efficiency and loss probability are changed toward ideal values. However, the realization of these near ideal parameters would probably result in higher cost, mitigating the perceived increase in task force MOE. Also, any design change in the large CMD that would push defense efficiency and loss probability toward ideal values would be valid to some degree for the medium CMD.

The task force MOEs with the small CMD could not equal the task force MOEs with the large or medium CMD, even as defense efficiency and loss probability approached ideal values.

Figure 4-1. Scenario 1 Sensitivity Graphs. CMD(L) — CMD(M) ··· CMD(S) —·—·



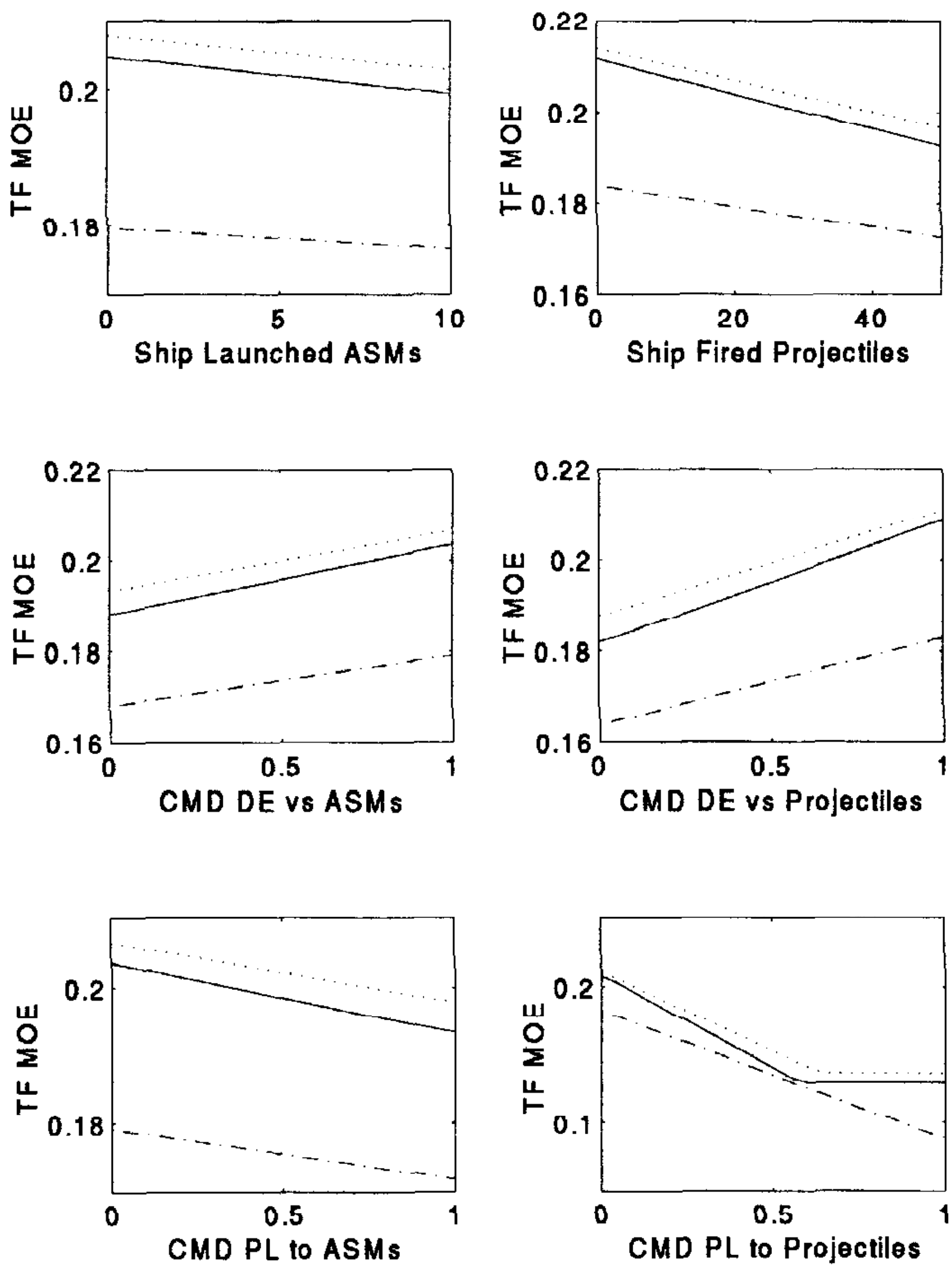


Figure 4-2. Scenario 2 Sensitivity Graphs. CMD(L) — CMD(M) ··· CMD(S) —·—

Figure 4-3. Scenario 3 Sensitivity Graphs. CMD(L) — CMD(M) ··· CMD(S) —·—

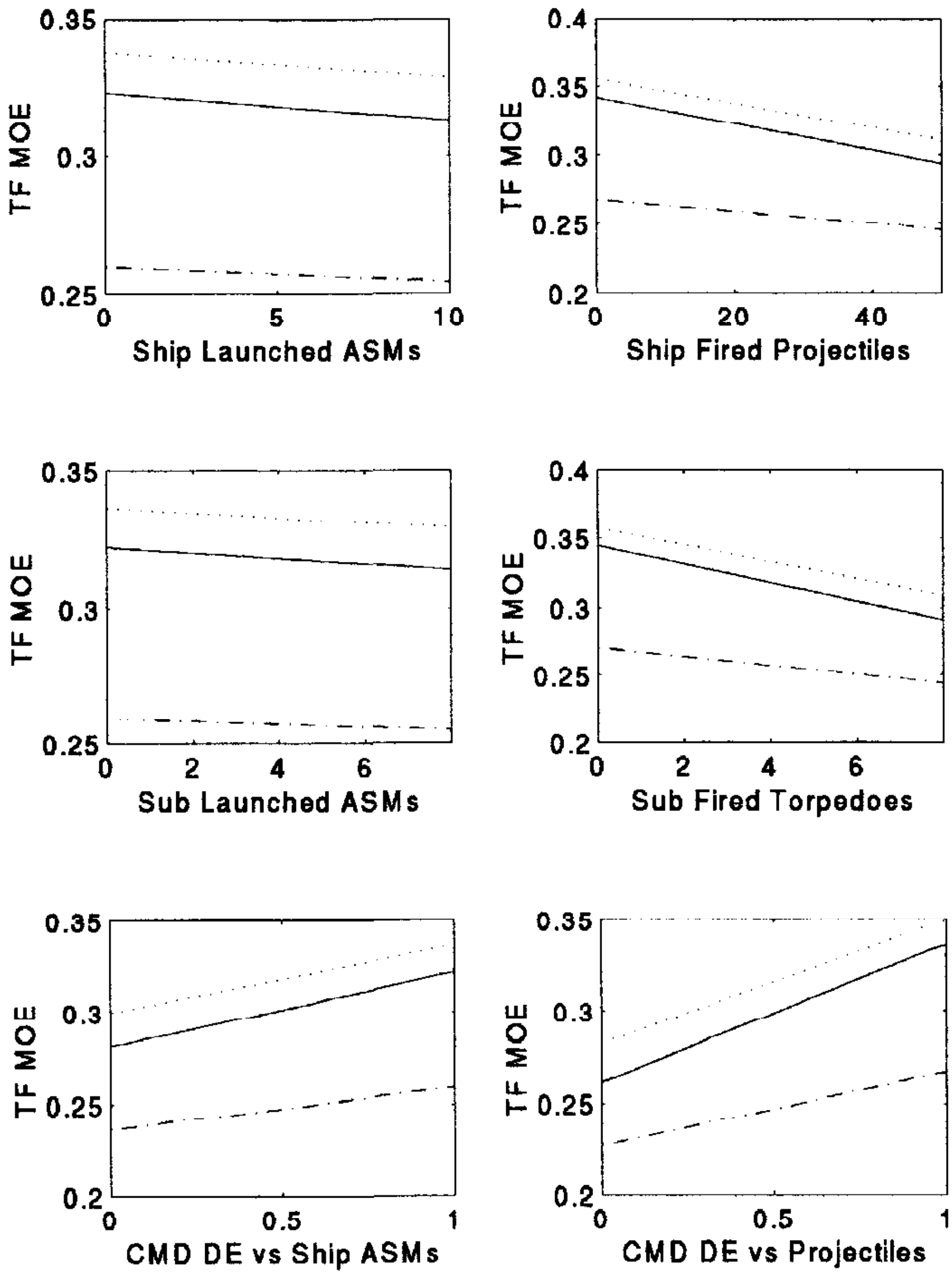


Figure 4-4. Scenario 3 Sensitivity Graphs. CMD(L) — CMD(M) ··· CMD(S) —·—

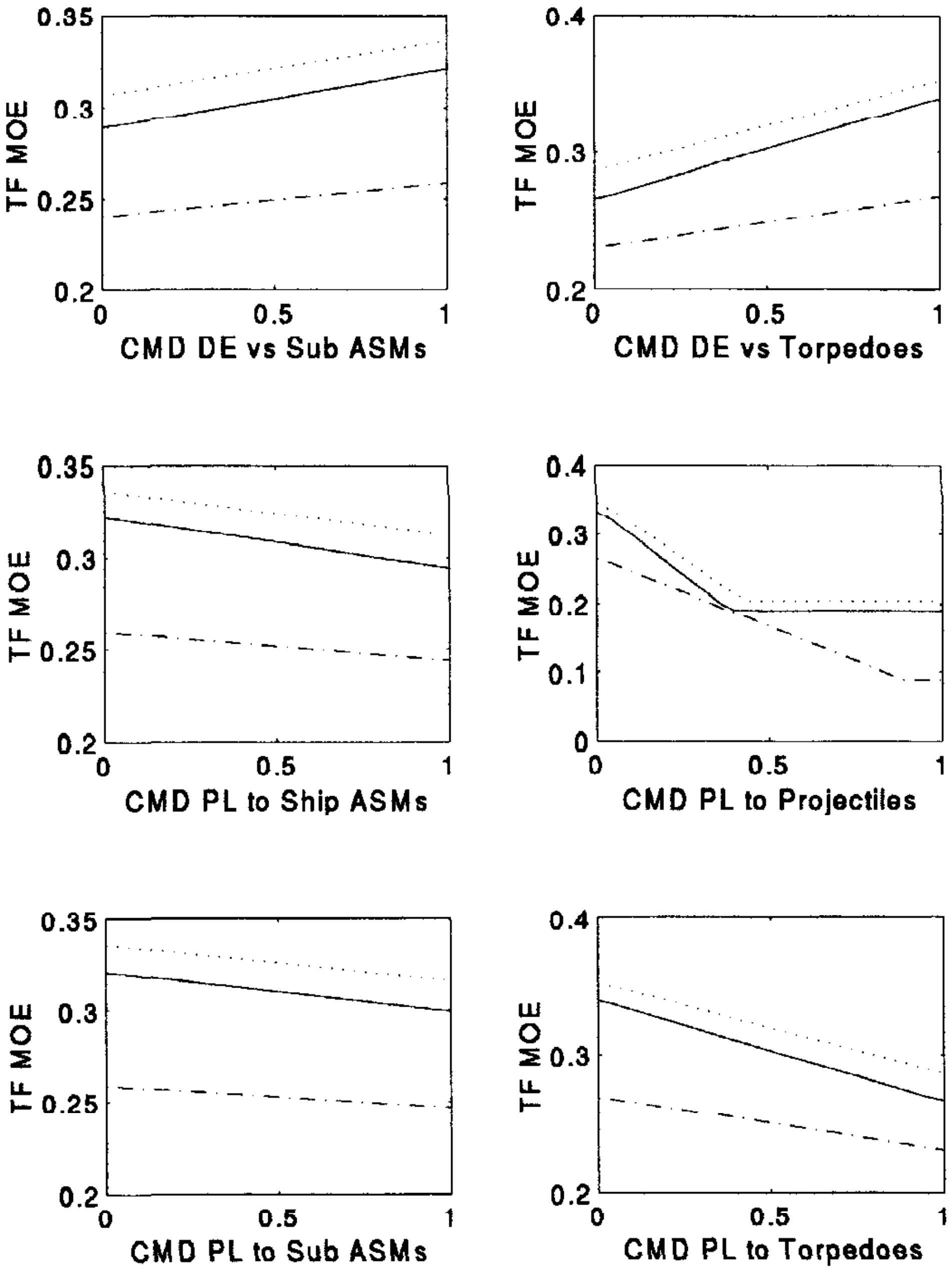


Figure 4-5. Scenario 4 Sensitivity Graphs. CMD(L) — CMD(M) ··· CMD(S) —·—·

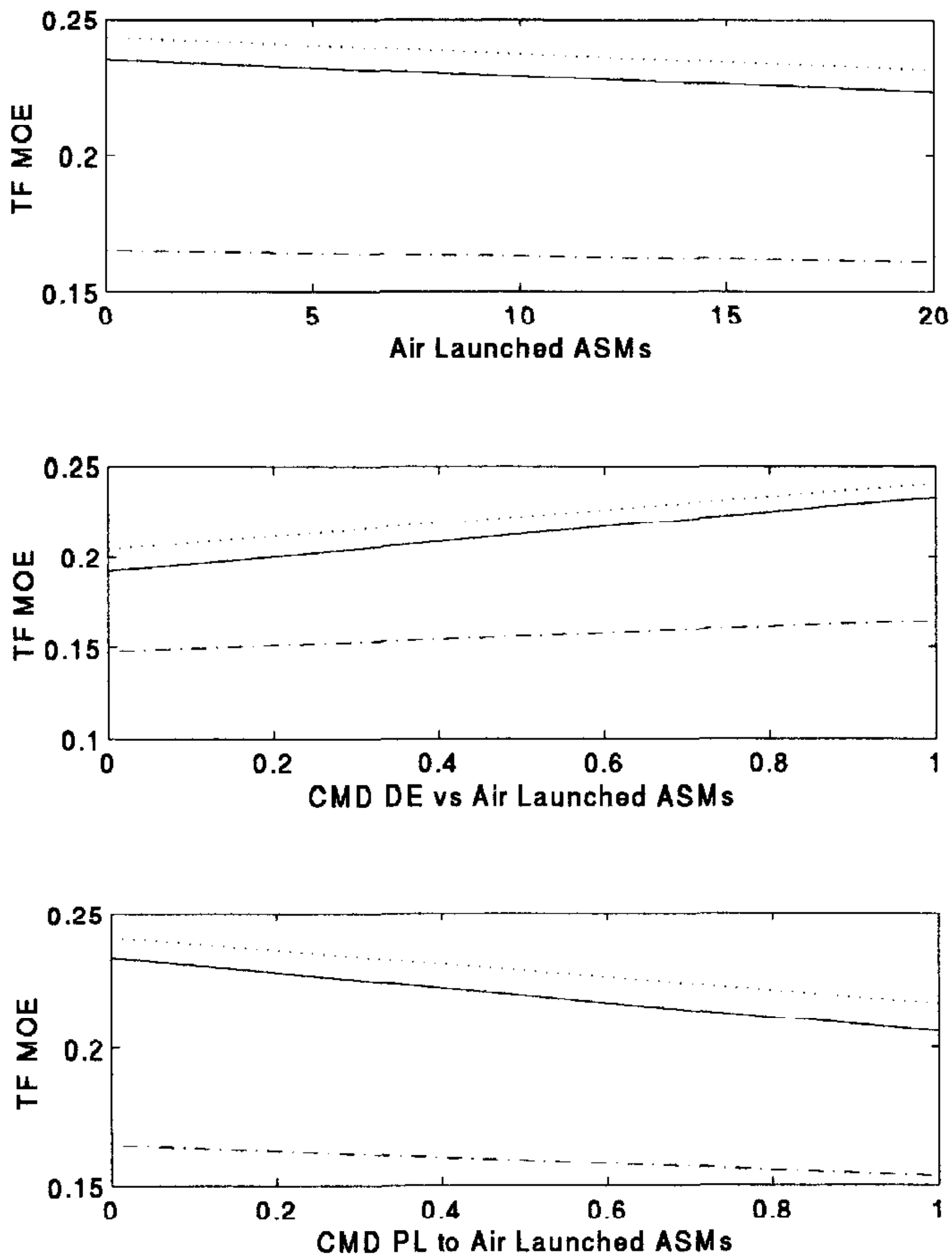


Figure 4-6. Scenario 5 Sensitivity Graphs. CMD(L) — CMD(M) ··· CMD(S) —·—

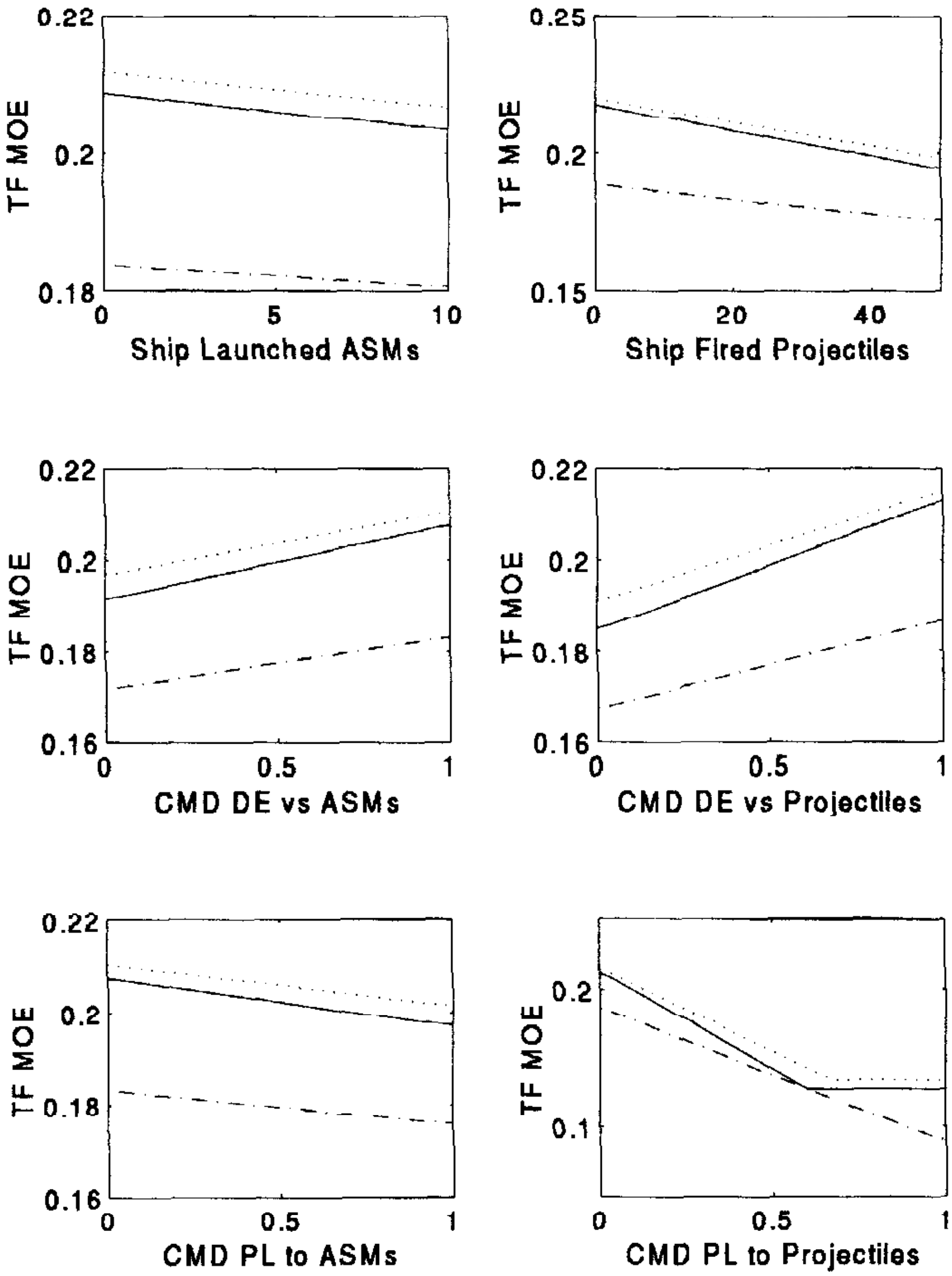
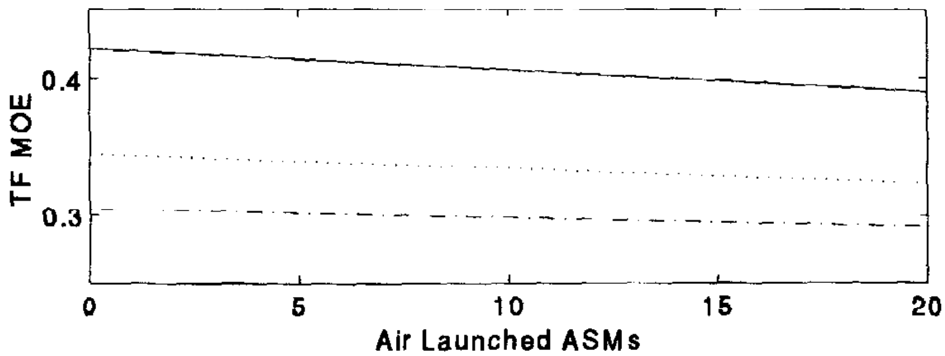
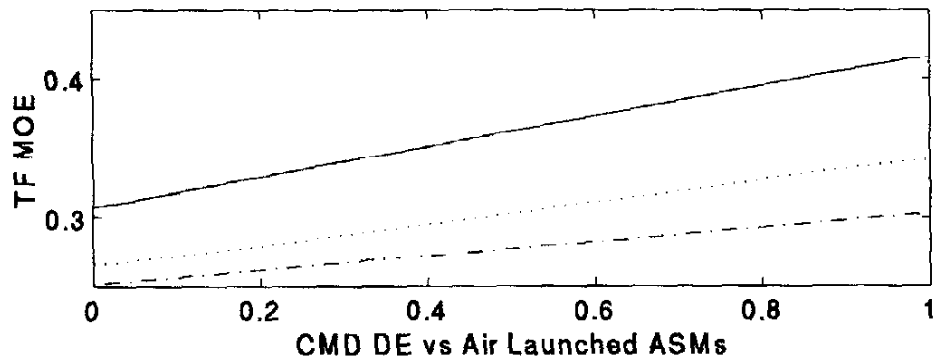
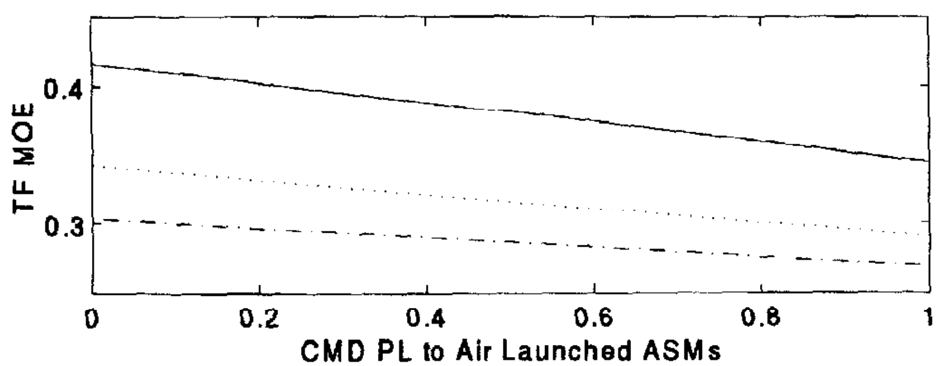


Figure 4-7. Scenario 6 Sensitivity Graphs. CMD(L) — CMD(M) ··· CMD(S) —·—·







C. CMD DESIGN SELECTION

Using the ASSET design model alternatives and the Measure of Effectiveness studies (MOEs) the medium sized CMD was chosen. The justification for this selection is based on the design philosophy, MOEs, and anticipated scenario environments.

1. Major Characteristics Review

The major CMD(M) ship characteristics are specified in table 4-2. The following information is provided to amplify these characteristics and to serve as a comparison with current Navy assets.

A. DISPLACEMENT

The displacement of the CMD(M) is slightly greater than the current LSD-41 class Dock Landing Ship and less than half that of the LHD-1 class Helicopter Dock Landing Ship.

B. DRAFT

The draft of the CMD(M) is comparable to the LSD-41 class and less than the LHD-1 class.

C. MANNING

The total manning requirements for the CMD(M) are comparable to the LSD-41 class and slightly higher than the CG-47 class Cruiser. The CMD(M) is not designated as a troop carrier.

D. ENDURANCE

The endurance of the CMD(M) is within prescribed limits as designated in the ORD. This endurance is comparable to both the CG-47 class Cruiser and the LSD-41 class Dock Landing Ship.

2. Design Selection Justification

To justify the selection of the CMD(M) the top priority design philosophy requirements must be compared.

A. COST

The cost of the CMD(M) is within prescribed limits as set in the ORD. The CMD(L), at $623 million, exceeded the $600 million limit. The smaller crew size on the CMD(M) will provide for a lower life cycle cost than that of the CMD(L).

B. MISSION EFFECTIVENESS

The Measure of Effectiveness (MOE) models generated in the previous section compare ship cost to combat effectiveness. The MOEs determined that the CMD(M) had a greater "bang for the buck" than the other two platforms in most of the scenarios.

C. MISSION FLEXIBILITY

Mission flexibility is inherent in the SPECTRE design concept, however due to its size the CMD(L) can be configured to handle a more diverse tactical atmosphere. Since the CMD(M) is smaller, one CMD platform can be configured for one type of scenario while another can be configured for a completely different scenario. Each platform has desireable characteristics but the medium sized CMD is more cost effective.

D. GENERAL

The CMD(M) leads all three selections in MOEs, has a smaller crew than the CMD(L), and results in less detrimental loss in the case of loss of the ship than the CMD(L).

The CMD(S) does not have sufficient capability to make it a viable platform. The number of small CMDs required in most of the scenarios cause the economic unfeasibility of the CMD(S).

The overall ship characteristics of the CMD(M) provide for the use of other design philosophy considerations such as survivability, producibility, fuel economy and the possibility of future growth.

3. Preliminary Design Specification

The preliminary design process will begin with the ASSET design model chosen. The propulsion plant type, propulsion arrangements, combat system integration and topside arrangements are some of the topics which will be addressed in the preliminary design process.

The overall ship characteristics generated in the ASSET design model will remain intact throughout the prelimnary design phase. Some adjustments in ship defense efficiency may be required to improve the combat effectiveness of the CMD platform chosen and ship size will be altered to compensate for varying aspects of the ship design.

SECTION V

PRELIMINARY DESIGN

A. CMD FINAL PROPULSION PLANT SELECTION

Four types of propulsion plants were considered for the CMD. The ASSET design model was used to generate pertinent data for each type and the design program outputs are enclosed as appendix F. Table 5-1 is a tabulated list of the main ship characteristics generated by each type of propulsion plant. The engine powers are provided in kilowatts to provide unit continuity.

Table 5-1

	LM-2500 ELECT DRIVE FP PROP	LM-2500 MECH DRIVE CRP PROP	PC2 DIESEL MECH DRIVE CRP PROP	LM-2500 ELECT DRIVE PODS
SHIP LENGTH (LBP)	630 FT	630 FT	630 FT	630 FT
FULL LOAD SHIP DISPLACEMENT	20,680 LT	21,375 LT	19,690 LT	20,680 LT
NUMBER OF ENGINES	4 GAS TURBINE @ 19,600 KW (EA)	4 GAS TURBINE @ 19,600 KW (EA)	4 PC2/18 DIESEL @ 8,725 KW (EA)	4 GAS TURBINE @ 19,600 KW (EA)
NUMBER OF GENERATORS	2 MTU-16V538 @ 2000 KW (EA)	4 MTU-16V538 @ 2000 KW (EA)	4 MTU-16V538 @ 2000 KW (EA)	2 MTU-16V538 @ 2000 KW (EA)
MAX SPEED	29.75 KTS	30.2 KTS	25.35 KTS	27.31 KTS
PROP DIAMETER	19.2 FT	17.6 FT	15.0 FT	19.3 FT
SHAFT LENGTH (PORT)	148.7 FT	246.3 FT	252.6 FT	4.8 FT
SHAFT LENGTH (STBD)	148.7 FT	340.7 FT	387.6 FT	4.8 FT
PROP PLANT WEIGHT	1024.7 LT	1037.5 LT	1081.6 LT	914.9 LT
PROP PLANT VOLUME	176,026 CU FT	144,381 CU FT	179,967 CU FT	152,946 CU FT
FULL POWER SFC	0.393 LBM/HP-HR	0.393 LBM/HP-HR	0.340 LBM/HP-HR	0.393 LBM/HP-HR
CRUISE SFC	0.521 LBM/HP-HR	0.628 LBM/HP-HR	0.333 LBM/HP-HR	0.456 LBM/HP-HR
MANNING	468 TOTAL	468 TOTAL	468 TOTAL	468 TOTAL

1. Propulsion Plant Selection

Based on the detailed listings of propulsion plant and ship characteristics in appendix F and using the design philosophy the LM-2500, Advanced Integrated Electric Drive (AIED) with fixed pitch propeller was chosen. The four large gas turbine engines coupled with the two small diesel engines will be used in a power off the main bus configuration. This system will provide for added flexibility in propulsion plant alignment leading to reduced ship response times and improved fuel efficiency at low operating speeds.

2. Selection Justification

A. DIESEL/MECHANICAL DRIVE

The diesel/mechanical drive combination does not support the required max speed as delineated in the ORD. This type of arrangement, therefore, reduces the mission effectiveness and mission flexibility of the SPECTRE system. A diesel/AIED was not considered in the ASSET models for two reasons. (1) The AIED output would have had similar results in maximum speed. (2) An increase of approximately three PC2/18 diesel engines would have to be incorporated in the model to achieve the desired maximum speed. This would lead to an overall propulsion plant weight and volume increase. The new weight would be approximately twice and volume would be approximately three times that of the gas turbine plants. The additional engines would increase the maintenance requirements for shipboard and shore facilities personnel.

B. GAS TURBINE/AIED/PODS

The gas turbine POD design has appealing attributes in that the weight and volume of the propulsion plant are low, the maximum speed is good, and the Specific Fuel Consumptions (SFC's) are low. The POD propulsor however, has not been proven in past ship designs. The location of the POD motors would require special tools and may require the ship to be dry docked to conduct repairs.

C. GAS TURBINE/MECHANICAL DRIVE

The main disadvantages of the Gas Turbine/mechanical drive propulsion plant are the long lengths of shafting and the high SFC's. The LONG shafting length leads to reduced survivability since more critical volume of the ship is vulnerable to a weapon detonation. The use of Controllable/Reversible Pitch (CRP) propellers also adds to the complexity of the propulsion system.

D. GAS TURBINE/AIED

The Gas Turbine/AIED propulsion plant offers a very good mix of system performance and system characteristics. The plant is light weight, medium volume, and has much shorter shaft lengths than the mechanical drive system. The AIED plant uses Fixed Pitch (FP) propellers which are much less complex than CRP propellers. The incorporation of power off the main bus allows for a flexible plant configuration which improves mission flexibility, mission effectiveness, survivability and plant efficiency.

The use of LM-2500 gas turbines will lead to improved R,M&A characteristics since the LM-2500 engines have been proven to operate well in all environmental conditions. Maintenance and installation costs should be lower than the previously mentioned propulsion plants.

B. GENERAL COMBAT SYSTEMS ARCHITECTURE

The combat system elements were defined in section 2. To provide a more detailed architecture for the combat system, readiness logic diagrams, mission area architecture diagrams and Funtional Flow Description Diagrams (F^2D^2) were generated. The purpose of these diagrams is to aid in the combat system equipment and space arrangements.

1. Readiness Logic Diagrams

The readiness logic diagrams provide combat readiness information for the entire SPECTRE system. The diagrams for each warfare area are specified in figures 5-1 through 5-6. The readiness rating levels utilized are established in NWP 10-1-11 , Status of Resources and Training System (SORTS). A brief summary of these rating levels is provided in table 5-2.

TABLE 5-2

RATING LEVEL	DESCRIPTION OF CAPABILITY
M1	90 to 100 percent
M2	70 to 89 percent
M3	60 to 69 percent
M4	1 to 59 percent
M5	No Capability

The S and P designations on the readiness logic diagrams denote parallel and/or series combinations respectively. The actual values of the individual ratings may vary depending on ship survivability characteristics. The readiness of the PTXs has great influence on the overall readiness of the SPECTRE sytstem.

2. Architecture Diagrams

The mission area architecture diagrams for the CMD only are depicted in figures 5-7 through 5-12. The functional relationship between operating systems is shown along with the inter-connectablity of each individual combat system. Detection and tracking capability is not included in the intelligence (INT) mission area since most intelligence data will be received from outside sources.

All mission areas rely on onboard computer systems for information correlation, command and decision and weapons control actions. Computer centers and command and control stations will be located in separate zones within the CMD to provide for redundancy and improved survivability.

3. Functional Flow Diagrams

The Functional Flow Description Diagrams are provided for Tier 0 in figure 5-13 and Tier 1 in figures 5-13a through 5-13k. These diagrams provide guidance to ensure equipment is configured and arranged to provide for maximum effectiveness and to aid in the combat system arrangements.

Each block in Tier 0 is expanded in the Tier 1 diagram. It is imperative for the SPECTRE system that readiness information is available to the CMD from the PTX platforms. This will provide for acurate target designation and weapons assignment. The CMD will use PTXs to engage targets as well as its own installed weapons.

4. Support Services

The combat system on the CMD will require both AC and DC electric power, cooling water, air conditioning and various other support services.

The combat system will be connected with fiber optic data buses wherever feasible to decrease data transmission cable weight and provide for increased volume of data transfer.

