# Special Operations Forces (SOF) Support Ship Ship Conversion Feasibility Study

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## Massachusetts Institute of Technology
**Projects in Naval Ship Conversion Design, 13.413**

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# Executive Summary

This report describes the results of a high-level concept exploration conducted for the 21st Century Special Operations Forces Ship. The study began with a detailed examination of the Sponsor Requirements and development of a Mission Need Statement. An initial design sequence was performed with the goal of maximizing Overall Measure of Effectiveness (OMOE) for minimum cost. The OMOE and cost of the ship were determined by applying modified versions of the Massachusetts Institute of Technology (MIT) OMOE and Cost Models. After analyzing several possible variants using OMOE versus cost optimization techniques, a single design was selected for further evaluation and refinement.

One of the driving factors was to be able to produce this and any follow-on ships at relatively low cost. In order to do this, mature technologies were used, particularly in the area of communications, berthing accommodations, and previous designs and arrangements were emulated to exploit repeatability and to reduce cost. The Large, Medium-Speed, Roll-On/Roll-Off Ship (LMSR) was used as the starting point for the variant characteristics in an effort to leverage on previous design efforts.

The Program of Ships Salvage and Engineering (POSSE) software package was used to analyze a modified midship structural section and to perform intact and damaged stability analyses. Finally, seakeeping of the design was analyzed using the Ship Wave Analysis (SWAN) program. The ship design has undergone numerous changes since the study's inception. The current design is extremely stable and meets all of the project engineering constraints. The final baseline design meets current naval performance standards. According to a weight-based cost model, the lead ship conversion cost estimate is $86.16 million. This is within the threshold value of $90 million. The baseline design characteristics are provided below:

**SOF Ship Dimensions and Performance**

| | | | |
|---|---|---|---|
| **LBP** | 884 ft | **LOA** | 951 ft |
| **Beam** | 106 ft | **Full Load Draft** | 27.80 ft |
| **Full Load Displacement** | 48,937 ltons | **Light Ship Displacement** | 37,681 ltons |
| **Full Load KG** | 39.98 ft | **Light Ship KG** | 45.57 ft |
| **Max speed** | 24.0 knots | **Endurance** | 10,000+ nm @ 24 knots |

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# 1.0 MISSION NEED

## 1.1 Defense or National Guidance and Policy

The Mission Needs Statement (MNS) provides requirements for a Special Operations Forces (SOF) platform. The MNS is included in Appendix A.

The need for such a ship is addressed in part by the Joint Chiefs of Staff:

> "The landmark Strategic Mobility Requirements Study by the Joint Chiefs of Staff in 1992 concluded that the United States had insufficient sealift capacity to transport military equipment to an overseas conflict. This shortfall was highlighted during Operations Desert Shield and Desert Storm when the majority of cargo had to be moved by chartered, non-U.S.-flag ships. To address this capacity shortfall, Congress authorized the Strategic Sealift Program."[1]

Although this program provides afloat prepositioning of Army equipment, the need for immediate transport of SOF can be directly related. This is evident in the war on terror in Afghanistan where USS Kitty Hawk (CV-63) was taken from her assigned duties to serve as a SOF transport and support platform. The MNS should be used to guide SOF platform design, research, development, and cooperative efforts with U.S. Allies. Based on the MNS guidance and policy, the SOF platform must provide support for interagency, joint, and allied forces. This vessel will provide modular flexibility to perform individual or multiple missions, thereby freeing other major assets to dedicate their full resources to the performance of their primary missions.

## 1.2 Threat Analysis

The SOF platform itself can be characterized as a non-combatant; however, the mission of the forces it transports is offensive. The SOF platform serves as a mobile offshore base from which SOF can be deployed.

## 1.3 Current Capability Assessment

Currently there is no platform specifically designated for SOF purposes. Submarines, aircraft carriers, and other surface ships are detailed as needed for SOF deployment. A recent example, as mentioned previously, is USS Kitty Hawk (CV-63) which was relieved of carrier duties to provide SOF support for Operation Enduring Freedom (i.e., the war on terror in Afghanistan).

## 1.4 Capability Need

The logistics and costs associated with utilizing an operational and fully manned aircraft carrier for SOF missions is expensive. A need exists for a platform specifically tasked with the transport, support, and deployment of SOF that can operate jointly with other naval forces. This platform would allow for rapid deployment of SOF, as well as SOF aviation and SOF boat support. Timeliness, versatility, and flexibility are essential to global power projection.

## 1.5 Recommended Alternatives

Non-material alternatives, such as changes in doctrine or operational concepts, are not sufficient. Part-time tasking of vessels like USS Kitty Hawk removes an essential element of the fleet and employs her in a role for which she was not specifically designed. Material alternatives include (1) conversion of an amphibious assault ship, (2) conversion of a commercial tanker/container ship/roll-on roll-off vessel, (3) conversion of an existing LMSR ship, and (4) design and acquisition of a new ship.

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[1] Strategic Mobility Requirements Study, 1992

## 2.0 DESIGN REQUIREMENTS AND PLAN

### 2.1 Required Operational Capability

The Required Operational Capabilities (ROC) are based on guidance given by the sponsors of this ship conversion. Table 1 lists the sponsor requirements (SR), while Table 2 lists the ROCs for the SOF ship. Measures of effectiveness (MOE) assess the degree to which the various design concepts meet these ROCs. The MOE are listed in Table 3.

**Table 1. Sponsor Requirements (SR)**

| SR # | Sponsor Requirement |
|---|---|
| SR1 | Provide platform for SOF/Aviation support missions |
| SR2 | Total acquisition and conversion cost not to exceed $90 million |
| SR3 | Low operational costs |
| SR4 | Reduce operational tempo of assets currently supporting SOF missions |
| SR5 | Provide test platform for future SOF technology |
| SR6 | Provide weight/space margin for insertion of future modular SOF systems |
| SR7 | Maintain partial Roll On/Roll Off capability for prepositioned disaster relief |

**Table 2. Required Operational Capabilities (ROC)**

| ROC | Area of Operations |
|---|---|
| 1 | Steam to design capability in most fuel efficient manner |
| 2 | Conduct SOF deployment and support operations |
| 3 | Provide own unit's C4I functions |
| 4 | Provide platform for launch and recovery of multiple rotary-wing and VTOL/STOVL aircraft for SOF aviation missions |
| 5 | Provide minor maintenance to aircraft |
| 6 | Provide refueling to aircraft |
| 7 | Provide platform for Navy Special Boat Unit operations |
| 8 | Provide search and rescue capability |
| 9 | Provide ability to install/test new technology |
| 10 | Provide accommodations and medical facilities for SOF personnel |
| 11 | Prevent and control damage |
| 12 | Perform seamanship, airmanship and navigation tasks (navigate, anchor, mooring, scuttle, life boat/raft capacity, tow/be-towed) |
| 13 | Replenish at sea |
| 14 | Maintain health and well-being of crew |
| 15 | Provide upkeep and maintenance of own unit |

**Table 3. Measures of Effectiveness (MOE)**

| MOE # | Associated MOE |
|---|---|
| 1 | Support SOF operations |
| 2 | Support SOF aviation missions |
| 3 | Support Navy Special Boat Unit missions |
| 4 | Support aircraft maintenance/refueling |
| 5 | Support partial Roll On/Roll Off disaster relief operations |

### 2.2 Concept of Operations/Operational Scenarios

The SOF Ship Concept of Operations (COO) is based on the expected SOF mission needs and operating characteristics. The notional composite scenario is outlined in Table 4. Due to classification requirements, the operational missions of SOF can not be included in this report.

**Table 4. Notional Composite Scenario**

| | |
|---|---|
| Day 1-10 | Transit to Operational Area 1 |
| Day 11-18 | Support SOF mission and deployment |
| Day 19-28 | Transit to Operational Area 2 |
| Day 29-50 | Support SOF mission and deployment |
| Day 51-60 | Underway Replenishment/Return to Operational Area 1(2) |

### 2.3 Constraints and Standards

The MNS identified several constraints on the SOF ship development.

#### 2.3.1 Constraints

##### 2.3.1.1 Design

The ship design must employ a total-ship engineering approach. This approach would optimize Life Cycle Cost (LCC) and performance, permit rapid upgrade in response to evolving operational requirements, and provide the capability to continually perform its mission. The developmental phase must account for emerging technologies, including modern, flexible information processing systems. Since communication and data systems hold the greatest potential for growth, these installations must be as modular as possible to allow for future upgrades. Standard man-to-machine interfaces between onboard systems should be consistent with current Navy practice and systems.

The SOF ship will be modified from its original configuration such that the ramps and large cranes will be removed. The topside configuration will be obstruction-free flight deck areas both forward and aft of the superstructure. Below decks, the ships holds will be converted to offices, briefing rooms, berthing areas, and other various spaces required to support a SOF deployment. These modifications will be done at a minimum cost without neglecting the comfort of the personnel.

#### 2.3.1.2 Manning

The manning requirements of the SOF ship will be the normal manning of the T-AKR 300. This consists of 30 Military Sealift Command (MSC) civilian personnel, a fraction of what is typically required for an operational naval vessel of this size. Since this vessel will not have any offensive capability and is not envisaged to engage in ship-to-ship warfare, the crew will not be sized for combat condition damage control.

The ship must provide berthing accommodations for significant numbers of personnel for SOF operation. Embarked SOF personnel will be considered in the same manner as an Air Wing embarked on an aircraft carrier, and their accommodations will be maintained separate from the ships crew.

The Navy-wide initiatives in manning reduction will be incorporated into the design of the SOF ship modifications. Recent advances made in habitability, upkeep, and shipboard training should all be investigated for utilization in the below-decks modifications to the LMSR. The forward thinking already used in the LPD-17, CVN(X), and DD(X) projects should be leveraged to provide the best possible use of manpower on the SOF ship.

### 2.3.2 Standards

The following standards were used in the development of this conversion design:

- General Specifications for Ships of the United States Navy, NAVSEA S(AA0-AA-SPN-010/Gen-Spec)
- Structural Strength: DDS 100-1,2,4,5,6,7
- Stability and Buoyancy: DDS 079-1
- Freeboard: DDS 079-2
- Ship System Survivability: DDS 072-4
- Powering: DDS 200-1, 310-1.

## 2.4 Goals and Thresholds

Nominal ship operational capabilities as required by the sponsor are summarized in Table 5.

**Table 5. Nominal Ship Operating Characteristics**

| | |
|---|---|
| Maximum Speed | 20+ knots |
| Endurance Speed | 14 knots |
| Endurance Range | 10000+ nm |
| Endurance Stores | 60 days |
| Seakeeping | Sea State 5 |

The ability of the SOF ship to conduct its mission is paramount. The flight deck should be able to accommodate all U.S. Armed Forces rotary-wing and VTOL/STOVL aircraft that are used in SOF missions. The SOF ship must be able to refuel any aircraft onboard and provide for any repairs that are capable of being done on the flight deck. In addition, while at anchor, the ship must be able to launch, recover, and fuel large SOF tactical boats from the hangar deck.

The SOF ship must be capable of serving as a test bed for new technology. Due to the nature of SOF, much of the equipment may be non-standard or true cutting edge. The ship must be designed with an "open architecture" in mind that will allow for the installation of special equipment.

The ship used for this study, T-AKR 300, has a propulsion plant capable of achieving a speed of 24.0 knots. This speed enables the ship to operate well within joint naval tactical parameters.

## 2.5 Design Philosophy and Decision Matrix

The goal of this conversion design was to determine the most suitable platform for a SOF ship while minimizing LCC. In fact, throughout this design, cost effectiveness has been of equal or greater influence than mission effectiveness. Generally, the required equipment modifications were performed in order to minimize effects to the existing ship. Each modification carried a cost apart from its mission impact. Each modification, such as removing a system, installing another system, modifying a structure, and so forth, received a cost and weight assessment. The weight reductions or additions for discrete systems came from a weight and balance report for the T-AKR 300 and weight information from CSC Advanced Marine Center. Modification weights were estimated.

The primary mission of this ship is to support SOF missions. Therefore, all other considerations are subordinate to performing this mission. The essential measures of effectiveness reflect fulfillment of the SOF mission, as well as operational requirements for the ship. To assess operational effectiveness, an OMOE model provided a score based on performance relative to the sponsor requirements. This model consists of a weighted-sum of individual MOE scores. The weightings are the averaged results of independent comparisons of all MOE by each design team member. Table 6 lists the OMOE weights.

**Table 6. OMOE Weights**

| **Overall** | | 1 | |
|---|---|---|---|
| LCC Reduction | Reduced Operational Costs | 0.5 | 0.25 |
| | Reduced Conversion Costs | | 0.25 |
| SOF Mission | Support SOF Aviation Missions | 0.5 | 0.2 |
| | Support Navy Special Boat Unit Missions | | 0.2 |
| | Support New Modular Technology | | 0.1 |

## 3.0 CONCEPT EXPLORATION

### 3.1 Baseline Concept Design

The starting point for the conversion is the T-AKR 300 Bob Hope class ship, which is a Large, Medium-Speed, Roll-On/Roll-Off Ship (LMSR). LMSRs provide afloat prepositioning of Army heavy vehicles and supplies. They are operated by the Military Sealift Command (MSC). The LMSR program currently has 19 ships. These consist of 5 ex-commerical vessels and 14 new construction LMSRs. Table 7 lists the dimensions and performance of this ship. Figure 1 shows the external arrangement.

**Table 7. LMSR Dimensions and Performance**

| | | | |
|---|---|---|---|
| **LBP** | 884 ft | **LOA** | 951 ft |
| **Beam** | 106 ft | **Full Load Draft** | 37 ft |
| **Full Load Displacement** | 62,069 Ltons | **Light Ship Displacement** | 33,026 Ltons |
| **Full Load KG** | 45.29 ft | **Light Ship KG** | 47.47 ft |
| **Max speed** | 24 knots | **Endurance** | 12,000 nm @ 24 knots |

The T-AKR 300 ships have a cargo capacity of 13,250 long tons with 397,413 square feet of available cargo area. They provide roll on/roll off (RO-RO) capability, and lift on/lift off capability. The ships are powered by four Colt Pielstick 10 PC4V diesel engines that can produce a speed of 24 knots at a design draft of 35 feet. The Bob Hope class is currently being built for the US Navy by Avondale Industries. The oldest ship was commissioned in 1998, so a long service life is expected. This 951 foot long LMSR is an excellent platform on which to perform SOF ship modifications.

Courtesy of www.globalsecurity.org

**Figure 1. LMSR Outboard Profile**

The major modifications done to the base hull were the removal of all appendages, ladders, ramps, and cranes above the main deck (designated Deck A). A new deck, or "flight deck," was then attached to the main deck forward of the existing superstructure. The major components added were the systems and support equipment required for self-defense and for SOF operations. These major additions were: (1) two Rolling Airframe Missile Launchers (RAMs); (2) two Close-In Weapon Systems (CIWS); (3) modular C4I system infrastructure; (4) two aircraft elevators; (5) aviation refueling and medium-level maintenance support; (6) two hangar bay boat cranes; (7) increased berthing and messing facilities; and (8) medical and dental facilities.

### 3.2 Alternative Technologies and Systems

Several technological alternatives were analyzed for this conversion. New technology exists, or is in development, for the modular communication equipment. Similarly, innovations to crew habitability are always being investigated.

The LMSRs are not armed and do not possess a combat system. They do have a C3I suite sufficient to perform standard operations with other naval vessels. As a result, modular C4I systems will be installed. This will reduce not only size and weight from the SOF ship, but also required maintenance and repair costs as well as manning.

Because embarked SOF personnel will be considered in the same manner as an Air Wing embarked on an aircraft carrier, berthing and messing facilities will be maintained separate from the ships crew. Based on the mission requirements of the ship, the berthing on the ship will consist of large, modular berthing compartments, with the exception of berthing for officers who will have larger multi-person staterooms. The food preparation will become more automated and streamlined, using an outside service to support preparation and cleanup of meals, as well as using the new "prepared meals" currently being tested.

### 3.3 Concept Ship Variants and Trade-Off Studies

An initial search for a ship conversion candidate was conducted based on the criteria given in Table 1 and a combined acquisition and conversion budget of $90 million. Table 8 summarizes the suitable hulls found based on a search using this criteria. The assumption was made that at least one ship from each class was available. To assess operational effectiveness, an OMOE model provided a score based on performance relative to sponsor requirements. This model consists of a weighted-sum of individual OMOE scores. In each of the five categories below: aviation, boat capability, transformational (support of modular new technology), operational costs and conversion costs, a maximum OMOE was assigned based on the relative importance to the overall mission. The individual items in each category were assigned values between zero and the maximum OMOE assigned to each category as discussed previously in Table 6. As with all ship acquisition and conversions, budget is a concern and was the driving factor for this entire design. Therefore, some hull forms were eliminated on cost consideration alone.