Figure 5-1. SPECTRE AAW Readiness Logic Diagram

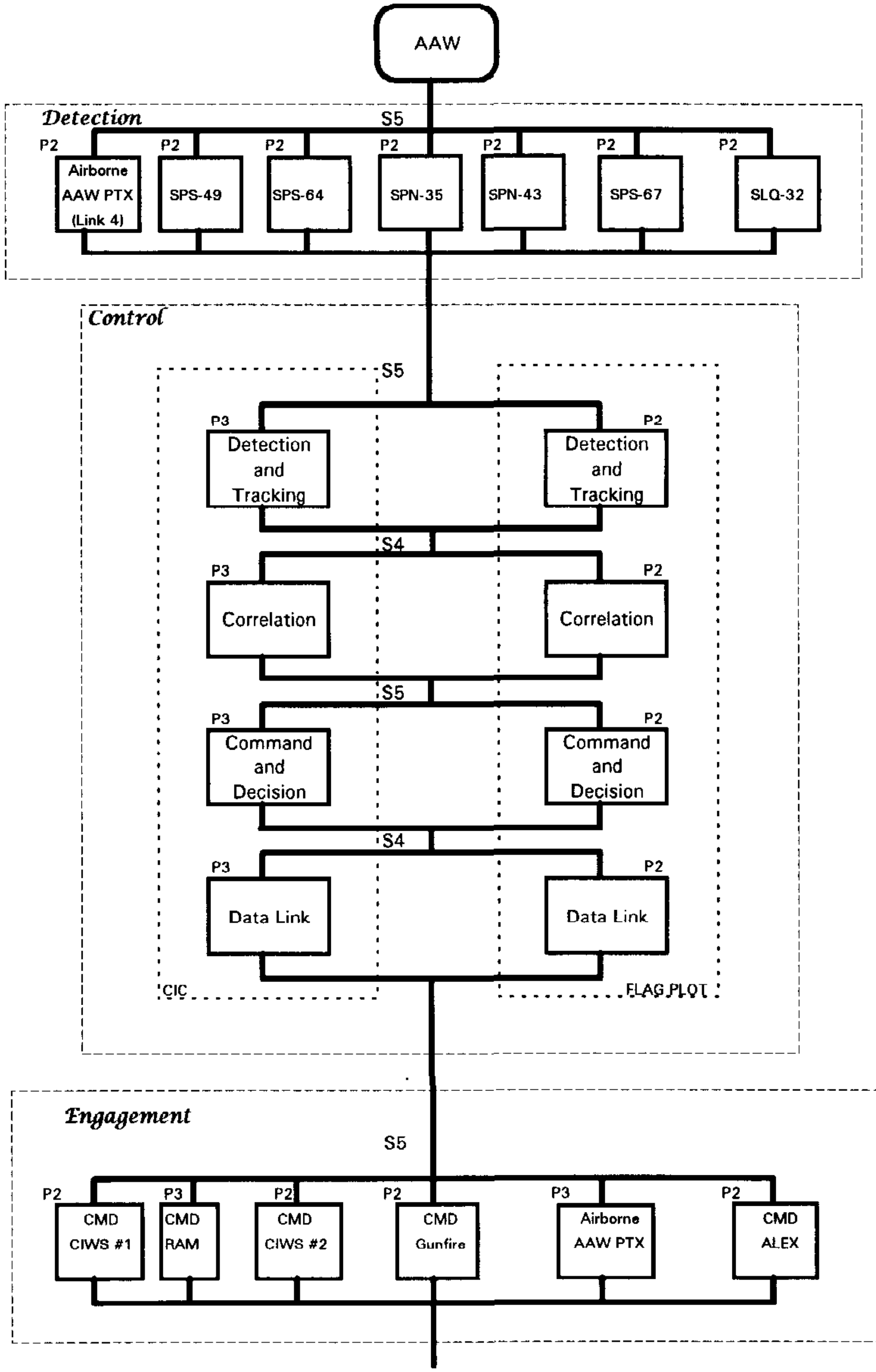


Figure 5-2. SPECTRE ASU Readiness Logic Diagram

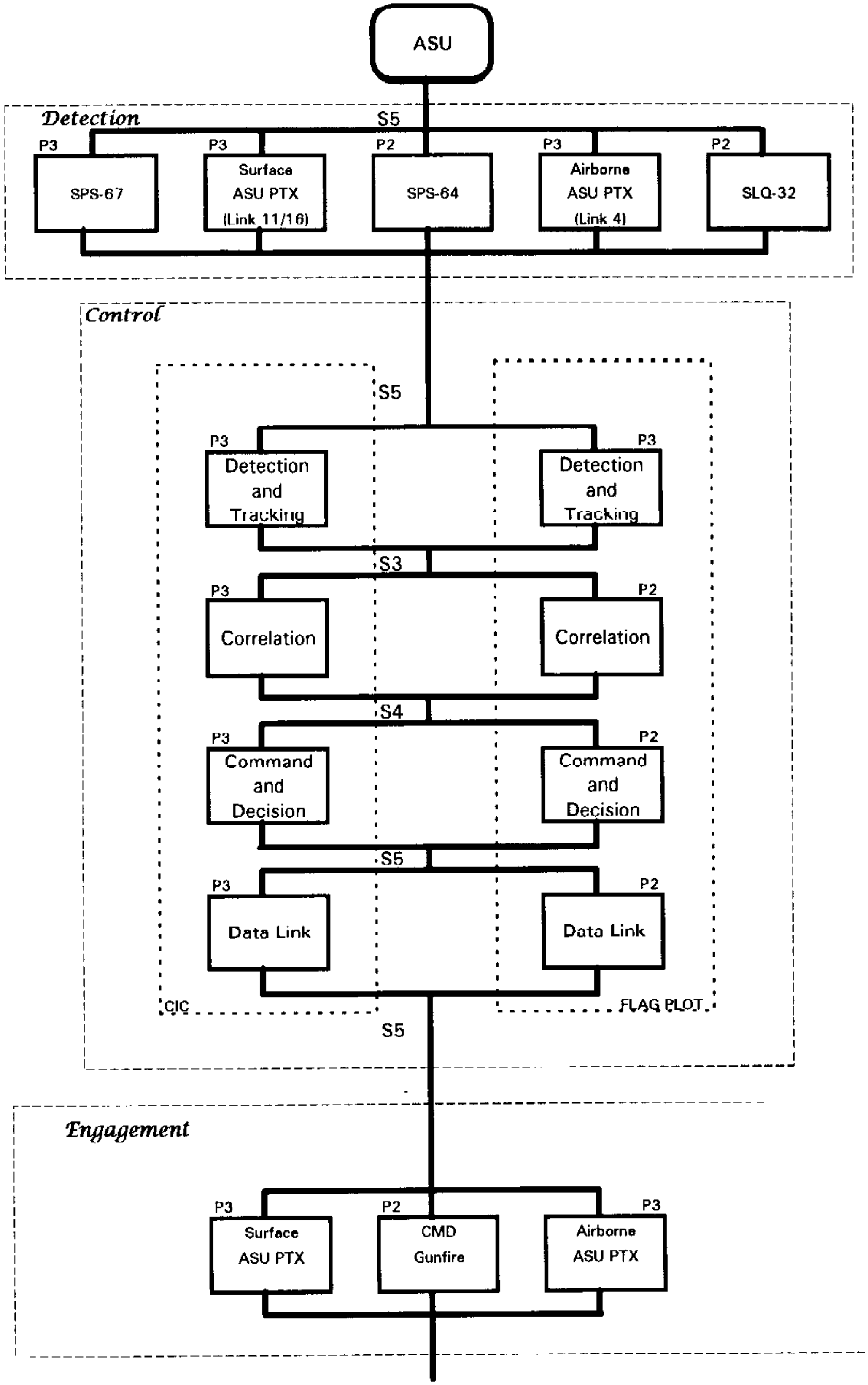


Figure 5-3. SPECTRE ASW Readiness Logic Diagram

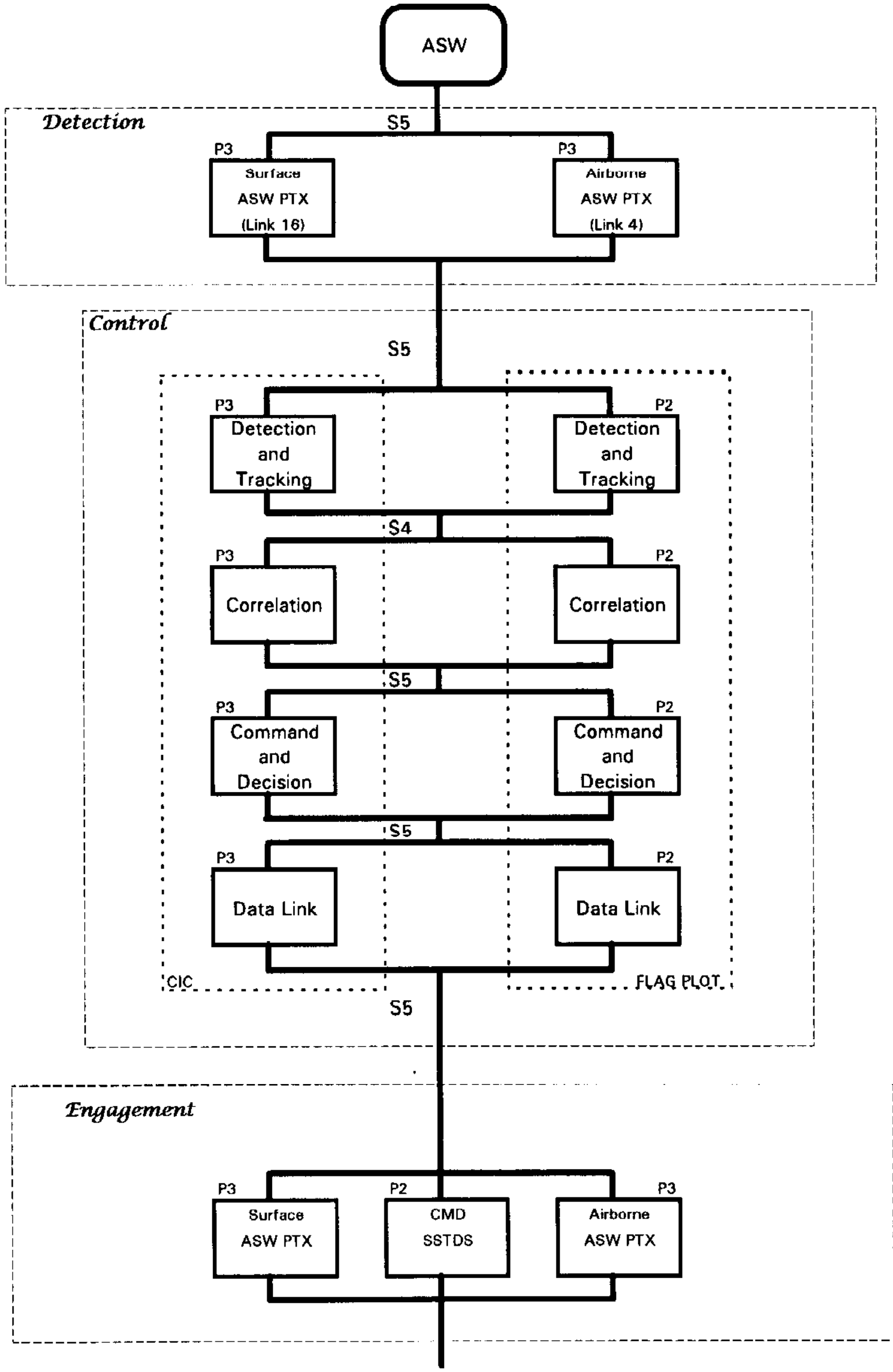


Figure 5-4. SPECTRE INT Readiness Logic Diagram

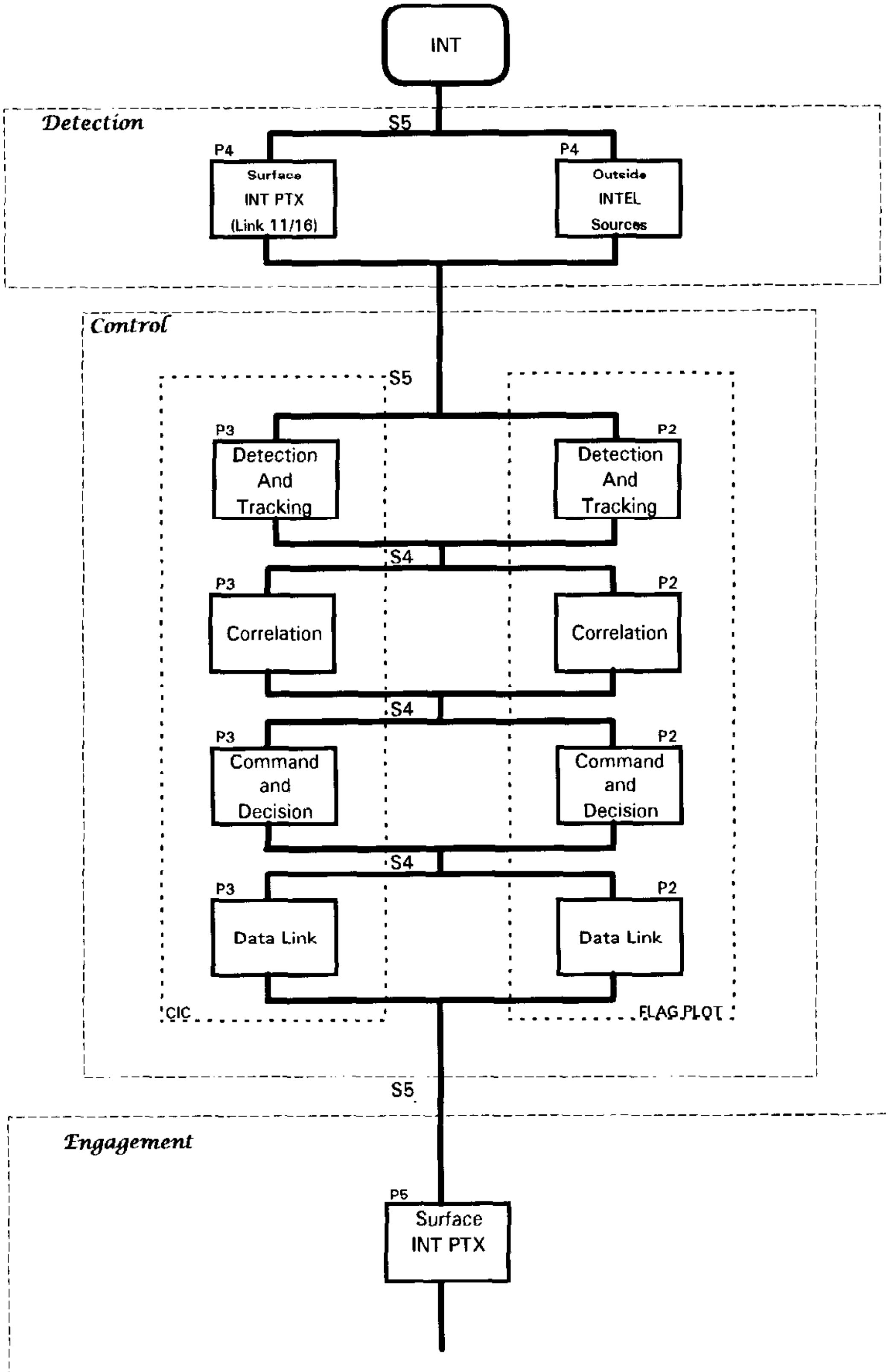


Figure 5-5. SPECTRE MIW Readiness Logic Diagram

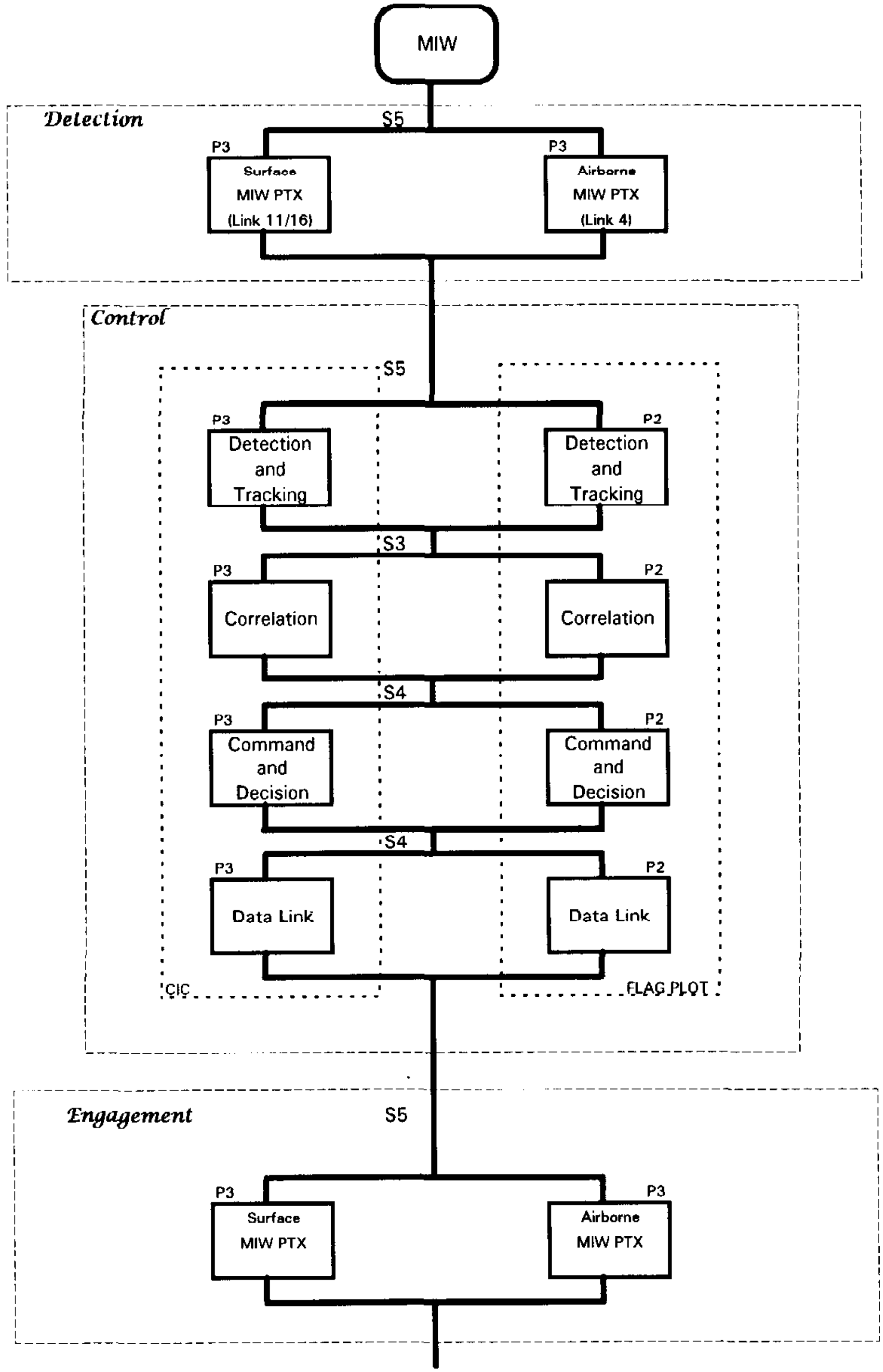


Figure 5-6. SPECTRE STW Readiness Logic Diagram

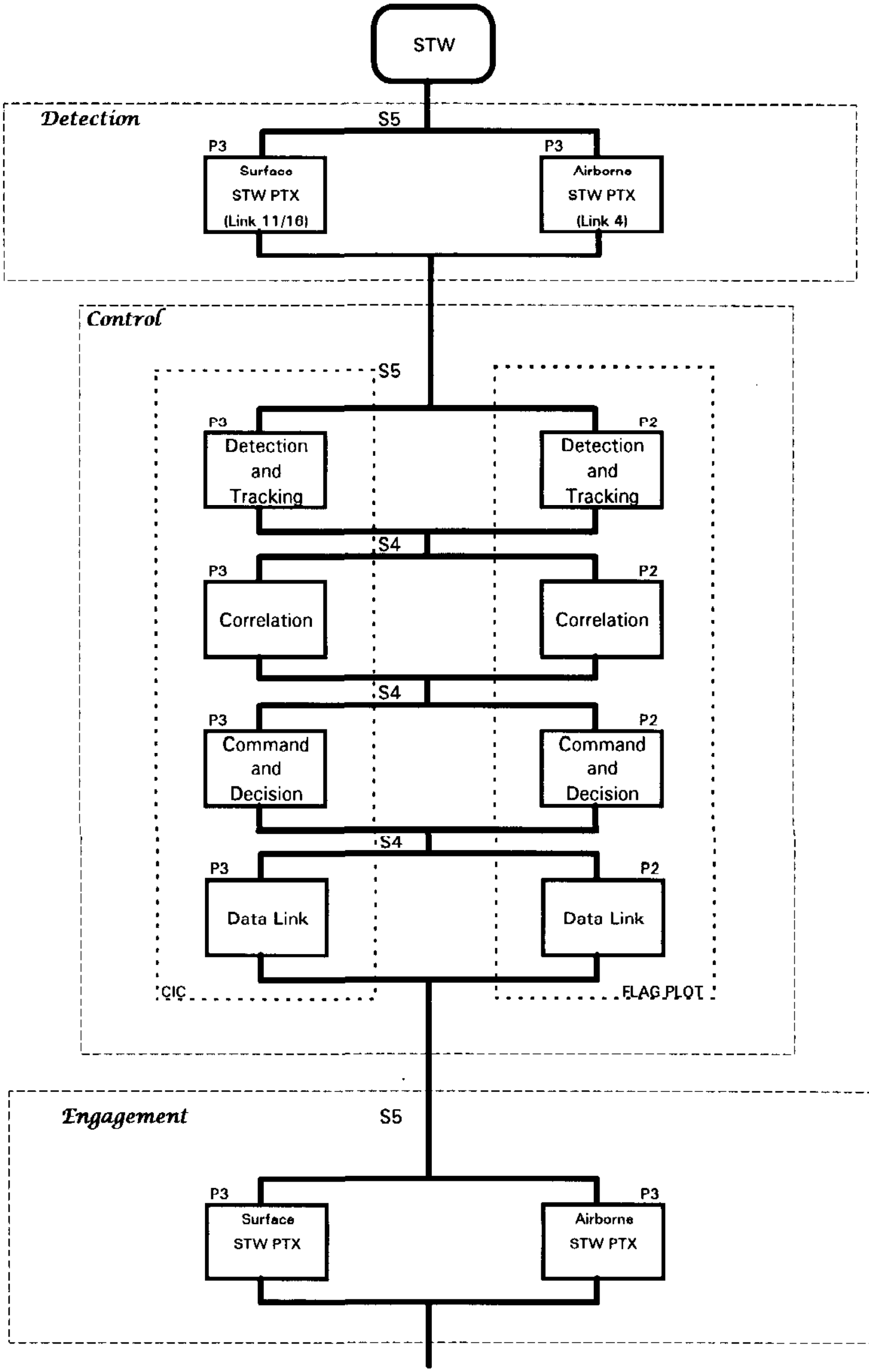


Figure 5-7. CMD AAW Architecture

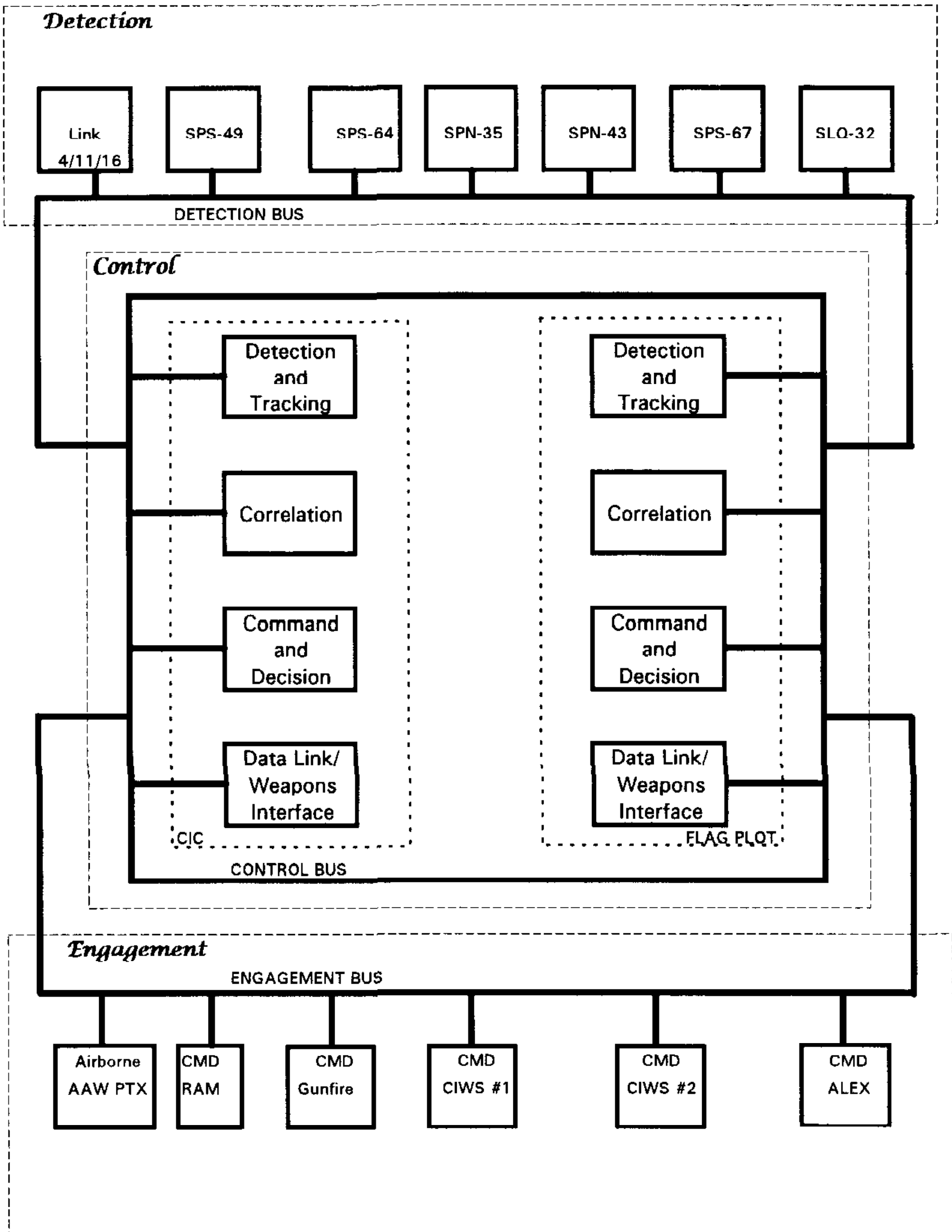


Figure 5-8. CMD ASU Architecture

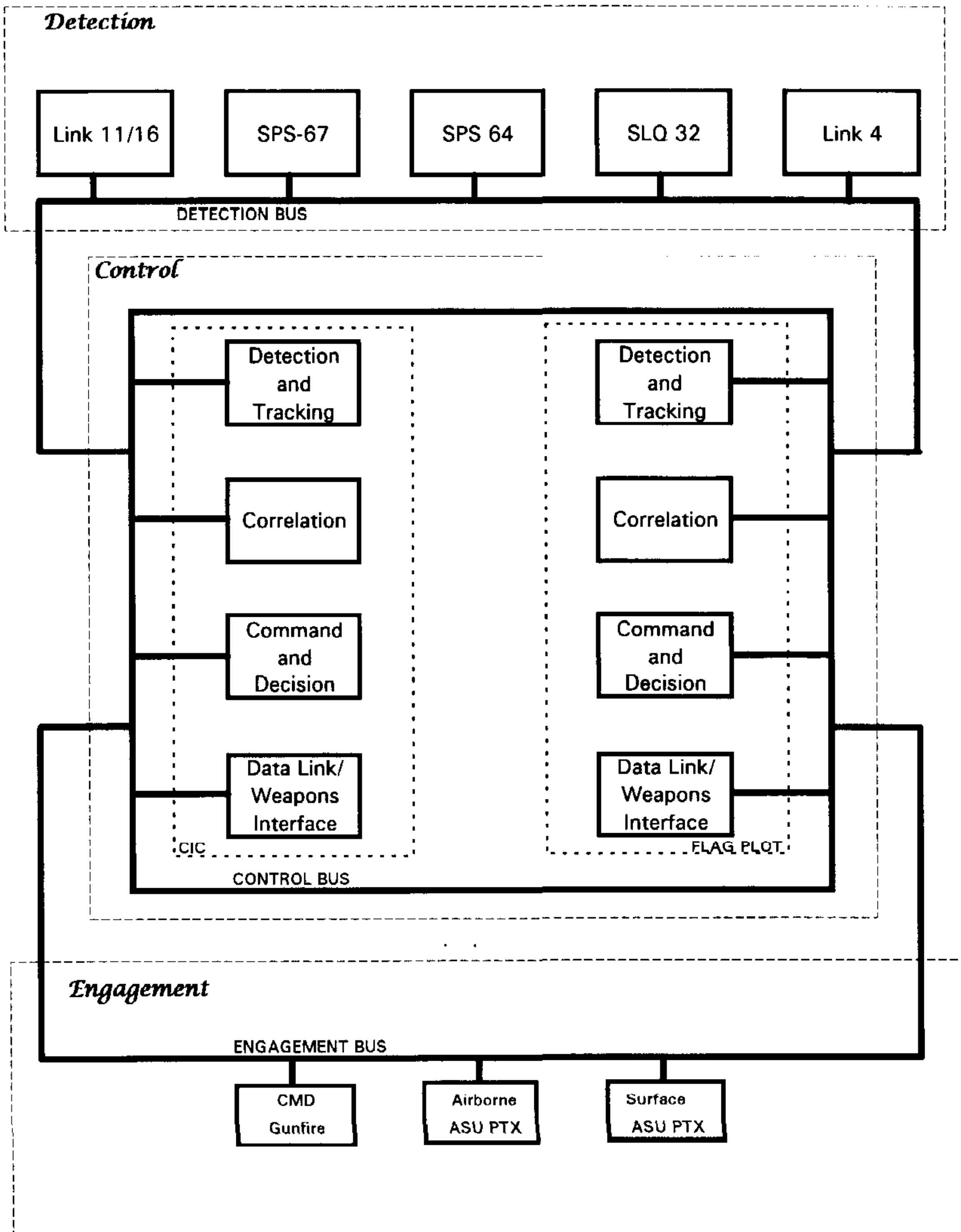


Figure 5-9. CMD ASW Architecture

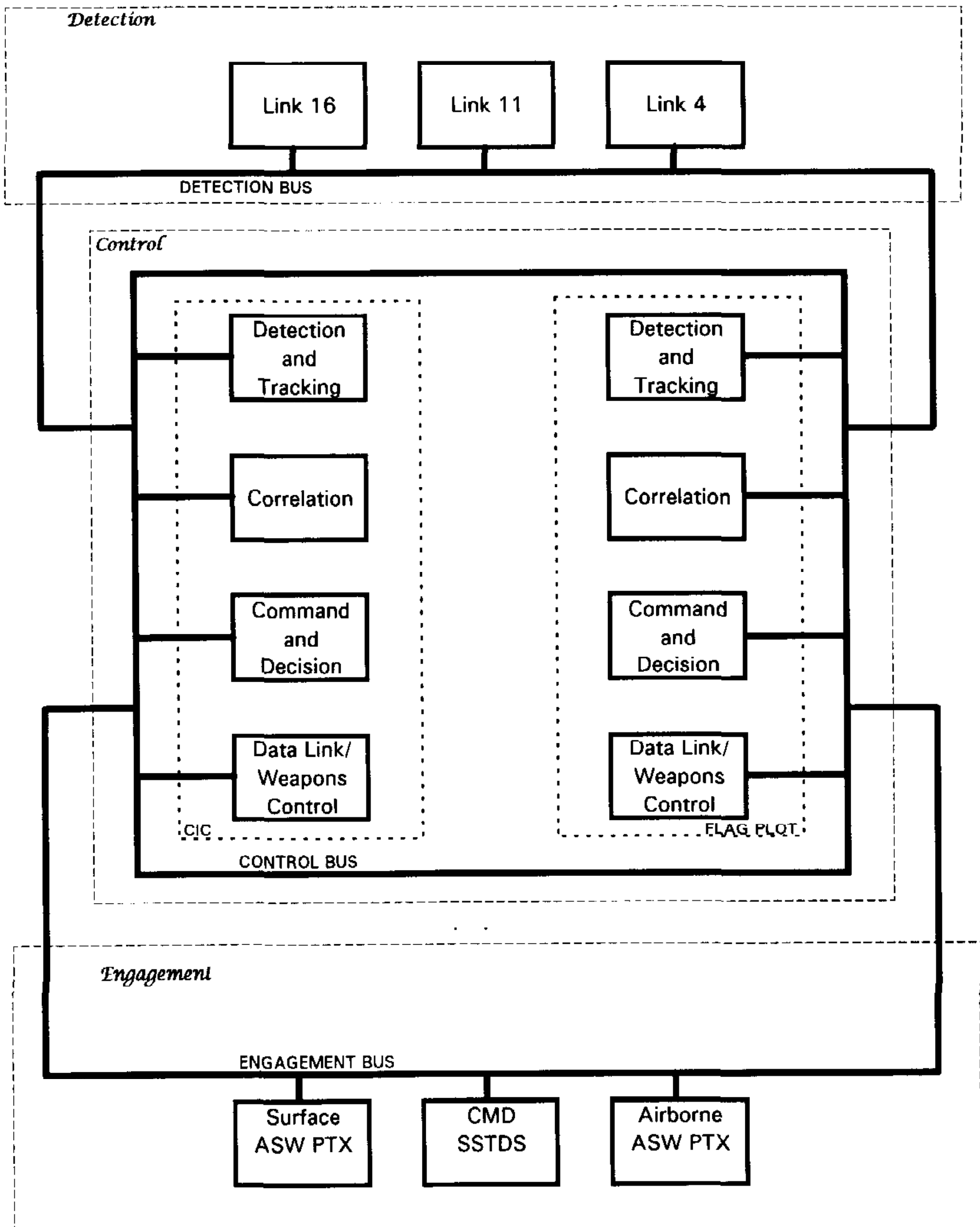


Figure 5-10. CMD INT Architecture

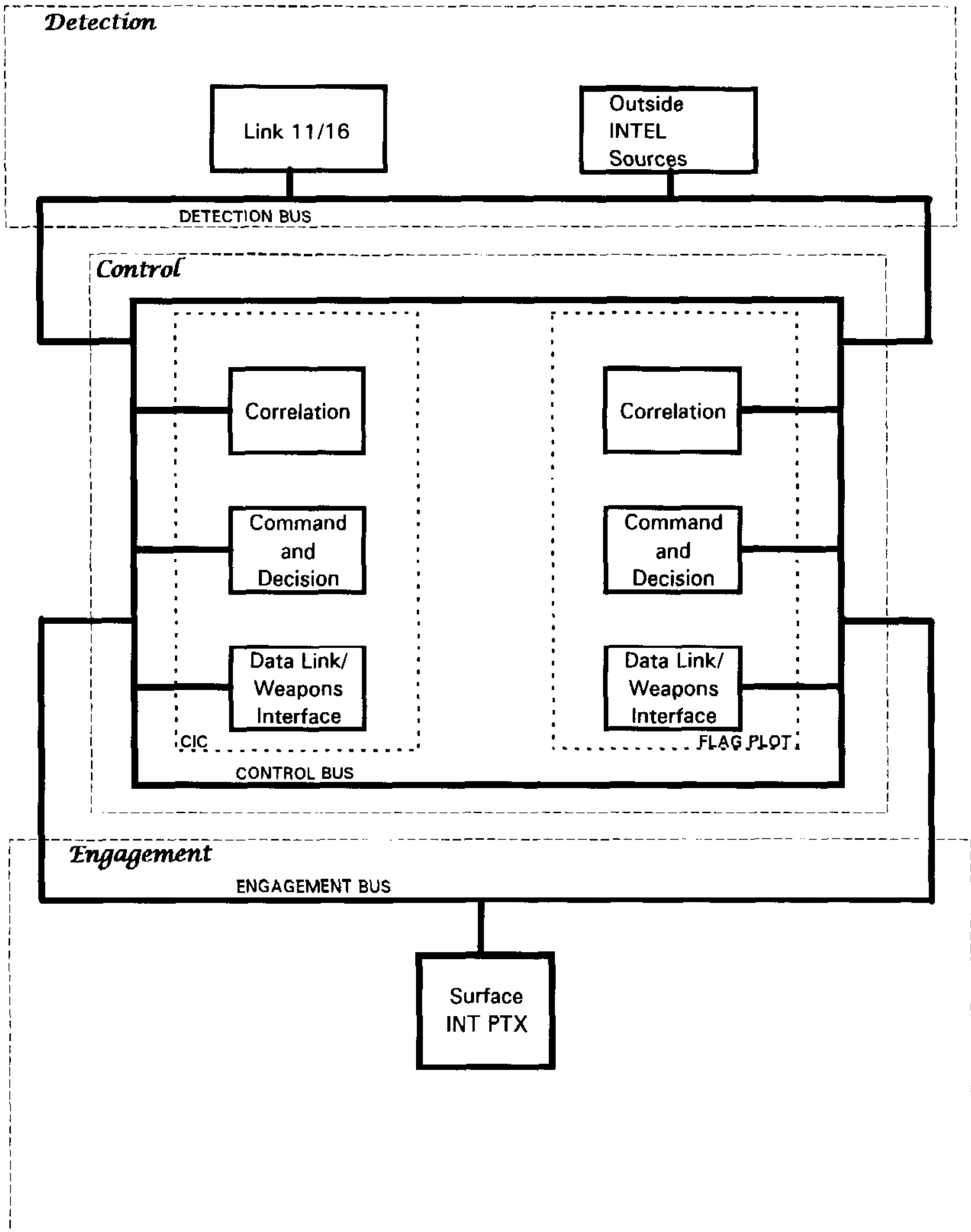


Figure 5-11. CMD MIW Architecture

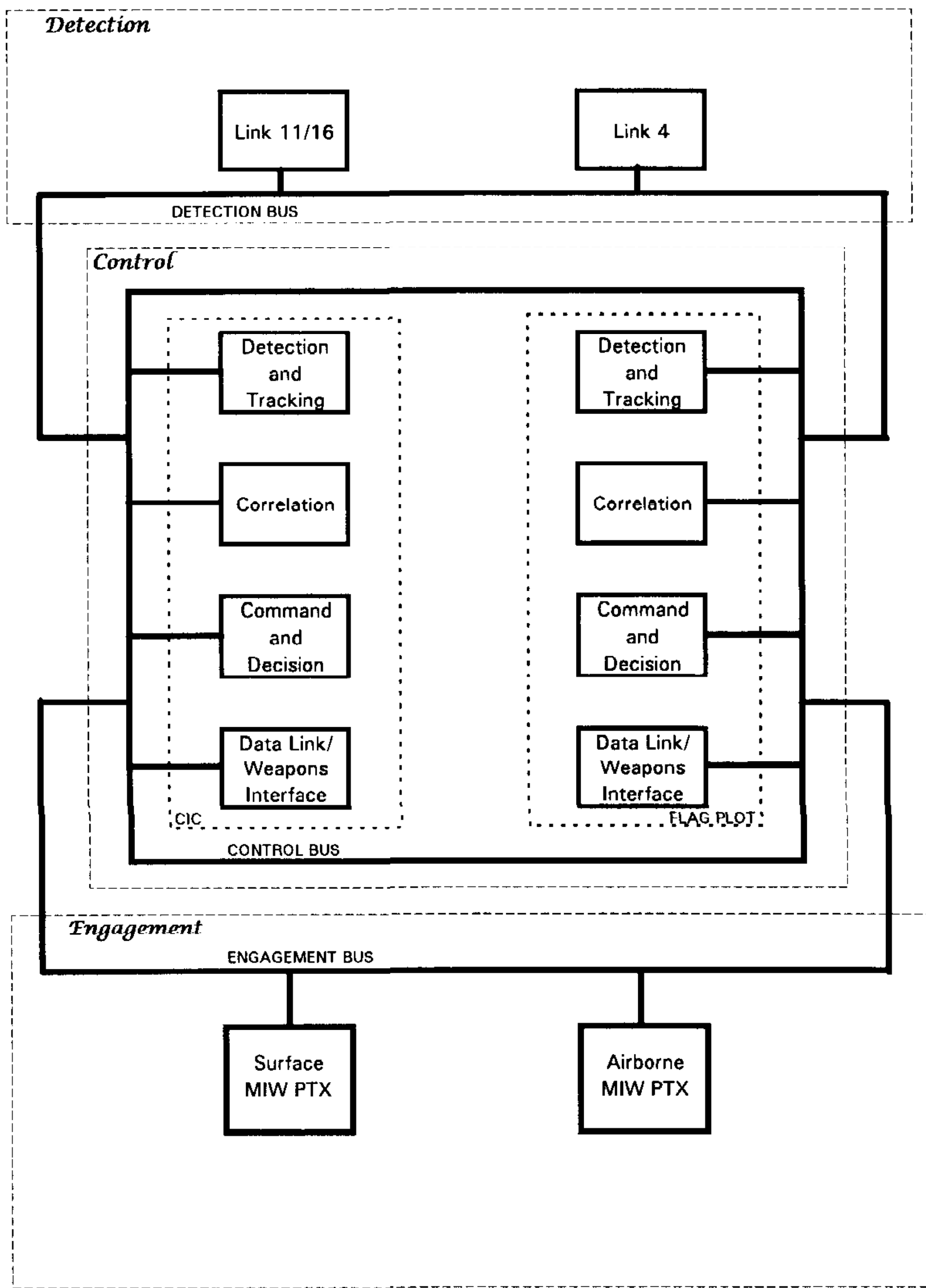