**Table 8. Concept Ship Variant Summary**

| | **LPH** | **LPD** | **CV** | **AO** | **LMSR** | **Merchant (commercial)** |
|---|---|---|---|---|---|---|
| **SOF Mission** | | | | | | |
| **Aviation** | | | | | | |
| Flight Deck | 0.05 | 0.04 | 0.07 | 0.03 | 0.03 | 0.03 |
| VTOL/STOVL | 0.04 | 0.04 | 0.05 | 0.01 | 0.01 | 0.01 |
| **sum** | 0.09 | 0.08 | 0.12 | 0.04 | 0.04 | 0.04 |
| **ratio to max of .2** | **0.16** | **0.13** | **0.20** | **0.07** | **0.07** | **0.07** |
| | | | | | | |
| **Boat Capability** | 0.07 | 0.07 | 0.07 | 0.07 | 0.07 | 0.07 |
| **ratio to max of .2** | **0.20** | **0.20** | **0.20** | **0.20** | **0.20** | **0.20** |
| | | | | | | |
| **Transformational** | 0.01 | 0.01 | 0.03 | 0.02 | 0.03 | 0.03 |
| **ratio to max of .1** | **0.02** | **0.04** | **0.10** | **0.06** | **0.10** | **0.08** |
| | | | | | | |
| **Costs** | | | | | | |
| **Operational Cost** | | | | | | |
| Age | 0.00 | 0.05 | 0.00 | 0.03 | 0.08 | 0.08 |
| Propulsion | 0.00 | 0.05 | 0.00 | 0.05 | 0.08 | 0.07 |
| Speed | 0.07 | 0.05 | 0.07 | 0.05 | 0.07 | 0.07 |
| Crew size | 0.02 | 0.05 | 0.00 | 0.07 | 0.08 | 0.08 |
| Draft | 0.05 | 0.05 | 0.02 | 0.05 | 0.03 | 0.03 |
| **sum** | 0.13 | 0.25 | 0.08 | 0.25 | 0.35 | 0.33 |
| **ratio to max of .25** | **0.10** | **0.18** | **0.06** | **0.18** | **0.25** | **0.24** |
| | | | | | | |
| **Conversion Cost** | | | | | | |
| Structure | 0.00 | 0.02 | 0.07 | 0.03 | 0.07 | 0.03 |
| Tankage | 0.02 | 0.02 | 0.02 | 0.07 | 0.07 | 0.05 |
| Habitability | 0.07 | 0.07 | 0.07 | 0.03 | 0.02 | 0.02 |
| C4I | 0.05 | 0.05 | 0.05 | 0.03 | 0.02 | 0.02 |
| Self-defense | 0.07 | 0.07 | 0.05 | 0.03 | 0.02 | 0.02 |
| Propulsion | 0.02 | 0.02 | 0.00 | 0.03 | 0.08 | 0.00 |
| **sum** | 0.22 | 0.23 | 0.25 | 0.23 | 0.27 | 0.13 |
| **ratio to max of .25** | **0.20** | **0.22** | **0.23** | **0.22** | **0.25** | **0.13** |

Figure 2 shows that the LMSR received the highest OMOE of the six ship classes considered. Although one ship might have an advantage for a given category, the LMSR had the highest overall OMOE. As mentioned previously, the LMSR program currently has 19 ships. The oldest ship was commissioned in 1998, so a long service life is expected and availability of the LMSR is not a concern.

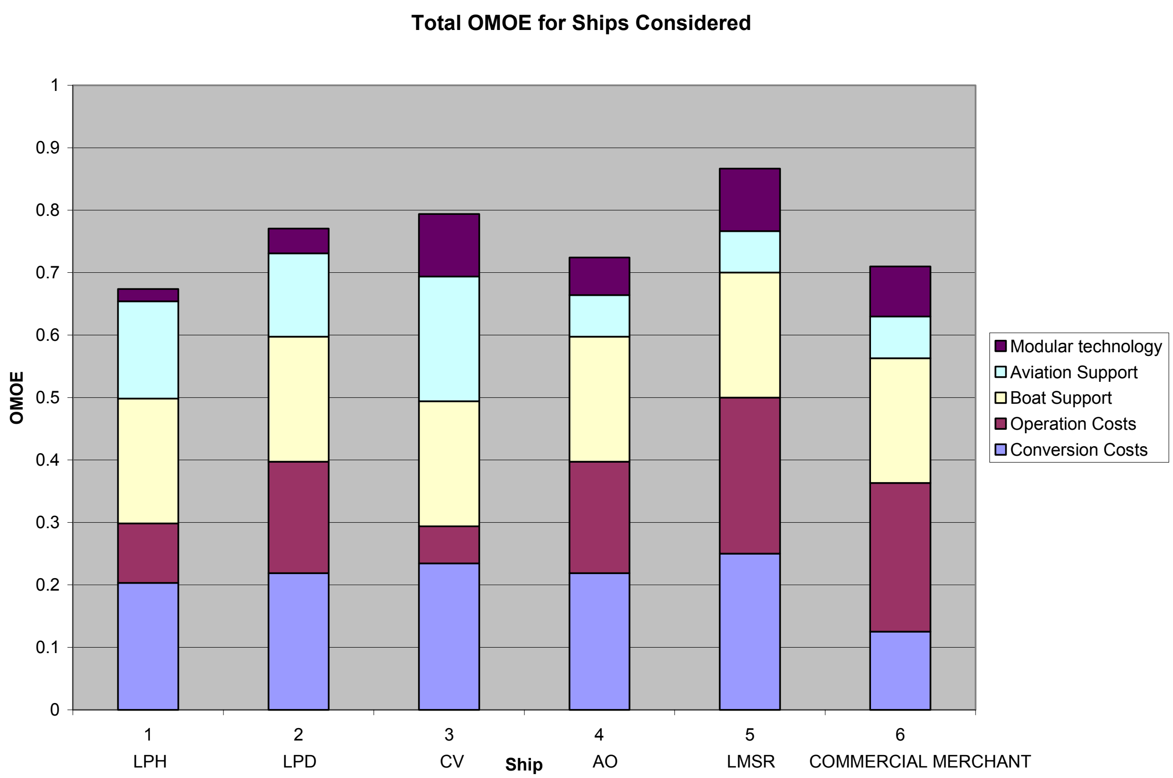


**Figure 2. Total OMOE for Ships Considered**

### 3.4 Variant Assessment

The variants defined above in Table 8 and shown in Figure 2 were assigned a scale factor to estimate overall OMOE and costs for each variant. Using cost as the leading driver, only those cost increases that had the potential to improve the OMOE significantly were considered. The OMOE weights are shown again in Table 9. Based on this study, the only variants that are feasible are those that offer new missions, but no ship modifications. Therefore, the design of the ship will be that proposed by the LMSR variant.

**Table 9. OMOE Weights**

| Overall | | 1 | |
|---|---|---|---|
| LCC Reduction | Reduced Operational Costs | 0.5 | 0.25 |
| | Reduced Conversion Costs | | 0.25 |
| SOF Mission | Support SOF Aviation Missions | 0.5 | 0.2 |
| | Support Navy Special Boat Unit Missions | | 0.2 |
| | Support New Modular Technology | | 0.1 |

### 3.5 Final Baseline Concept Design

The LMSR is the optimal variant. This became the SOF ship concept design. This design removes all structures above the main deck, and replaces them with a new flight deck forward of the existing superstructure. Although the light ship displacement increased by 4,655 long tons, there was little effect on stability. Since the engineering plant and hull did not change, while the displacement increased only slightly, the speed and endurance remained relatively unchanged compared to the baseline. The other variants are good options, but all lost out due to cost. With cost as the ultimate driver, the LMSR model was the best available choice.

The SOF ship dimensions and performance, after the conversion modifications, are shown in Table 10.

**Table 10. SOF Ship Dimensions and Performance**

| | | | |
|---|---|---|---|
| **LBP** | 884 ft | **LOA** | 951 ft |
| **Beam** | 106 ft | **Full Load Draft** | 27.80 ft |
| **Full Load Displacement** | 48,937 ltons | **Light Ship Displacement** | 37,681 ltons |
| **Full Load KG** | 39.98 ft | **Light Ship KG** | 45.67 ft |
| **Max speed** | 24.0 knots | **Endurance** | 10,000+ nm @ 24 knots |

Table 11 summarizes the total weight removed from and added to the ship by Ships Work Breakdown Structure (SWBS). The complete list of equipment removed is included in Appendix B. The complete list of equipment added, including SOF support systems and ship self-defense armament, is included in Appendix B.

**Table 11. Weights Removed and Added by SWBS**

| SWBS Group | | Weight Removed (ltons) | Weight Added (ltons) |
|---|---|---|---|
| 100 | Hull Structure | 607.37 | 4389.98 |
| 200 | Propulsion Plant | 15.74 | 15.74 |
| 300 | Electric Plant | 34.19 | 69.9 |
| 400 | Command and Surveillance | 0 | 76.19 |
| 500 | Auxiliary Systems | 695.63 | 1425.72 |
| 600 | Outfit and Furnishings | 99.09 | 1405.95 |
| 700 | Armament | 0 | 38.06 |
| **Total** | | **1452.02** | **7421.54** |

# 4.0 FEASIBILITY STUDY AND ASSESSMENT

## 4.1 Design Definition

### 4.1.1 Ship Geometry

The modification from the LMSR to the SOF ship design does not affect the hull form dimensions. Table 12 lists the ship's principal dimensions. Figure 3 shows the outboard profile, both before and after the modifications. The most important changes included the removal of elements above the weather deck (Deck A) including the cranes and ramps. The addition of elements included ship self-defense equipment, SOF crew berthing and messing spaces, C4I System Infrastructure, and Aircraft Elevators. The LMSR Weight and Moment report served as an initial estimate for full load condition, and elements were removed and added in the same format as the LMSR Weight report. A complete list of the elements removed and added is included in Appendix B. A comparison between the main characteristics of both ships is shown in Table 12.

**Table 12. LMSR & SOF Ship Principal Dimensions**

| | LMSR | SOF Ship |
|---|---|---|
| LBP | 884 ft | 884 ft |
| Beam | 106 ft | 106 ft |
| LOA | 951 ft | 951 ft |
| Full Load Displacement | 62,069 ltons | 48,937 ltons |
| Full Load KG | 45.29 ft | 39.98 ft |
| Full Load Draft | 37 ft | 27.82 ft |
| Light Ship Displacement | 33,026 ltons | 37,681 ltons |
| Light Ship KG | 47.47 ft | 45.67 ft |
| Light Ship Draft | 20.74 ft | 22.63 ft |

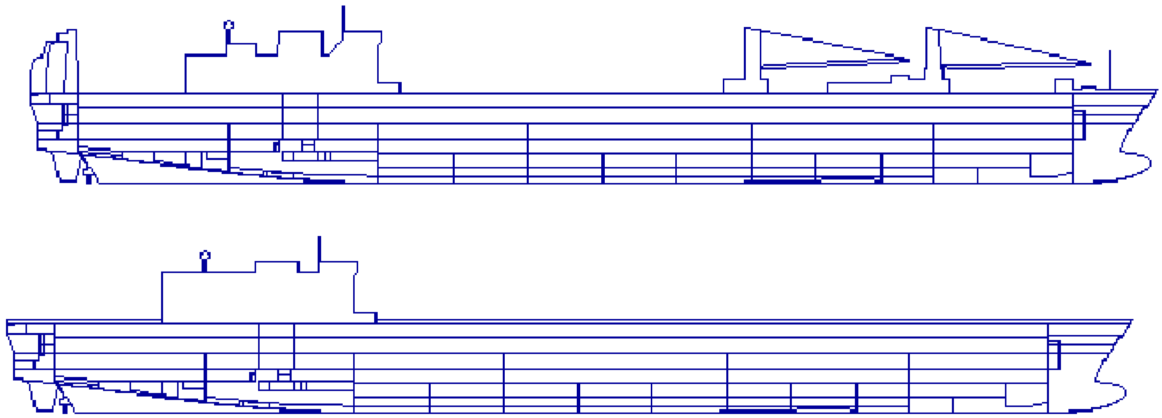

**Figure 3. LMSR and SOF Ship Comparison of Outboard Profiles**

#### 4.1.2 Combat Systems and Mission Payload

The baseline ship includes Link 11 and Link 14. This offers support for communication between the SOF ship and other Navy ships. Joint support, however, for the SOF ship will require upgrade to Link 16. Central command and control suites will be installed on the 02 and 03 levels just aft of licensed and unlicensed crew staterooms, between frames 99 and 104. As a result, the emergency diesel generator was moved forward to Hold 1 between frames 20 and 33. Self-defense mission modules and the two Rolling Airframe Missiles (RAMs) will also be monitored from the centralized command and control.

Primary flight control will be located on the 04 level. Prior to conversion, the 04 level on the LMSR was empty and only used for access to the pilothouse between frames 85 and 90. Modifications were made to this level to lengthen the entire compartment, imitating the 03 level from frames 85 to 104, to serve as flight control. This allowed for viewing the entire deck during all helicopter operations.

The ship combat systems will be upgraded with the addition of the Ship Self-Defense System (SSDS). The SSDS is comprised of the RIM-116 RAM, the Close-In Weapon System (CWIS), and the decoy launch system. The SSDS integrates the AN/SPS-49, the AN/SPS-67 surface search radar, the AN/SLQ-32 sensor, and the CIWS search radar into a cohesive ship defense system. The SSDS provides a high level of protection against anti-ship missiles and aircraft. The CIWS has a combined coverage of 360°, while the RAMs each have 360 ˚ of coverage. The topside arrangement is shown in Figure 4 and the arcs of fire coverage are shown in Figure 5.

The SOF ship will also have a Global Command and Control System: Maritime (GCCS-M) and Joint Maritime Communication and Information System (JMCIS). All systems must be compliant with the Defense Information Infrastructure (DII) and Common Operating Environment (COE). Furthermore, an additional Command and Control Center is located aft on the C Deck directly under the superstructure for ease of access.

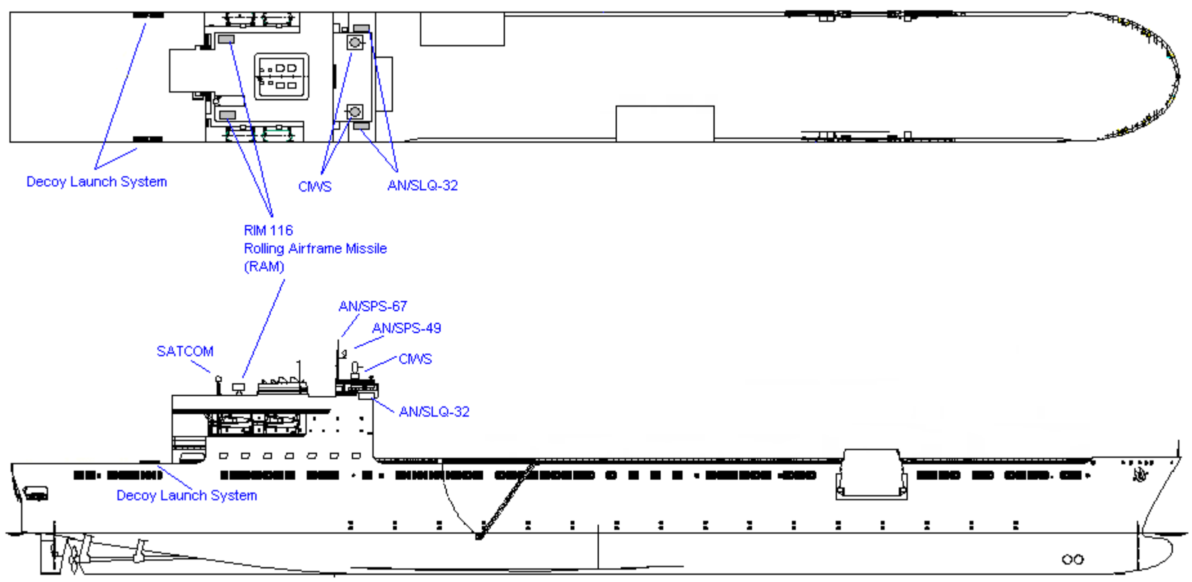


**Figure 4. SOF Ship Topside Arrangement**

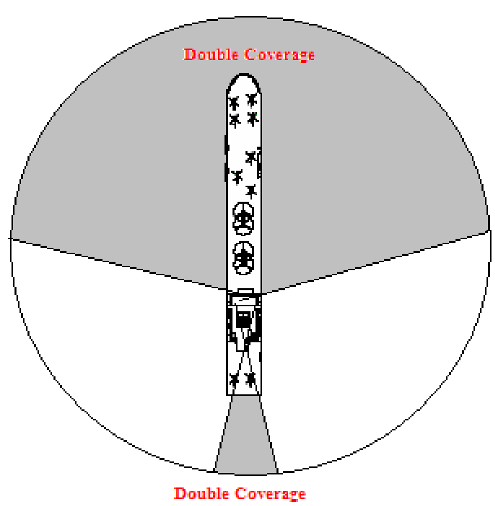


**Figure 5. CIWS Arcs of Fire**

### 4.1.3 Propulsion, Electrical, and Auxiliary Systems

The SOF ship design does not alter the engineering plant or any systems in the machinery rooms as shown in Figure 6. The LMSR installed power meets maximum speed and requirements set forth by the sponsor. The propulsion plant has four Colt Pielstick 10 PC4.2V diesel engines (65,160 hp) driving two shafts with controllable pitch propellers. Similarly, most of the electrical distribution system will remain untouched. The LMSR is equipped with four ship's service Wartsilla diesel generators. Each generator delivers 4160V, 60Hz, three phase, and 3500kW. The LMSR electrical power generation system was built with nearly 50% excess capacity. This was done to accommodate redundancy in the event of the loss of a generator. Removing the topside cranes and ramp, as well as the internal deck ramps, will further reduce the demand for electrical loading. The addition of the hotel loads and communication equipment will add to the total loading of the ship, but there should still be sufficient capacity to provide reliability. The emergency diesel generator originally located in the superstructure was moved forward to Hold 1 between frames 20 and 33 above the waterline to maintain emergency response capability. The emergency diesel generator delivers 480 V, 60 Hz, three phase, and 1625 kW.