Figure 5-12. CMD STW Architecture

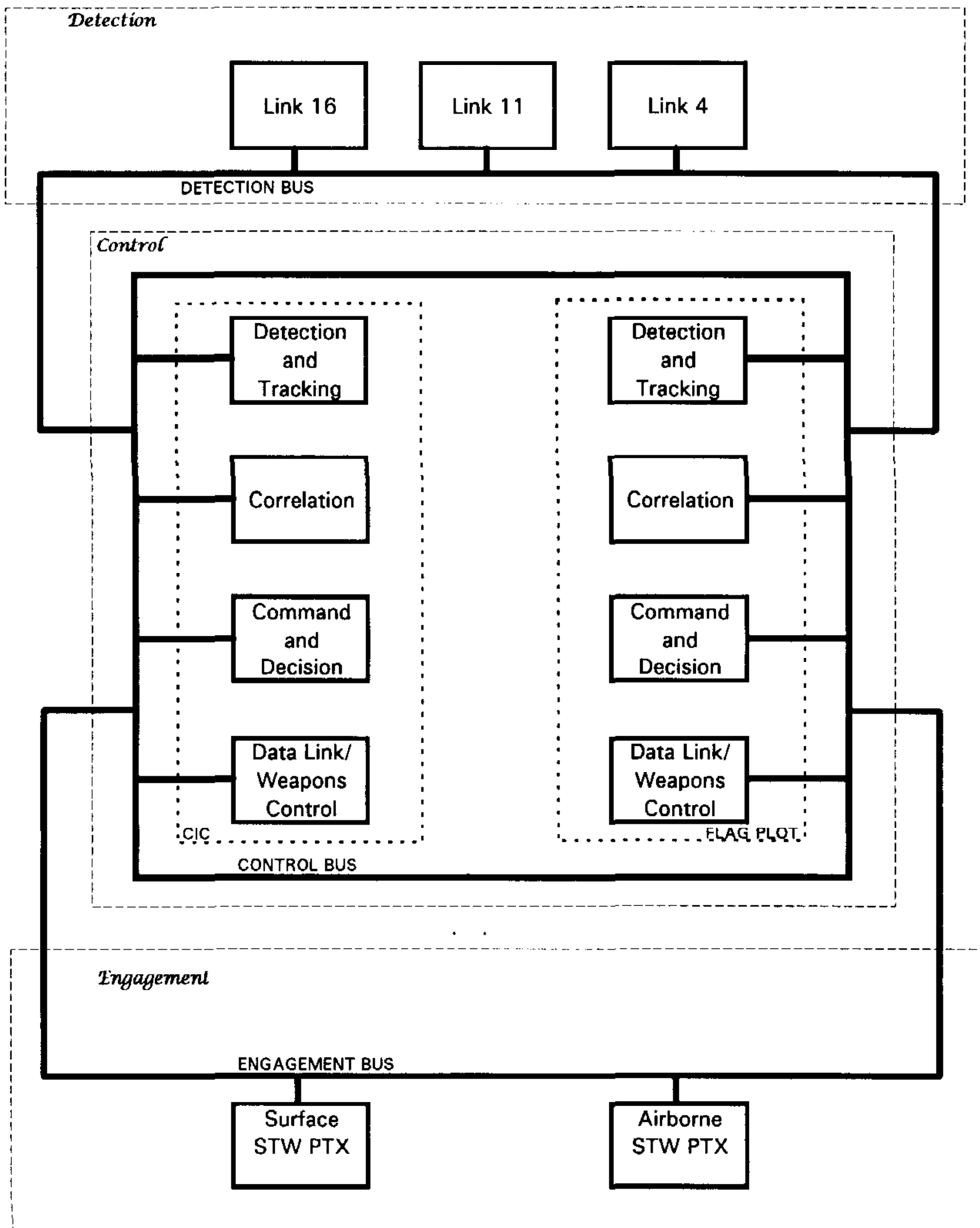


Figure 5–13. Functional Flow Diagram (Tier 0)

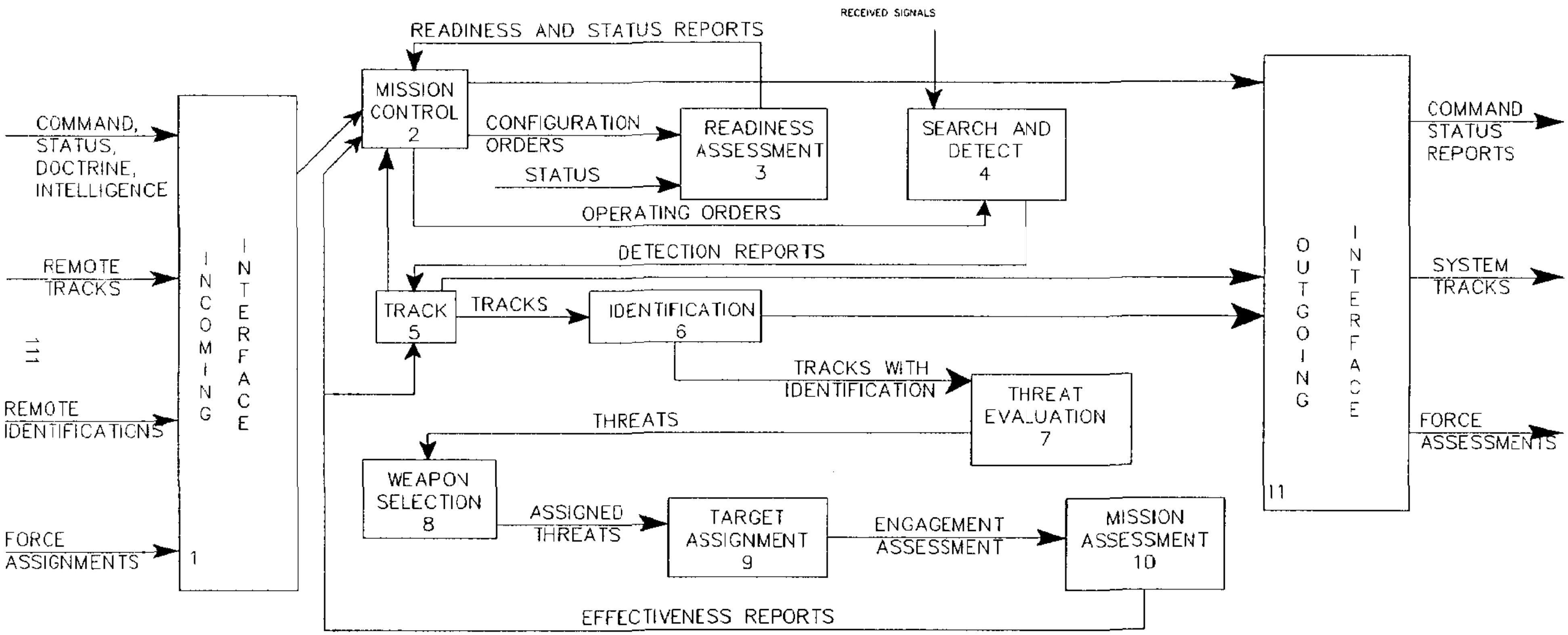
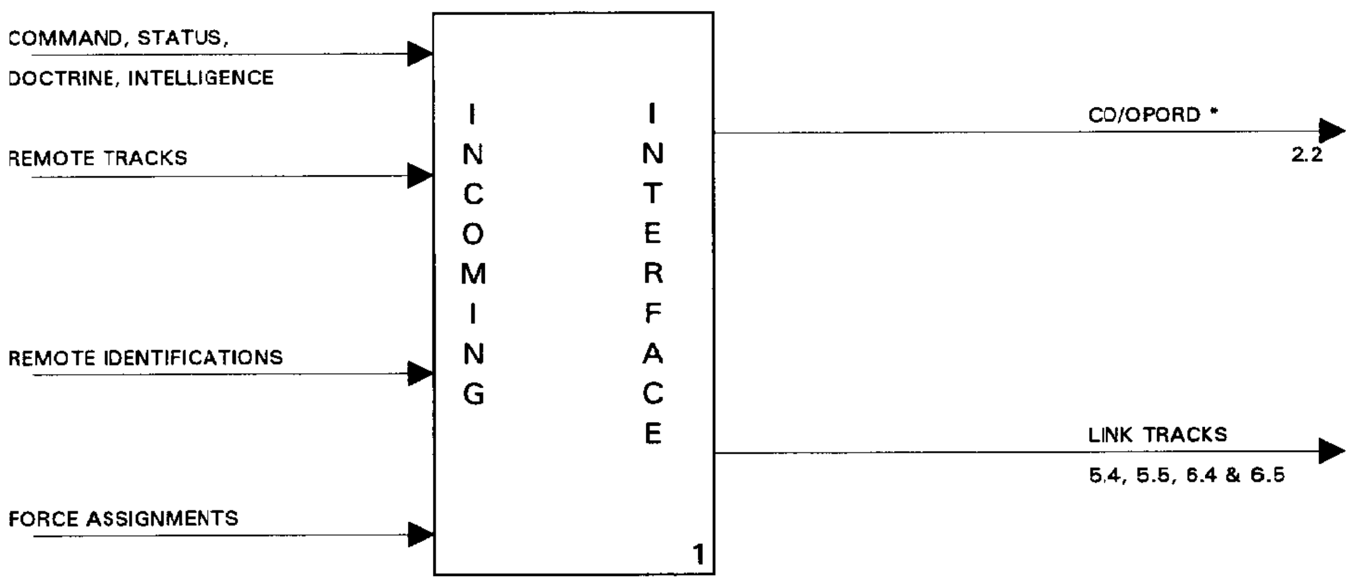
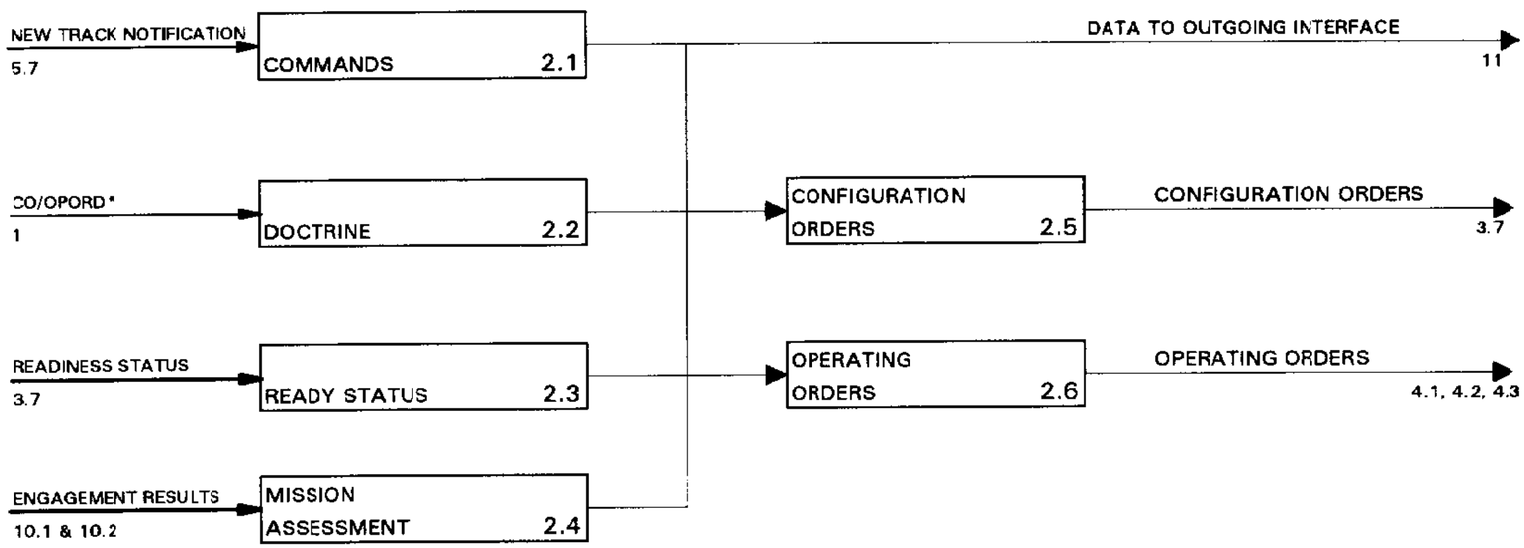


Figure 5-13a. Functional Flow Diagram (Tier 1, Block 1)



* -- COMMANDING OFFICERS STANDING ORDERS/OPERATIONAL ORDERS

Figure 5-13b. Functional Flow Diagram (Tier 1, Block 2)



*-- COMMANDING OFFICERS STANDING ORDERS/OPERATIONAL ORDERS

Figure 5-13c. Functional Flow Diagram (Tier 1, Block 3)

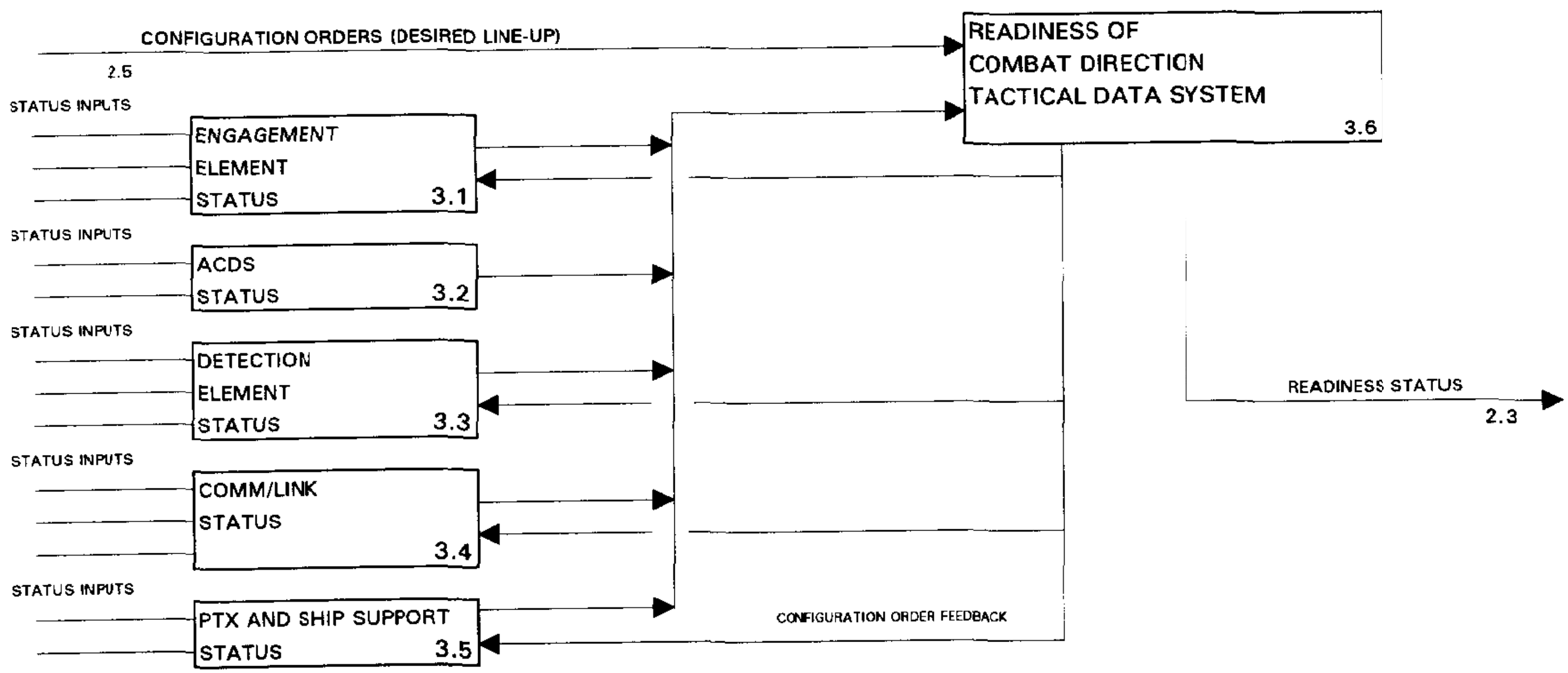


Figure 5-13d. Functional Flow Diagram (Tier 1, Block 4)

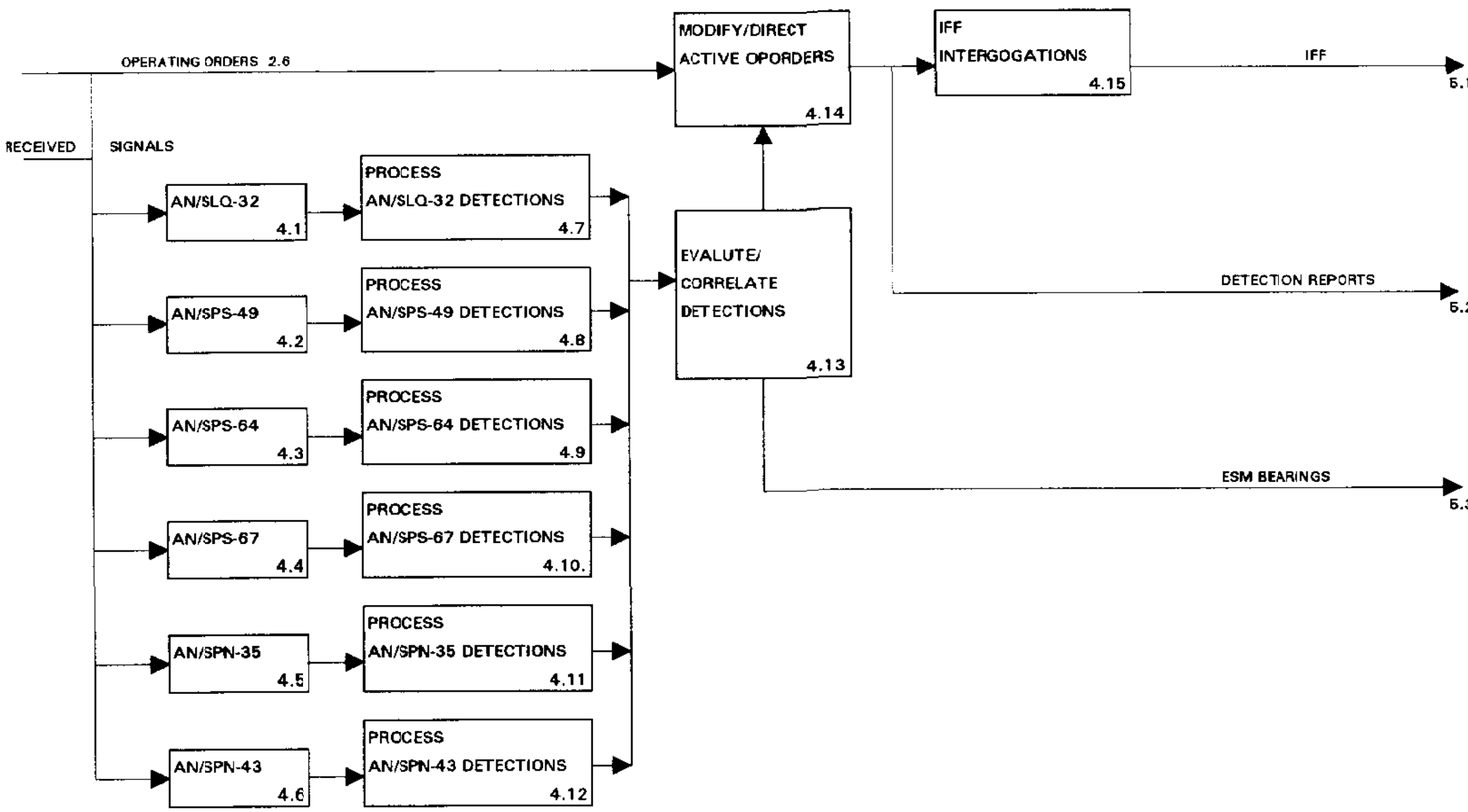


Figure 5-13e. Functional Flow Diagram (Tier 1, Block 5)

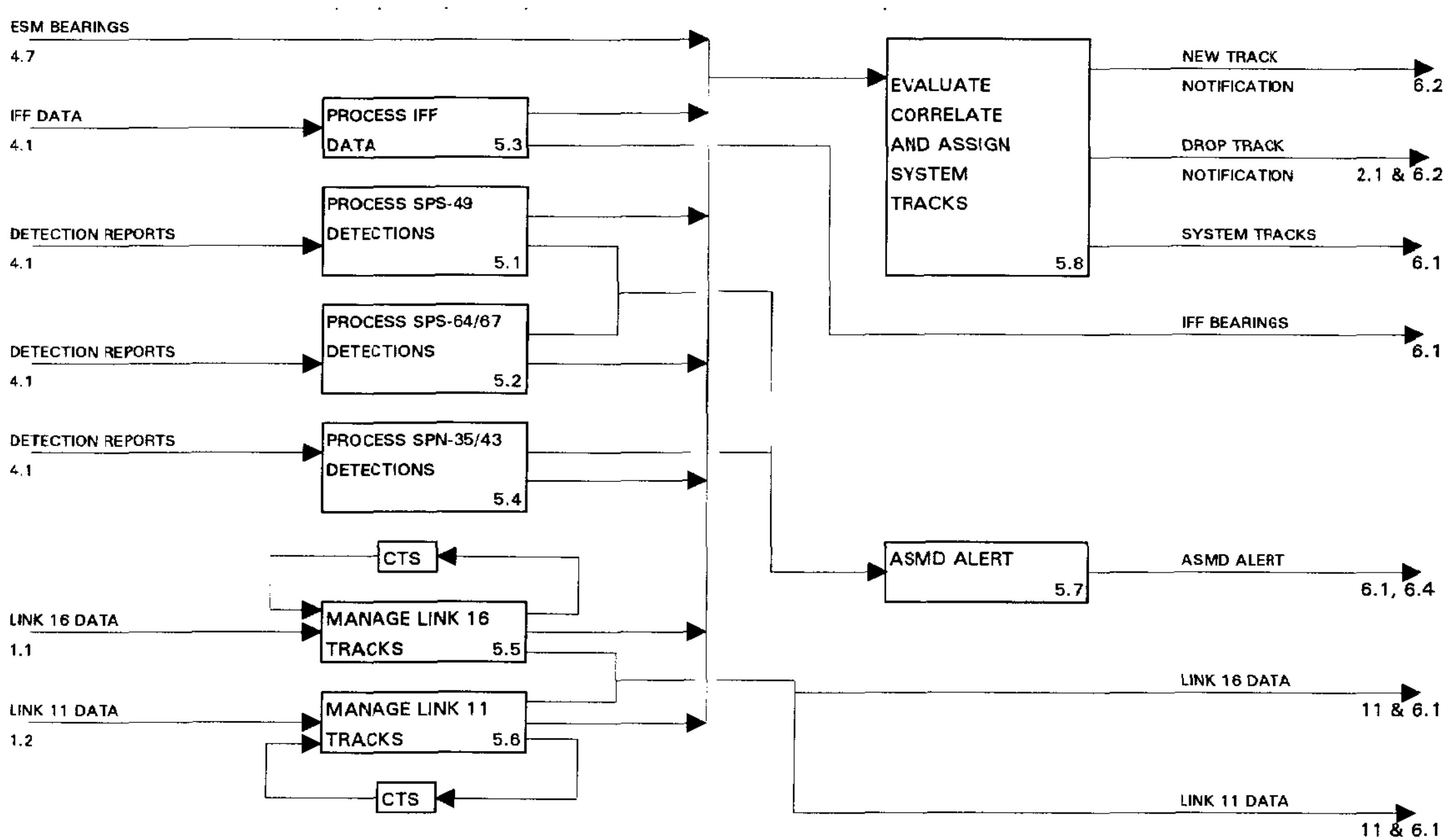


Figure 5-13f. Functional Flow Diagram (Tier 1, Block 6)

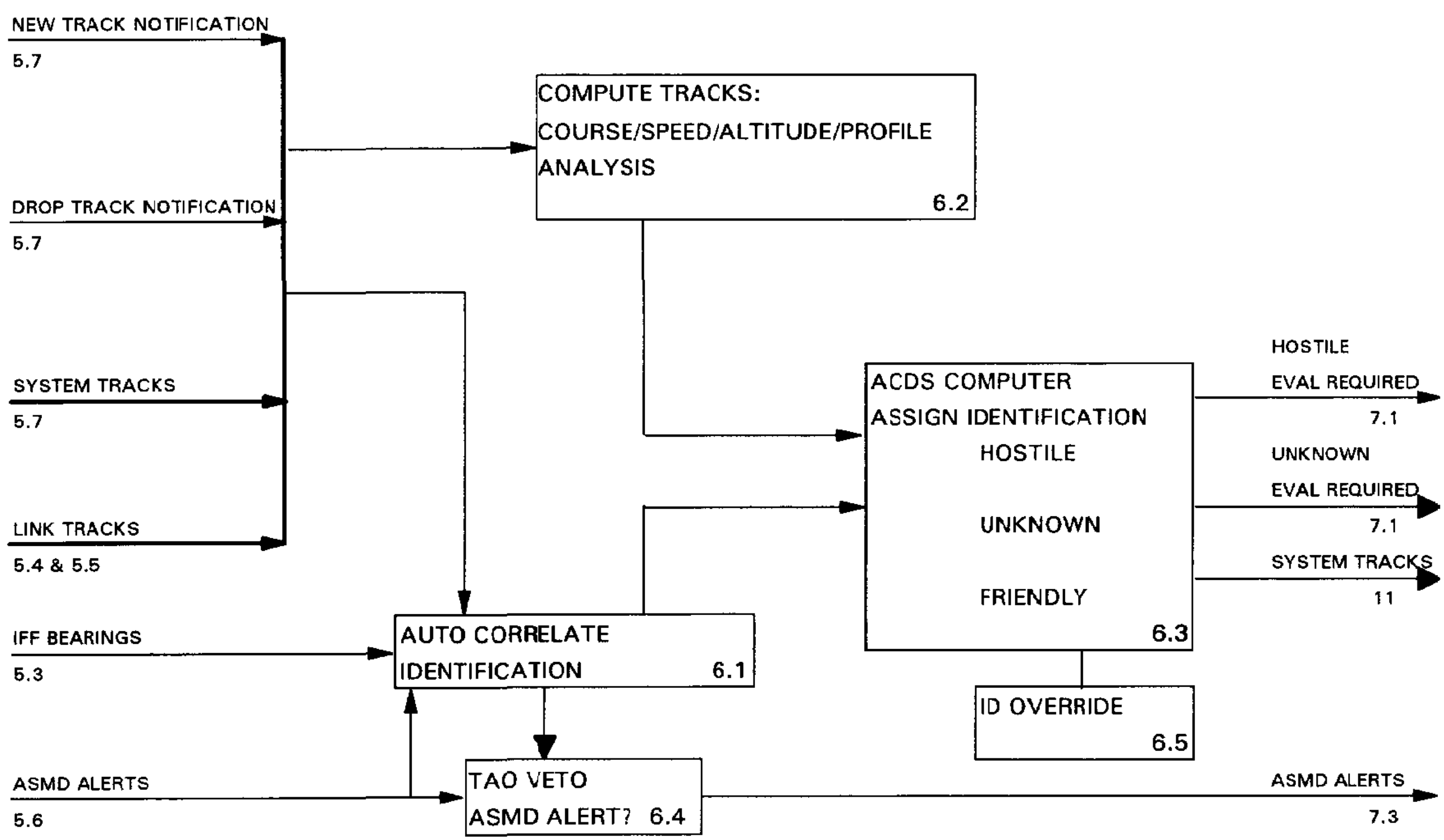


Figure 5-13g. Functional Flow Diagram (Tier 1, Block 7)