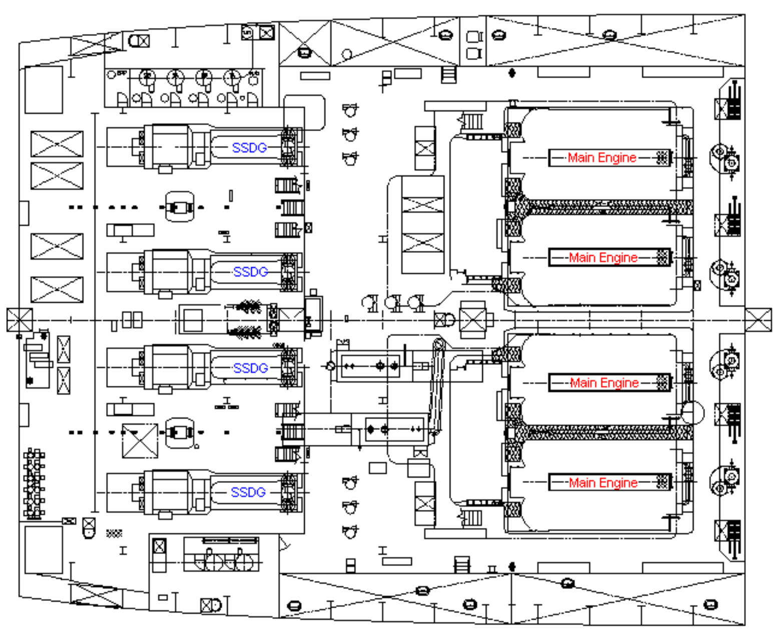


**Figure 6. LMSR Middle Level Machinery Arrangement**

### 4.1.4 Survivability and Signatures

The damaged stability criterion for DD-079 is based on flooding 15% of the Length Between Perpendiculars (LBP), whereas the damaged stability criterion for the American Bureau of Shipping (ABS) is based on 3 compartment flooding. ABS requirements were met when the ship was built. Also, flooding of two compartments is more than 15% of the LBP.

There is no need for signature reduction measures since the ship operates as a mobile offshore platform for SOF operations. Additionally, there is no need for design for shock and other combat related survivability standards.

### 4.1.5 Manning

The LMSR has a base crew of 30 civilian MSC personnel. It was very important to maintain segregation between crew manning and SOF manning so as not to interfere with the ship's routine.

Manning requirements for SOF are classified. The SOF ship does, however, carry a separate air and boat crew. The assumption was made that manning would be similar to that of an LPH for embarked troops. As a result, berthing and messing facilities were provided for 1800 enlisted personnel and 200 officers. SOF will provide additional personnel for all mission related and hotel servicing functions. When the SOF depart the ship, minimal manning will be required. Caretakers will board to perform routine ship maintenance.

### 4.1.6 Arrangements

#### 4.1.6.1 General Arrangements

Comparison of available area in the spaces considered for modification shows that sufficient space is available. Required space estimates come from approximations made for SOF mission items detailed in the Surface Ship Classification Summary (SSCS) breakdown. Table 13 lists the available space in the modified compartments and the required space for the SOF equipment and components. Appendix C contains a breakdown of the available area versus the area required for the SOF ship.

**Table 13. Space Balance**

| Available Space | | |
|---|---|---|
| Compartment | Area (ft2) | Volume (ltons) |
| Total Available | 397,413 | 14,080 |
| **Required Space** | | |
| Payload Type | Area (ft2) | |
| Mission Support | 170,476 | |
| Human Support | 103,496 | |
| Ship Support | 40,007 | |
| Ship Machinery System | 52,167 | |
| **Tanks** | | Volume (ltons) |
| Freshwater Tanks | | 1,231 |
| Seawater Tanks | | 2,173 |
| Diesel Oil Tanks | | 4,361 |
| JP-5 | | 1,043 |
| Miscellaneous Tanks | | 456 |
| Lube Oil Tanks | | 134 |
| Total Required | 366,146 | 9,398 |

### 4.1.6.2 Inboard Profile

#### 4.1.6.2.1 Deck Plans

Due to a significantly different role, the SOF ship does not require the large stores handling apparatus of the LMSR. The two large cranes and all other deck obstructions were removed from the A deck to create a flight deck. The structural support for the flight deck is actually 3 feet higher than the original A deck, thus allowing the creation of catwalks within the original hull structure of the ship. This is important because it allows the SOF ship to retain its PANAMAX capability. The catwalks were included to allow for safe personnel movement around the flight deck, aircraft servicing and fueling stations, and damage control casualties.

Flight deck areas are located both forward and aft of the deckhouse. The primary landing areas are located forward of the deckhouse. Two aircraft elevators are located in the forward flight deck area. The starboard elevator is located near midships, and the port elevator is just forward of the deckhouse. These are sized to accommodate the large helicopters that could be utilized by a SOF group. A smaller secondary landing area is located directly aft of the deckhouse. There is no direct access to the aircraft elevators from this area, but there is a small hangar built into the rear of the deckhouse. This area is large enough to support major maintenance to one small helicopter.

The ability to create a large flight deck was a primary concern when selecting a platform for the SOF ship. Figure 7 shows scale comparisons of CVN68, LMSR (SOF ship configuration), and LHD1. The reconfiguration of the SOF ship provides a flight deck area comparable to that of the LHD.

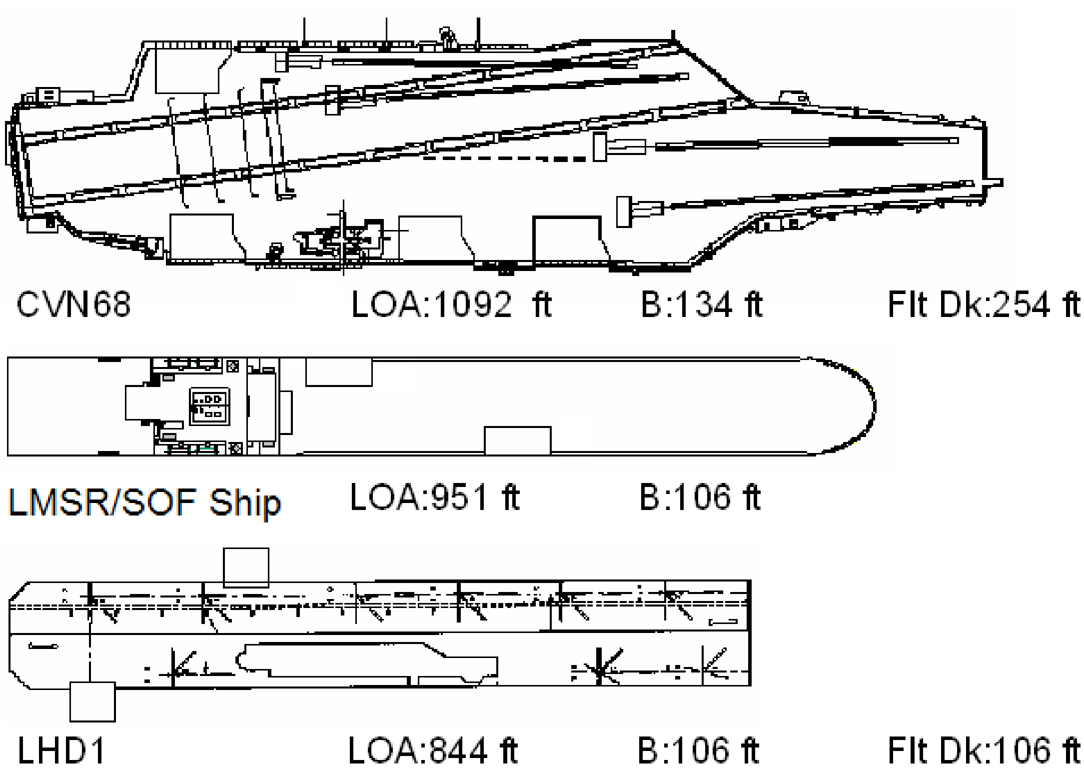


**Figure 7. Topside Arrangement Comparison**

The B deck is the hangar bay. Figure 8 shows a potential arrangement for decks A through E. The spaces contain descriptions of general departments and crew comforts found aboard a typical navy vessel, but do not contain all allocated spaces. For a complete space allocation breakdown, see Appendix C. Aircraft access to the hangar bay is via the two elevators described above. Forward of the elevators are boat ramps on both the port and starboard sides, the center of which is at frame 37. Inboard of the ramps are storage locations for a number of helicopters. Helicopters can be stored between frames 50 and 92. At frame 58, a cargo elevator is located centerline which connects to the F deck and all intervening decks. Between frames 92 and 96 the machinery exhaust stacks are found centerline; these stacks extend from the C deck to the top of the deckhouse. Between frames 99 and 113, additional helicopters can be stored.

The C deck contains departmental areas, officer country, and briefing rooms. The ship's store and barber are located between frames 20-33. Medical/Dental and the library/chaplain (frames 33 and 50), briefing rooms and air/weapons departments (frames 50-65), officer country and SCIF rooms (frames 65-85), CIC/Ops and Radio/Crypto spaces (frames 85-99), and supply and personnel departments (frames 99-113) are located on opposite sides of centerline between the given frames. The steering gear is positioned between frames 113 and 117.

The D deck contains the gym, crew berthing, crew galley and mess, machinery room and auxiliary machinery room. The gym is located between frames 20-33. Crew berthing (frames 33 and 50), crew galley and mess (frames 50-65), crew berthing (frames 65-85), machinery room (frames 85-99), and auxiliary machinery room (frames 99-113) are located on opposite sides of centerline between the given frames.

The E deck contains EDG room, general stores, reefer stores, food stores, MAA/Brig, armory, machinery room and auxiliary machinery room. The EDG room is located between frames 20-33. General stores (frames 33 and 50), reefer stores and food stores (frames 50-65), MAA/Brig and armory (frames 65-85), machinery room (frames 85-99), and auxiliary machinery room (frames 99-113) are located on opposite sides of centerline between the given frames.

The F deck contains general stores, weapons magazine, machinery room and auxiliary machinery room. The general stores are located between frames 33-50 weapons magazine (frames 50-85), machinery room (frames 85-99), and auxiliary machinery room (frames 99-113) are located on opposite sides of centerline between the given frames.

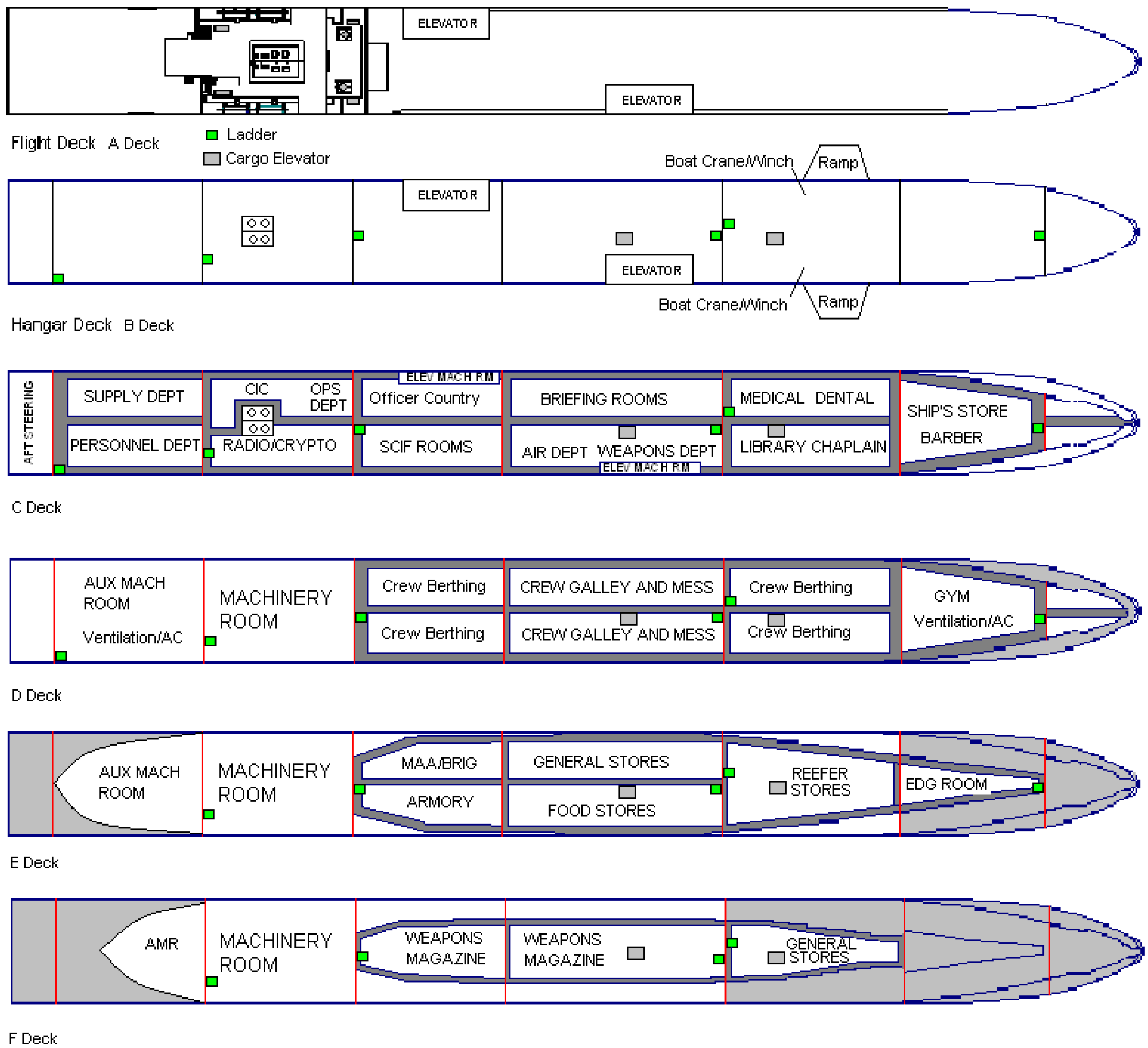


**Figure 8. SOF Ship Deck Layouts**

### 4.1.6.2.2 Deckhouse Plans

The deckhouse is largely unchanged. The emergency diesel generator was relocated from the deckhouse to the most forward space on the E Deck. This allowed for creation of Command and Control (02 and 03 levels) with easy access to passageways. The 04 level is now primary flight control. The licensed and unlicensed civilian crew berthing remains in the deckhouse. The deckhouse plans are illustrated in Figures 9a through 9f.

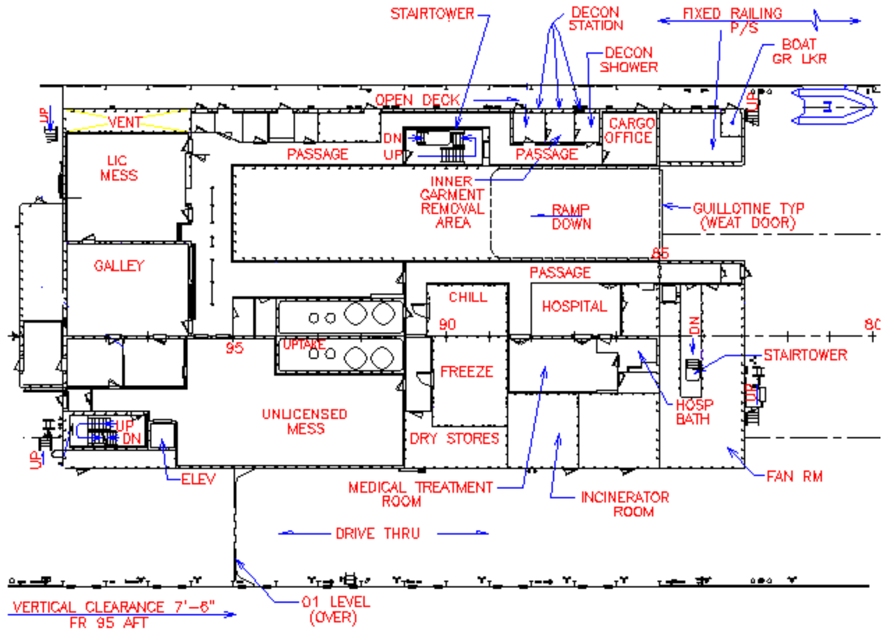


**Figure 9a. Deckhouse Layout-A Deck**

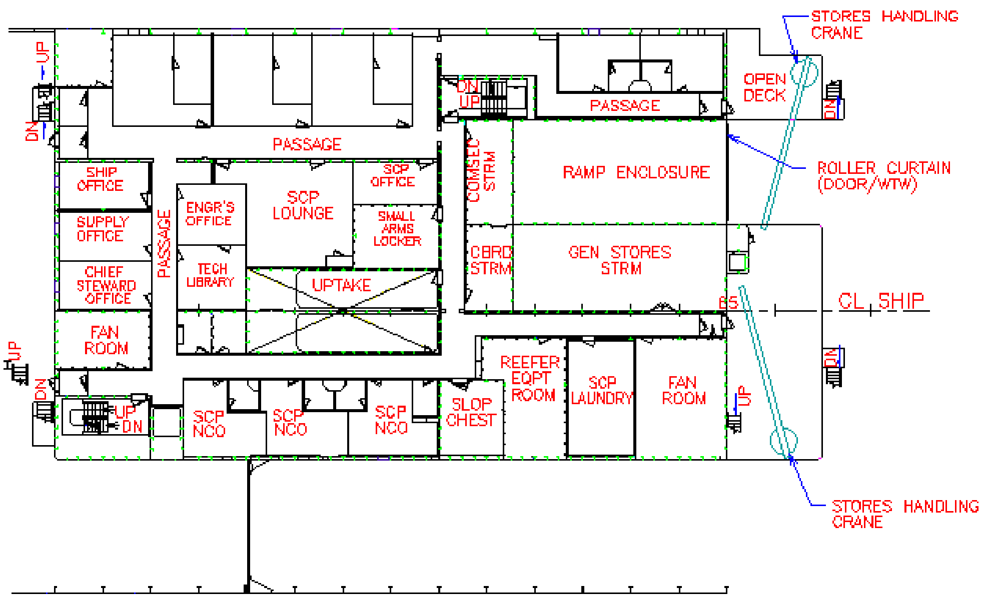


**Figure 9b. Deckhouse Layout-01 Level**

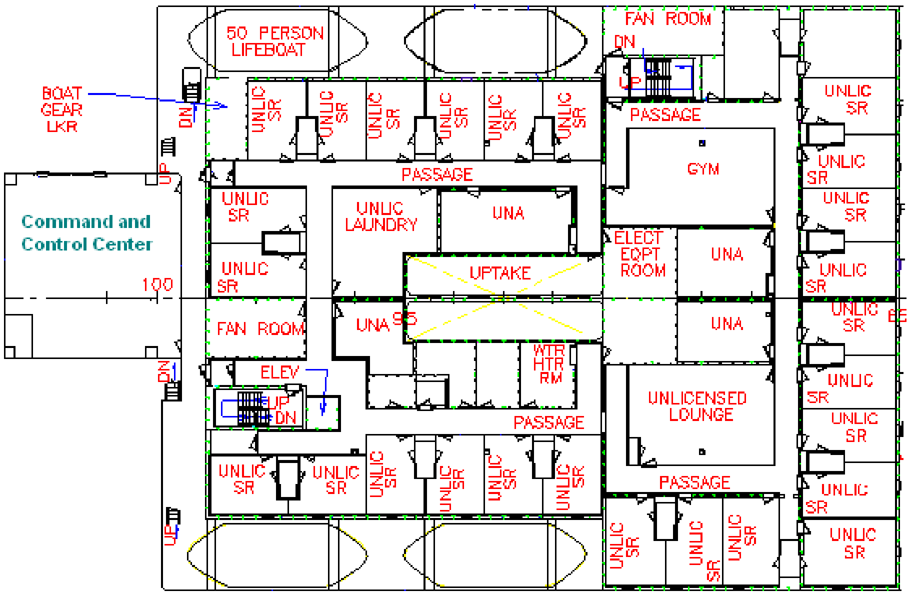


Figure 9c. Deckhouse Layout-02 Level

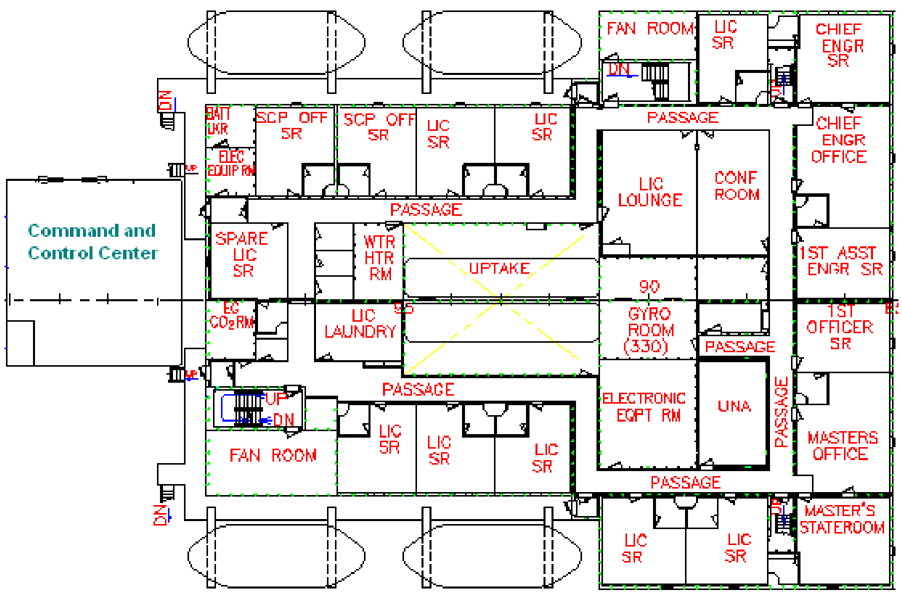


Figure 9d. Deckhouse Layout-03 Level

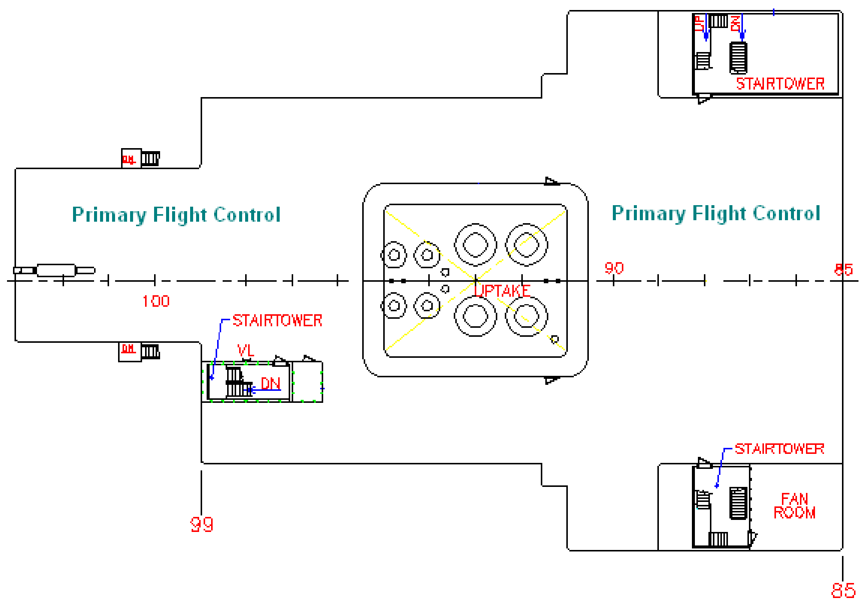


Figure 9e. Deckhouse Layout-04 Level

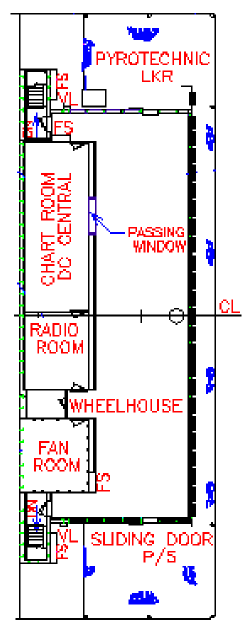


Figure 9f. Deckhouse Layout-05 Level

### 4.1.6.3 Tank Layouts

The tank layouts are as depicted in Figure 10 below. Diesel oil (4928 ltons) and seawater ballast (6304 ltons) are well distributed throughout the ship. JP-5 (1600 ltons) for the helicopters is located just forward of frame 65 in six tanks outboard of centerline and extending to the hull. Freshwater (1381 ltons) is located in six tanks just aft of frame 99. Lube oil and miscellaneous service tanks contain 136 and 466 ltons respectively.

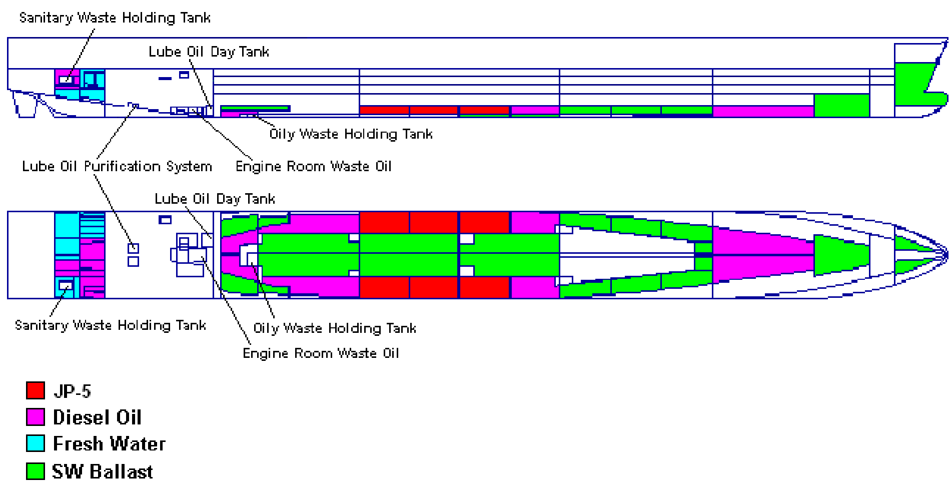


**Figure 10. SOF Ship Tank Layouts**

### 4.1.7 Structural Design

#### 4.1.7.1 Midship Section Concept Design

There are two classes of LMSR ships, the Bob Hope class built by Avondale Industries and the Watson class built by National Steel Shipbuilding Company (NASSCO). The design of the midship section was largely based on the section generated by the POSSE Watson class files. The Bob Hope class files were unavailable in Version 2 of POSSE. As a result, the Watson class midship section was modified to reflect the differences between the classes. The greatest difference is the A-B deck configuration. The Watson class ships have a fixed A-B deck, whereas the Bob Hope class ships have a hoistable A-B deck. The hoistable A-B deck made the Bob Hope class more desirable for the SOF platform because it simplifies the creation of a hangar deck. Figure 11 shows the structural design of the midship section defined using POSSE after modifications were made. The strength of the new design was tested using the POSSE Intact and Damaged Stability Modules.

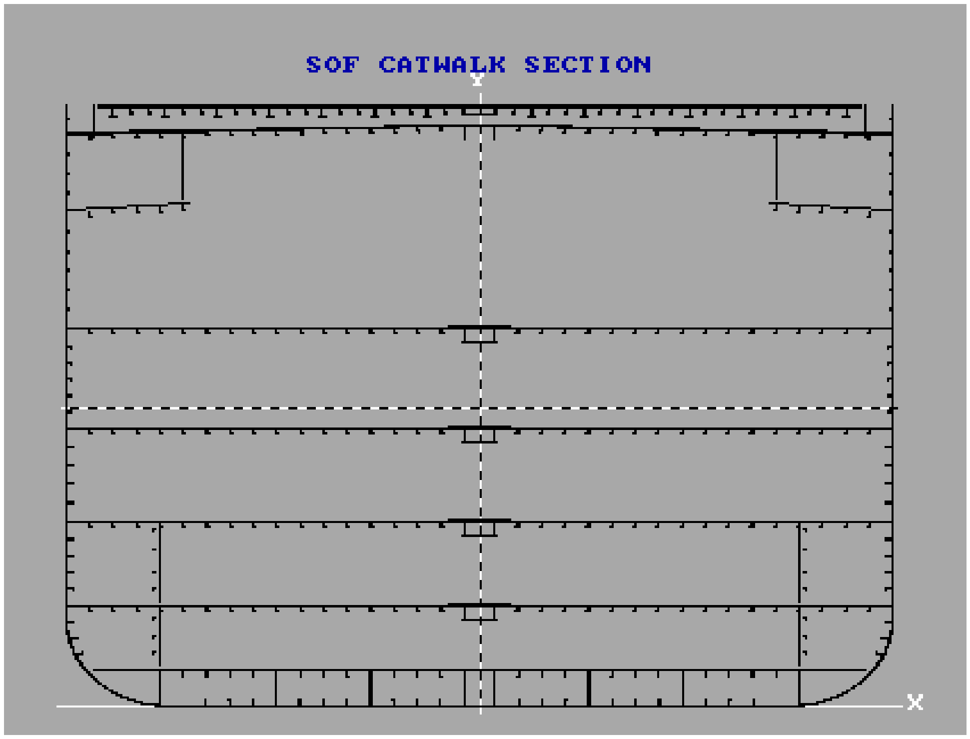


**Figure 11. SOF Ship Midship Section Structure**

### 4.1.7.2 Flight Deck Modifications

The SOF ship design will not change the essential LMSR structural design and will add a flying deck three feet above the current A or Weather deck. The flight deck will be built in modular sections for ease of installation and for cost minimization. The flight deck was built four feet narrower than the full beam of the A Deck. This provided space for catwalks within the original hull structure of the ship. The catwalks extend from Frame 28 to Frame 80, with exception of the elevators which run to the hull of the ship. This catwalk design is important because it allows the SOF ship to retain its PANAMAX capability. The catwalks were included to allow for safe personnel movement around the flight deck, helicopter fueling stations, and damage control casualties. Also, drains were installed around the flight deck and catwalks for removal of green water on deck.

#### 4.1.7.3 Section Properties

The properties of the new sections lower the center of gravity as well as the section total area and moments of inertia. Overall, the properties of the section modulus remain unaffected. Table 14 makes a comparison between the values of the LMSR and the SOF ship mid-ship section.

**Table 14. LMSR to SOF Ship Comparison**

| | LMSR | SOF |
|---|---|---|
| Area | $.76 \times 10^4$ [in$^2$] | $1.3 \times 10^5$ [in$^2$] |
| $I_{xx}$ | $8.9 \times 10^6$ [in$^2$-ft$^2$] | $1.6 \times 10^7$ [in$^2$-ft$^2$] |
| Dist. To upper extreme fiber | 47.48 [ft] | 47.31 [ft] |
| Section Modulus Upper Flg | $1.8 \times 10^5$ [in$^2$-ft] | $3.3 \times 10^5$ [in$^2$-ft] |
| Dist. To lower extreme fiber | 48.65 [ft] | 46.26 [ft] |
| Shear Area *y* | 2027.4 [in$^2$] | 4345.5 [in$^2$] |
| $I_{yy}$ | $2.7 \times 10^6$ [in$^2$-ft$^2$] | $1.5 \times 10^7$ [in$^2$-ft$^2$] |
| Dist. To left extreme fiber | 29.28 [ft] | 52.95 [ft] |
| Section Modulus Left Flg | $9.2 \times 10^4$ [in$^2$-ft] | $2.9 \times 10^5$ [in$^2$-ft] |
| Dist. To right extreme fiber | 27.51 [ft] | 52.95 [ft] |
| Section Modulus Right Flg | $9.8 \times 10^4$ [in$^2$-ft] | $2.9 \times 10^5$ [in$^2$-ft] |
| Shear Area *x* | 5681.1 [in$^2$] | 9496.5 [in$^2$] |

From the table analysis, it can be predicted that the converted ship sections are going to have similar, if not lower, due to increased cross-sectional area, stresses over its structure when compared to the LMSR under the same applied loads.

### 4.1.8 Weights and Margins

#### 4.1.8.1 Weight and Stability Modifications for Lightship

The total weight removed from the LMSR by the deletion of all the elements stated above was 1,452.02 ltons. The weight added for conversion was 7,421.54 ltons. This included a weight margin of 10% which was incorporated into each SWBS weight breakdown. The main contribution for the added weight came from the flying deck structure, which is symmetric with respect to the ship's centerline and from the C4I equipment located in both the modified superstructure and C deck configuration. A lightship weight summary is presented in Table 15.