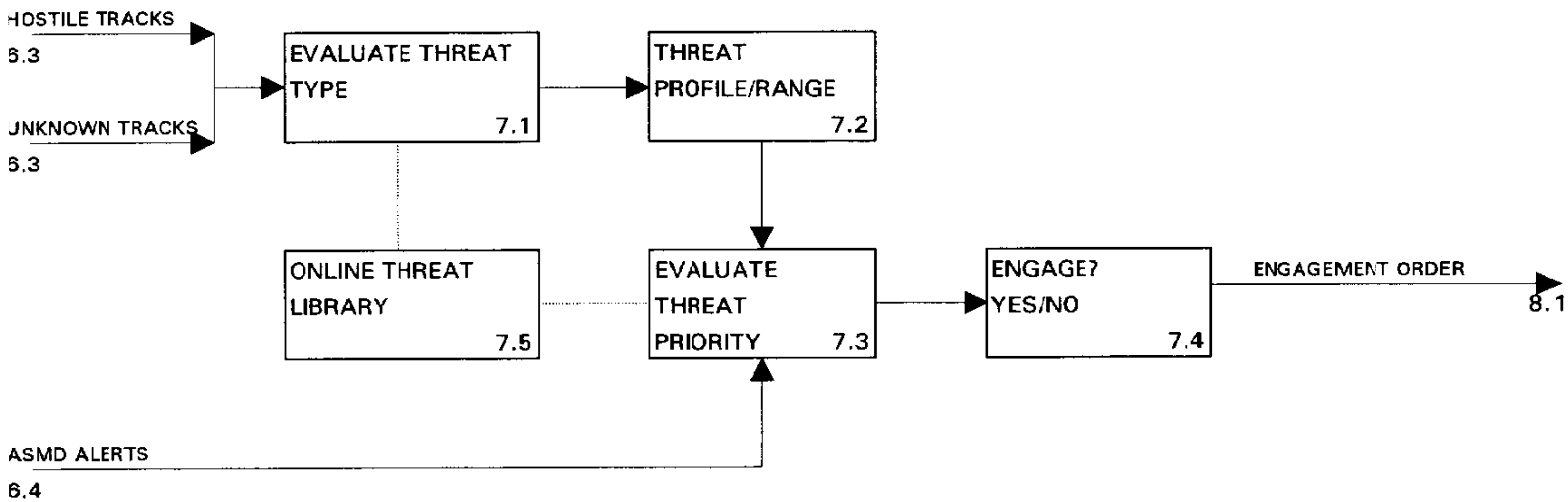


Figure 5-13h. Functional Flow Diagram (Tier 1, Block 8)

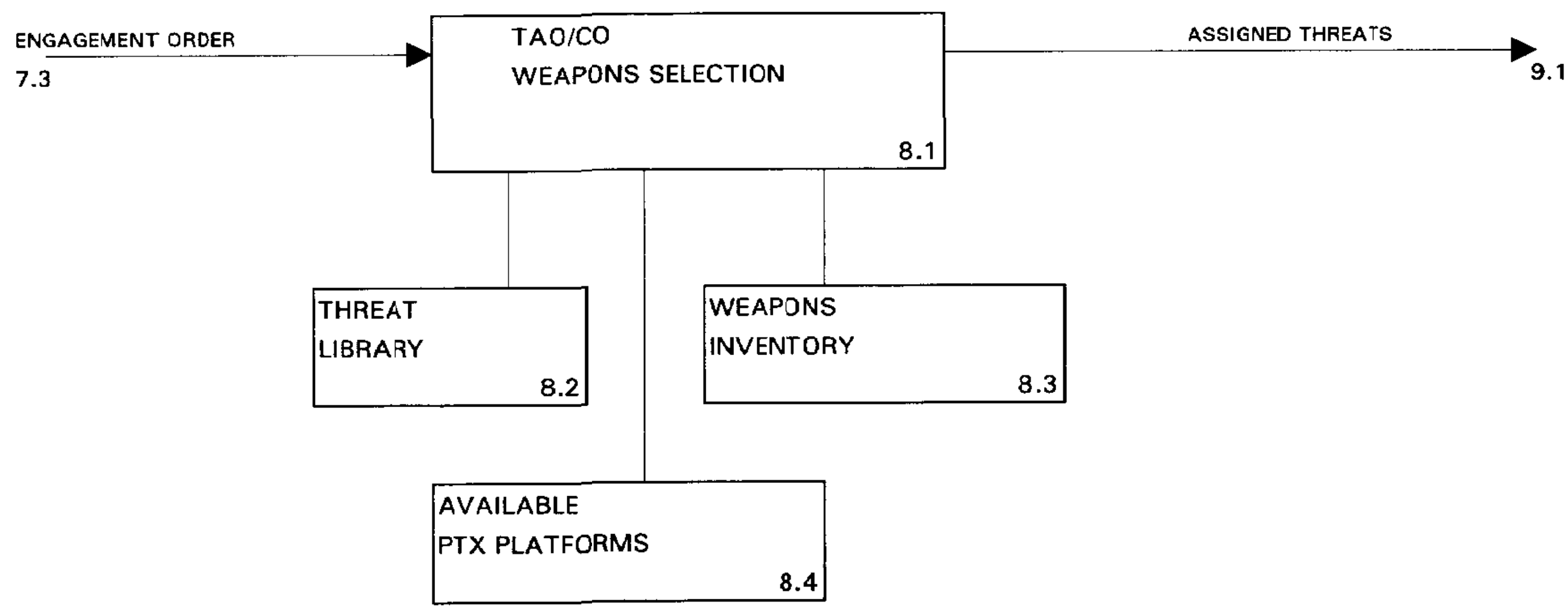


Figure 5-13i. Functional Flow Diagram (Tier 1, Block 9)

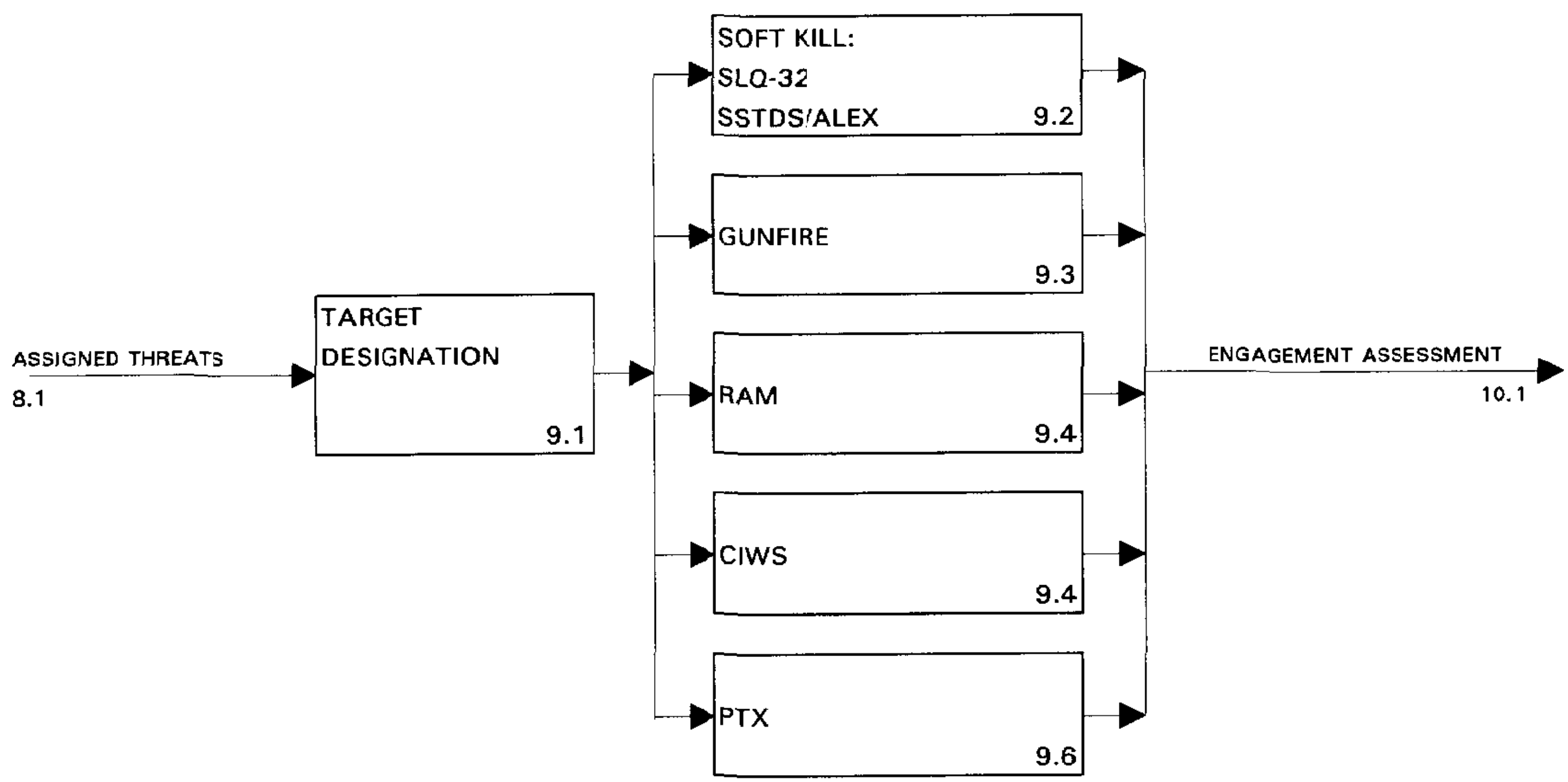


Figure 5-13j. Functional Flow Diagram (Tier 1, Block 10)

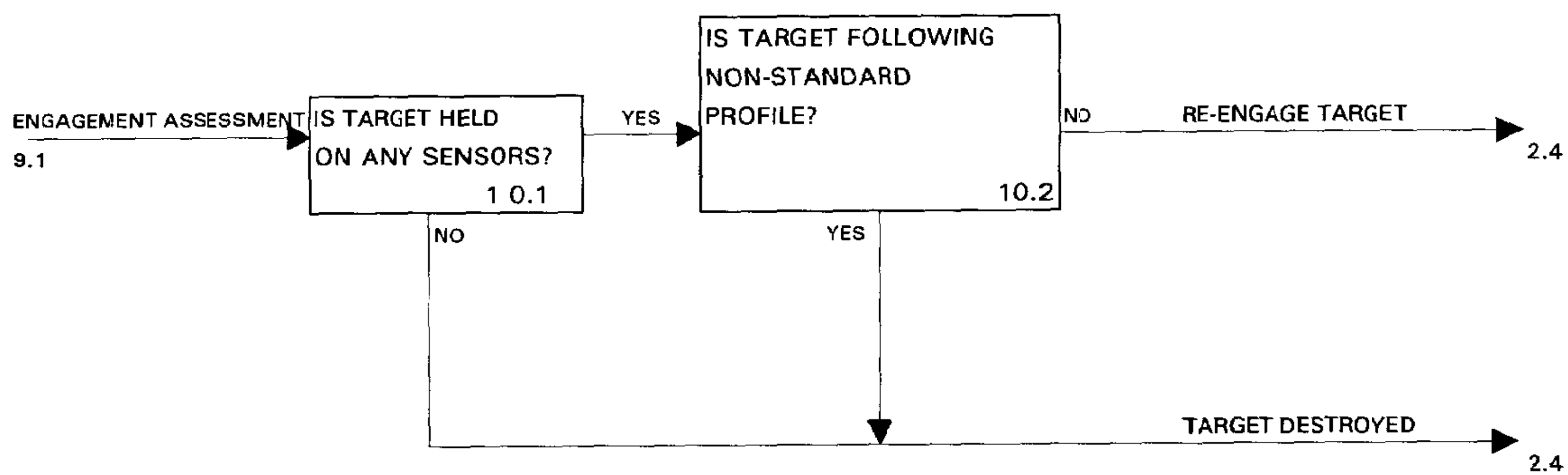
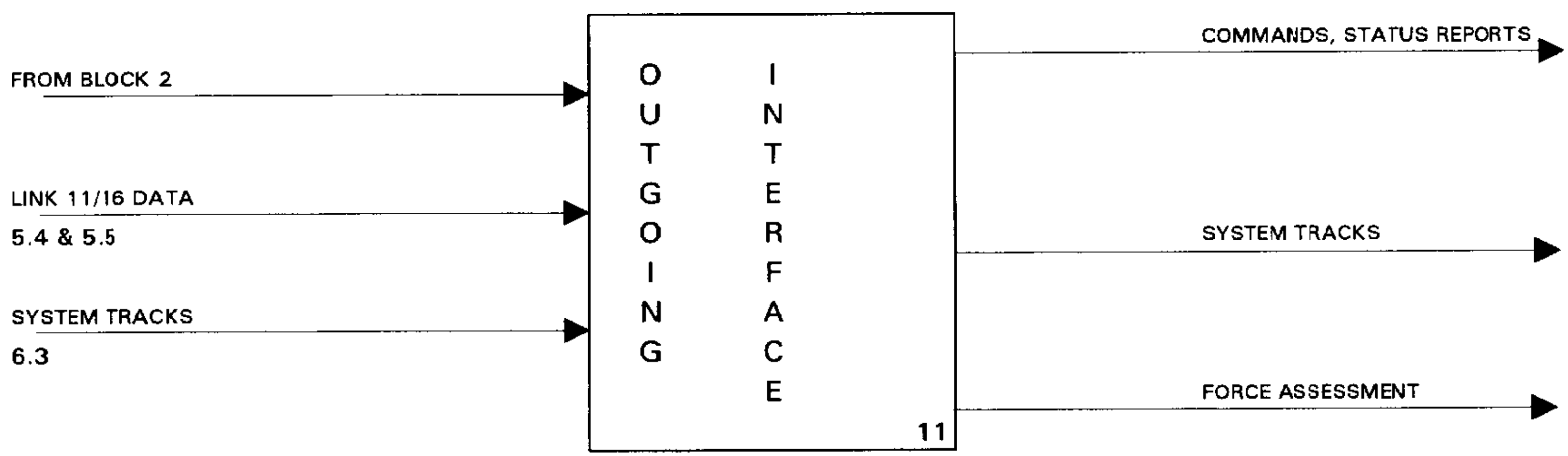


Figure 5-13k. Functional Flow Diagram (Tier 1, Block 11)



C. HULL, MECHANICAL AND ELECTRICAL ARCHITECTURE

1. Power Generation and Distribution System

The CMD propulsion plant and ship service electrical distribution are structured in an Integrated Power Architecture (IPA) consisting of five functional elements: power generation, power distribution, power conversion, power load, system control and information. It can be characterized as a Direct Current Zonal Electrical Distribution system (DC ZED). In general, all power produced will be alternating current which is immediately rectified to direct current. Propulsion power is distributed radially on a propulsion bus, as shown in figure 5-14; ship service generators are connected in a ring bus and power is distributed via zonal architecture. Most loads throughout the ship, including the propulsion motors, are alternating current; therefore, power conversion is made within each zone at local distribution centers. The power plant is primarily controlled from the Central Control Station (CCS).

Electrical power is produced from two types of Power Generation Modules (PGM). The first is a LM-2500 GE gas turbine engine connected to a 20 MW generator; the second is a MTU 16V538 diesel engine connected to a 2000 KW generator. There are four gas turbine engines, two in each Main Machinery Room (MMR) and two diesel engines, one in each Auxiliary Machinery Room (AMR). The generators utilize permanent magnet technology. The propulsion motors are advanced electric permanent magnet synchronous machines that are directly coupled to the propeller shafts. They receive power via Power Converter Modules (PCM) and Power Distribution Modules (PDM).

The ship service electrical distribution system, shown in figure 5-15, is supported via the power generation ring bus to each zone. At appropriate locations, the direct current is converted in PCMs then distributed locally through PDMs or supplied directly as DC, which can be a great beneifit to many combat systems. Vital power loads are serviced from both sides of the bus while non-vital loads are serviced from the closest bus. The distribution system is managed by the Standard Monitoring and Control System (SMCS).

The IPA offers many advantages over conventional mechanical drive and former diesel-electric drive platforms. The primary advantages of the IPA are

Figure 5-14 Propulsion Power Distribution Architecture

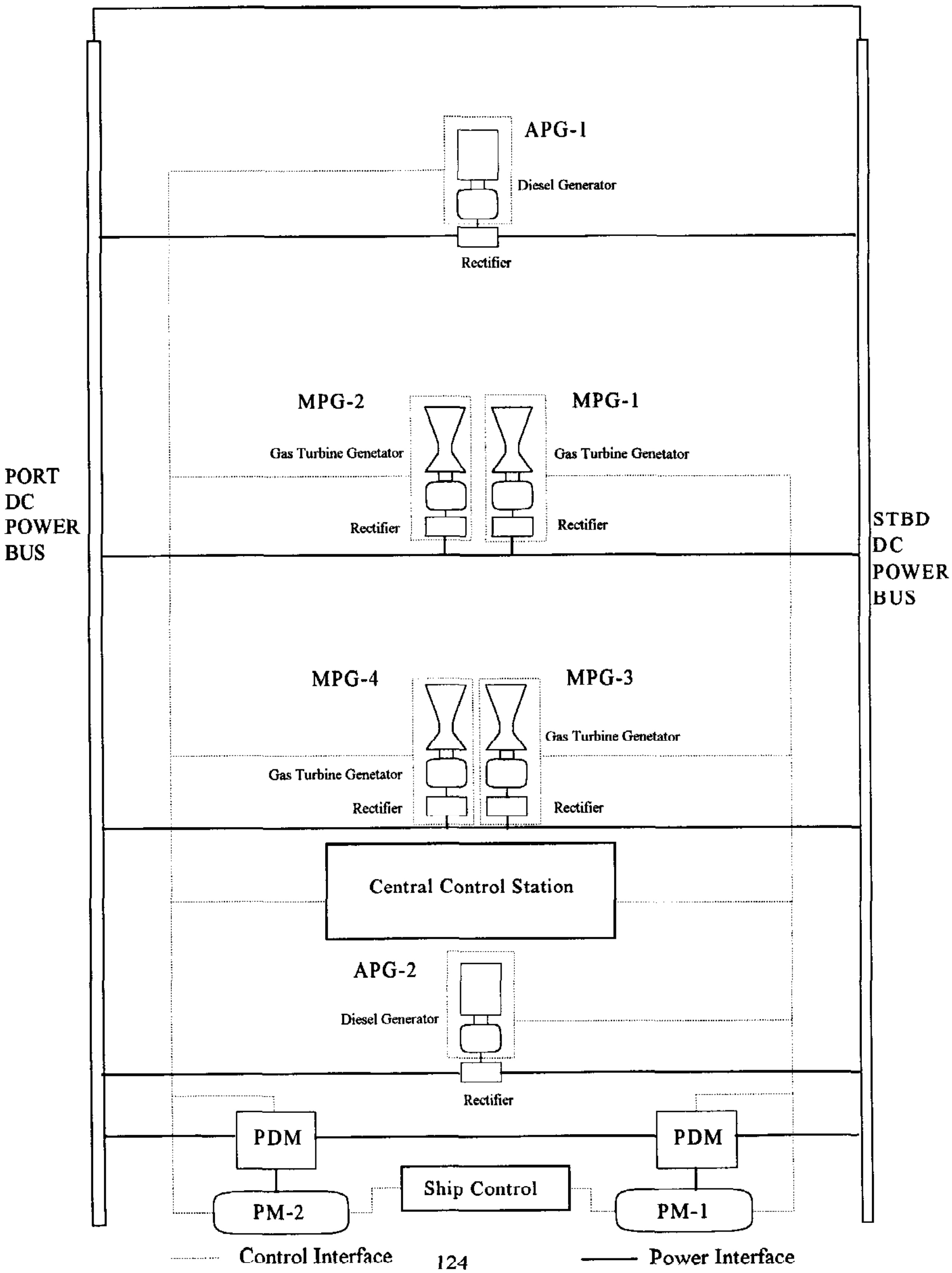
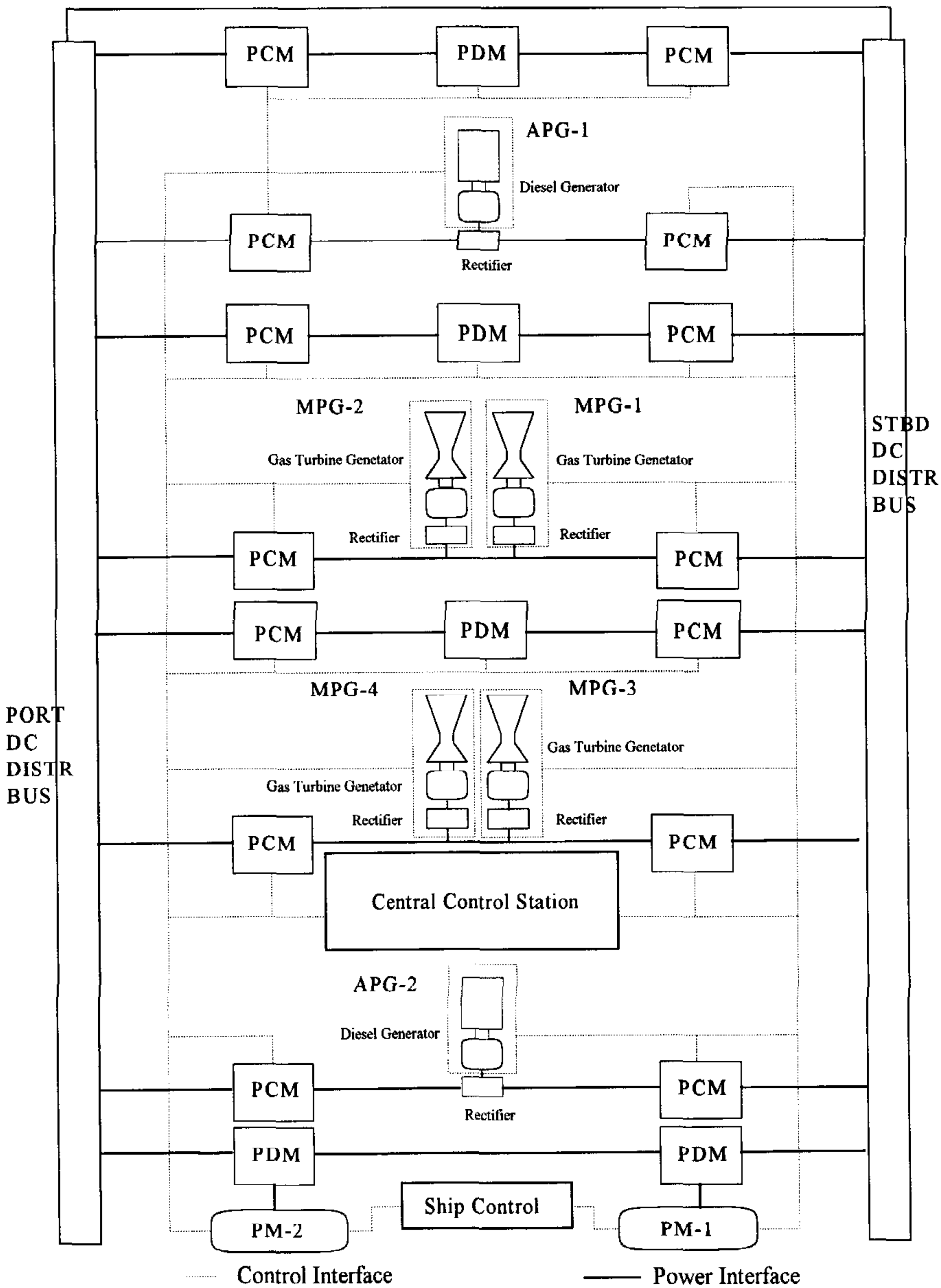


Figure 5-15 Electrical Distribution Architecture



improved economy in aquisition, construction and fuel savings and its ability to support the advanced system control and information data bus. Operationally, these advantages equate to many features. Efficiency and reliability are increased by having flexibility in selecting various combinations of generation units on-line to meet the required load, while at the same time providing redundancy. Survivability is enhanced with the ability to produce both propulsion and ship service electrical power from any machinery room as well as to provide power to either propulsion motor unit. Power plant operation is supported by the systems near instantaneous power transfer abilities and inherent current-limiting protection. Additionally, the control and information data bus offers the ability to manage the plant from many locations in the ship; subject only to the number and inherent capablity of the data consoles and ports installed. Electrical power supplied to the propulsion motor is clean thus reducing the amount of torque noise transmitted through the hull. Electric power is distributed throughout the ship as DC and converted to the appropriate level DC or AC as required.

2. Command, Control, Communication and Instrumentation (C^3I)

The C^3I system provides unparalled ability to manage all combat systems, major power plant systems and ship control systems from a single data bus. It is a Fully Integrated, Fault Tolerant (FIFT) system that runs throughout the ship and is only limited by the level to which local information ports and control consoles are outfitted. It combines control and monitoring of all major electronic and electrical systems on board into one centralized C^3I system. Some of the advantages over existing systems are: fully multiplexed interior communications, centralized ship data for use by all systems, improved reliability and survivability, reduced construction and operating costs, and simplification of man to machine interfaces.

The FIFT C^3I system provides digital real time processing and communications and is to be designed with the intention that it is responsible for mission success and survivability. It consists of the following functional areas: computing and control, communications, input/output, control stations and power distribution. System hardware incorporates generic consoles, central computing group processors and fiber optic data buses.

The following articles provide substantial information regarding current research which forms the basis for the power plant and C^3I systems:

A. Integrated Power System for Marine Applications, N.H. Doerry and J. C. Davis, ASNE Journal, May 1994.
B. Advanced Electric Propulsion, Power Generation and Power Distribution, T. B. Dade, ASNE Journal March 1994.
C. Fully-Integrated, Fault-Tolerant Command, Control, Communication and Instrumentation System for a Nuclear Attack Submarine, M. G. Dauman, ASNE Journal, March 1994.

3. Firemain System

Firemain supply is distributed throughout the ship with a double horizontal loop system. The lower loop circulates along the damge control deck (second deck) and the upper loop along the third level of the superstructure (03 level). Risers on port and starboard sides link the two loops and supply from each machinery space. The distribution system is supplied by six firepumps: one in the aft AMR (AMR2), two in the aft MMR (MMR2) and three additional pumps located in pump rooms in the forward two zones. The system incorporates electrically operated isolation valves at key locations that are controllable from CCS, the Integrated Control and Information System or manually. The system is further managed with manual isolation valves and the ability to provide jumper connections across zones.

4. Ballast Control

Ballasting of the ship is an evolution that is central to the ships primary mission areas. The degree to which trim and well deck water depth can be maintained as well as the speed at which the ship can ballast up or down significantly impacts mission effectiveness. The amount of ballast weight required is estimated at approximately 9,000 tons; this amount is exacerbated by a flared hull form. The system incoporates third deck tanks which are above the water line and six and seventh deck tanks in the inner bottom and skirting the underwater hull. the third deck tanks are filled from the firemain system and gravity drained. the lower deck tanks are seawater filled and drained with low pressure air. Ballast Control Central (BCC) is located on the second deck at the extreme forward end of the well deck. This location provides for complete viewing access of the well deck area. All tank valves are electrically operated from BCC.

5. Equipment Cooling and Air Conditioning

The availability of electronic equipment cooling to combat systems is as important as the supply of electricity; therefore, the concept of enclaving and zonal architecture of combat systems for increased survivability must also be applied to the distribution of support elements. Electronic Cooling Modules (ECM) of appropriate capacity will be located nearby all vital electronic equipment and or spaces. The modules will provide electronic cooling water as well as air conditioning to the space. All other spaces, such as berthing, mess facilities and offices will be supplied with air conditioning on a shipwide distribution system.

6. Additional Comments on Power Plant Computer Models

The ASSET computer program is unable to handle a power off the main bus arrangement; therefore, an attempt to assess the impact of the power plant type on ship speed has been made by incorporating Propulsion Derived Ship Service (PDSS) into the ASSET model using four 1000 KW PDSS generators. The ship service electrical power assesment section of ASSET does not provide realistic capability for any model. This problem had been noted by previous TSSE students as well. To solve this problem the installed electrical power capability is assigned using past experience and discussion with engineers during ship tours. It is expected that normal underway operations will be made with any combination of main engines (gas turbines) on-line.

It is expected that operational achorage loads can be met with one secondary engine (diesel) supplying ship service power. The diesel engine has been selected because an appropriately size gas turbine is not available (i.e. Solar Saturn at 750 KW or Allison 501 at 2700 KW). Additionally, two diesels vice one larger gas turbine allows for power generation in any of the four enclaving zones.

7. Power Plant Equipment Listing

The power plant equipment list for the main machinery, auxiliary machinery and motor rooms is provided in tables 5-3 through 5-8.

TABLE 5-3 Forward Main Machinery Room (MMR1)

EQUIPMENT	NUMBER INSTALLED
Power Generation Module: LM-2500 with 20 MW Generator	2
Power Conversion Modules	As Required
Power Distribution Modules	As Required
Lube Oil Scavenging System (LOSCA)	1
Fuel Oil Service Tank/Purifier/Pump	2
Fuel Oil Transfer Pump	2
Air Conditioning Plant	1
High Pressure Air Compressor	1
Ships Service Low Pressure Air Compressor	1
Ballast Low Pressure Air Compressor	1

TABLE 5-4 Aft Main Machinery Room (MMR2)

EQUIPMENT	NUMBER INSTALLED
Power Generation Module: LM-2500 with 20 MW Generator	2
Power Conversion Modules	As Required
Power Distribution Modules	As Required
Firepump	2
Reverse Osmosis Distilling Plant	1
Potable Water Pump	2
Lube Oil Scavenging System (LOSCA)	1
Fuel Oil Service Tank/Purifier/Pump	2
Fuel Oil Transfer Pump	2
Eductor	1
Air Conditioning Plant	1
High Pressure Air Compressor	1
Ships Service Low Pressure Air Compressor	1
Ballast Low Pressure Air Compressor	1

TABLE 5-5 Forward Auxiliary Machinery Room (AMR1)

EQUIPMENT	NUMBER INSTALLED
Power Generation Module: MTU-16V538 with 2000 KW Generator	1
Power Conversion Modules	As Required
Power Distribution Modules	As Required
Lube Oil Purifier	1
Lube Oil Storage Tank	1
Fuel Oil Service Tank/Pump	2
Diesel Jacket Water Pump	2
Air Conditioning Plant	1
Ships Service Low Pressure Air Compressor	1
Ballast Low Pressure Air Compressor	1

TABLE 5-6 Aft Auxiliary Machinery Room (AMR2)

EQUIPMENT	NUMBER INSTALLED
Power Generation Module: MTU-16V538 with 2000 KW Generator	1
Power Conversion Modules	As Required
Power Distribution Modules	As Required
Firepump	1
Reverse Osmosis Distilling Plant	1
Potable Water Pump	2
Lube Oil Purifier	1
Lube Oil Storage Tank	1
Fuel Oil Service Tank/Pump	2
Diesel Jacket Water Pump	2
Eductor	1
Air Conditioning Plant	1
Ships Service Low Pressure Air Compressor	1
Ballast Low Pressure Air Compressor	1

TABLE 5-7 Starboard Propulsion Motor Room (PMR1)

EQUIPMENT	NUMBER INSTALLED
Propulsion Motor	1
Power Conversion Modules	As Required
Power Distribution Modules	As Required
Motor Cooling System	1
Motor Lubricating System	1
Eductor (shared with other PMR)	1

TABLE 5-8 Port Propulsion Motor Room (PMR2)

EQUIPMENT	NUMBER INSTALLED
Propulsion Motor	1
Power Conversion Modules	As Required
Power Distribution Modules	As Required
Motor Cooling System	1
Motor Lubricating System	1
Eductor (shared with other PMR)	1

D. ARRANGEMENTS

The arrangements for the CMD are divided into five sub groups; topside, H,M &E, combat systems, well deck and miscellaneous. Each of these is illustrated by drawings in this section. Detailed drawings of Combat Information Center (CIC), the bridge, and the Central Control Station (CCS) are provided in subsection F.

1. Topside Arrangements

The topside arrangements are shown in figure 5-16. The CMD has two masts, one located just aft of the bridge and the second located above the hangar space. Both masts are on the ships centerline and cantered aft at 13 degrees.

The SPN-35 and SPN 43 (3-D air search radars) are located on the aft mast to provide for a large area of coverage but more significantly to provide a complete viewing zone of the flight deck.

The forward mast supports the SPS-49 (2-D air search radar), the SPS-67 (surface search radar), the Mk 92 CAS antenna (for 76mm gun), TACAN and various other communication antennas. The SPS-64 (navigation radar) is mounted above the bridge on its own pedestal type mount.

The two CIWS (close in weapons system) mounts are located above the hangar with one placed on the port side and one on the starboard. These locations provide a good area of coverage and do not interfere with helo operations.

A RAM (rolling airframe missile) launcher is located in the platform forward of the bridge on the 02 level and another is located aft and to starboard of the after mast on the hangar. These two locations increase the area of coverage for point defense.

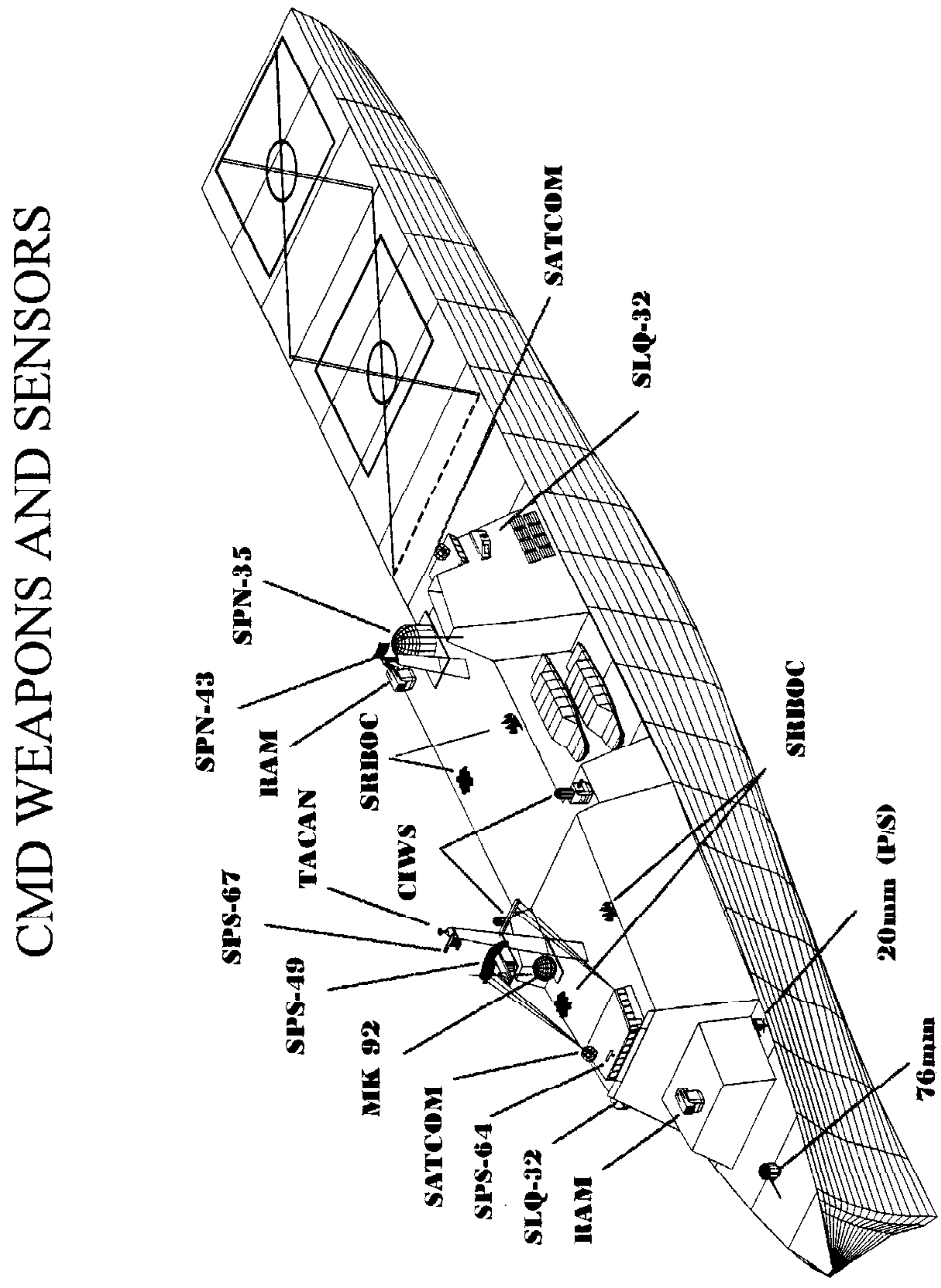
The 76 mm gun is located on the forecastle area of the main deck. It was not possible to locate the Mk 92 CAS within the same structural zone as the 76 mm gun. The guns arc of coverage is almost 225 degrees which provides for flexibility in its use.