Removing the topside cranes, the aft ramp, the topside fan rooms, and relocating the emergency diesel generator contributed to lowering the VCG. From the stability standpoint the weight removed has a center of gravity well above the VCG, near amidships and close to the centerline. Its values were:

- Removed $w_{vcg}$ BL: 95.96 ft.
- Removed $w_{lcg}$ FP: 712.86 ft
- Removed $w_{tcg}$ CL: 0.93 ft.

Adding berthing accommodations, weapons magazines, increased ventilation and air conditioning systems, and relocating the emergency diesel generator also lowered the VCG. The addition of the two elevators contributed to moving the LCG forward. The values obtained were:

- Added $w_{vcg}$ BL: 58.09 ft.
- Added $w_{lcg}$ FP: 317.36 ft
- Added $w_{tcg}$ CL: 2.28 ft.

The final stability conditions produce a TCG of 0.65 ft to starboard, an LCG of 441.7 ft, and a KG of 45.67 ft. The results are very similar to the LMSR Lightship conditions, and as such fulfill all the stability requirements. The lightship weight distribution can be seen in Figure 12. The final stability parameters and a comparison between the original and modified ship are shown in Table 15.

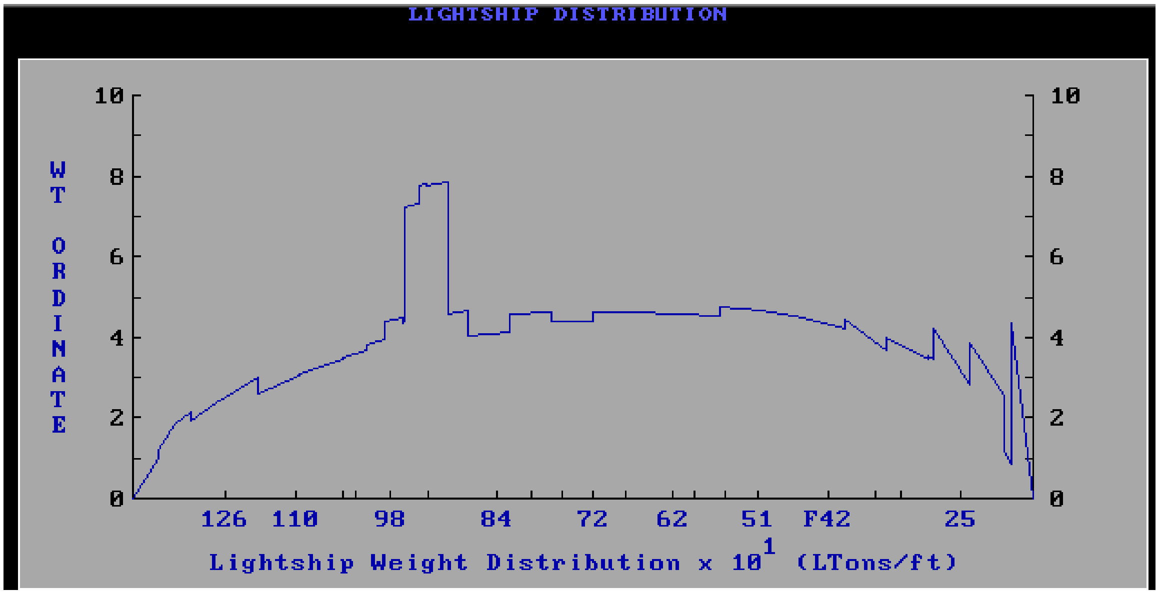


**Figure 12. Lightship Weight Distribution**

**Table 15. LMSR & SOF Ship Stability Parameters Comparison**

| | **LMSR** | **SOF** |
|---|---|---|
| Lightship Displacement | 33,026 Ltons | 37,681 Ltons |
| Lightship KG | 44.47 ft | 45.67 ft |
| Lightship LCG | 496.87 ft. | 441.70 ft. |
| Lightship TCG | 0.32 ft. | 0.65 ft. |

#### 4.1.8.2 Tank Modifications

To provide aircraft refuel capacity, six DO side tanks were converted to JP-5. The total JP-5 capacity is 1,043 ltons. For comparison purposes, the LHD carries approximately 1,232 ltons of JP-5 on board. Similary, the SOF ship has 4,619 ltons of diesel oil, whereas an LHD carries approximately 6,000 ltons. The ship's maximum range will be reduced slightly due to the DO tanks modification, however, because the full load displacement decreased by approximately 14,000 ltons, the SOF ship should still have a maximum range of 10,000+ nm. The full load draft also decreased by approximately 9 feet, resulting in less hull resistance on the ship. This further increases the range of the SOF ship. This decrease in draft does not, however, disturb any seawater inlets or outlets for the machinery room equipment.

#### 4.1.8.3 Weight Summary

The full load and minimum operating conditions were evaluated for both intact and damaged stability. Table 16 lists a breakdown of weights for each of these conditions.

The full load condition assumes the following:

- One empty fuel tank
- Compensated ballast to account for empty fuel tank if necessary
- Fresh water reduced by 1/3
- Crew and effects remain unaffected
- Misc. Related Expenditures remain unaffected
- Ships Stores remain unaffected.

The minimum operating condition assumes the following:

- Total fuel reduced by 2/3
- Compensated ballast to account for empty fuel tank if necessary
- Fresh water reduced by 1/3
- Crew and effects remain unaffected
- Misc. Related Expenditures reduced by 2/3
- Ships Stores reduced by 2/3.

*Source: Stability and Buoyancy: DDS 079-2*

**Table 16. LMSR & SOF Ship Stability Parameters Comparison**

| Weight (ltons) | Full Load | Minimum Operating |
|---|---|---|
| Lightship Weight | 37,681 | 37,681 |
| Crew and Effects | 360 | 360 |
| Mission Related Expenditures | 120 | 40 |
| Helo | 127 | 127 |
| Boats | 117 | 117 |
| Ships Stores | 678 | 224 |
| Medical | 19 | 19 |
| Dry Stores | 260 | 86 |
| Freeze Stores | 180 | 59 |
| Fuels and Lube Oil | 6,274 | 4,289 |
| Fresh Water | 925 | 455 |
| Clean Ballast | 1,741 | 2,687 |
| Miscellaneous | 456 | 307 |
| Total Displacement | 48,937 | 46,452 |

The tank weight summary for both the full load and the minimum operating condition is included in Appendix D.

### 4.1.9 Intact Strength and Stability Analysis

The intact stability analysis was conducted using the POSSE modified Watson class files. Every loading condition described previously was tested under the next three different conditions:

- Still water
- 100 knots wind
- High Speed Turn. 24 knots, Radius of turn 3000 ft.

The results were satisfactory for every case. Table 17 shows the stability results for the cases described. It is important to highlight that the SOF ship model has a better stability performance than the Watson does for the three conditions described. Figure 13 shows the worst case GZ curve, the high speed turn for the minimum operating condition.

**Table 17. Intact Stability results**

| | Disp. [ltons] | KG [ft] | Mean Draft [ft] | Trim [ft] | GZ Max [ft] | Heel Angle Still Water | Heel Angle 100kt wind | Heel Angle High Speed Turn | Propeller Immersion |
|---|---|---|---|---|---|---|---|---|---|
| Full Load | 48,937 | 39.98 | 27 ft 9.7 in | 0.20 A | 8.00 @ 38.4$^o$ | 0.1$^o$ Port | 0.9$^o$ | 2.2$^o$ | 114 % |
| Min Op Cond | 46,452 | 40.92 | 26 ft 8.3 in | 0.35 A | 7.13 @ 38.3$^o$ | 0.4$^o$ Stbd | 1.4 $^o$ | 2.8 $^o$ | 109 % |

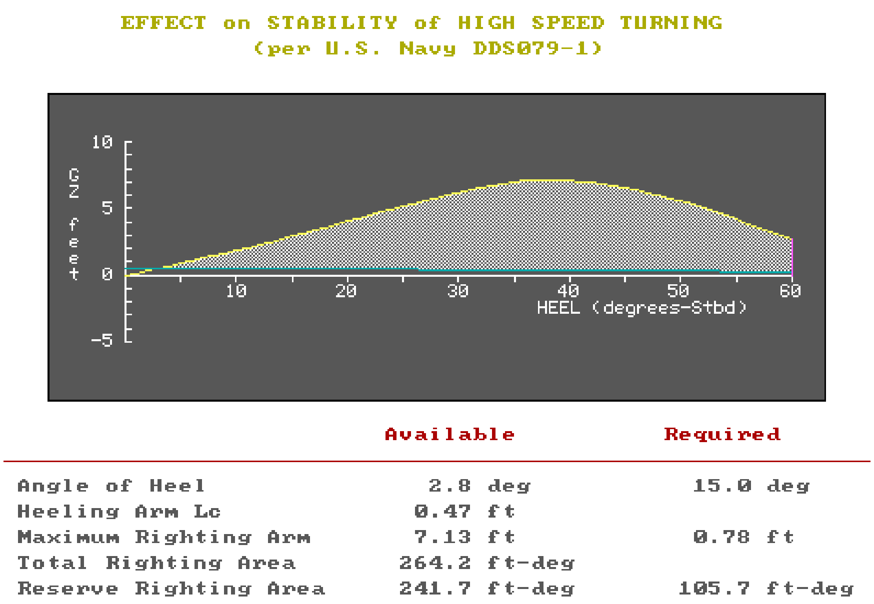


**Figure 13. GZ Curve for Intact Stability in Stillwater**

The POSSE Intact Stability Module does not simulate the ship behavior in waves or under severe weather conditions. The Salvage Module is used for this purpose as well as for assessing damage due to flooded compartments. For the non-damaged case, the procedure is to damage a small compartment that will not affect stability during hogging and sagging cases so that wave and wind conditions can be applied. The hull strength was also tested using the POSSE Intact Module for stillwater conditions indicated in the stability analysis. The stresses were found to be very close for both the full load and minimum operating conditions. The hogging condition has the highest stresses, and they are significantly higher than the sagging conditions. This can be attributed a higher loading density distribution in the fore and aft parts of the ship to maintain trim and stability. Table 18 shows a summary of the strength analysis for the two loading cases analyzed. Figure 14 shows full load shear and bending stresses. A complete report of all intact stability case results and diagrams are included in Appendix E.

**Table 18. Stress Comparison**

| **Sea Condition** | **Stress (ksi)** | **Full Load** | **Minimum Operating Condition** |
|---|---|---|---|
| Stillwater | Shear | -3.47 | -3.53 |
| | Bending, at Deck | 7.72 | 7.85 |
| | Bending, at Keel | -8.46 | -8.62 |
| Hogging | Shear | -5.36 | -5.31 |
| | Bending, at Deck | 14.95 | 15.09 |
| | Bending, at Keel | -16.23 | -16.31 |
| Sagging | Shear | -1.70 | -1.70 |
| | Bending, at Deck | -2.72 | -2.32 |
| | Bending, at Keel | 2.74 | 2.34 |

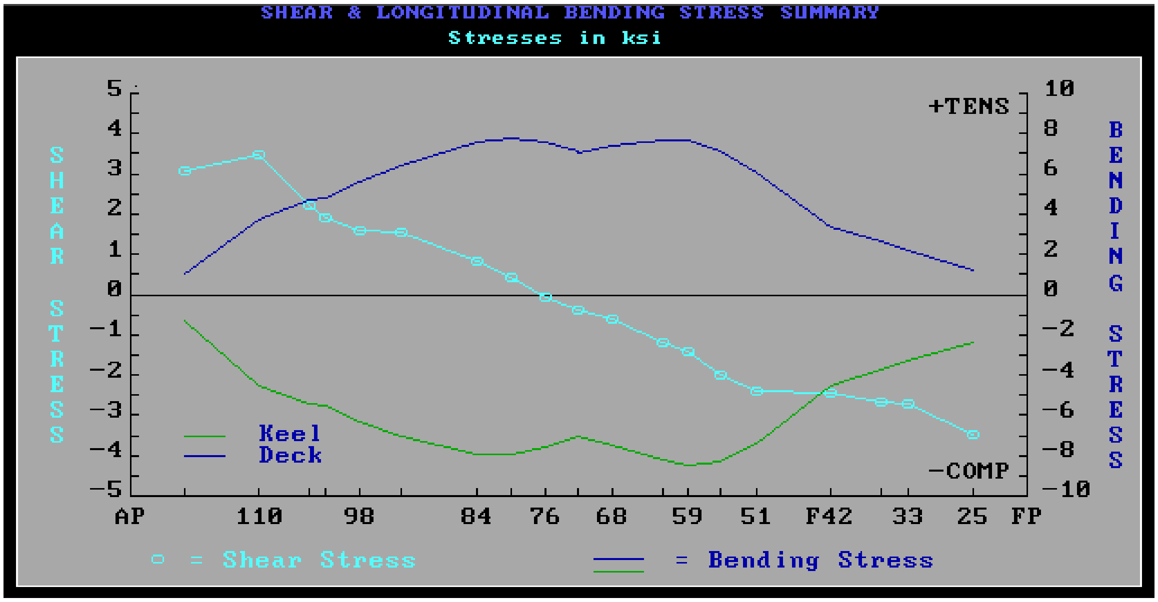


**Figure 14. Full Load Shear & Bending Stresses for Intact Stability in Stillwater**

### 4.1.10 Damaged Stability and Strength Analysis

#### 4.1.10.1 Damaged Stability Analysis

The Salvage Module is used to assess the effects of flooding compartments. Large compartments are flooded to check the worst condition that the ship can withstand. The wave height used in this analysis was $1.1 \cdot \sqrt{LBP}$. The wavelength is the LBP and its crest position was defined to test stillwater, hogging, and sagging conditions. Damaged stability was assessed for three cases: damage forward, amidships, and aft. The limiting case was two compartment flooding for each section. The analysis considered the same loading cases defined previously. The wave and wind settings were:

- Wave height: 32.7 feet
- Wave length: 884 feet
- Wind speed: 100 knots

The stability results for full load and minimum operating conditions are listed in Tables 19 and 20 respectively. The stability values show that the SOF ship is extremely stable under extreme conditions. The worst case condition occurs with damage to the midship section during a hogging condition. Overall, the ship will experience its worst heel angle of 5.2

degrees while hogging during minimum operating conditions. Figures 15 and 16 show the worst case GZ curves for the damaged full load and minimum operating conditions under wind-wave effects.