Each SRBOC launcher consists of six tubes and are positioned to provide for maximum effectiveness. Two launchers are located on the forward mast platform on the 04 level and two are positioned on top of the hangar on the 03 level.

Two surface patrol (INT) PTX craft craft are stored on the port side of the hangar on the main deck. These will serve as ready lifeboats in the case of personnel overboard.

Bushmaster 25 mm machine guns will be placed in accessible areas in various locations as deemed necessary by ship operators.

Figure 5-16. Topside Arrangements



The arcs of coverage for detection elements and engagement elements are shown in figures 5-17 and 5-18.

2. Hull, Mechanical and Electrical Arrangements

The H,M &E arrangements are shown in figures 5-19 through 5-23. Each machinery room is capable of supporting itself with equipment located in its own zone.

The forward Auxiliary Machinery Room (AMR1) is located in zone I on the second and third decks. The forward Main Machinery Room (MMR1) is located in zone II on the third and fourth decks. The aft Main Machinery Room (MMR2) is located in zone III on the sixth and seventh decks, below the well deck. The aft Auxiliary Machinery Room (AMR2) is located in zone IV on the sixth and seventh decks. The two PMRs (Propulsion Motor Rooms) are located in zone IV on the sixth and seventh decks. The steering gear rooms are located in zone IV on the sixth deck with equipment removal hatches in the bottom of the well deck.

Gyro rooms are located adjacent to CIC and flag plot (one in zone I and one in zone II) with the IC room adjacent to the forward gyro room.

The CCS (Central Control Station) is loacted on the second deck above the forward MMR. It will act as Damage Control central as well as the central control station for machinery operations.

Power Distribution Modules (PDMs) are located adjacent to each machinery room with Power Conversion Modules (PCMs) dispersed throughout the ship to provide separation and redundancy of operations.

Ballast control is located on the second deck aft of the CCS and positioned in a way to provide complete viewing of the well deck at all times.

Firemain pumps are dispersed throughout the ship to provide sufficient fire fighting capability in each zone. Two firemain pumps are located in MMR2, one in AMR2, one in the forward pump room and two in the after pump room.

3. Combat Systems Arrangements

The general combat system arrangements are shown in figures 5-19 and 5-23. CIC is located on the 02 level below and aft of the bridge. It is surrounded by other non vital spaces to provide added protection and increased survivability. A detailed layout of CIC is provided in subsection F.

Figure 5-17. Arcs of Coverage (Detection Elements)

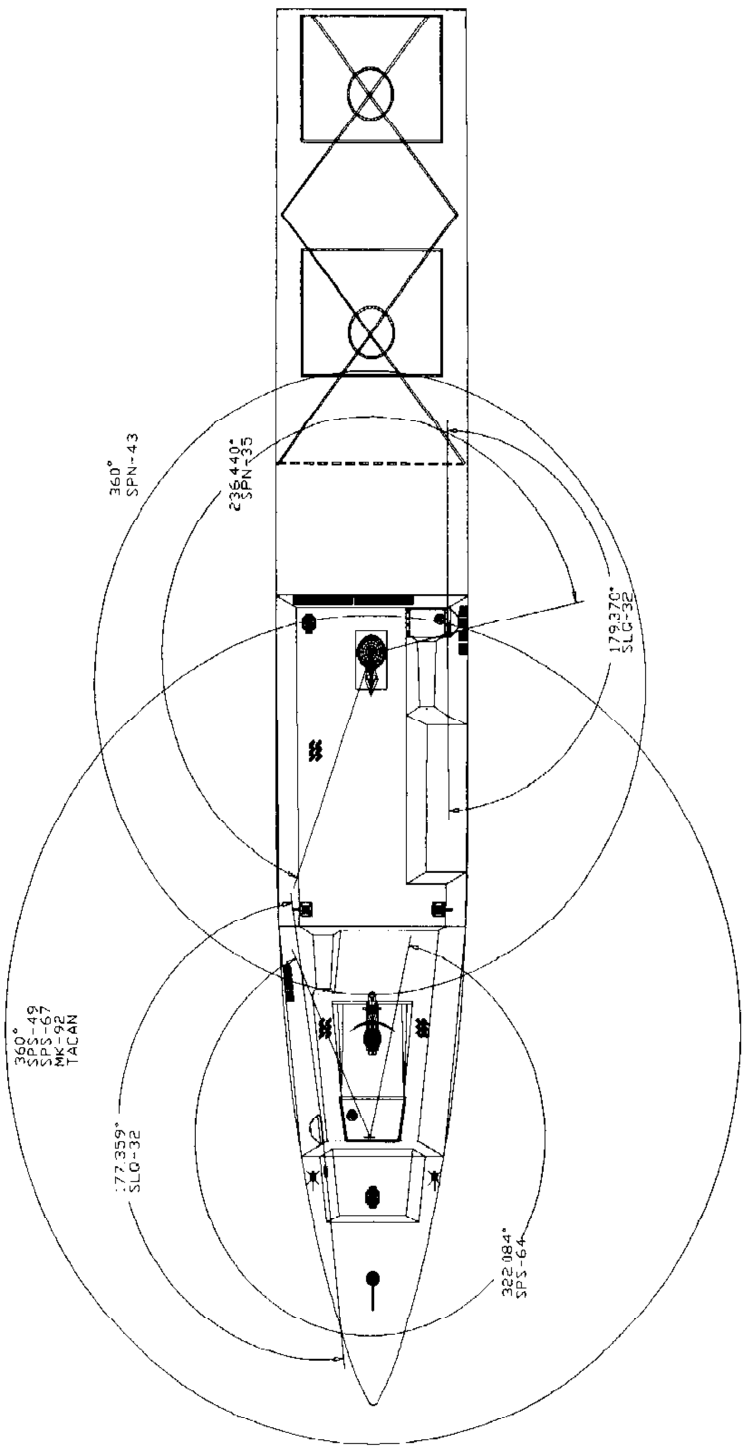
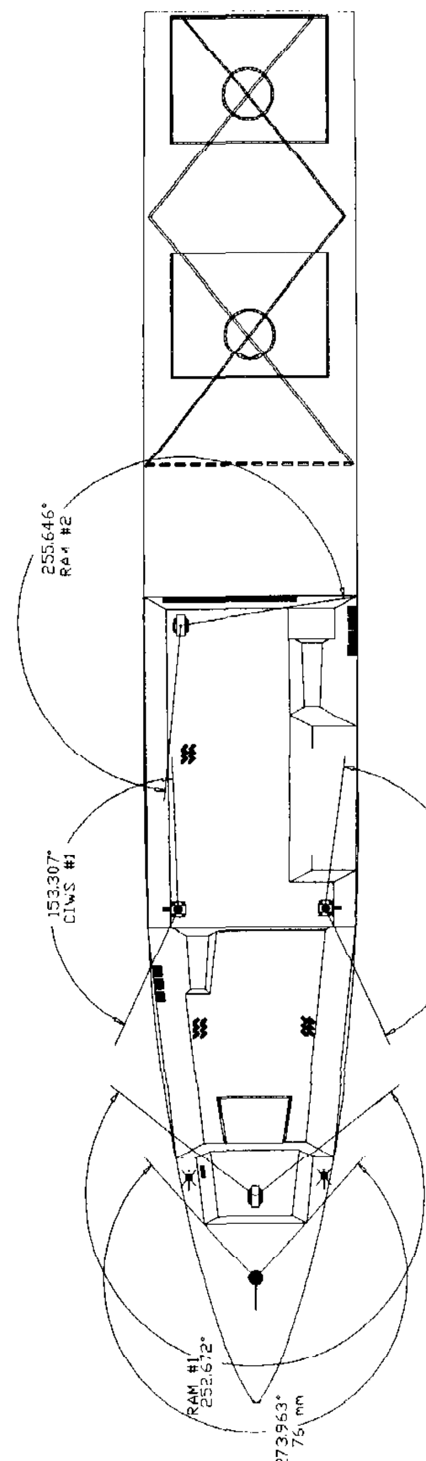


Figure 5-18. Arcs of Coverage (Engagement Elements)



Flag plot is located on the fourth deck forward of MMR1. The detailed layout of flag plot is similar to CIC, however the overall size is smaller and the required equipment to support the space is less.

A weapons/cargo elevator is located in the forward port corner of the hangar and runs from the main deck to the sixth deck. It will be used to carry weapons from the magazines as well as PTX modules from the module storage spaces. The ability to store PTX modules aboard the CMD provides for increased mission flexibility. Modules can be installed on the PTX craft to tailor them to provide a specific warfare area capability.

A module handling area is located on the second deck aft of CCS. An overhead crane is positioned above the well deck in the overhead of the second deck to lift modules and machinery from the berthed surface PTX platforms.

Vital combat systems spaces such as radio central, computer rooms, etc. are located within the superstructure to provide easy access from CIC and the bridge. These spaces are surrounded by non vital areas to increase survivability characteristics.

The bridge is located on the 04 level. A detailed layout of the bridge is provided in subsection F.

4. Well Deck (with PTX craft berthed) Arrangements

A schematic of the well deck with the surface PTX craft berthed is shown in figure 5-20. The second deck of the CMD will be provided with retractable accomodation ladders to facilitate personnel removal from the surface PTX craft while they are berthed. The well deck is equipped with retractable skids for mooring of the surface PTX craft.

5. Miscellaneous Arrangements

Other general arrangements are shown in figures 5-19 through 5-23. The locations of vital spaces and zones are shown in figure 5-24.

A. MESSING AND BERTHING

Crew berthing is located on the second deck outboard of the catwalk on both the port and starboard sides. The separation of these two spaces provides for male and female berthing assignments. The crew galley and mess decks are located on the main deck forward of the AIMD (Aircraft Intermediate Maintenace Detachment).

Officer and CPO (Chief Petty Officer) berthing is located on the 01 and 02 levels. These spaces are also separated to provide to male and female berthing assignments. The wardroom is located on the 01 level with prepared food provided by the crews galley.

Food service conveyors are installed in various locations to provide for easy loading and unloading of stores.

B. PROPULSION FUEL

All DFM tankage for the CMD and surface PTX craft is distributed on the sixth and seventh decks forward of MMR2. The total weight of DFM stored onboard the CMD is 4170 LT and occupies 175,100 cubic feet of volume. This quantity exceeds the required 3100 LT to maintain the endurance specified in the ORD. There is an unknown or unspecified amount of volume below the inner bottom in the bilge area, seventh deck aft of the PMRs and the sixth deck aft of the steering gear rooms.

C. AVIATION FUEL

All aviation fuel (JP-5) is located on the third, fourth and fifth decks aft in the wing walls. The total weight of JP-5 stored onboard the CMD is 1150 LT and occupies 48,500 cubic feet. The amount of JP-5 carried equates to approximately 120 sorties conducted by MH-53 aircraft.

D. BALLAST

Ballast tanks are distributed along the length of the ship on decks three through six. The total volume of ballast allocated to the CMD is 375,200 cubic feet which provides for 10,720 LT of weight. This quantity exceeds the minimum required of 8900 LT to obtain eight feet of water in the well deck at full load. The margin allows for boat operations in light load conditions.

E. OTHER TANKAGE

Lube oil and fuel oil service tanks are located in the respective machinery space in which they serve. Potable water tanks are located near the aft machinery rooms near the reverse osmosis generation units.

Figure 5-19. Sixth and Seventh Deck Arrangements

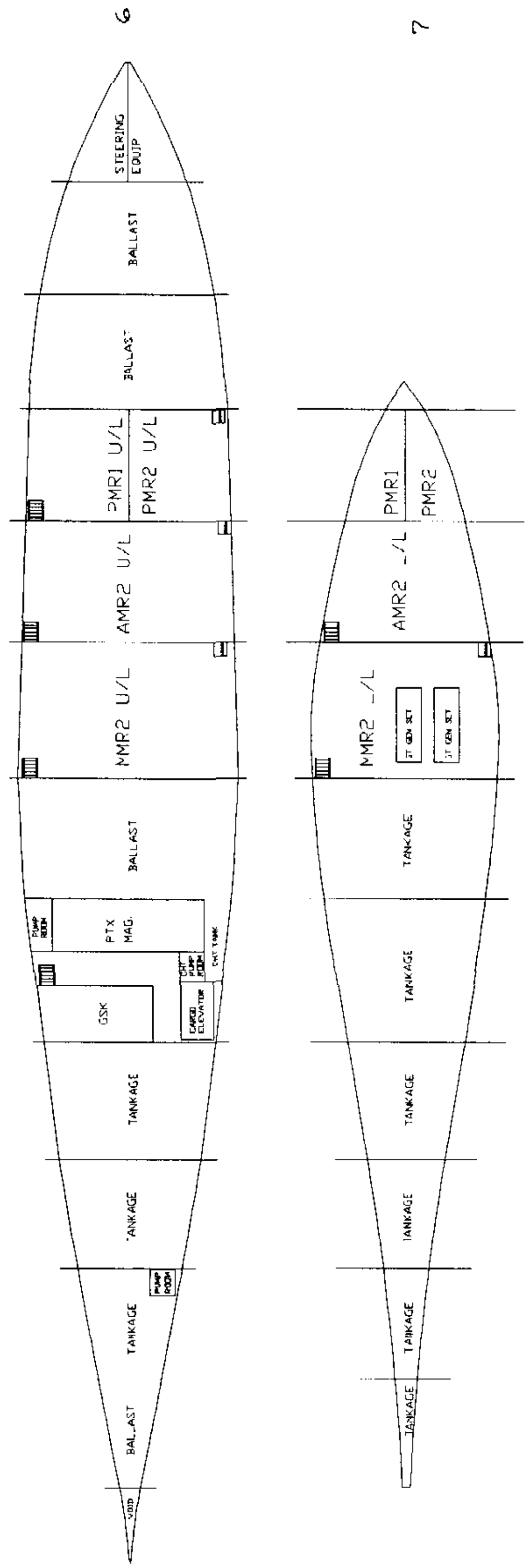


Figure 5-20. Fourth and Fifth Deck Arrangements

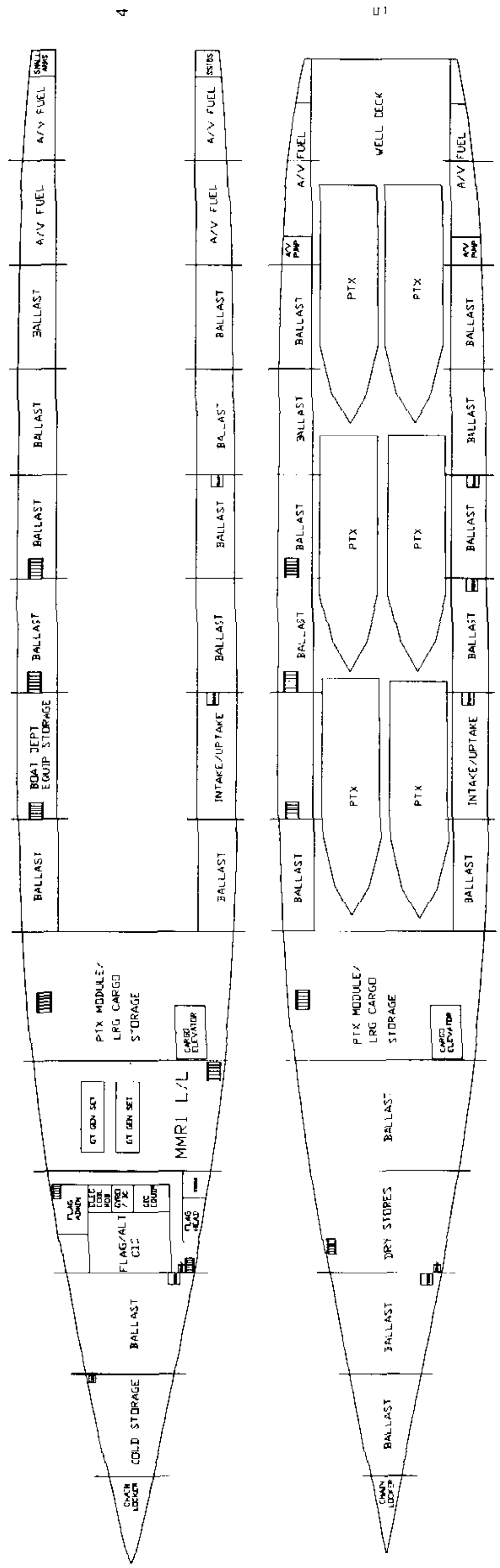


Figure 5-21. Second and Third Deck Arrangements

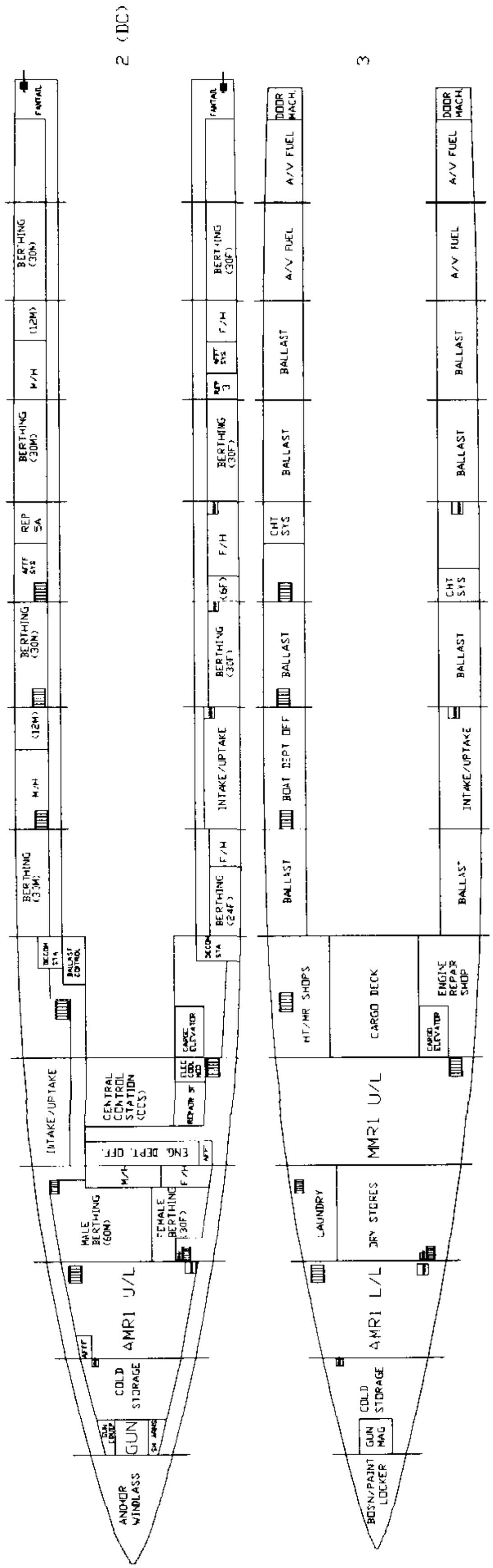


Figure 5-22. Main Deck and 01 Level Arrangements

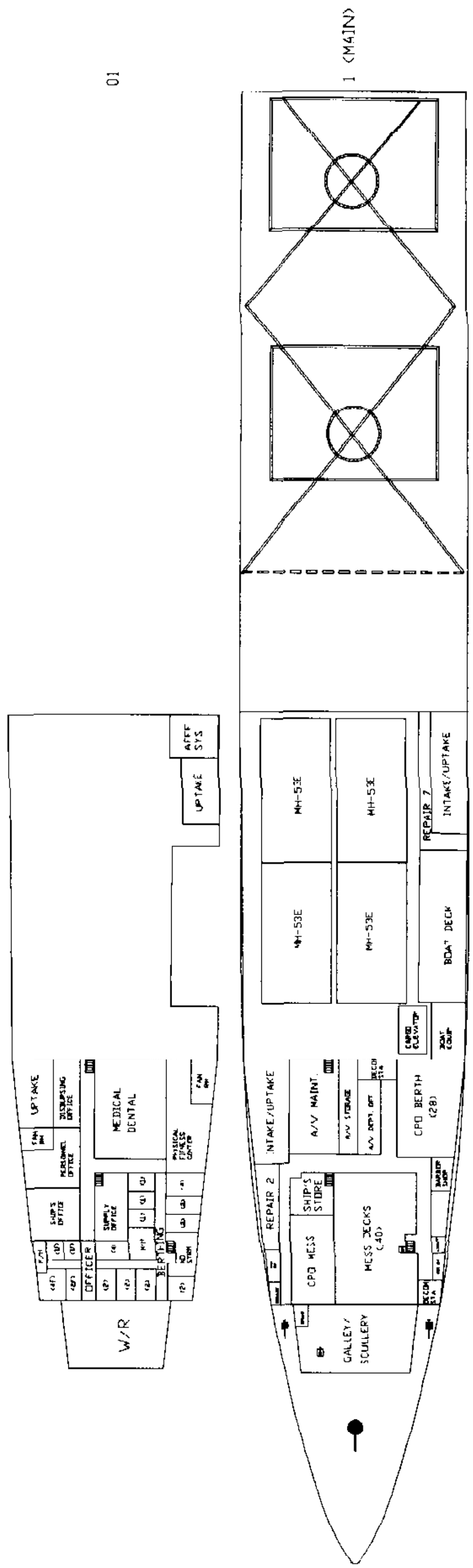


Figure 5-23. 02, 03 and 04 Level Arrangements

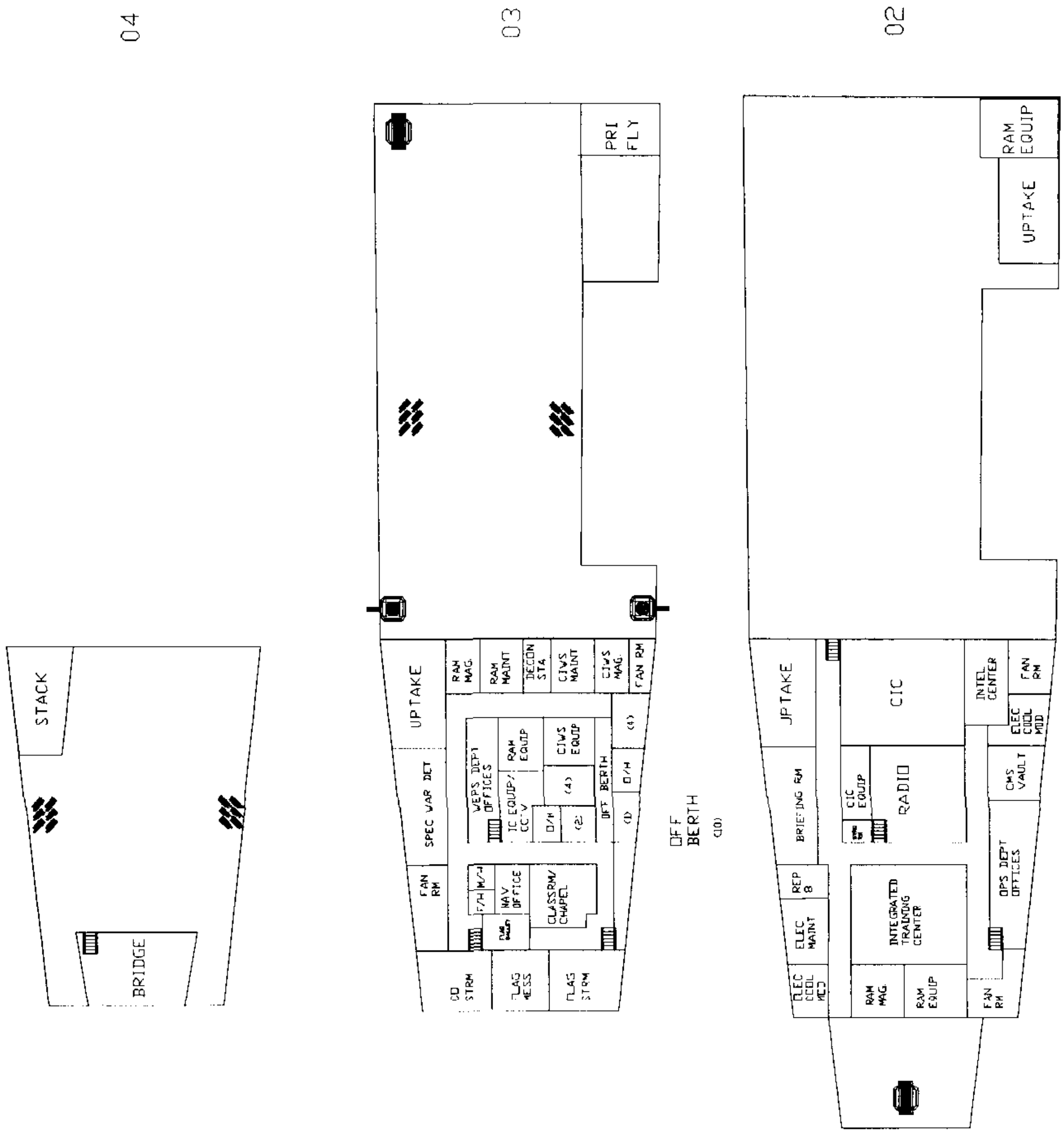
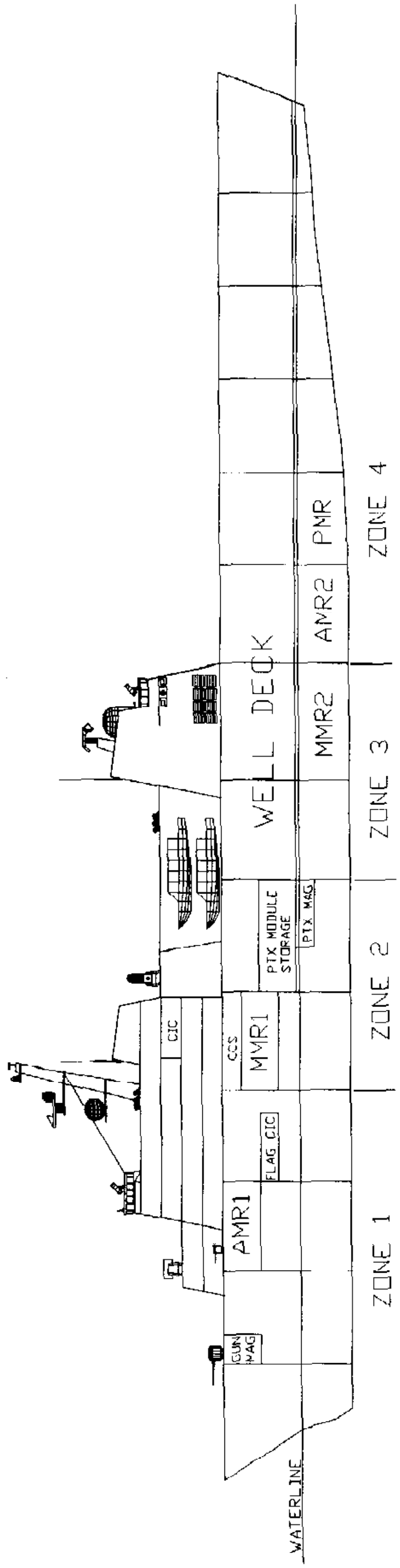


Figure 5-24. Vital Spaces and Zones



E. NAVAL ARCHITECTURE

The complete data file on the CMD is contained in Appendix G and the naval architecture tabulations are provided in Appendix H. Using Appendix H and the Genral HydroStatics (GHS) software, the major ship stability and control characteristics for the CMD are graphically displayed. The naval architecture drawings provided include: lines drawing, curves of form, section area curves, hydrostatic properties, floodable length curve, cross curves of stability, static stability curves, and bending moment curves. All hydrostatic analyses were performed on the hull offsets created by ASSET. Floodable length and bending moment curves used a modified hull form that included allowance for the well deck. There was a slight difference in the displacement for a given draft, as calculated by ASSET and GHS; therefore, the nominal full load draft was set to 23.2 ft and displacement of 19789 LT for all applicable analyses.

1. Lines Drawings

The CMD lines drawings and hull characteristics are shown in figure 5-25.

2. Curves of Form

The CMD curves of form are shown in figure 5-26.

3. Section Area Curves

The CMD section area curves for level trim at the DWL and for a variety of drafts are shown in figures 5-27 and 5-28.

4. Hydrostatic Properties at Level Trim

The CMD hydrostatic properties are shown in figure 5-29.

5. Floodable Length Curve

The CMD floodable length curve is shown in figure 5-30. It is used to determine the allowable compartments which will ensure that the margin line is not submerged should the compartments spanning the defined factor of subdivision become flooded. Regulations require U.S. Navy ships to sustain flooding damage up to 15 % of LWL, or

95 ft. for the CMD. Upon analysis of this requirement to the present locations of the bulkheads at general permeability levels of 0.7, 0.8, 0.9, it is observed that the floodable length is violated in the forward and aft portions of the ship. Therefore, further design iterations would require a detailed assesment of bulkhead locations and space permeabilities.

6. Cross Curves of Stability

The CMD Cross curves of stability are shown in figure 5-31. It provides a display of the ship's righting arm for various angles of heel over the range of likely displacements.

7. Static Stability Curves

The CMD static stability curve is shown in figure 5-32, the intact turning stability curve in figure 5-33 and the intact stability with wind effects is shown in figure 5-34. Review of figure 5-32 shows that the CMD reaches a maximum righting arm of 6.197 ft. at a heel of 50.67° and an intact dynamic stability of 293.4 ft-deg. The CMD stability was evaluated for a high speed turn with a radius of 1000 yds. at 20 knots. The metacentric height is 9.19 ft. Figure 5-33 shows a turning heel angle of 6.2° which is below the maximum allowed angle of 10° for a new design hull. Additionally, the righting arm at the tuning heel is less than 60% of the maximum turming arm and the residual righting energy is not less than 40 % of the intact dynamic stability. Per DDS 079-1, to ensure all weather operation, the stability of the CMD was determined using a 100 knot wind. The resulting heel is 3.9° with the associated righting arm less than 60 % of the maximum righting arm. The residual dynamic stability is greater than 140 % of the ship's rolling energy during a 25° roll to windward. For both turning and wind effects, the CMD mets all requirements for static and dynamic stability.

8. Bending Moment Curves

The CMD bending moment curves with load distribution for level flotation, hogging and sagging conditions with a trochoidal wave are shown in figures 5-35 through 5-37 respectively.

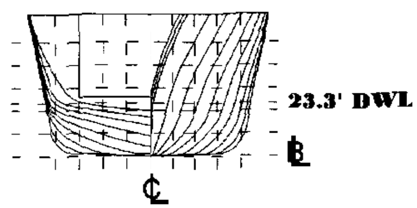
Figure 5-25. Lines Drawings

CMD PRINCIPLE CHARACTERISTICS

DWL = 23.3'   Lpp = 630'   B = 92'   DEPTH @ STA. 10 = 62'

Δ = 19790 LT Cb = .523   Cw = .783   Cp = .576   Cvp = .668

L/B = 6.97   L/D = 27.12   B/D = 3.89



31.5' STATION SPACING

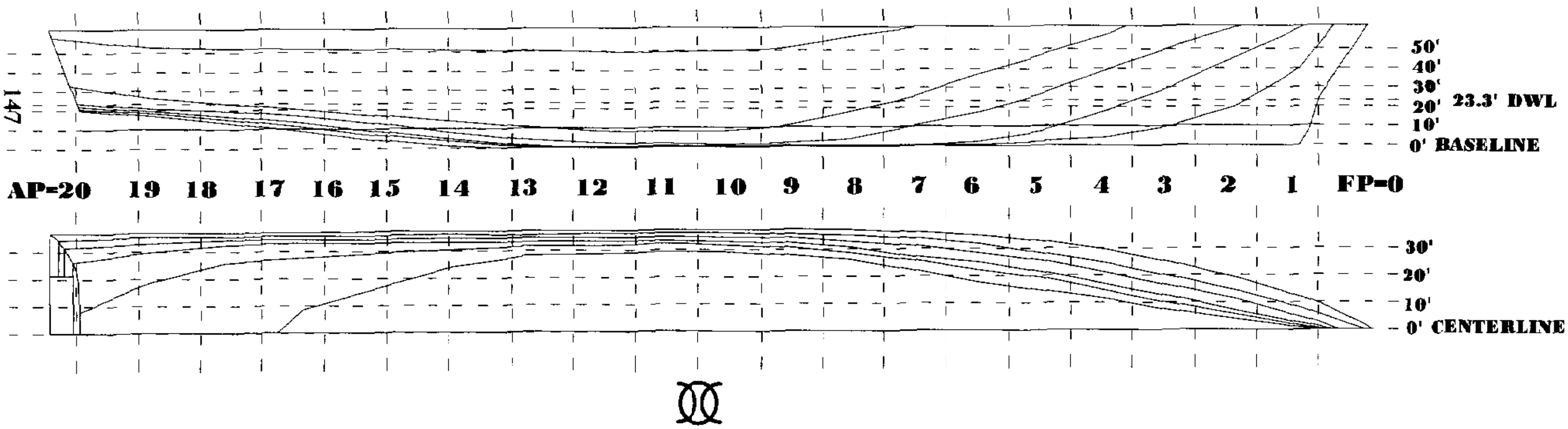


Figure 5-26. Curves of Form

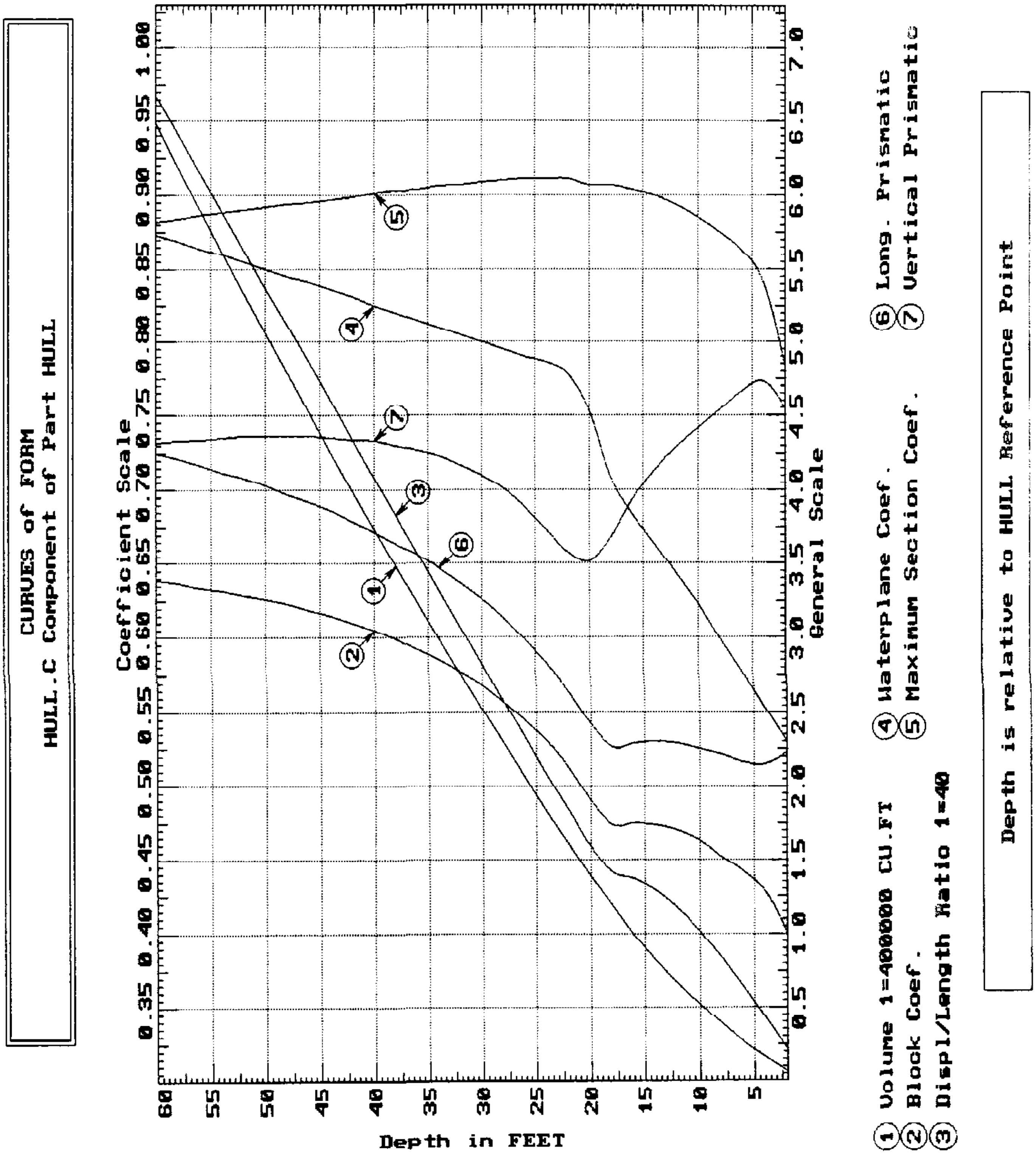


Figure 5-27. Section Area Curves

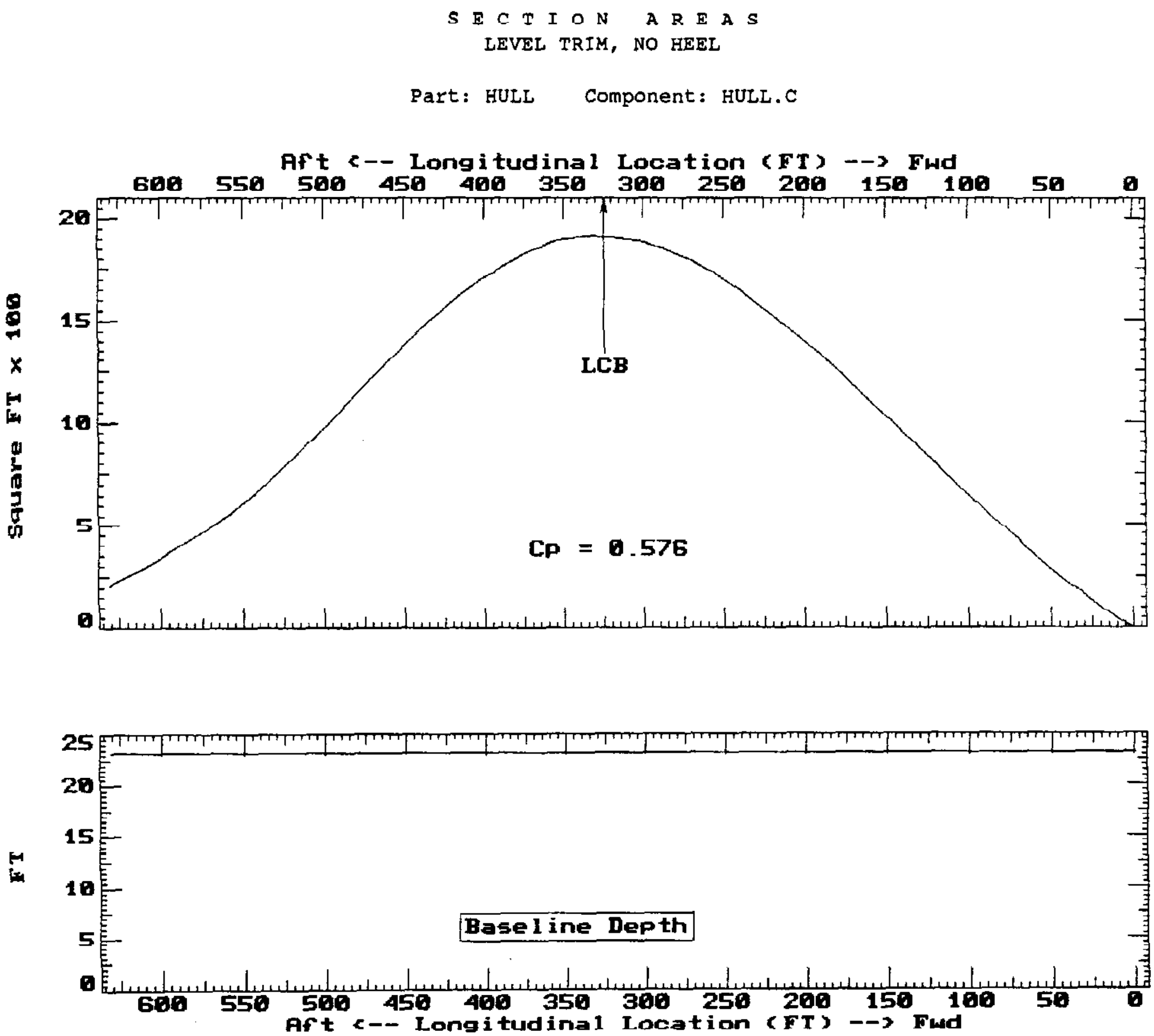


Figure 5-28. Section Area Curves

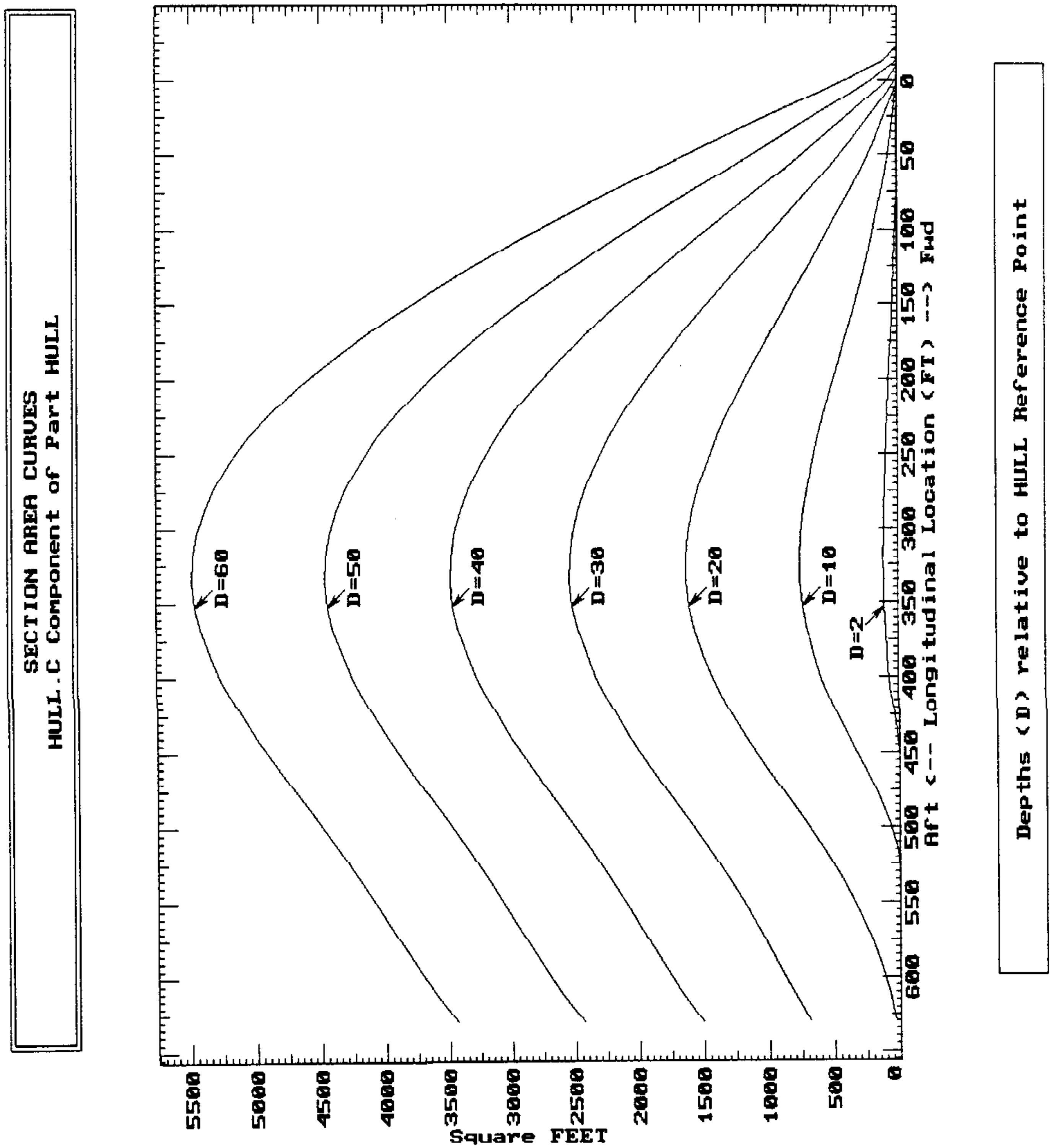


Figure 5-29. Hydrostatic Properties at Level Trim

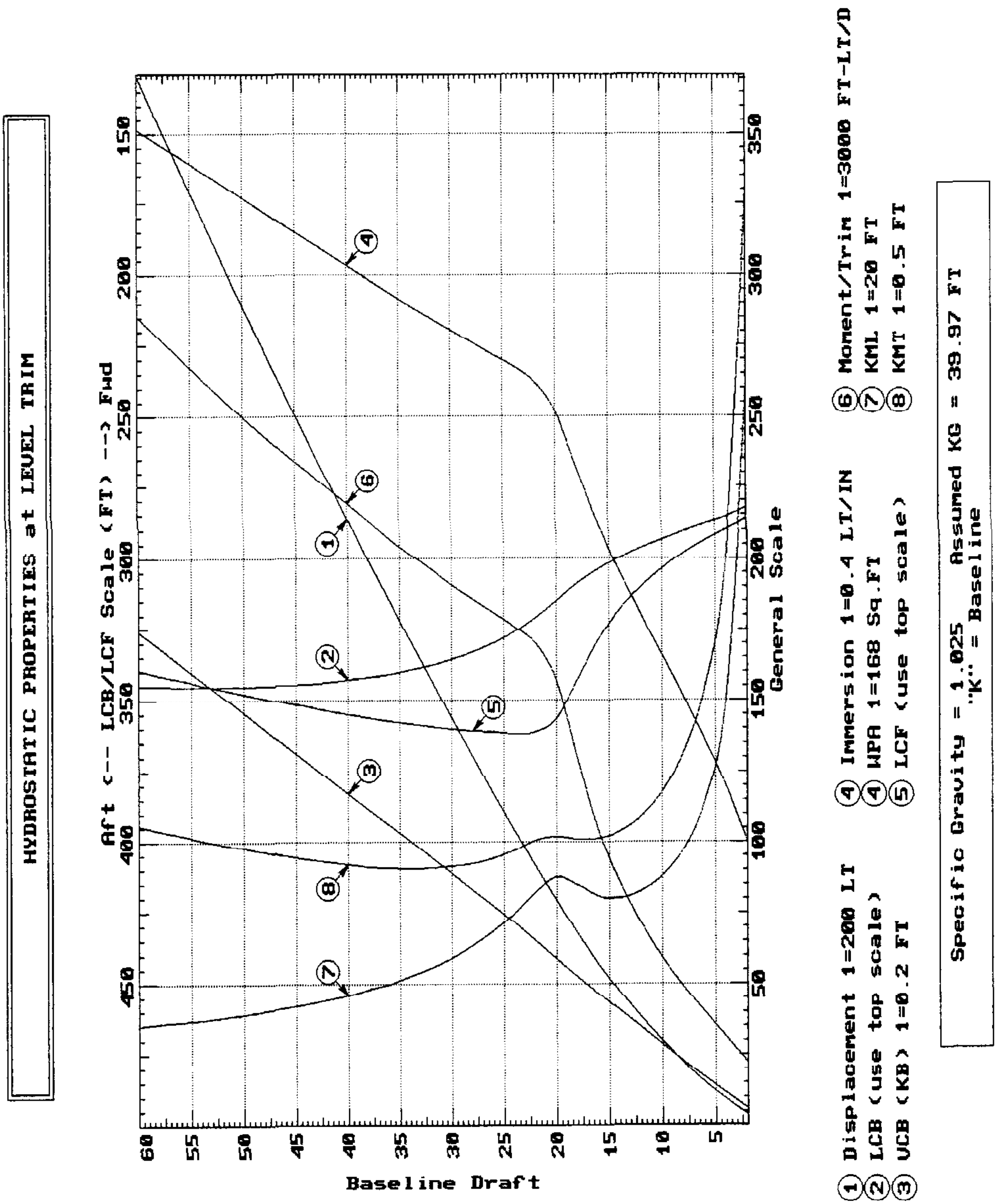


Figure 5-30. Floodable Length Curve

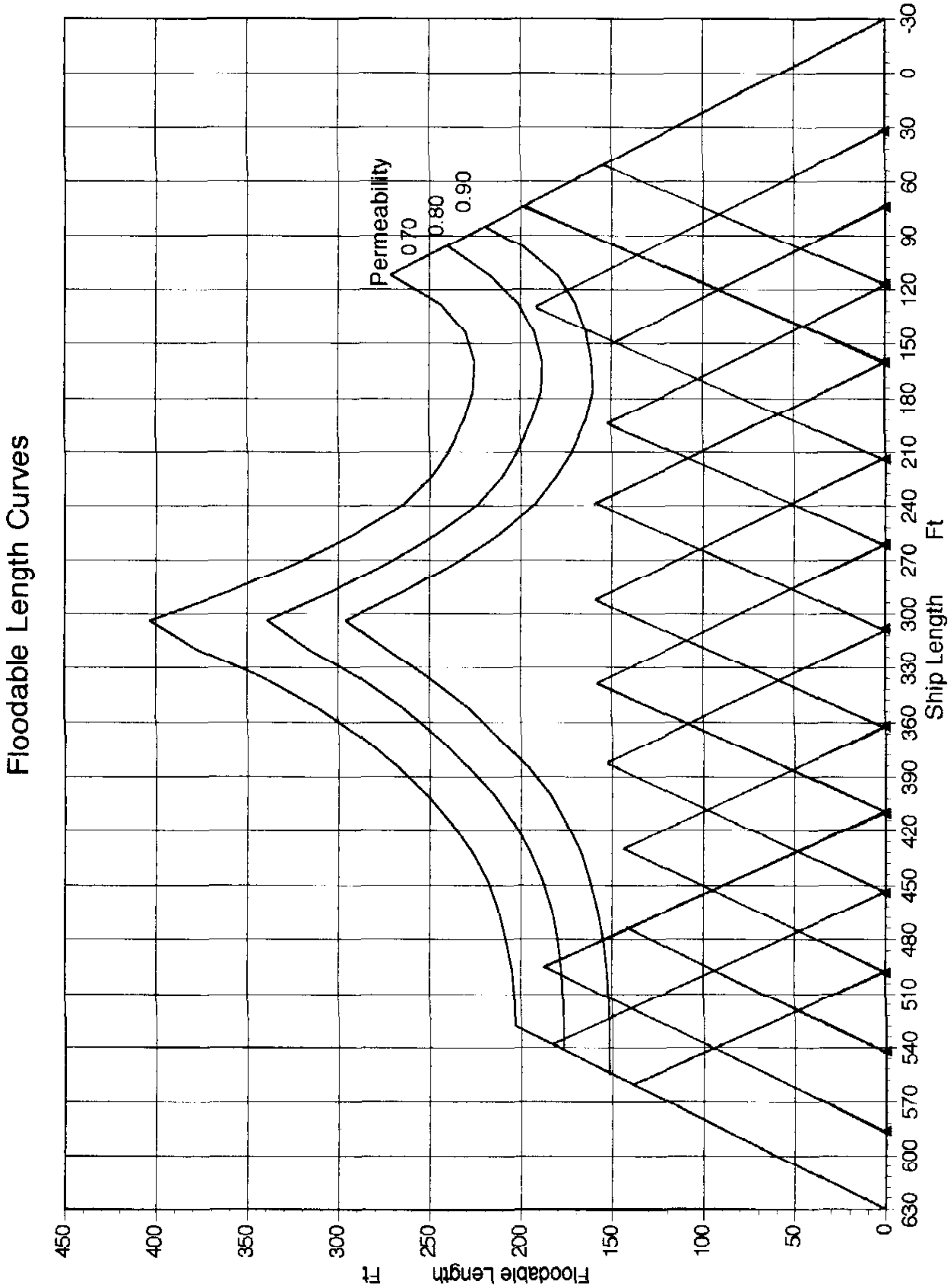


Figure 5-31. Cross Curves of Stability

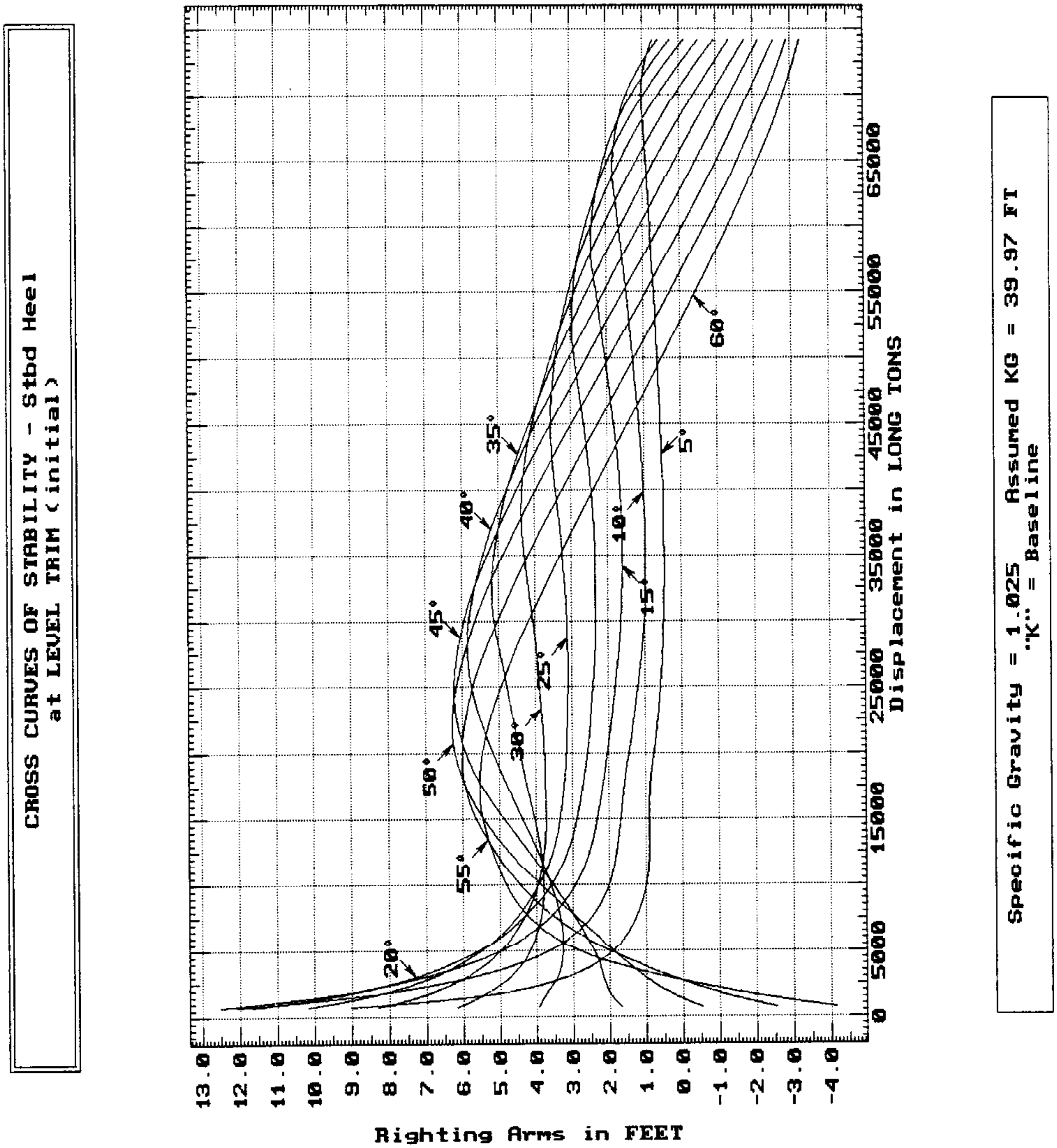


Figure 5-32. Static Stability Curve

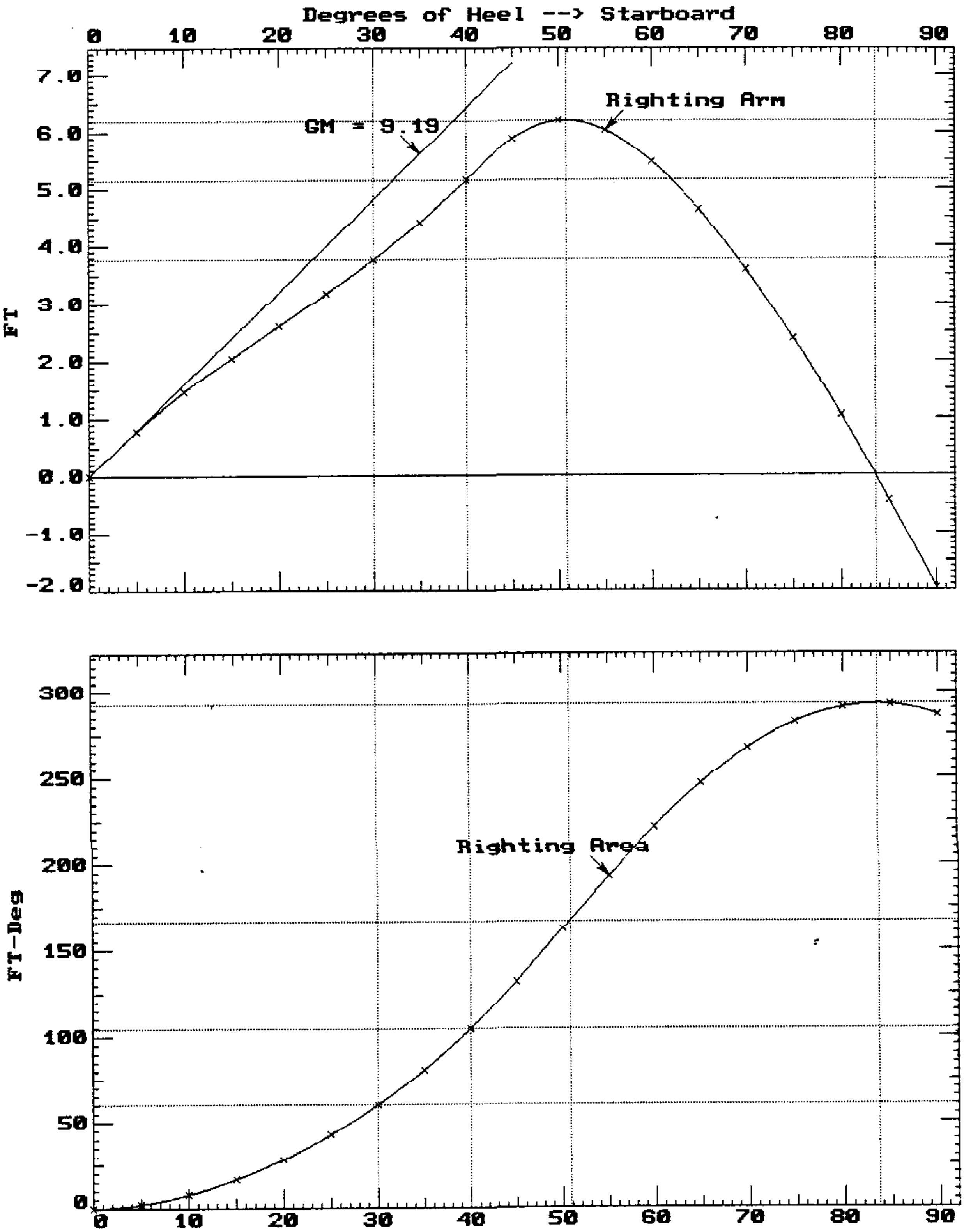


Figure 5-33. Intact Turning Stability Curve (No Wind)

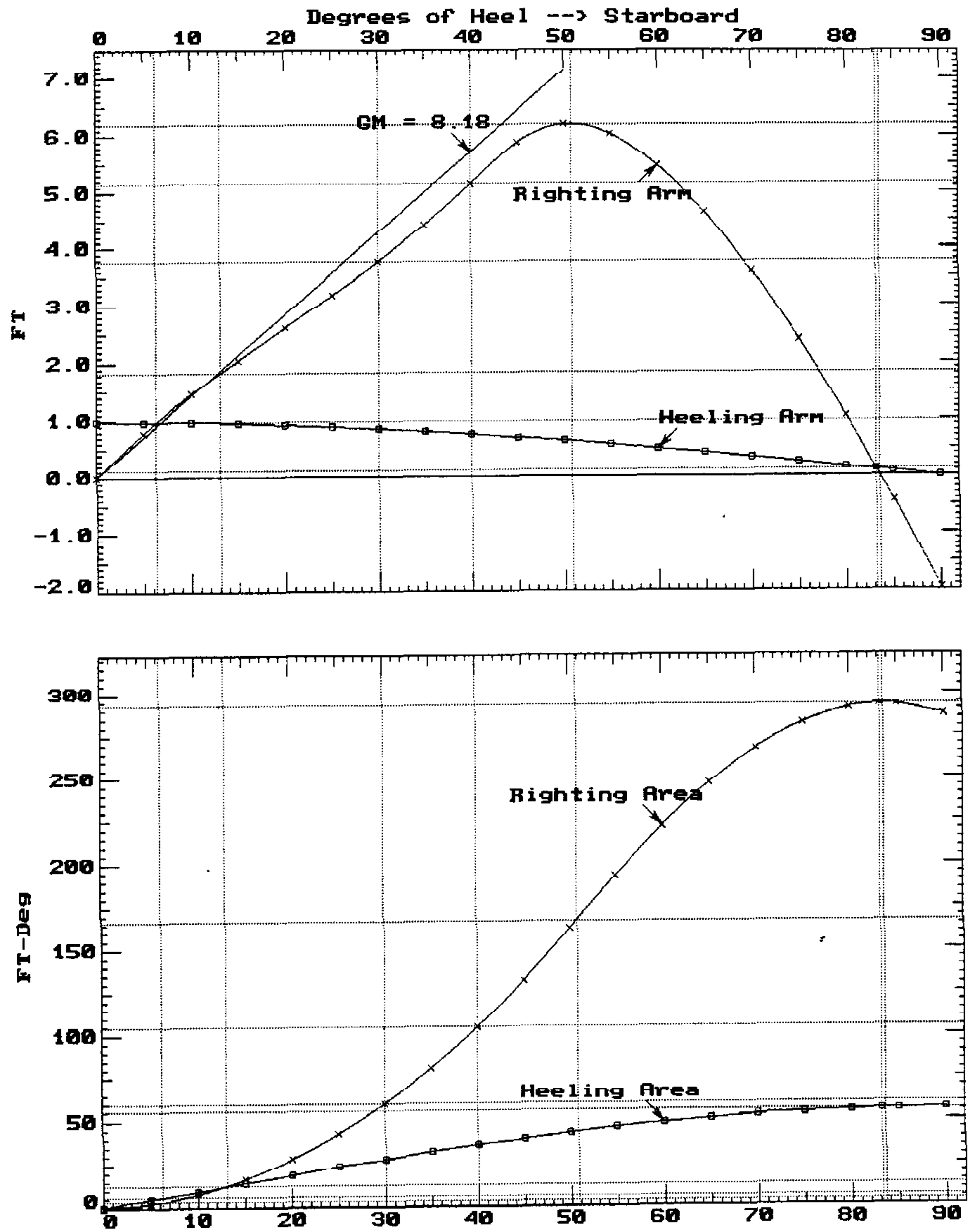


Figure 5-34. Intact Turning Stability Curve (Wind)

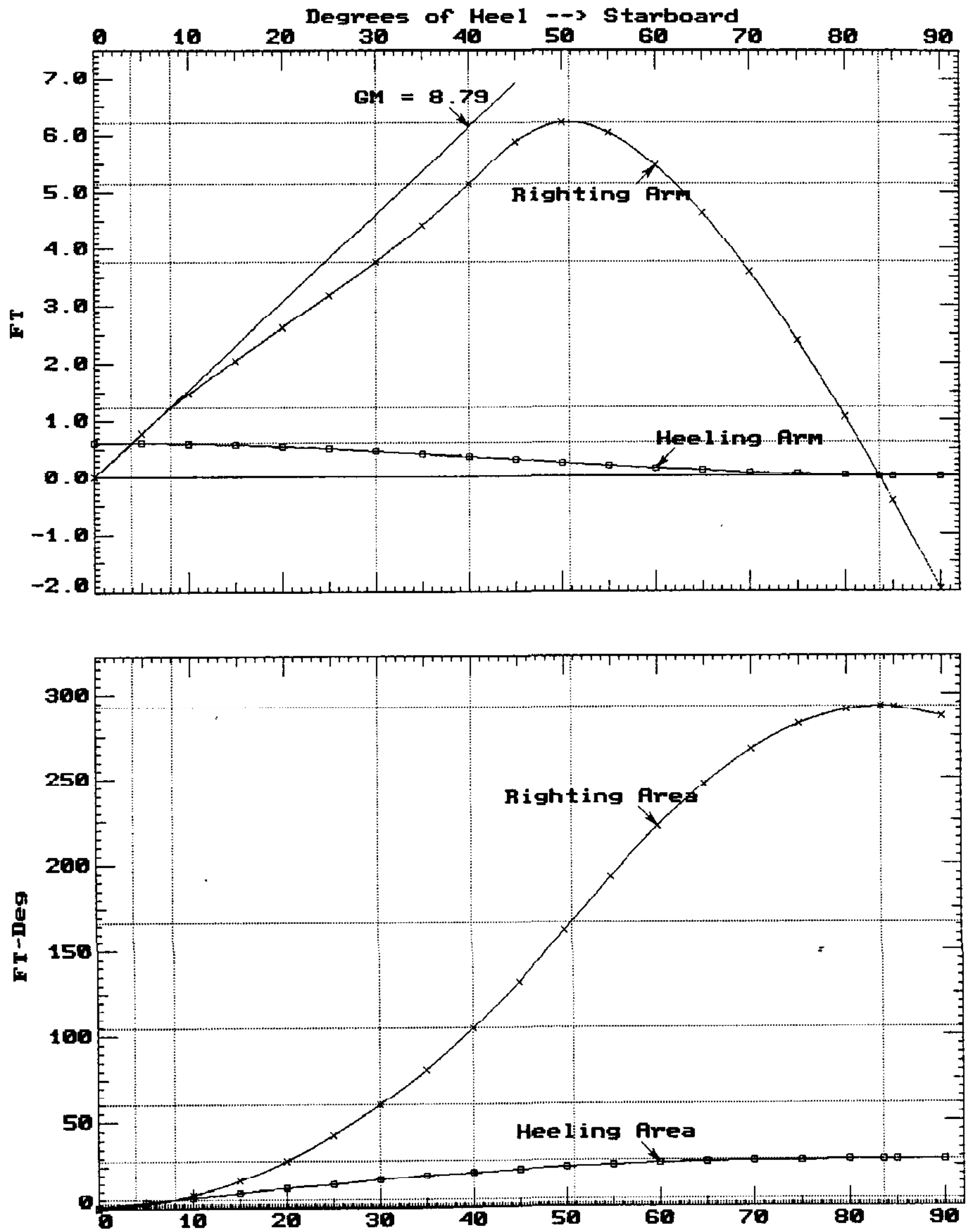


Figure 5-35. Bending Moment Curve (Level Trim)