**Table 19. Damaged Stability Results for Full Load Case Under Severe Wind and Wave Conditions**

| Condition | | GMt [ft] | GZ max [ft] | Static Heel Angle [deg] | Wind Heel Angle [deg] | Range of positive GZ [deg] | Freeboard to margin line [ft] |
|---|---|---|---|---|---|---|---|
| Stillwater | Damage Fwd | 11.16 | 7.19 @37.0S° | 0.1S° | 0.9S° | > 59.9 ° | 53.65 |
| | Damage Mid | 10.34 | 4.83 @32.3S° | 0.6S° | 1.1S° | > 59.4 ° | 41.78 |
| | Damage Aft | 8.12 | 6.11 @37.9P° | 0.1P° | 1.4P° | > 59.9 ° | 62.62 |
| Hogging | Damage Fwd | 7.85 | 5.29 @39.0S° | 0.1S° | 1.6S° | > 59.9 ° | 67.08 |
| | Damage Mid | 6.55 | 2.31 @35.7S° | 1.0S° | 1.7S° | > 58.0 ° | 39.22 |
| | Damaged Aft | 7.61 | 5.22 @38.9P° | 0.1P° | 1.8P° | > 59.9 ° | 64.44 |
| Sagging | Damage Fwd | 17.28 | 7.90 @35.1S° | 0.0S° | 0.4S° | > 60.0 ° | 35.43 |
| | Damage Mid | 15.52 | 5.98 @32.5S° | 0.4S° | 0.8S° | > 59.6 ° | 39.91 |
| | Damaged Aft | 10.40 | 5.68 @37.5S° | 0.8S° | 1.6S° | > 59.2 ° | 46.88 |

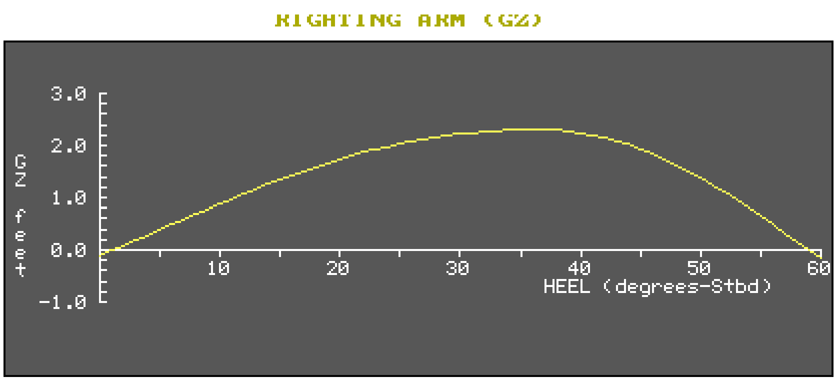


**Figure 15. GZ Curve for Damaged Full Load under Wind-Wave Conditions**

**Table 20. Damaged Stability Results for Minimum Operating Case Under Severe Wind and Wave Conditions**

| Condition | | GMt [ft] | GZ max [ft] | Static Heel Angle [deg] | Wind Heel Angle [deg] | Range of positive GZ [deg] | Freeboard to margin line [ft] |
|---|---|---|---|---|---|---|---|
| Stillwater | Damage Fwd | 10.32 | 6.53 @36.4S° | 0.4S° | 1.4S° | > 59.6 ° | 53.59 |
| | Damage Mid | 9.09 | 4.25 @32.1S° | 2.5S° | 3.1S° | > 56.5 ° | 42.90 |
| | Damage Aft | 7.09 | 5.28 @37.4P° | 0.6P° | 2.3P° | > 59.4 ° | 63.15 |
| Hogging | Damage Fwd | 6.85 | 4.67 @38.0S° | 0.6S° | 2.5S° | > 59.4 ° | 68.52 |
| | Damage Mid | 6.19 | 1.65 @34.8S° | 4.1S° | 5.2S° | > 49.5 ° | 39.38 |
| | Damaged Aft | 6.44 | 4.49 @37.9P° | 0.7P° | 2.9P° | > 59.3 ° | 65.76 |
| Sagging | Damage Fwd | 17.42 | 7.29 @34.1S° | 0.2S° | 0.6S° | > 59.8 ° | 35.97 |
| | Damage Mid | 15.22 | 5.40 @31.7S° | 1.5S° | 1.9S° | > 58.5 ° | 41.86 |
| | Damaged Aft | 8.88 | 4.98 @36.4S° | 0.3S° | 1.3S° | > 59.7 ° | 48.59 |

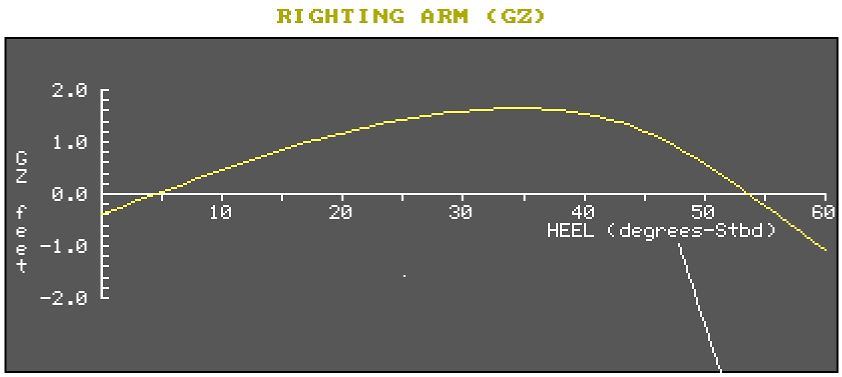


**Figure 16. GZ Curve for Damaged Minimum Operating under Wind-Wave Conditions**

#### 4.1.10.1.1 LMSR and SOF Ship Stability Comparison

Table 21 compares the stability results for the SOF ship and LMSR when operating under similar full load conditions. The SOF ship has better stability performance than the LMSR. Removal of the topside cranes compensates for the addition of the flight deck. This can be seen from the GM results for the SOF ship. The slight difference in GM makes the modified LMSR ship better in stability than the original Watson class ship.

**Table 21. Weight and KG Comparison**

| | | LMSR | SOF |
|---|---|---|---|
| Displacement | | 62,069 ltons | 48,937 ltons |
| KG | | 45.29 feet | 39.98 feet |
| Draft, Amidships | | 37 ft | 27.8 ft |
| Trim | | 0.99 feet | 0.20 feet |
| $GM_t$ (corrected) | | 7.61 feet | 11.94 feet |
| $GZ_{MAX}$ | | 5.61 feet | 8.00 feet |
| Damage Forward | Initial $GM_t$ | 7.14 feet | 11.16 feet |
| | $GZ_{MAX}$ | 4.88 feet | 7.19 feet |
| Damage Amidship | Initial $GM_t$ | 8.99 feet | 10.34 feet |
| | $GZ_{MAX}$ | 2.96 feet | 4.83 feet |
| Damage Aft | Initial $GM_t$ | 3.53 feet | 8.12 feet |
| | $GZ_{MAX}$ | 3.24 feet | 6.11 feet |

#### 4.1.10.2 Damaged Strength Analysis

The hull strength was also tested using the POSSE Salvage Module under the same loading conditions indicated in the stability analysis. The worst case scenario was found for the hogging, full load condition operating under extreme wind and wave conditions. Tables 22 and 23 show a summary of the strength analysis for the two loading cases analyzed. Figures 17 and 18 show the worst case shear and bending stress curves for the damaged full load and minimum operating conditions under wind-wave effects. A complete report of all damaged case results and diagrams are included in Appendix F.

**Table 22. Damaged Stability Results for Full Load Case Under Severe Wind and Wave Conditions**

| Condition | | Shear Stress [ksi] | Deck Bending Stress [ksi] | Keel Bending Stress [ksi] |
|---|---|---|---|---|
| Stillwater | Damage Fwd | -4.95 | 11.42 | -12.63 |
| | Damage Mid | 2.71 | 3.38 | -3.93 |
| | Damage Aft | -3.51 | 7.70 | -8.52 |
| Hogging | Damage Fwd | -5.49 | 15.28 | -16.62 |
| | Damage Mid | 4.11 | 7.09 | -7.68 |
| | Damaged Aft | -4.61 | 13.13 | -14.41 |
| Sagging | Damage Fwd | -5.44 | 6.67 | -7.74 |
| | Damage Mid | 3.41 | -8.63 | 9.43 |
| | Damaged Aft | -2.44 | 3.76 | -4.12 |

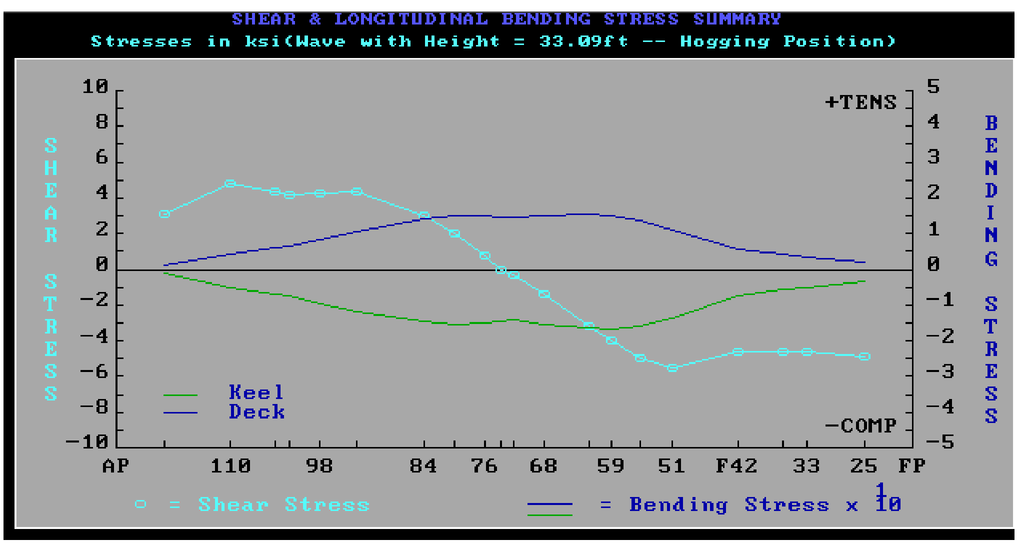


**Figure 17. Damage Full Load Shear & Bending Stresses, Hogging**

**Table 23. Damaged Stability Results for Minimum Operating Case Under Severe Wind and Wave Conditions**

| Condition | | Shear Stress [ksi] | Deck Bending Stress [ksi] | Keel Bending Stress [ksi] |
|---|---|---|---|---|
| Stillwater | Damage Fwd | -4.95 | 11.76 | -13.00 |
| | Damage Mid | 2.91 | 7.12 | 4.51 |
| | Damage Aft | -3.59 | 8.08 | -8.88 |
| Hogging | Damage Fwd | -5.55 | 15.68 | -16.98 |
| | Damage Mid | 3.90 | 14.07 | 10.84 |
| | Damaged Aft | -4.67 | 13.55 | -14.77 |
| Sagging | Damage Fwd | -5.43 | 6.85 | -7.92 |
| | Damage Mid | 3.32 | -8.40 | 9.19 |
| | Damaged Aft | -2.51 | 3.80 | -4.13 |

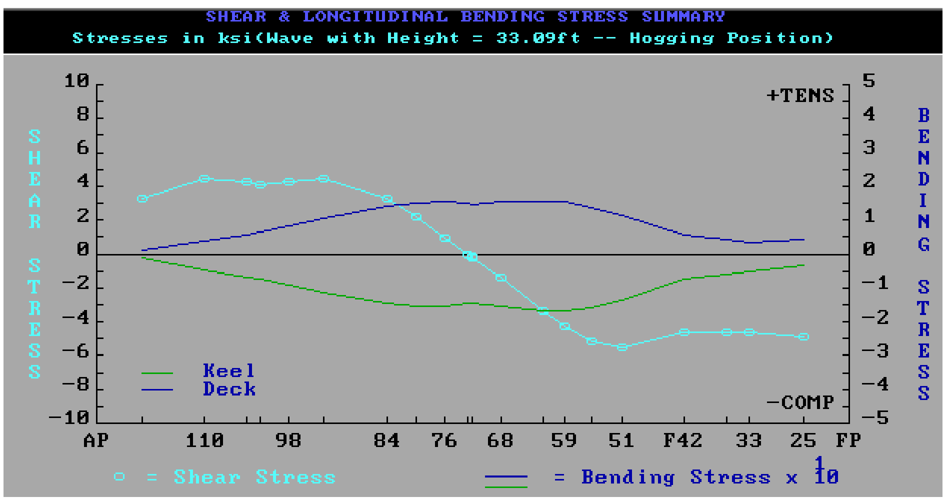


**Figure 18. Damage Minimum Operating Shear & Bending Stresses, Hogging**

### 4.1.10.2.1 Comparison of LMSR and SOF ship

The strength properties of the LMSR and SOF ship are compared below in Table 24, as determined using POSSE. The SOF ship has a significantly better performance during hogging conditions, while the sagging conditions are nearly twice as high. Overall, the SOF ship is structurally sound.

**Table 24. LMSR-SOF Stress Comparison**

| Load Condition | Sea Condition | Stress (ksi) | LMSR | SOF |
|---|---|---|---|---|
| Full Load | Hogging | Shear | 8.84 | -5.49 |
| | | Bending, at Deck | 34.25 | 15.28 |
| | | Bending, at Keel | -24.77 | -16.62 |
| | Sagging | Shear | 1.48 | 3.41 |
| | | Bending, at Deck | -4.72 | -8.63 |
| | | Bending, at Keel | 4.14 | 9.43 |

The ship has a satisfactory performance for all the cases analyzed and presents better stability and structural performance than the original LMSR. The results obtained for both the Intact and Damaged Conditions indicate, from a stability standpoint, that the conversion is feasible and will have good performance in all weather conditions.

## 4.2 Performance Analysis

### 4.2.1 Mission

The primary mission of the SOF ship is to provide a platform for SOF operations. The SOF ship will act as a base of operations for the planning and execution of SOF missions ashore (insertion, close air support, extraction) and afloat (naval interdiction, capture of assets such as oil platforms).

#### 4.2.1.1 Aircraft Operations

The SOF ship will provide a platform for rotary wing and VTOL/STOVL air operations in support of SOF missions.

#### 4.2.1.2 Boat Operations

The SOF ship can act as a base for SOF boats, such as Navy Special Boat Units. The hangar deck can accommodate a 12 medium-size patrol or assault boats which can be launched by crane from the forward hangar deck ramps. SOF typically use RIBs that are 36 feet in length. Therefore, space availability for boat operations should be adequate.

### 4.2.2 Survivability and Signatures

The only major changes to the SOF ship will be the removal of the large deck cranes and the rear roll-on roll-off ramp, so it will retain the signature of the Bob Hope class LMSR. The survivability will be significantly upgraded with the addition of the Ship Self-Defense System (SSDS). The SSDS is comprised of the RIM-116 Rolling Airframe Missile (RAM), the Close-In Weapon System (CWIS), and the decoy launch system. The SSDS integrates the AN/SPS-49, the AN/SPS-67 surface search radar, the AN/SLQ-32 sensor, and the CIWS search radar into a cohesive ship defense system. The SSDS provides a high level of protection against anti-ship missiles and aircraft.

### 4.2.3 Seakeeping and Maneuvering

#### 4.2.3.1 Natural frequencies

The resonant roll and pitch frequencies were computed using standard naval architecture equations and the ship's dimensions as calculated by SWAN. All calculations are shown in Appendix G. A Pierson-Moskowitz sea spectrum was then used to relate the resonant periods to significant wave heights. These results gave a rough indication of the motion of the ship. The results are summarized in Table 25.

**Table 25. Calculated Resonant Data**

| | |
|---|---|
| $k_{roll}$ | 5.33 m |
| $k_{pitch}$ | 46.08 m |
| $k_{yaw}$ | 15.787 m |
| $\omega_{roll}$ | 0.17 Hz |
| $\omega_{pitch}$ | 0.225 Hz |
| $T_{roll}$ | 5.876 sec |
| $T_{pitch}$ | 4.454 sec |

The motions of the ship have vertical components (heave, pitch and roll) that can create serious problems, thus causing the ship to behave like a damped spring-mass system. In order to understand the nature of the ship response to sinusoidal waves, it is useful to derive the natural frequencies for heave and pitch. For ship motions, the maximum motions do not necessarily occur around synchronism. The magnitude of the exciting forces and the coefficients in the equations of motion all depend on the encounter frequency. Encounter frequency can depend on various parameters, including wavelength, ship speed, and heading. Therefore, at low frequencies, resonance can occur at very short wavelengths with a very small exciting force. However, at higher forward speeds, the frequency of encounter can cause resonance to fall within the range of wavelengths where the exciting forces are large. The T-AKR 300 Bob Hope class hull currently has good seakeeping characteristics, as it is a relatively large, heavy ship with a low KG.

#### 4.2.3.2 SWAN Analysis

The SWAN software package was used to calculate RAOs for the SOF ship. Analyses were conducted for three different ship speeds (12 kts, 18 kts, and 24 kts) and seven wave periods (6-18 sec). This provided enough permutations to accurately assess the ship's performance over most normal operating conditions. Appendix G shows the SWAN input files for the three different speeds, SWAN output files, and SWAN RAO files. The goal of the SWAN analysis was to obtain the RAO functions for the ship.

The RAO outputs from SWAN were then entered into the SWAN Integrator Excel spreadsheet. This spreadsheet calculated the Pierson-Moskowitz sea spectrum for a given wave height. A significant wave height of 3.1 meters, corresponding to sea state 5, was used in this analysis. The SWAN RAOs were also used to calculate actual ship motions (roll, pitch, heave, and heave velocity) at a location 75 ft fwd and aft of the midships on the flight deck. The spreadsheet produced plots of the sea spectrum, the RAOs, and the ship response spectrum. These plots are also shown in Appendix G for the three speeds specified.

The flight deck location was analyzed to determine the feasibility of flight operations at various speeds. The criteria to conduct flight operations were: pitch angle less than 3$^{o}$, roll angle less than 5$^{o}$, and heave velocity less than 6.5 ft/s with seas broad off the bow at 150 degrees. The results for the three speeds are summarized in Table 26.

**Table 26: Flight Deck Motions for Various Speeds**

| | Limit | 12 knots | 18 knots | 24 knots |
|---|---|---|---|---|
| **Pitch (degrees)** | 3.0 | 0.05 | 0.04 | 0.03 |
| **Roll (degrees)** | 5.0 | 0.11 | 0.12 | 0.12 |
| **Heave velocity (ft/s)** | 6.5 | 0.219 | 0.208 | 0.164 |
| **Heave (m)** | N/A | 0.11 | 0.09 | 0.08 |

The flight deck motion analysis indicates that the SOF ship can conduct flight operations in sea state 5 up to its maximum sustained speed of 24 knots. Generally, as the ship's speed increases, it becomes more stable and motions decrease. As speed increases, the maximum value of the spectrum peak decreases. Therefore, as the design currently stands, flight operations would NOT be limited at any speed in Sea State 5.