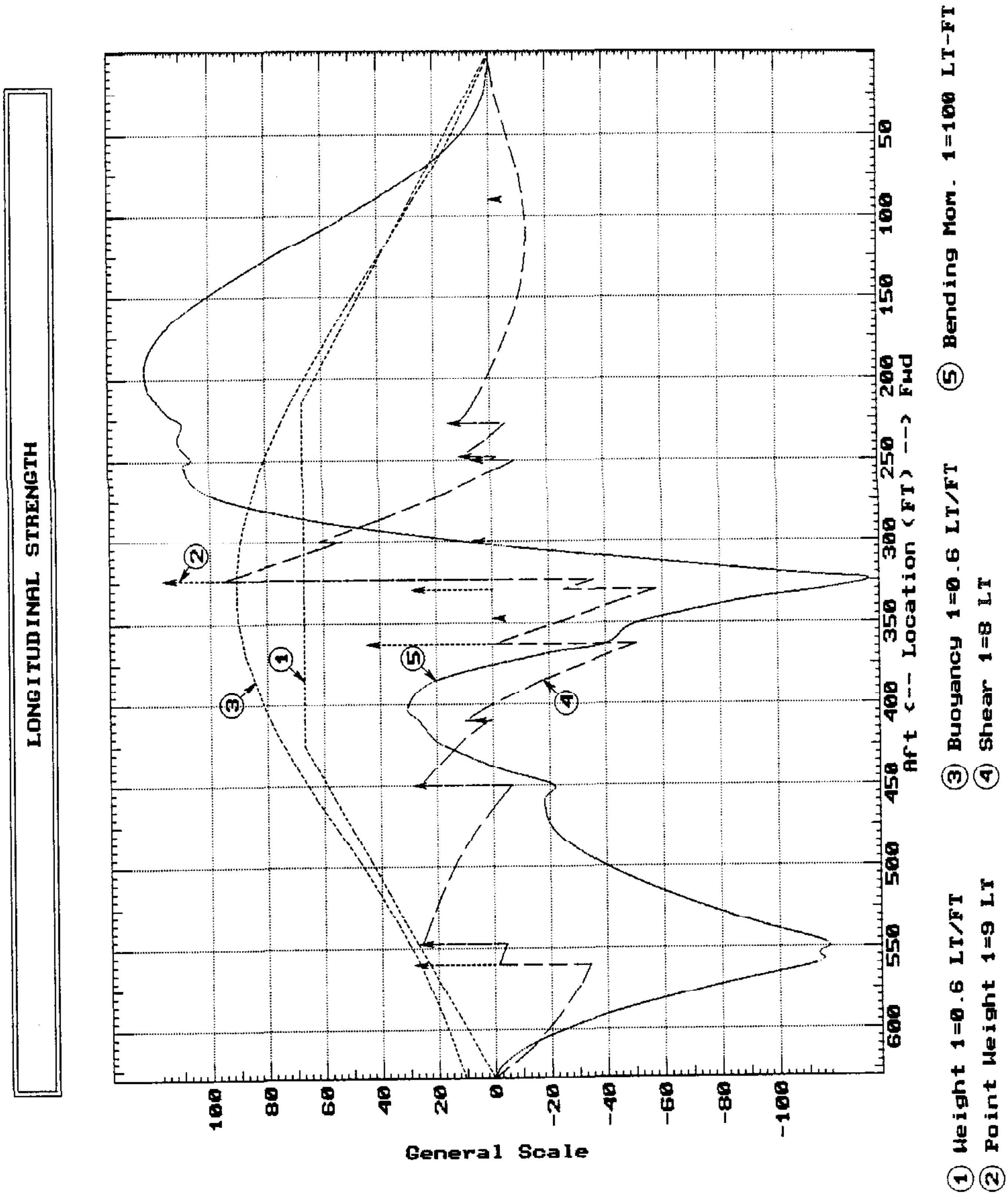


Figure 5-36. Bending Moment Curve (Hogging)

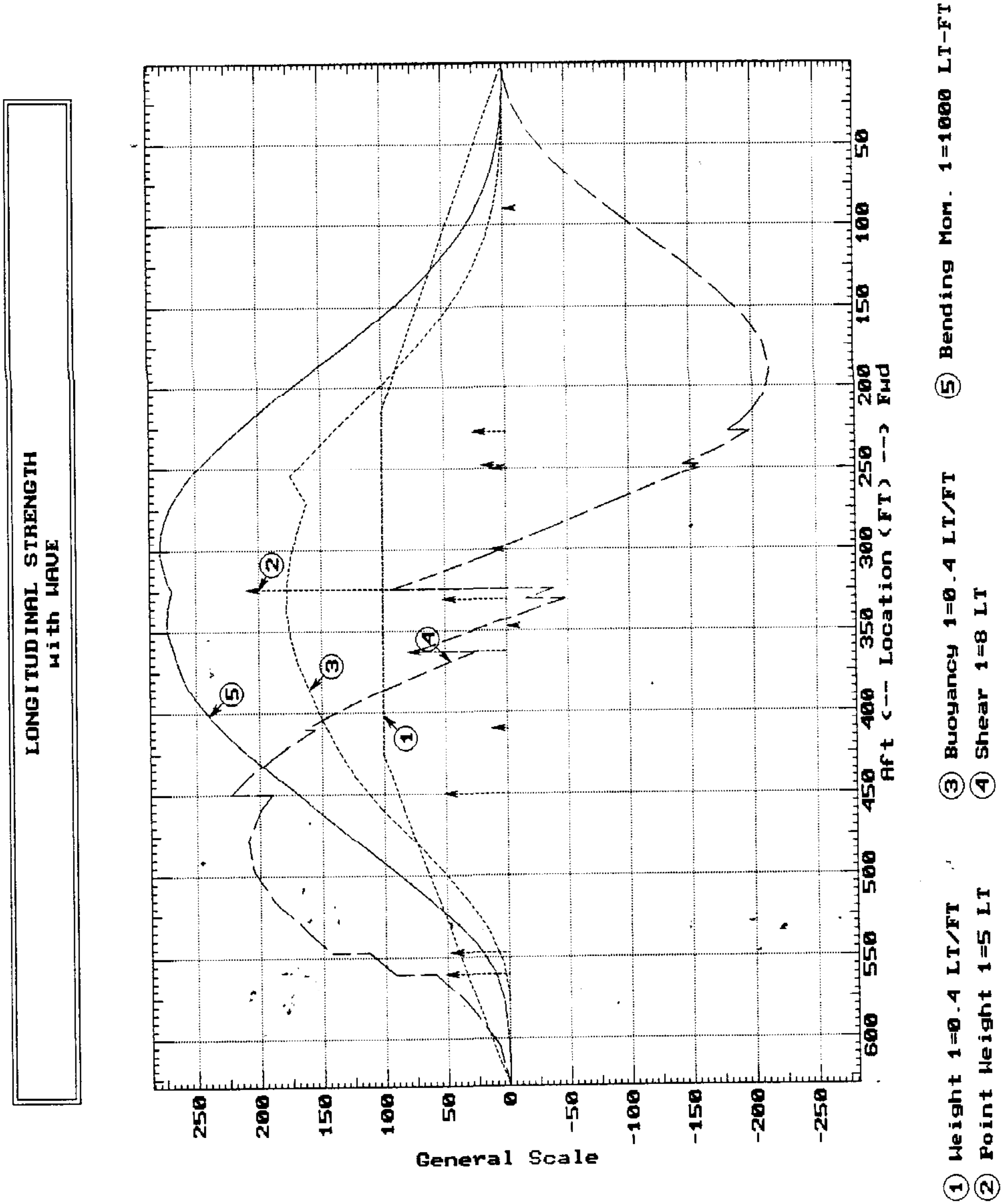
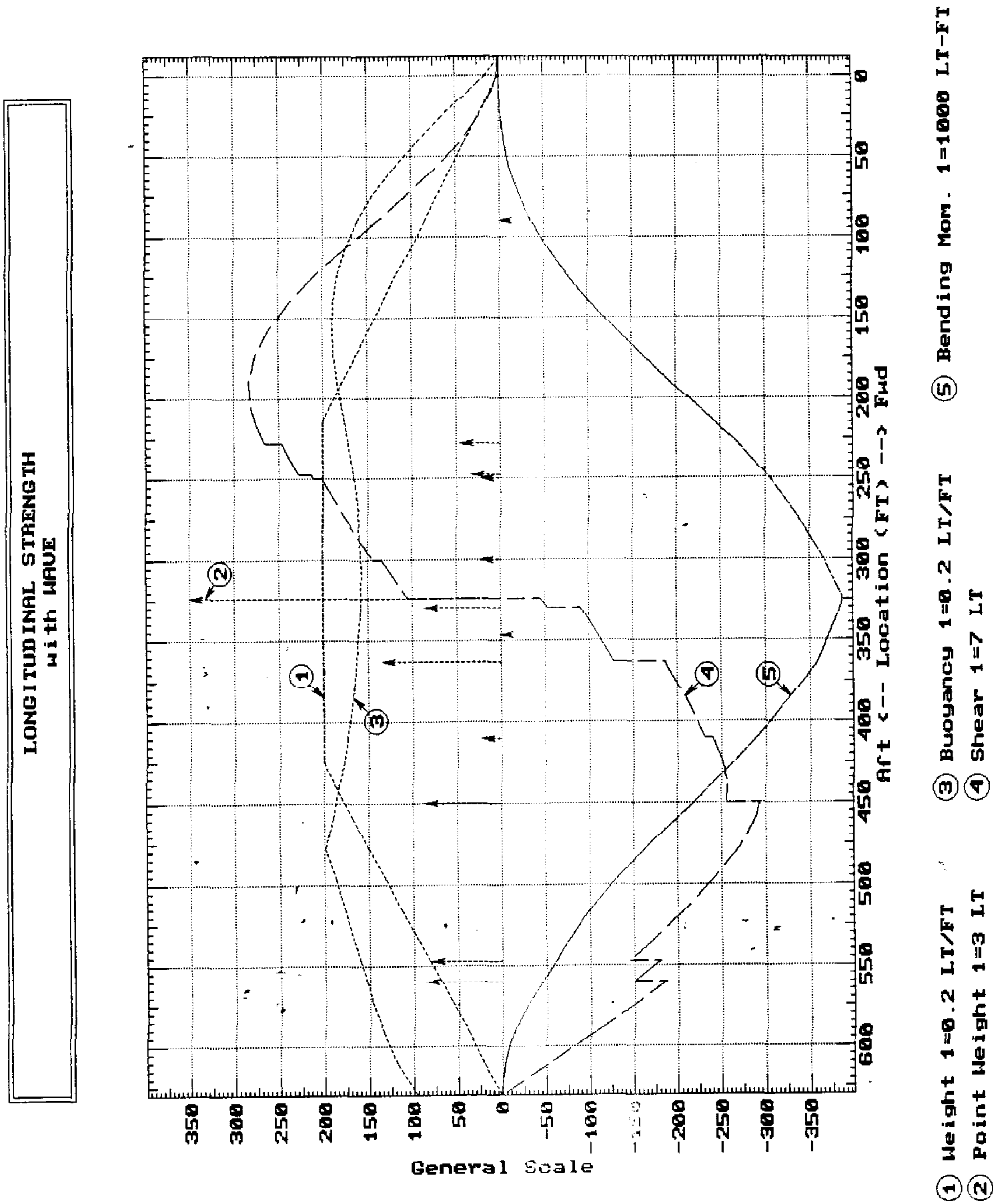


Figure 5-37. Bending Moment Curve (Sagging)



F. DETAILED DRAWINGS

Detailed drawings are generated for three of the mission control spaces: the bridge, Combat Information Center, and the Centrol Control Station, and three dimensional isometric views of the entire ship are provided.

1. Mission Control Spaces

A. BRIDGE

The detailed drawing for the bridge arrangements is shown in figure 5-38. The bridge contains the necessary ship control equipment to safely and comfortably navigate the CMD. The bridge has two radar repeaters one for the OOD/JOOD and one for the navigation team. The ship control console contains the equipment needed to operate both propulsion and steering controls. One gyro repeater is positioned on the bridge centerline and one on each bridge wing.

B. COMBAT INFORMATION CENTER (CIC)

CIC, figure 5-39, contains eight NTDS (Navy Tactical Data System) consoles, a large display panel consisting of three computer display screens which are controlled from two separate operating consoles, a radar operating console, an EW (Electronic Warfare) console and a navigation/dead reckoning plotting table. The space also contains the necessary control panels, radio handsets and computer consoles to support the needs of the space.

C. CENTRAL CONTROL STATION (CCS)

The CCS, figure 5-40, contains the necessary gage boards, damage control panels, communication gear and operating consoles to provide control of all propulsion machinery on the CMD. The CCS will act as damage control central in condition I.

2. Three Dimensional Views

Three dimensional views of the CMD are shown in figures 5-41 through 5-46.