### 4.2.4 Environmental

As the conversion did not affect existing waste processing equipment, the ship maintains the same level of environmental standards and remains in compliance with US Navy policy for waste disposal. There will, however, be a need for increased sanitation equipment due the addition of SOF. All sanitation equipment installed for this conversion will meet all guidelines and environmental standards within US Navy environmental policies.

## 4.3 Operation and Support

The SOF ship crew is the same as that of the LMSR. This crew will operate the ship under all circumstances. When a SOF group is embarked, the ship's crew and SOF will operate largely independent of each other. However, as mentioned previously, SOF will be required to provide personnel to augment the ship's crew with "hotel" tasks.

## 4.4 Cost and Risk

### 4.4.1 Cost Estimation

A weight-based methodology developed by the MIT 13A program was modified and used to estimate the conversion costs. The estimate is broken down into removal costs, addition costs, shipbuilder, and government costs. Table 27 lists the major cost estimates in FY03 dollars. The model assumed a 3% inflation rate, an in-service date of 2004, and a 30-year service life. The development of the SOF model sought to be cost-effective in all decisions. Each specific modification received a cost estimate through a SWBS breakdown approximation of weights added and removed. This weight change was entered into the weight-based cost model and a variant cost was obtained. Accuracy of this variant cost is subject to change based on contractor and overhead costs. This weight-based cost analysis produced costs within sponsor requirements. If the entire removal and addition of weights was performed in the cheapest category of the SWBS breakdown groups (Hull Structure), the estimated conversion cost is 41.2 million dollars. Obviously, there are electrical and outfitting modifications that need to be performed, and these SWBS weight groups have higher Cost Equivalent Ratios (CERs) associated with them. That brings the conversion cost to 86.16 million dollars. Further investigation would need to be performed in this area to ensure that the CERs being used are accurate. The complete cost model is included in Appendix H.

**Table 27. Conversion Cost Estimates**

| Estimate Source | Estimate ($M) |
|---|---|
| Conversion of LMSR to SOF Ship | 86.16 |
| New construction of LMSR | 250.00 |
| New construction of SOF Ship | 300.49 |

The LMSR program currently has 19 ships. The addition of each ship to the fleet lowers the cost associated with each follow-on vessel. The values listed above take into account the lead ship serving as a follow-on ship. The cost calculated for new construction of an LMSR using our cost model is 434.29 million dollars. According to Avondale Industries, the contract for the seventh strategic sealift ship is $250 million. A cost correction factor of 0.576 was applied to the total SOF conversion cost and new construction ships.

### 4.4.2 Risk

Risk can be defined as the probability of failure multiplied by a measure of the consequences of failure. This design attempts to minimize risk where feasible, while still maintaining an aggressive approach to use of innovative technology to improve effectiveness and lower cost. The following areas were considered in the risk areas in the assessment of the SOF Ship design:

- Development of the flight deck
- Advanced berthing installation and messing
- Development of modularized C4I infrastructure

The primary function of the SOF Ship is to support SOF missions. A failure in this area is a failure of the mission of the ship. Therefore, the two most important areas to develop are the flight deck and hangar bay. Flight decks have been installed on carriers for over 80 years. However, as with all other new ship modifications, first time installation of a new component is always full of risk. The technology used to install the new flight deck, therefore must be compatible with that used to install the flight decks on the other modern CVNs or LHAs.

Advanced crew berthing and accommodation technology is well developed, and has been used successfully on recent ship modifications.  These berthings are light, simple to construct, and provide more crew comfort.  It is essential that such technology be incorporated into the design of this ship for weight reduction and reduced equipment costs.

The last area of possible risk entails the development of modularized C4I systems. Since SOF bring their own equipment, it was essential that sections of the ship be designated for such equipment as a “plug and play” design.  Further study would have to be conducted in this area to determine exactly what modifications would have to be made to the existing command and control systems, particularly what kind of electronic provisions would have to be “cable ready”.

## 5.0 DESIGN CONCLUSIONS

### 5.1 Summary of Final Concept Design

Starting from a T-AKR 300, the SOF ship development process created a platform with the same, or improved, weight, KG, and strength. Table 28 summarizes the SOF Ship conversion design.

**Table 28. SOF Ship Dimensions and Performance**

| | | | |
|---|---|---|---|
| **LBP** | 884 ft | **LOA** | 951 ft |
| **Beam** | 106 ft | **Full Load Draft** | 27.80 ft |
| **Full Load Displacement** | 48,937 ltons | **Light Ship Displacement** | 37,681 ltons |
| **Full Load KG** | 39.98 ft | **Light Ship KG** | 45.67 ft |
| **Max speed** | 24.0 knots | **Endurance** | 10,000 + nm @ 24 knots |

The SOF ship design removes the topside cranes, aft ramp, and internal deck hatches and ramps from the current LMSR. It was important to retain the original superstructure for cost reduction as well as for strength and stability concerns. The flight deck was then mounted on the main deck and the elevators were added. The SOF Ship design increases the lightship weight by 3957 long tons. The ship's crew size remains the same, but it has capacity for an additional 2000 personnel for troop transport. Also, a ship self-defense system was installed for protection against threats. Similarly, space was allocated for the command and communications center for mission need. The cost of the conversion is estimated at $86.16 million. Table 29 summarizes the removals and additions to the original ship.

**Table 29. Summary of Removals and Additions**

| Removals | Additions |
|---|---|
| Cranes | Flight Deck |
| Aft Ramp | Elevators |
| Topside Fan Rooms | Ship Self-Defense System |
| Internal Hatches and Ramps | Command and Control Centers |
| | Ready/Briefing/SCIF Rooms |
| | Berthing Facilities |
| | Weapons Magazines |
| | Ship Support Storage |
| | Mission Support Storage |
| | Medical and Dental Facilities |
| | Boat Cranes and Winches |
| | AC/ventilation |

## 5.2 Final Conclusions and Recommendations

Conversion of an LMSR, such as the T-AKR 300, to a SOF platform is feasible and merits consideration. The design meets the requirements for a cost-effective, near-term solution to the need for a SOF/Aviation support platform. The ship serves as a mobile offshore platform for SOF mission support and is equipped with its own self-defense armament.

Based on the MNS guidance and policy, the SOF platform will provide support for interagency, joint, and Allied forces. This vessel will provide modular flexibility to perform individual or multiple missions, thereby freeing other major assets to dedicate their full resources in the performance of their primary missions. As a result, this conversion provides a valuable asset to the fleet.

This report describes ship conversion concept design results based on SOF mission estimates. A hands-on inspection of the Bob Hope class LMSR would serve to improve the accuracy of space allocation and design for this project. Further analysis is required in the following areas:

- cost analysis and LMSR follow-on ship costs
- elevator cross section structural strength (using software program like Maestro)
- detailed manning breakdown for routine functions
- ventilation and air conditioning system
- hotel services such as sanitation services
- hangar bay drainage/freeboard issues
- boat launch and recovery details
- detailed wind study

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[15] Weight and Moment Estimate, T-AKR 300 Bob Hope Class

The Program of Ships Salvage and Engineering (POSSE) and Ship Wave Analysis (SWAN) software packages were used for this for this study.

# Appendix A
# Mission Needs Statement

**UNCLASSIFIED**

# MISSION NEED STATEMENT

# FOR

# A SPECIAL OPERATIONS FORCES SHIP

## 1. **DEFENSE PLANNING GUIDANCE ELEMENT**

a. This Mission Need Statement (MNS) provides requirements for a Special Operations Forces (SOF) ship for the near future. The multi-mission capabilities are a result of the chosen combat suite, hull, and mechanical and electrical systems. The above systems ensure battlespace dominance for expeditionary, interagency, joint and allied forces. This ship must operate wherever required to provide SOF capabilities. The mission capabilities must be fully interoperable with other naval, interagency, joint and allied forces.

b. This MNS should guide 21st Century SOF surface ship design, research, development and acquisition program decisions, service and joint doctrine, and cooperative efforts with U.S. allies.

## 2. **MISSION AND THREAT ANALYSIS**

a. Mission. The general mission of this ship is to provide integrated SOF capabilities, to provide independent forward presence, and to operate as an integral part of joint and allied maritime warfare operations.

b. Objectives. The Special Operations Forces Ship must have flexibility to meet the multi-mission requirements, while at the same time, employing a self defense capability against a variety of threats. It must be interoperable with other expeditionary, interagency, joint, and allied forces under the C4I for the Warrior/Copernicus architecture. The Special Operations Forces Ship must contribute to open ocean surface, air, and sub-surface dominance.

c. Capabilities.

(1) Power Projection – The ship must destroy or neutralize enemy targets ashore through the use of coordinated aviation and special operations forces. It must be capable of conducting cooperative operations with other ships, submarines, aircraft, space and land systems.

(2) Battlespace Dominance – To support regional expeditionary, joint and allied force operations, and maintain sea lines of communication. The ship must be able to embark and support armed rotary-wing, VTOL/STOVL aircraft as well as deployment of SOF.

(3) Command, Control and Surveillance – The ship must be fully interoperable with other naval, interagency, joint, and allied forces, and with space and ground based sensors under the C4I for the Warrior/Copernicus architecture. The communications suite must have an integrated database capable of interfacing in a Joint Task Force/Combined Task Force (JTF/CTF) environment to include

compatibility with joint systems such as the Global Command and Control System (GCCS), the Joint Worldwide Intelligence Communications System (JWICS) and the Joint Deployable Intelligence Support System (JDISS). It must be designed to be a tactical operational extension using Tactical Command Center (TCC) and Tactical Data Information Exchange System (TADIX) within the emerging Joint Communications Planning and Management System. The ship must have a full suite of radios and antennas to support full connectivity via EHF/SHF/UHF SATCOM using full DAMA for each circuit. The ship must have an cryptologic capability designed to collect, process and geolocate signals of interest in order to describe and fully exploit the electronic battle space. Cryptologic capability is required to provide near real-time indications and warning and situational awareness to tactical decision makers and to support CO situational awareness, coordinate actions with other forces and communicate the ship's actions to appropriate commanders. Connectivity must include seamless integration for both organic and off-ship sensor inputs to shooter actions.

(4) Survivability – The ship shall have the survivability criteria of ship system redundancy to ensure graceful degradation of capability to make the total loss of the ship highly unlikely even if hit.

(5) Mobility – The ship must steam to design capability and maneuver at sustained task force speeds. The design must provide sufficient machinery redundancy for graceful degradation of mobility and survivability. The ship must be able to perform seamanship, airmanship and navigation tasks; prevent and control damage; and replenish at sea.

(6) Fleet Support Operations – Conduct in-flight refueling of rotary wing aircraft; conduct Search and Rescue (SAR) operations; and provide routine health care, first aid assistance, triage and resuscitation.

(7) Non-Combat Operations – The ship must provide emergency and disaster assistance; support operations to evacuate noncombatant personnel in areas of civil or international crisis; support and conduct vertical takeoff and/or rotary wing aircraft operations; provide unit-level upkeep and maintenance.

## 3. **NON-MATERIAL ALTERNATIVES**

Mission Area Analyses were conducted as part of the SOF/Aviation support platform. These analyses determined that changes in doctrine and operational concepts are not sufficient to address deficiencies. Doctrine changes and operational concepts required without a SOF platform would include: inability to project expeditionary strike power from the sea; severely degraded ability to project precise strike power against land targets; inability to maintain meaningful, visible forward presence for coalition building; thus requiring allies undertake these missions.

4. **POTENTIAL MATERIEL ALTERNATIVES**

a. Material alternatives include (1) conversion of an amphibious class ship to a special operations forces ship, (2) conversion of a commercial tanker/container ship/roll-on roll-off vessel, (3) conversion of an existing LMSR ship, and (4) design and acquisition of a new ship.

b. The ongoing LMSR acquisition program could potentially address this need through a forward-fit modification program by capitalizing on advanced technology. However, to do this, it would need to employ a modified approach in the design.

5. **CONSTRAINTS**

a. Key Boundary Conditions.

(1) Architecture – The ship design must employ a total ship architectural/engineering approach that optimizes life cycle cost and performance; minimizes operating conflicts; permits rapid upgrade and change in response to evolving operational requirements; allows computational and communication resources to keep technological pace with commercial capabilities wherever possible. More specifically this implies physical element modularity; functional sharing of hardware; open systems information architecture; ship wide resource management; automation of Command, Control, Communications, and Computers (C4I), combat engineering, and navigation functions; integrated ship wide data management; automation and minimization of maintenance and administrative functions; and embedded training. The approach should also promote commonality of design among ship classes.

(2) Design – Consideration should be given to the maximum use of modular designs in the SOF ship infrastructure. Emerging technologies must be accounted for during the developmental phase. Since communication and data systems hold the greatest potential for growth, and therefore obsolescence, their installations must be modularized as much as possible to allow for future upgrades. Use standard man-to-machine interfaces among the systems onboard. The man-to-machine interfaces should be consistent with existing user-friendly systems.

(3) Personnel – The ship must be automated to a sufficient degree to realize significant manpower reductions in engineering, combat systems, ship support and Condition III watchstanding requirements.

(4) Back-fit – Major functional elements of a Special Operations Forces Ship must be applicable to other forward fit ship construction programs.

b. Operational Constraints.

(1) The Special Operations Forces Ship must incur only minimal degradation of operational capability in heavy weather or in the presence of electromagnetic, nuclear, biological and chemical contamination and/or shock effects from nuclear and conventional weapon attack.

(2) Any Special Operations Forces Ship must meet the survivability requirements of Level I as defined in OPNAVINST 9070.1.

(3) The Special Operations Forces Ship must provide rotary-wing, VTOL/STOVL, and unmanned aerial vehicle (UAV) landing and hangaring facilities. Ammunition storage for operational support of armed aircraft must also be provided.

(4) The ship must be able to operate in U.S., foreign, and international waters in full compliance with existing U.S. and international pollution control laws and regulations.

(5) All ship and combat system elements must make use of standard subsystems and meet required development practices. The Special Operations Forces Ship must be fully integrated with other U.S. Navy, Marine Corps, joint and allied forces, and other agencies. Joint goals for standardization and interoperability will be achieved to the maximum feasible extent.

(6) The ship must be able to transit through the Panama Canal (PANAMAX).