Figure 5-38. Bridge Detail Drawing

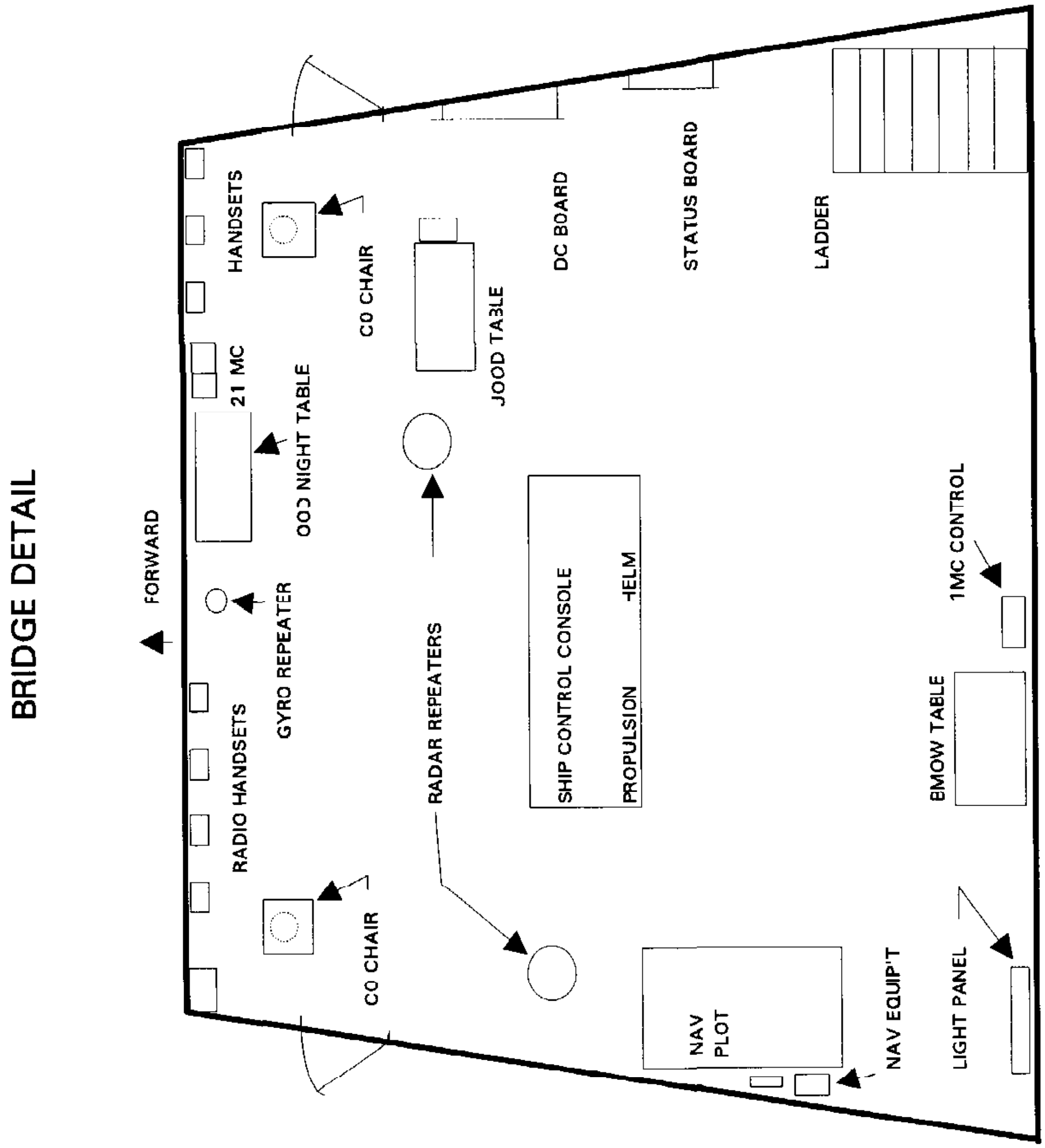


Figure 5-39. CIC Detail Drawing

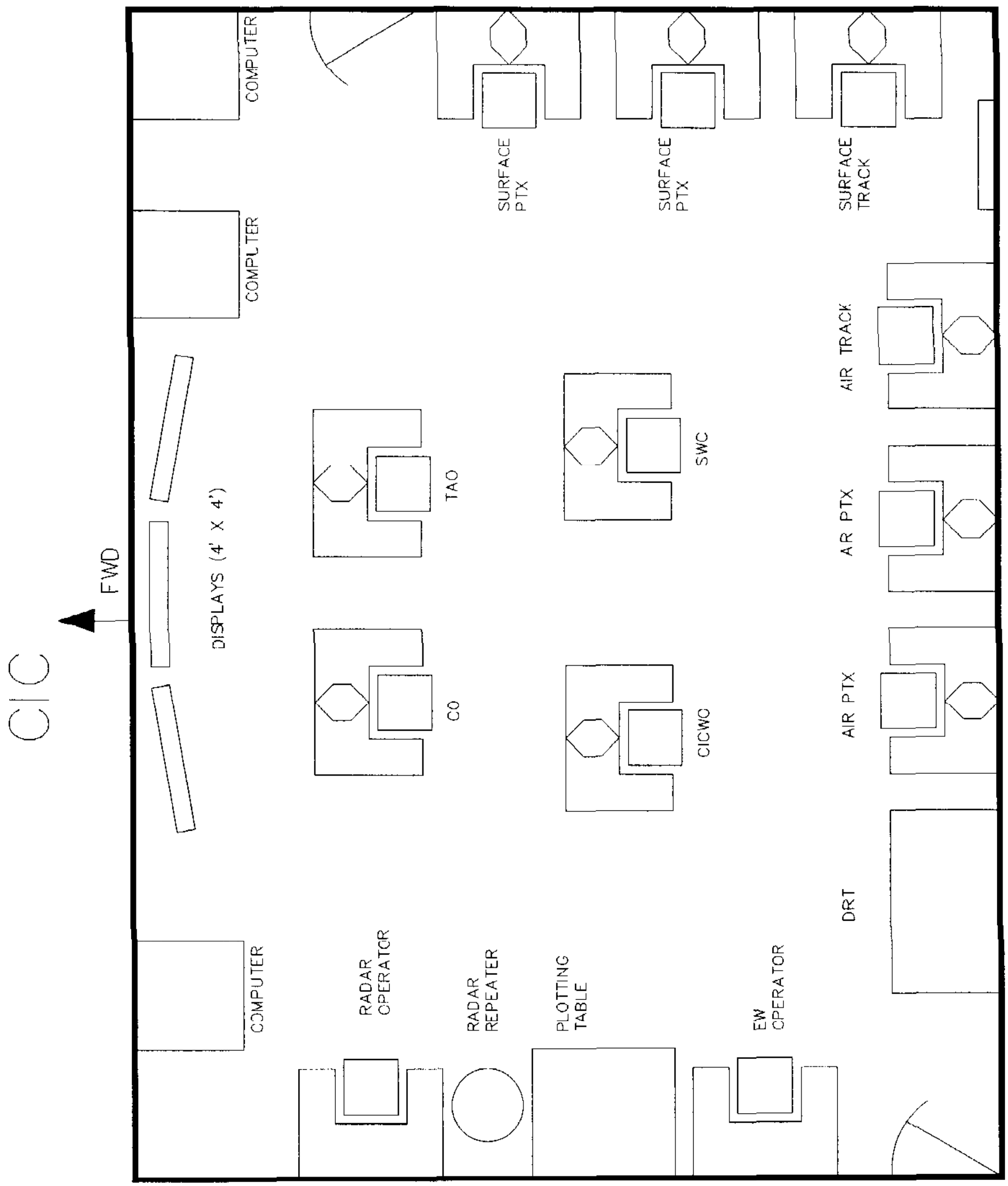


Figure 5-40. CCS Detail Drawing

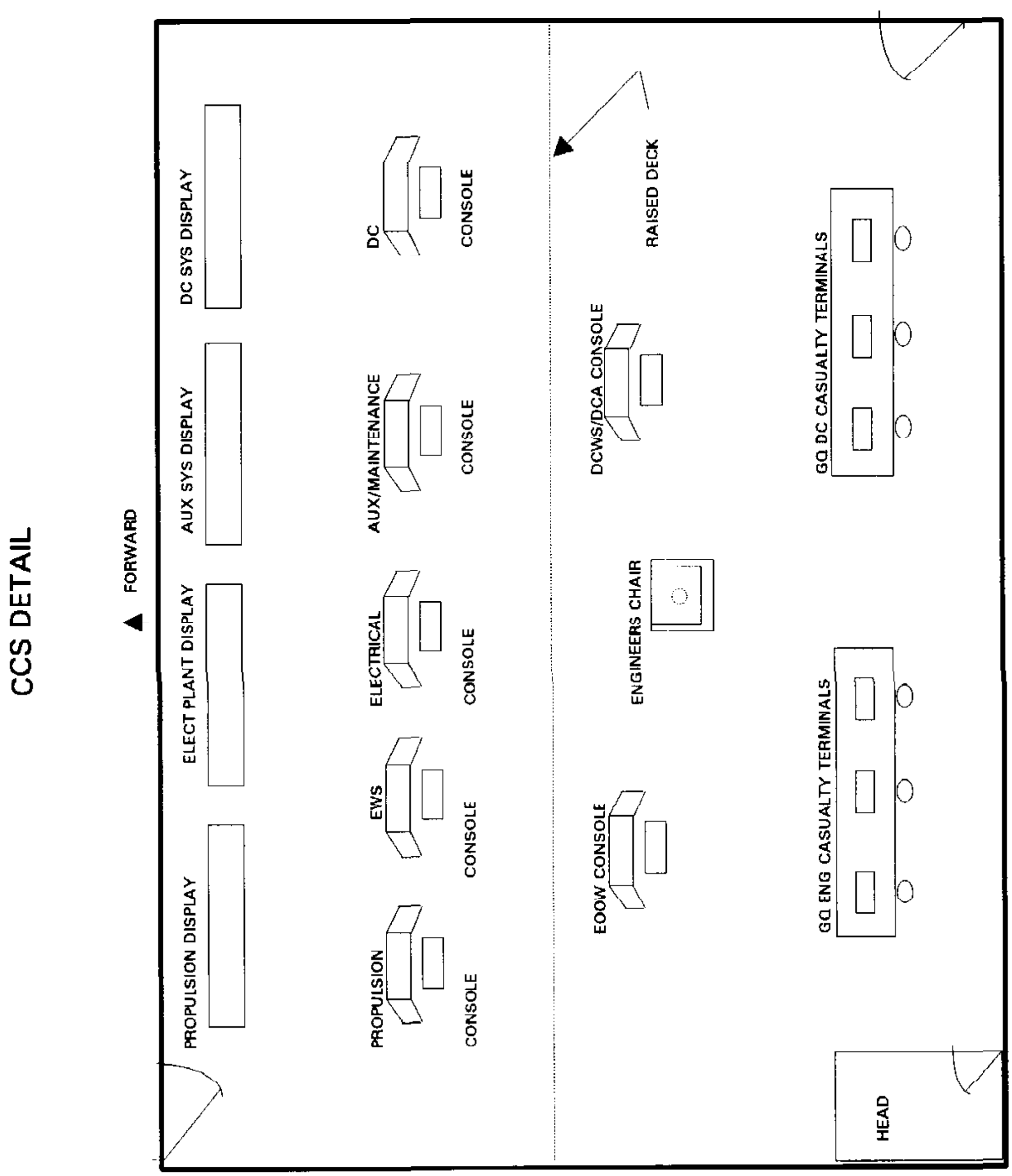


Figure 5-41. Port Bow View

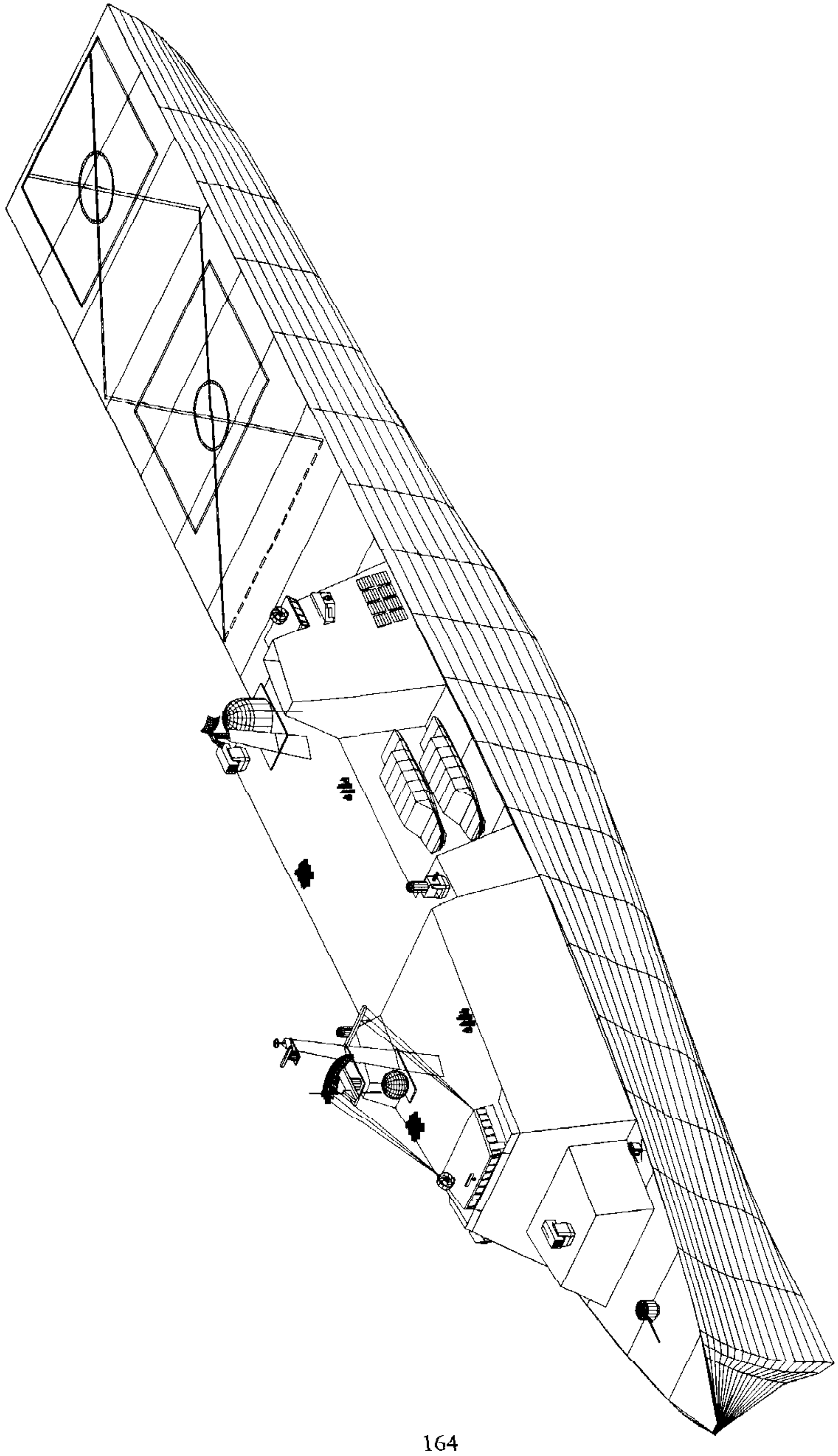


Figure 5-42. Port Quarter View

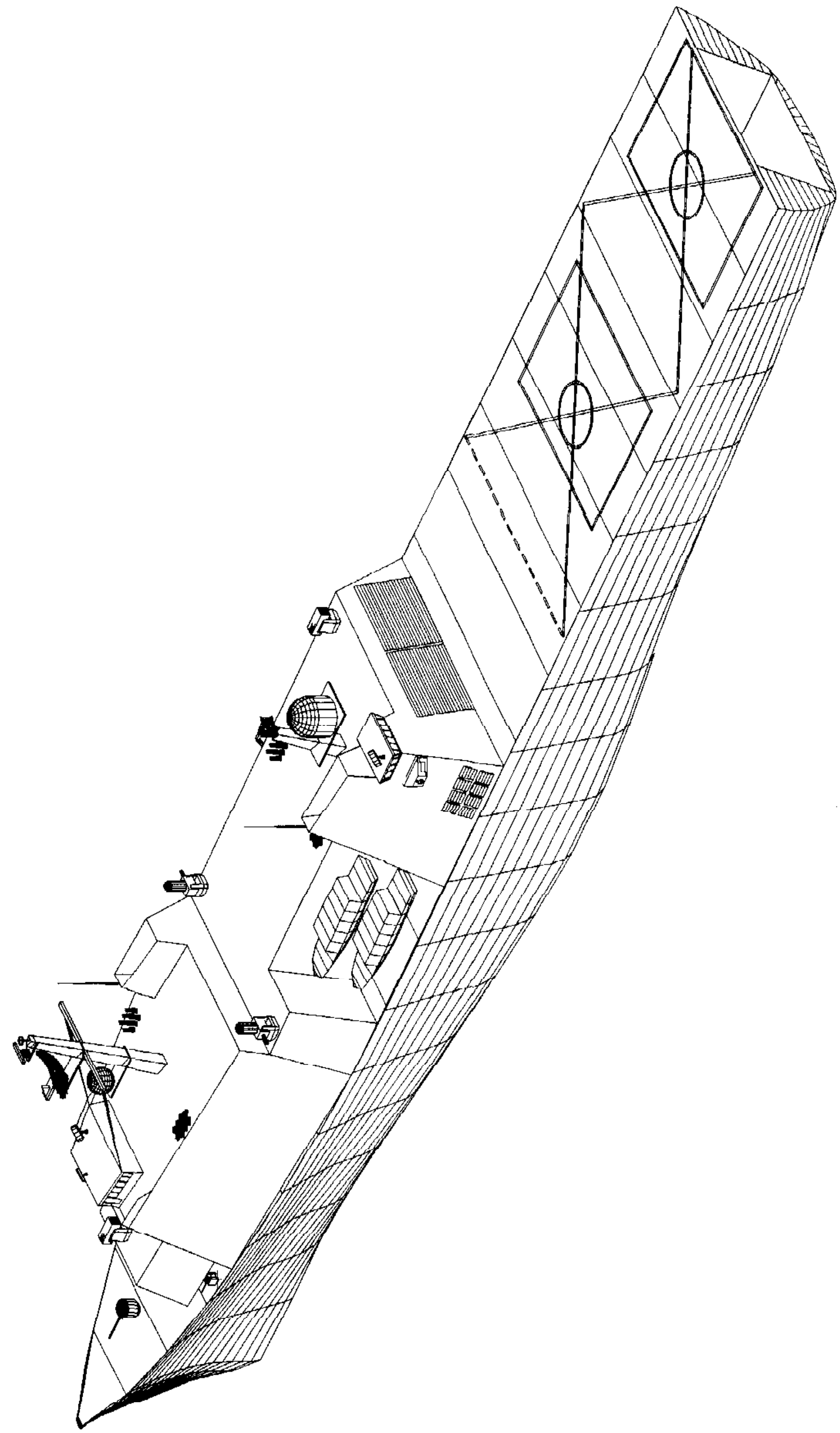


Figure 5-43. Starboard Bow View

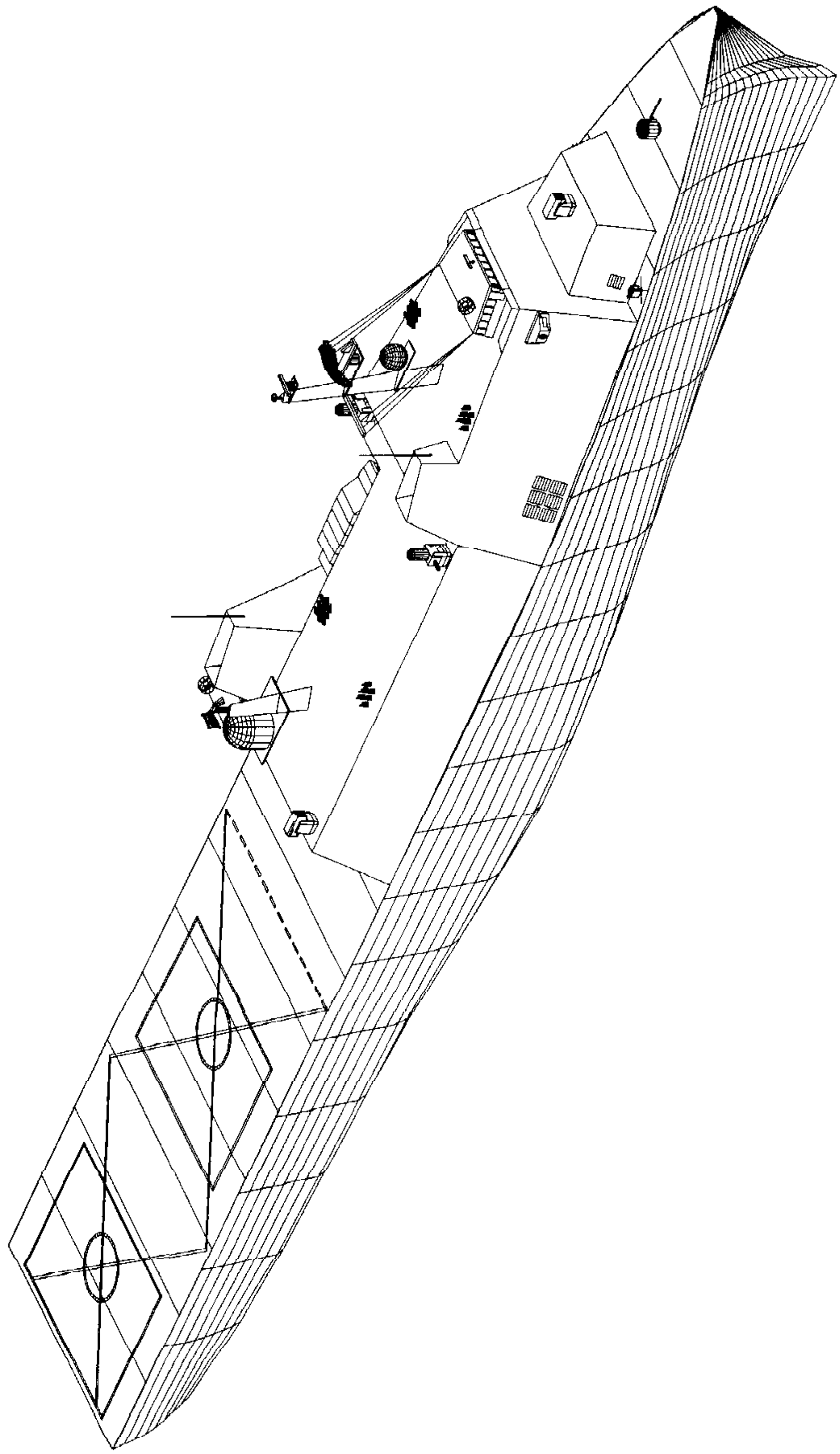


Figure 5-44. Starboard Quarter View

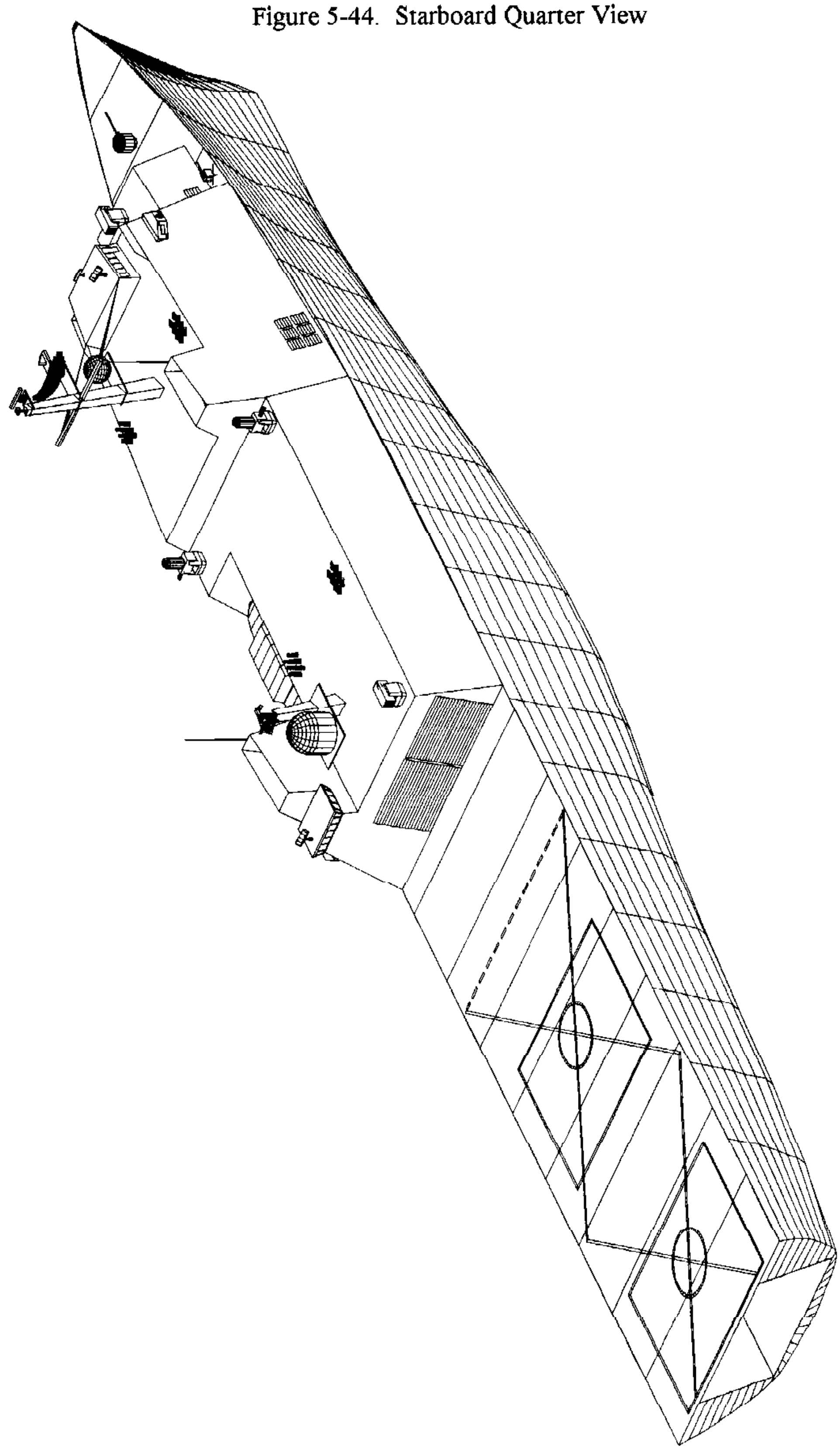


Figure 5-45. Bow View

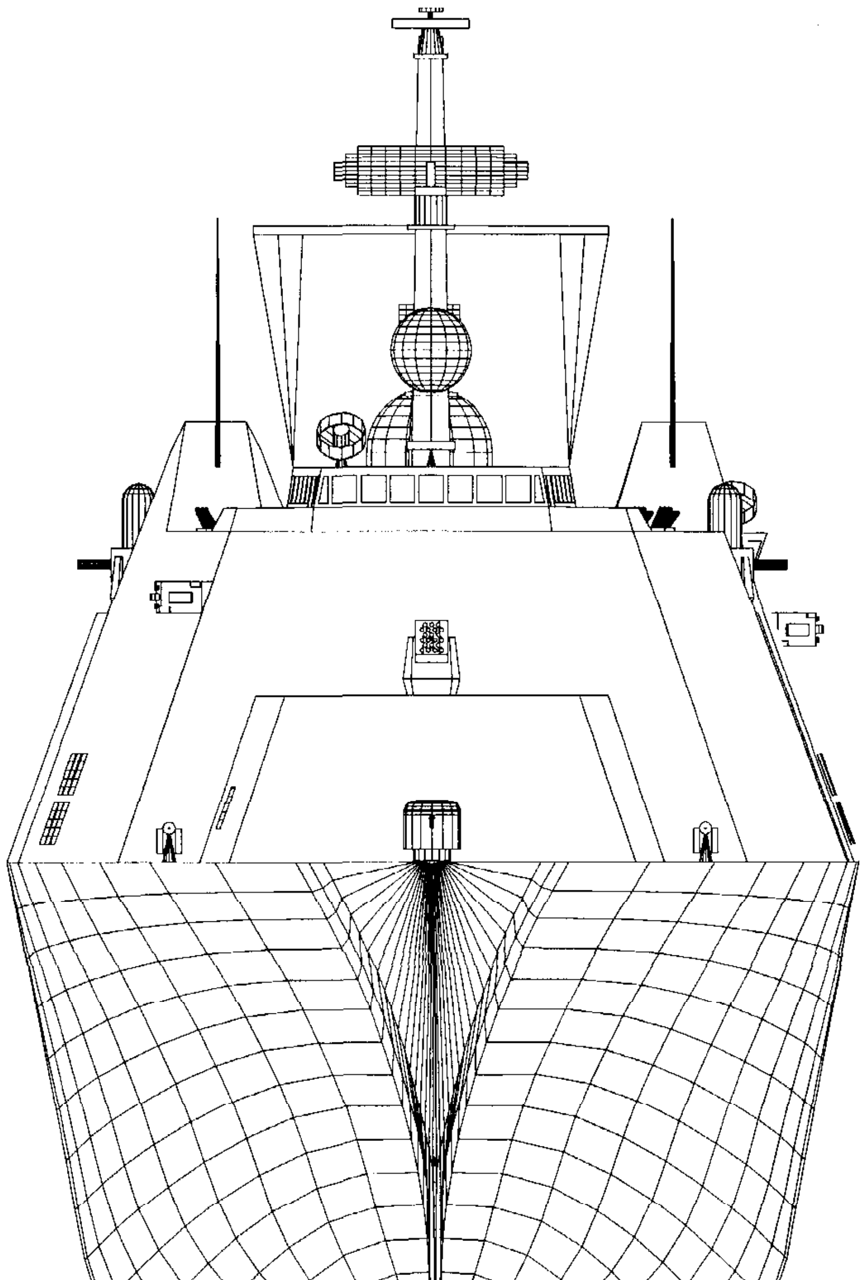
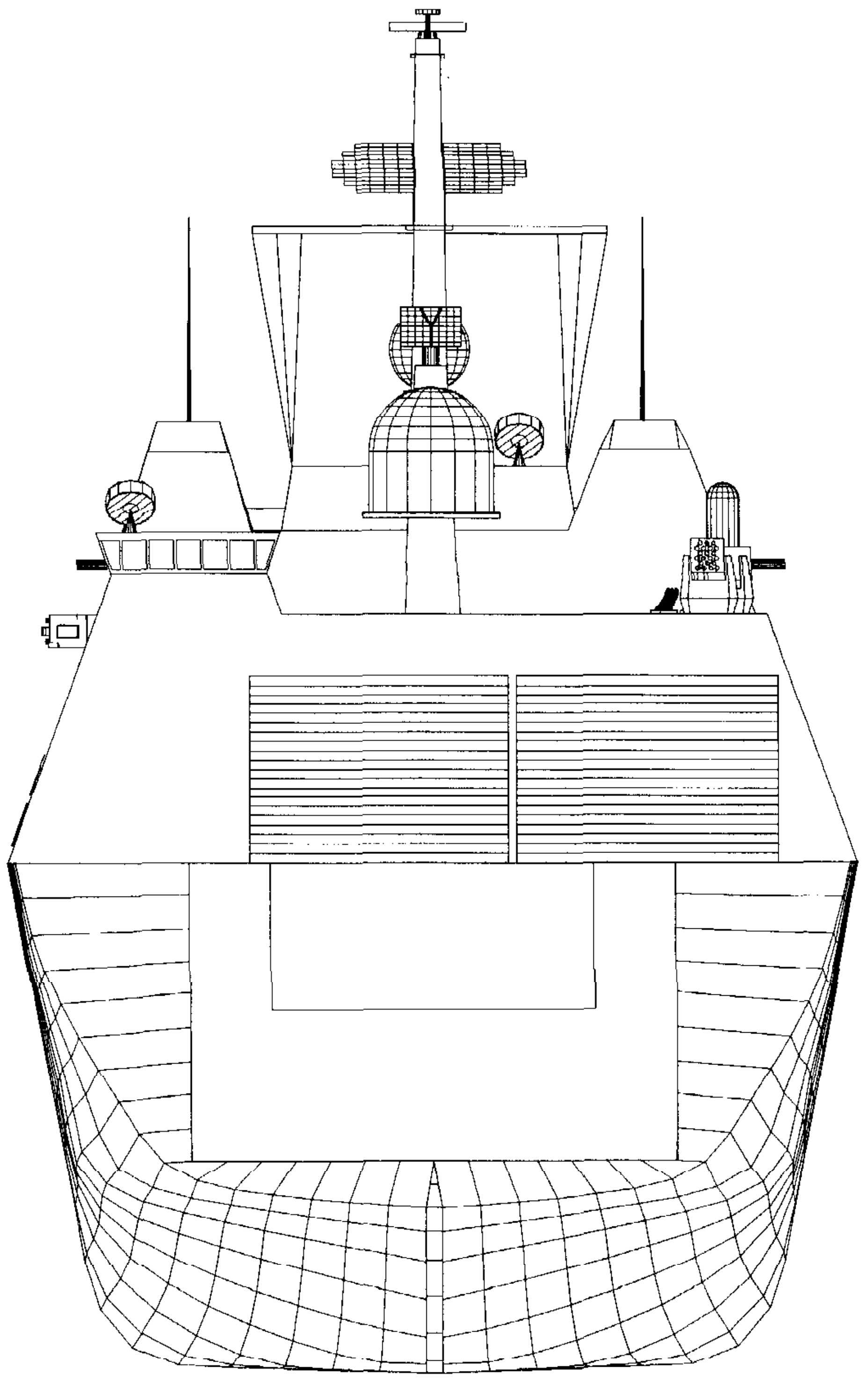


Figure 5-46. Stern View



G. MANNING AND BATTLE ORGANIZATION

1. Manning

Manpower within the SPECTRE concept is based on minimum requirements as delineated in the Design Philosophy. Two key technological elements that support reduced manning are the ship control and information data buses and standardized consoles for all major systems and an automated and simplified power plant.

Manning allowance for the CMD is broken into four groups: ship's crew, Flag, Air Detachment and Boat Detachment. The ship is expected to have the following departments: Operations, Engineering, Deck/Weapons, Air, Supply, Medical and Dental. Division Officers are: CICO, EMO, MPA, A/E, DCA and LAMB plus an additonal 3 junior officers. Estimates for enlisted personnel were based on the Decision Engineering ship design computer program for an initial manning plan. Adjustments were then made for expected technology advances. Similarly, initial estimates for Air Det and Boat Det crews were obtained with the computer program. Due to the offensive capability of many surface PTX platforms, it is anticipated that the Boat Det will have several officers and can be supplemented from ship's force if required. Additionally, manning for the Boat Det accounts for manning to support two 12 hour shifts of all boats. The CMD is designed to support only a small Flag or Group Commander staff. A ship design margin of 5% was incorporated to all categories for growth. The expected manning levels are depicted in table 5-9.

TABLE 5-9

	SHIPS CREW	FLAG	AIR DET	BOAT DET	TOTAL MANNING	TOTAL ACCOMODATIONS
OFFICERS	15	5	18	4	42	43
CPO	12	4	3	8	27	28
OEM	217	3	36	84	340	351
TOTAL	244	12	57	96	409	422

2. Battle Organization

The top level battle organization for condition I is illustrated in figure 5-47. It is anticipated that the critical space manning at condition I will resemble the numbers tabulated in table 5-10.

TABLE 5-10

SPACE	PERSONNEL
Bridge	4 Officer, 8 Enlisted
Combat Information Center	3 Officer, 12 Enlisted
Flag Plot	5 Officer, 6 Enlisted
Central Control Station	2 Officer, 10 Enlisted
Ballast Control Station	1 Officer, 2 Enlisted
Radio Central	1 Officer, 4 Enlisted
Repair Locker 2	1 Officer, 20 Enlisted
Repair Locker 3	1 Officer, 15 Enlisted
Repair Locker 5 - fwd	1 Officer, 25 Enlisted
Repair Locker 5 - aft	1 Officer, 25 Enlisted
Repair Locker 8	1 Officer, 8 Enlisted

The officers designated in table 5-10 may be either commisioned officers or Chief Petty Officers (CPO).

For condition III the top level watch organization will resemble that shown in figure 5-48.

Figure 5-47. Watch Organization (Condition I)

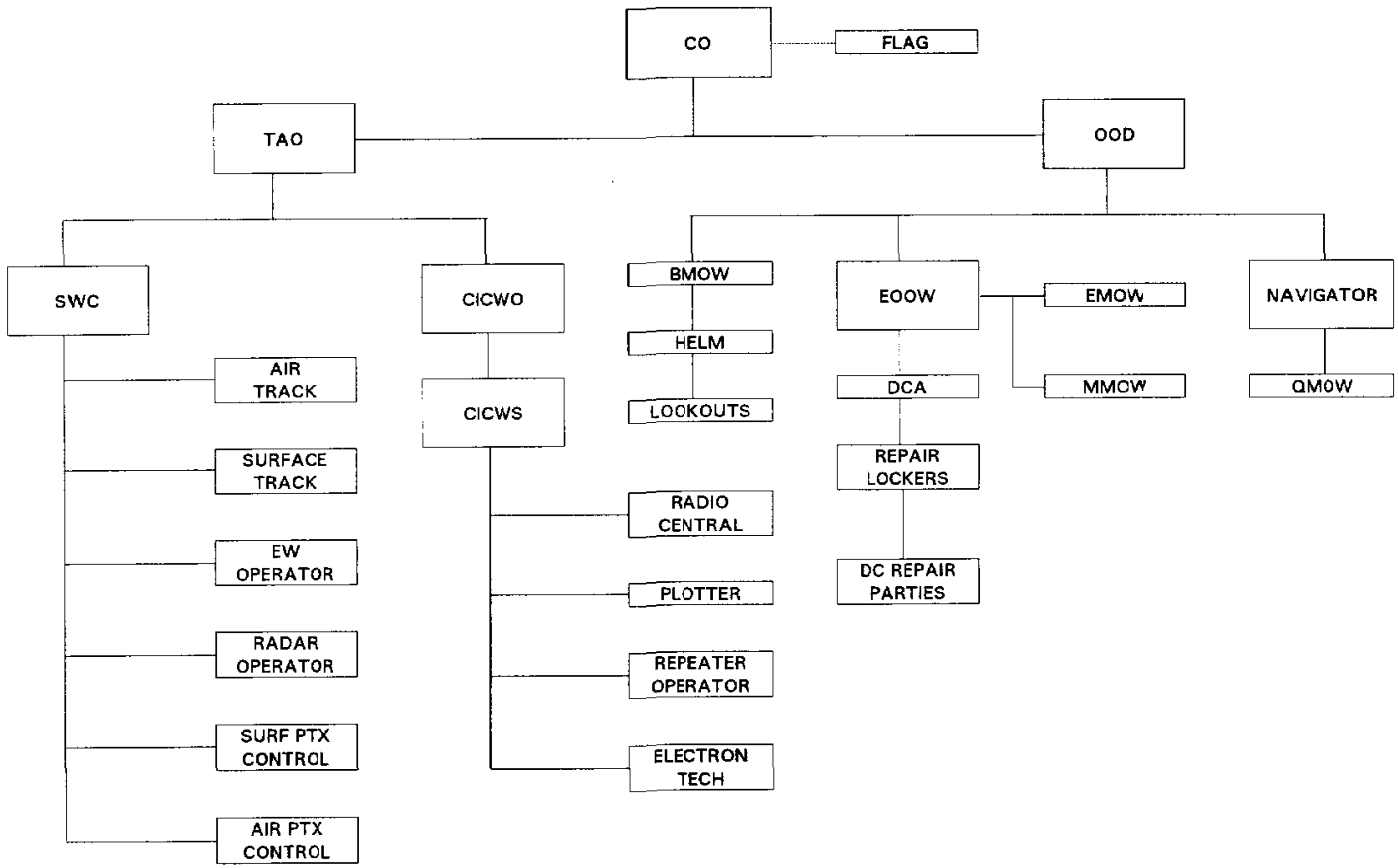
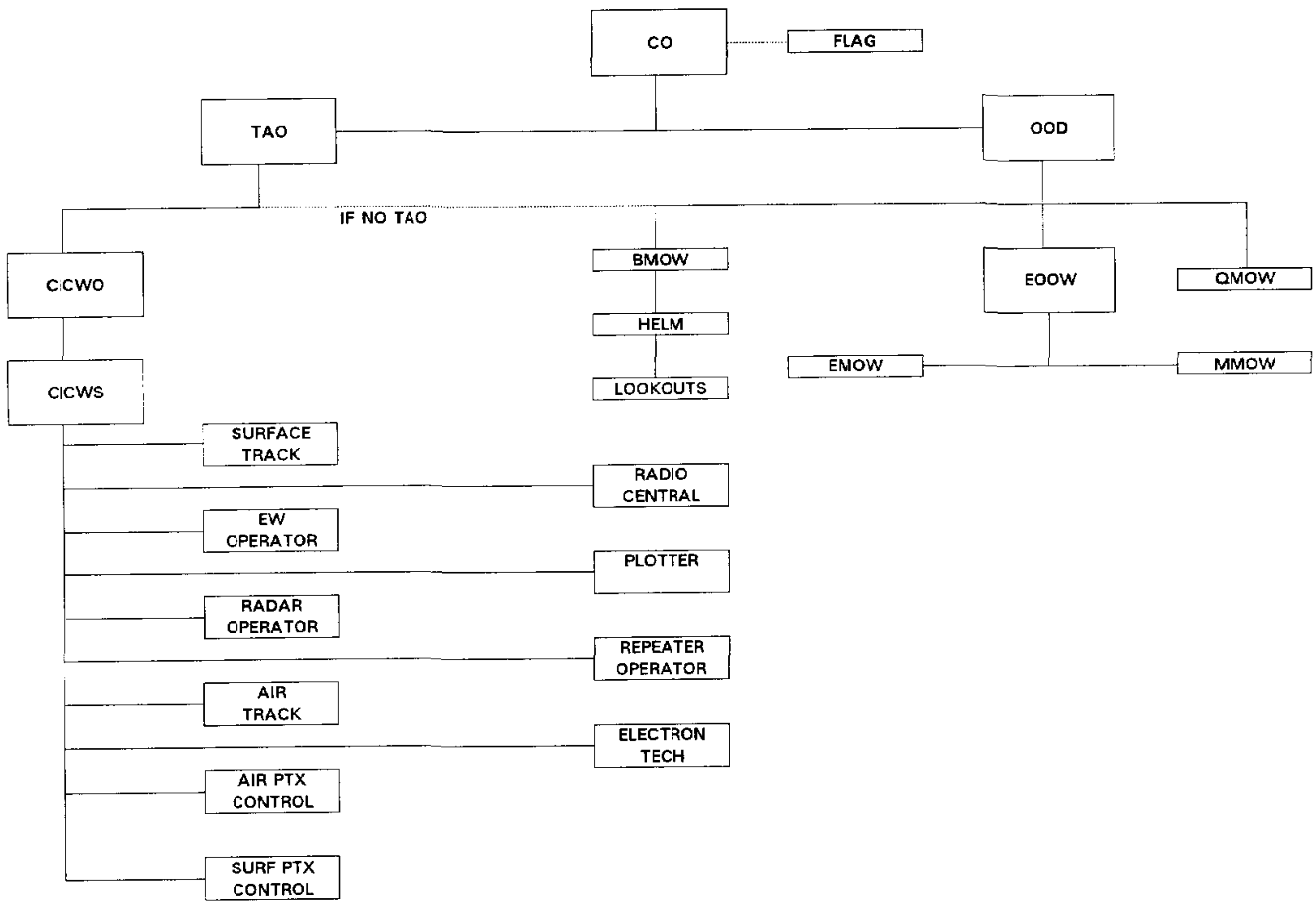


Figure 5-48 Watch Organization (Condition III)



SECTION VI

DESIGN EVALUATION

A. MEASURE OF EFFECTIVENESS STUDIES

Earlier in this report, six scenario based MOE studies were used to select one of three CMD designs. Using the same analysis technique, the SPECTRE task force can be compared to a conventional task force for each scenario.

1. Scenario Based MOE Evaluations

For each scenario, the task force composition, threat levels, defense efficiencies, and loss probabilities are listed in Appendix E. The platform costs and availabilites are as previously listed in section IV-B.

The results of the evaluations are listed in Table 6-1. The measure of effectiveness values are for the combined task forces and the costs are for the task forces in normalized dollars.

Table 6-1. SPECTRE and Conventional Task Force Comparison

	Conventional TF		Large CMD TF		Med CMD TF		Small CMD TF	
Scenario	MOE	Cost	MOE	Cost	MOE	Cost	MOE	Cost
1	0.0556	6.990	0.0907	5.376	0.0885	5.876	0.0869	6.223
2	0.0833	3.340	0.2022	2.646	0.2050	2.583	0.1773	3.493
3	0.0709	3.560	0.3188	1.7560	0.3315	1.6930	0.2530	2.603
4	0.1379	3.320	0.2295	3.072	0.2371	2.946	0.1625	4.766
5	0.1227	2.410	0.2062	2.546	0.2090	2.483	0.1813	3.393
6	0.4941	1.170	0.4061	1.7360	0.3339	2.236	0.2974	2.583

For each scenario, the task force with the highest MOE is highlighted. The SPECTRE task force has a higher MOE and lower cost than the conventional task force in five of the six scenarios. The conventional task force wins in the special operations scenario. Figures 6-1 and 6-2 graphically portray the MOE and cost data.

Figure 6-1. Task Force MOEs

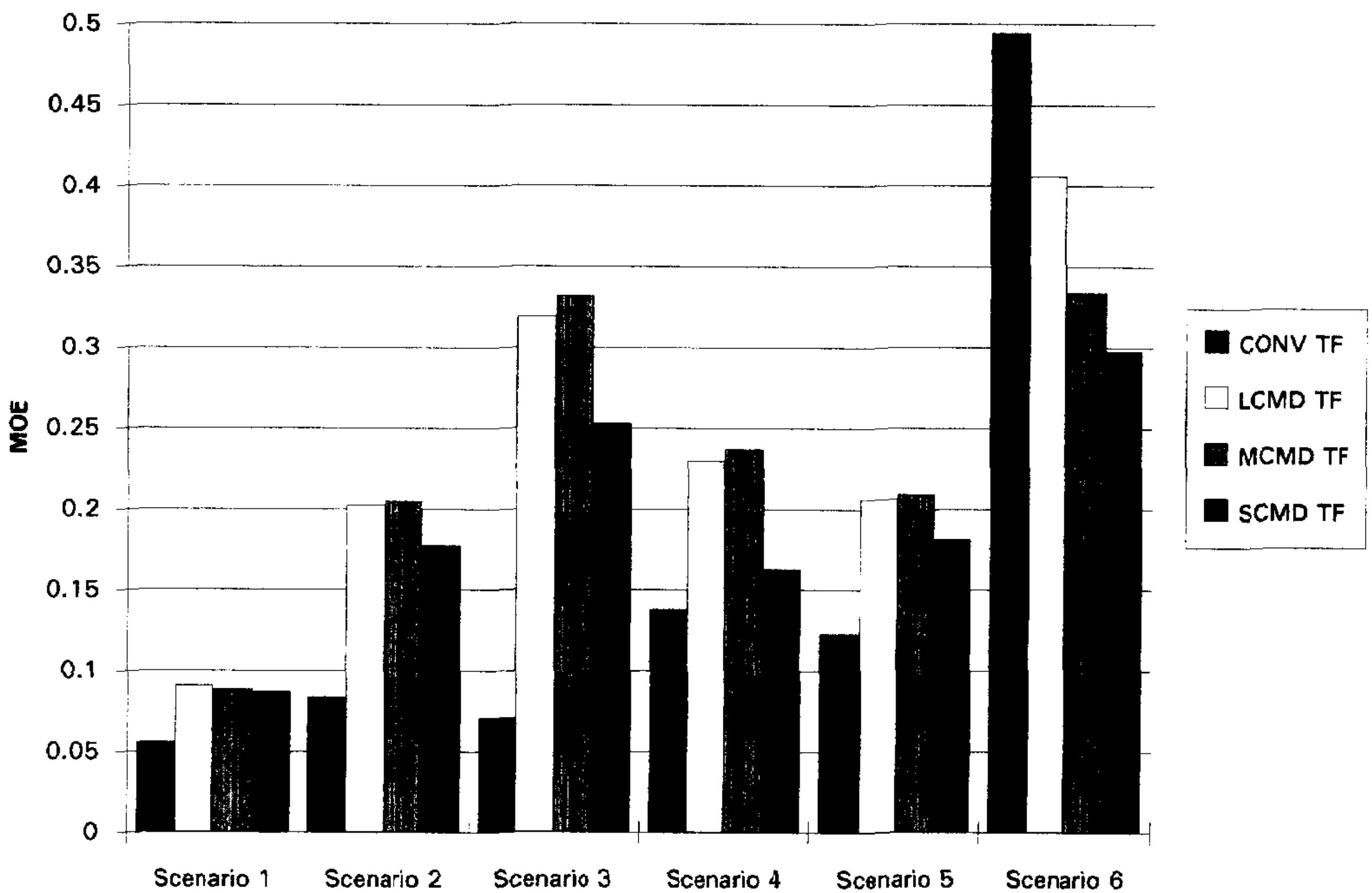
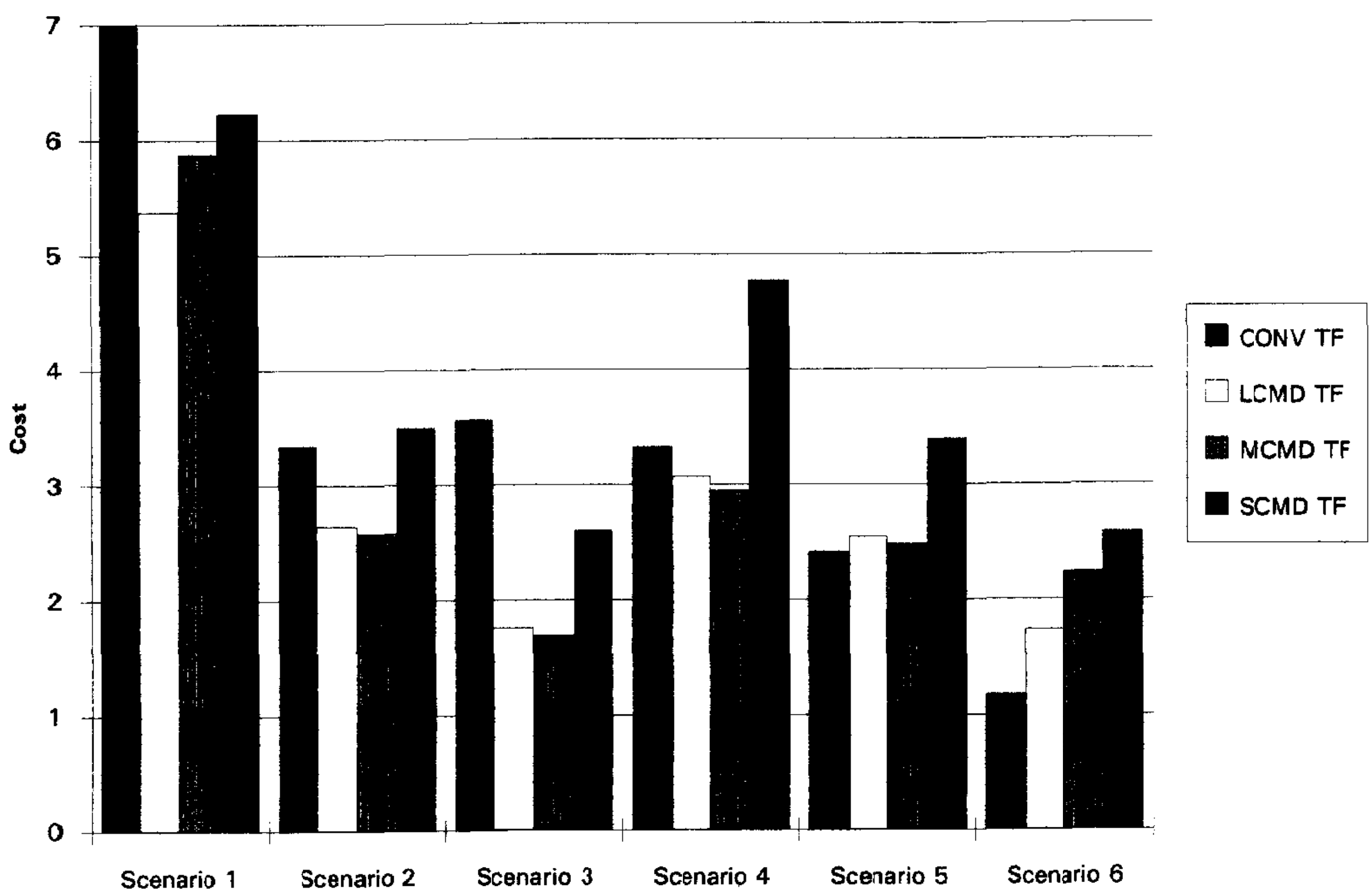


Figure 6-2. Task Force Cost



B. SURVIVABILITY

Survivability was a major design consideration throughout the design process. The use of enclaving including separation and redundancy is evident in all the arrangements chosen. The constraints imposed by the requirements to berth surface PTX craft greatly influence the degree to which survivability can be considered.

1. Radar Cross Section Reduction

The hull is sloped from keel to main deck at 7 degrees and the superstructure also has sloped sides in both the ransverse and longitudinal directions. The two masts are cantered fore and aft at 10 degrees with the total height of the mast reduced from conventional length.

The gas turbine engines are mounted on sound isolation mounts and enclosed in modules to reduce ambient noise. The use of electric drive transmission also provides for decreased ambient noise levels. The uptakes are equipped with an air eductor system to reduce exhaust gas temperatures consequently reducing the ships infrared signature.

2. Single-Point Failure Reduction

The use of enclaving and the inherent separation of systems within the SPECTRE concept greatly eliminates the single-point failure spaces on the CMD platform. Equipment has been effectively separated on the CMD itself to the maximum extent possible given the general design constraint in the ORD. For example: the two RAM launchers are located in separate zones, MMR1 is vertically separated from MMR2 and AMR2, SRBOC launchers are interspersed throughout the topside arrangements, CIC is separated from the bridge by a complete deck and flag plot, which will act as secondary CIC, is located in a separate zone from CIC. The use of electric drive allows for increased survivability from underwater detonation as fewer vital spaces are located below the water line.

A few single-point failure nodes do exist. The CIWS are located in the same zone. The SPN-35 and SPN-43 are both located on the after mast. The Mk-92 CAS is separated from the 76mm gun which is not in compliance with the enclaving concept. CIC, the bridge and CCS are all located in zone II.

C. RECOMMENDATIONS AND CONCLUSIONS

1. Recommendations

There are a number of items remaining to be investigated prior to and in the detailed design phase. Some of the more important items are as follows.

Use ASSET to determine the final stability characteristics based on the new AUTOCAD design. The stability information provided by the TSSE students is based on the original medium sized CMD without the weapons and detection systems installed.

Design of the individual surface PTX craft remains and the CMD imposes constraints on their size and operational requirements. The surface PTX craft are envisioned to have weapons modules carried aboard the CMD to provide for a flexible response if mission areas change.

The detailed arrangements of the Main Machinery Rooms and Auxiliary Machinery Rooms remains along with the intake and uptake design. A high degree of machinery instrumentation is required to keep the size of the crew at an acceptable level.

Conduct a complete survivability analysis of the CMD with PTX craft operational. This will undoubtably be a very complex task and will necessitate a computer model based on the operational scenarios previously developed.

Explore alternative scenarios using the CMD and PTX platforms and determine the SPECTRE effectiveness compared to current operational doctrine.

2. Conclusions

The CMD design developed by the TSSE students is a viable alternative to current Navy tactics and doctrine. The SPECTRE concept meets the requirements of ever changing missions of the U.S. Navy. The concept of SPECTRE is well suited to littoral warfare and the use of interchangeable modules for the PTX craft allows for rapid response to changing threat environments.

The low cost, ease of maintainability and low probability of loss of life due to a small crew will provide a good political argument for the acceptance of the SPECTRE system. The system was designed to operate as a complete and separate entity in naval warfare situations.

The requirements specified in the ORD have been met and the proposed system, as designed, should provide policy makers with an added option in ship acquisition.

3. Value of Design as a Learning Tool

The design undertaken by the TSSE students was a valuable learning tool in understanding the ship design process. The importance of well defined requirements was made evident as the ship design progressed through the preliminary design phase.

The team work used in this design allowed all members of the team to contribute their own background knowledge throughout the design process.

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