# Appendix B
# Weights Removed/Added

**13.413.- Conversion Project**

**Weight Removed**

| | | | Displacem | KG light | | LCG | | TCG | |
|---|---|---|---|---|---|---|---|---|---|
| | | **Light** | **33723.00** | **48.07** | **1621173.00** | **496.87** | **16756014.00** | **0.32** | **10640.00** |
| **#** | | **Element** | **Weight** | **VCG** | **Moment** | **LCG** | **Moment** | **TCG** | **Moment** |
| | | | **Tons** | **ft** | **ft-tons** | **ft** | **ft-tons** | **ft** | **ft-tons** |
| 1 | | 123 | 9.81 | 125.00 | 1226.00 | 701.11 | 6876.49 | -13.98 | -137.12 |
| 2 | Fan house 03 | 123 | 3.65 | 125.00 | 456.00 | 700.10 | 2553.96 | -42.34 | -154.46 |
| 3 | fan enclosures A deck | 123 | 15.24 | 93.00 | 1416.86 | 221.23 | 3370.44 | 5.38 | 81.96 |
| 4 | 04 mod to stack | 162 | 57.35 | 142.93 | 8196.75 | | 44338.61 | 11.66 | 668.68 |
| 5 | HULL STRUCTURAL CLOSURES | 167 | 162.10 | 93.33 | 15129 | 766.00 | 124169 | 0.00 | 0 |
| 6 | Hatch, scuttle & berp | 168 | 3.89 | 93.33 | 363.43 | 756.56 | 2946.04 | -7.55 | -29.40 |
| | Deck A-B | 168 | 2012.00 | 82.00 | 164984.00 | 687.00 | 1382244.00 | 0.00 | 0.00 |
| 7 | Hinged ramp A dk to B dk | 169 | 36.54 | 99.00 | 3616.97 | 723.74 | 26441.84 | -13.08 | -477.88 |
| 8 | Hinged ramp B dk to C dk | 169 | 132.35 | 66.00 | 8734.84 | 639.02 | 84571.74 | 35.52 | 4700.93 |
| 10 | fan enclosures A deck | 123 | 1.90 | 104.00 | 198.06 | 687.00 | 1308.31 | 99.00 | 188.53 |
| 11 | Kingpost for sternramp | 172 | 173.84 | 132.00 | 22947.14 | 910.16 | 158224.03 | 0.10 | 17.38 |
| 12 | Cargo hatches inst. Arrays | 172 | 10.71 | 99.69 | 1067.28 | 322.14 | 3448.83 | -2.82 | -30.19 |
| | **TOTAL GROUP** | **170** | **2619.37** | **87.17** | **228336.11** | **702.65** | **1840492.89** | **1.84** | **4828.45** |
| | | | | | | | | | |
| | **GROUP 100 WITH AB DK** | | **2619.37** | **87.17** | **228336.11** | **702.65** | **1840492.89** | **1.84** | **4828.45** |
| | | | | | | | | | |
| | **GROOP 100** | | **607.37** | **87.17** | **228336.11** | **702.65** | **1840492.89** | **1.84** | **4828.45** |
| | | | | | | | | | |
| 13 | Mchry csg A-03 | 259 | 15.74 | 120.00 | 1888.44 | 759.76 | 11956.34 | 12.49 | 196.56 |
| | **TOTAL GROUP** | **250** | **15.74** | **120.00** | **1888.44** | **759.76** | **11956.34** | **12.49** | **196.56** |
| | | | | | | | | | |
| | **GROUP 200** | | **15.74** | **120.00** | **1888.44** | **759.76** | **11956.34** | **12.49** | **196.56** |
| | | | | | | | | | |
| 14 | Emerg dsl outf | 312 | 29.61 | 120.00 | 3552.60 | 882.26 | 26119.31 | -0.33 | -9.77 |
| 15 | Blw arr 05 dk | 313 | 0.11 | 143.00 | 15.30 | 757.00 | 81.00 | -23.00 | -2.46 |
| | **TOTAL GROUP** | **310** | **29.71** | **120.08** | **3567.90** | **881.81** | **26200.31** | **-0.41** | **-12.23** |
| 16 | Outft Emerg diesel | 342 | 2.40 | 120.00 | 250.18 | 885.57 | 2128.02 | 3.66 | 8.79 |
| | **TOTAL GROUP** | **340** | **2.40** | **104.11** | **250.18** | **885.57** | **2128.02** | **3.66** | **8.79** |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 17 | Outft Emerg diesel | 398 | 2.08 | 120.00 | 212.65 | 885.10 | 1836.58 | 1.94 | 4.03 |
| | **TOTAL GROUP** | **390** | **2.08** | **102.49** | **212.65** | **885.10** | **1836.37** | **1.94** | **4.02** |
| | **GROUP 300** | | **34.19** | **117.89** | **4030.73** | **882.27** | **30164.70** | **0.02** | **0.58** |
| 18 | Outft Emerg diesel | 512 | 2.49 | 120.00 | 298.92 | 885.57 | 2205.95 | -4.55 | -11.33 |
| | **TOTAL GROUP** | **510** | **2.49** | **120.00** | **298.92** | **885.57** | **2205.95** | **-4.55** | **-11.33** |
| 19 | Outft Emerg diesel | 526 | 0.14 | 120.00 | 17.28 | 885.98 | 127.58 | 1.09 | 0.16 |
| 20 | Mchnery csge to 03 lvl | 526 | 0.20 | 120.00 | 23.40 | 765.38 | 149.25 | 5.55 | 1.08 |
| | **TOTAL GROUP** | **520** | **0.34** | **120.00** | **40.68** | **816.61** | **276.83** | **3.66** | **1.24** |
| 21 | Mchnery csge to 03 lvl | 534 | 0.42 | 120.00 | 45.20 | 766.33 | 323.39 | 5.10 | 2.15 |
| | **TOTAL GROUP** | **530** | **0.42** | **107.11** | **45.20** | **766.33** | **323.39** | **5.10** | **2.15** |
| 22 | Mchnery csge to 03 lvl | 551 | 0.34 | 120.00 | 36.91 | 766.96 | 261.53 | 5.96 | 2.03 |
| | **TOTAL GROUP** | **550** | **0.34** | **108.24** | **36.91** | **766.96** | **261.53** | **5.96** | **2.03** |
| 23 | Stern ramp assembly inst. | 589 | 20.53 | 132.00 | 2709.56 | 912.05 | 18721.65 | 0.00 | 0.00 |
| 24 | Stern ramp | 589 | 242.15 | 132.00 | 31963.14 | 950.94 | 230265.37 | 0.00 | 0.00 |
| 25 | Twin crane & boom rest | 589 | 405.74 | 117.29 | 47588.66 | 612.08 | 248342.28 | -4.45 | -1805.52 |
| | **TOTAL GROUP** | **580** | **668.41** | **123.07** | **82261.36** | **744.05** | **497329.30** | **-2.70** | **-1805.52** |
| 26 | Twin crane & boom rest | 598 | 23.63 | 120.65 | 2850.47 | 441.50 | 10430.44 | 0.00 | 0.00 |
| | **TOTAL GROUP** | **590** | **23.63** | **120.65** | **2850.47** | **441.50** | **10430.44** | **0.00** | **0.00** |
| | **GROUP 500** | | **695.63** | **122.96** | **85533.54** | **734.34** | **510827.44** | **-2.60** | **-1811.43** |
| 27 | Misc. boards & signs | 631 | 0.59 | 123.91 | 73.35 | 776.56 | 459.72 | 1.31 | 0.78 |
| 28 | Deck covering schedule | 634 | 98.50 | 127.50 | 12558.75 | 766.00 | 75451.00 | 0.00 | 0.00 |
| | **TOTAL GROUP** | **630** | **99.09** | **127.48** | **12632.10** | **766.06** | **75910.72** | **0.01** | **0.78** |
| | **GROUP 600** | | **99.09** | **127.48** | **12632.10** | **766.06** | **75910.72** | **0.01** | **0.78** |
| | **MODIFICATION INCLUDED AB DK (for POSSE analysis)** | | **3464.01** | **95.96** | **332420.92** | **712.86** | **2469352.10** | **0.93** | **3214.93** |
| | **TOTAL MODIFICATION** | | **1452.01** | **95.96** | **332420.92** | **712.86** | **2469352.10** | **0.93** | **3214.93** |

| | Total Disp | VCG | LCG | TCG |
|---|---|---|---|---|
| **FINAL STABILITY PARAMETERS** | **30258.99** | **42.59** | **472.14** | **0.25** |

**13.413.- Conversion Project**

| # | Description | Weight Added<br>Element | Displacem<br>Weight | KG after mod<br>VCG | Moment | LCG | Moment | TCG<br>tons TCG | Moment |
|---|---|---|---|---|---|---|---|---|---|
| - | - | - | | | | | | | |
| - | - | Light | 30258.99 | 42.59 | 0.00 | 472.14 | 0.00 | 0.25 | 10640.00 |
| | | | Tons | ft | ft-tons | ft | ft-tons | ft | ft-tons |
| 1 | Flying deck fwd section | 111 | 1210.49 | 89.37 | 108181.76 | 102.02 | 123494.50 | 0.00 | 0.00 |
| 2 | Flying deck ctr section | 111 | 1449.19 | 89.37 | 129514.29 | 351.63 | 509579.38 | 0.00 | 0.00 |
| 3 | Flying deck aft section | 111 | 175.35 | 89.37 | 15670.94 | 740.06 | 129768.78 | 0.00 | 0.00 |
| 4 | Fly. Dk Longit. Framing | 116 | 55.19 | 83.00 | 4580.52 | 475.00 | 26213.83 | 0.00 | 0.00 |
| 5 | Fly. Dk Trans. Framing | 117 | 192.00 | 83.00 | 15936.00 | 475.00 | 91200.00 | 0.00 | 0.00 |
| 6 | Fan house 02 | 123 | 3.23 | 18.00 | 58.07 | 181.35 | 585.04 | -2.78 | -8.97 |
| 7 | Fan house 03 | 123 | 3.46 | 18.00 | 62.28 | 727.00 | 2515.42 | -1.16 | -4.01 |
| | **TOTAL GROUP** | **170** | **3088.91** | **88.71** | **274003.86** | **285.98** | **883356.94** | **0.00** | **-12.98** |
| 8 | Mchry csg A-03 | 185 | 0.70 | 18.00 | 12.60 | 183.90 | 128.73 | -0.56 | -0.39 |
| 9 | 04dk frame fnd | 184 | 0.29 | 130.02 | 37.58 | 780.08 | 225.44 | 41.27 | 11.93 |
| 10 | 04dk fnd | 185 | 1.36 | 109.78 | 149.30 | 706.01 | 960.17 | 23.60 | 32.10 |
| 11 | 04dk fnd | 185 | 0.10 | 109.78 | 11.09 | 793.41 | 80.13 | 45.51 | 4.60 |
| 12 | 04dk fnd | 185 | 0.85 | 110.00 | 93.83 | 776.98 | 662.76 | -11.09 | -9.46 |
| 13 | 04dk fnd | 185 | 0.07 | 110.78 | 8.20 | 774.00 | 57.28 | 46.42 | 3.44 |
| 14 | 04dk fnd | 185 | 0.07 | 110.00 | 8.14 | 798.00 | 59.05 | -46.42 | -3.44 |
| 15 | 04dk fnd | 185 | 0.04 | 109.78 | 3.95 | 675.17 | 24.31 | 52.29 | 1.88 |
| 16 | 04dk fnd | 185 | 0.02 | 110.00 | 1.76 | 766.68 | 12.27 | 2.29 | 0.04 |
| 17 | 04dk fnd | 185 | 2.07 | 110.34 | 228.29 | 697.00 | 1442.09 | -19.94 | -41.26 |
| 18 | 04dk fnd | 185 | 0.04 | 110.11 | 4.84 | 784.17 | 34.50 | -52.36 | -2.30 |
| 19 | Comp array blw 04 dk | 185 | 2.72 | 124.98 | 339.95 | 732.36 | 1992.02 | -0.92 | -2.50 |
| 20 | Comp array blw 04 dk | 185 | 3.26 | 125.21 | 408.69 | 781.42 | 2550.55 | -7.19 | -23.47 |
| 21 | Comp array blw 04 dk | 185 | 0.37 | 125.00 | 46.63 | 828.89 | 309.18 | 3.64 | 1.36 |
| 22 | Comp array blw 04 dk | 185 | 1.90 | 125.21 | 237.40 | 739.04 | 1401.22 | -3.45 | -6.54 |
| 23 | Comp array blw 04 dk | 185 | 1.14 | 125.00 | 142.75 | 733.71 | 837.90 | -0.10 | -0.11 |
| 24 | Comp array blw 04 dk | 185 | 1.48 | 124.98 | 185.47 | 780.78 | 1158.68 | -0.71 | -1.05 |
| 141 | Arrg H dk | 185 | 0.13 | 90.00 | 11.70 | 871.74 | 113.33 | 35.25 | 4.58 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 142 | Arrg H dk | 185 | 3.46 | 90.00 | 311.58 | 756.70 | 2619.70 | 1.04 | 3.60 |
| 143 | Arrg H dk | 185 | 0.43 | 90.00 | 38.79 | 781.94 | 337.02 | 10.21 | 4.40 |
| 144 | Arrg H dk | 185 | 0.46 | 90.00 | 41.58 | 780.91 | 360.78 | -17.02 | -7.86 |
| 145 | Arrg H dk | 185 | 1.44 | 90.00 | 129.60 | 799.02 | 1150.59 | -35.25 | -50.76 |
| 32 | Comp array blw 04 dk | 185 | 0.18 | 121.98 | 21.83 | 775.73 | 138.86 | -6.61 | -1.18 |
| 33 | Comp array blw 04 dk | 185 | 0.16 | 122.00 | 19.64 | 839.88 | 135.22 | 2.40 | 0.39 |
| 34 | Comp array blw 04 dk | 185 | 0.23 | 121.98 | 28.06 | 744.60 | 171.26 | 2.97 | 0.68 |
| 35 | Comp array blw 04 dk | 185 | 0.09 | 122.12 | 11.48 | 802.46 | 75.43 | 3.35 | 0.31 |
| 144 | Comp array blw 04 dk | 185 | 0.20 | 122.14 | 24.18 | 799.85 | 158.37 | 0.04 | 0.01 |
| 145 | Comp array blw 04 dk | 185 | 0.25 | 122.23 | 31.05 | 855.94 | 217.41 | 0.00 | 0.00 |
| 146 | Comp array blw 04 dk | 185 | 0.35 | 121.78 | 42.62 | 744.96 | 260.74 | -3.83 | -1.34 |
| 147 | Comp array blw 04 dk | 185 | 0.72 | 122.00 | 87.84 | 799.52 | 575.65 | 4.69 | 3.38 |
| 148 | Comp array blw 04 dk | 185 | 0.22 | 121.98 | 26.59 | 741.04 | 161.55 | 1.34 | 0.29 |
| 149 | Comp array blw 04 dk | 185 | 0.16 | 122.12 | 19.66 | 760.30 | 122.41 | -7.78 | -1.25 |
| 150 | Comp array blw 04 dk | 185 | 0.18 | 122.14 | 22.23 | 826.90 | 150.50 | 0.50 | 0.09 |
| 44 | Comp array blw 04 dk | 185 | 0.41 | 122.23 | 49.75 | 846.75 | 344.63 | -2.45 | -1.00 |
| 45 | Comp array blw 04 dk | 185 | 0.31 | 122.00 | 37.70 | 728.07 | 224.97 | -0.15 | -0.05 |
| 46 | Comp array blw 04 dk | 185 | 0.20 | 122.00 | 23.79 | 793.46 | 154.72 | -11.20 | -2.18 |
| 47 | Comp array H dk | 185 | 0.14 | 91.00 | 12.47 | 829.87 | 113.69 | -2.88 | -0.39 |
| 48 | Comp array H dk | 185 | 0.23 | 91.00 | 20.84 | 883.17 | 202.25 | -22.13 | -5.07 |
| 49 | Comp array H dk | 185 | 0.32 | 91.00 | 28.67 | 844.95 | 266.16 | -3.47 | -1.09 |
| 50 | Side shell 04 | 185 | 0.81 | 120.00 | 97.68 | 649.05 | 528.33 | 6.12 | 4.98 |
| 51 | Side shell 04 | 185 | 0.15 | 120.00 | 17.40 | 585.44 | 84.89 | 51.54 | 7.47 |
| 52 | HELO ELEV. Supp. Sys. PORT | 185 | 145.60 | 60.00 | 8736.00 | 550.05 | 80087.28 | 35.50 | 5168.80 |
| 53 | HELO ELEV. Supp. Sys. STDB | 185 | 145.60 | 60.00 | 8736.00 | 390.05 | 56791.28 | -35.50 | -5168.80 |
| 54 | Arrg H dk | 185 | 0.33 | 91.00 | 30.03 | 846.29 | 279.28 | -10.11 | -3.34 |
| 55 | Arrg H dk | 185 | 1.57 | 91.00 | 143.14 | 887.07 | 1395.36 | -10.77 | -16.94 |
| 56 | Arrg H dk | 185 | 1.08 | 91.00 | 98.55 | 845.78 | 915.98 | -5.60 | -6.06 |
| 57 | Int arrgment | 185 | 0.17 | 90.00 | 14.85 | 799.00 | 131.84 | -10.44 | -1.72 |
| 58 | Hdk frame fnd | 185 | 0.14 | 90.00 | 12.87 | 801.00 | 114.54 | 15.56 | 2.23 |
| 59 | Hdk frame fnd | 185 | 0.13 | 90.00 | 11.61 | 786.00 | 101.39 | 1.92 | 0.25 |
| 60 | Hdk fnd | 185 | 0.07 | 90.00 | 6.39 | 794.00 | 56.37 | 43.25 | 3.07 |
| 61 | Hdk fnd | 185 | 0.07 | 90.00 | 6.57 | 702.00 | 51.25 | -19.34 | -1.41 |
| 62 | Hdk fnd | 185 | 0.14 | 90.00 | 12.24 | 767.00 | 104.31 | 40.38 | 5.49 |
| 63 | Hdk fnd | 185 | 0.21 | 90.00 | 18.81 | 819.63 | 171.30 | -28.47 | -5.95 |
| 64 | Hdk fnd | 185 | 4.13 | 90.00 | 371.61 | 817.89 | 3377.07 | 0.10 | 0.41 |
| 65 | Emergency diesel mach. Foundations | 185 | 160.00 | 16.10 | 2576.00 | 220.78 | 35324.80 | 0.00 | 0.00 |
| 66 | Storerooms + issue rooms | 185 | 814.11 | 15.00 | 12211.65 | 201.00 | 163636.11 | 6.45 | 5251.01 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **TOTAL GROUP** | **180** | **1301.07** | **27.72** | **36063.51** | **279.11** | **363142.88** | **3.96** | **5149.84** |
| | **GROUP 100** | | **4389.98** | **70.63** | **310067.36** | **283.94** | **1246499.82** | **1.17** | **5136.86** |
| 67 | Mchry csg A-03 | 259 | 15.74 | 16.00 | 251.79 | 219.76 | 3458.36 | 12.49 | 196.56 |
| | **GROUP 200** | | **15.74** | **16.00** | **251.79** | **219.76** | **3458.36** | **12.49** | **196.56** |
| 68 | Emerg dsl outf | 312 | 29.61 | 18.00 | 532.98 | 183.90 | 5445.28 | -0.56 | -16.58 |
| | **TOTAL GROUP** | **310** | **29.61** | **18.00** | **532.98** | **183.90** | **5445.28** | **-0.56** | **-16.58** |
| 69 | Mchnery csge to 03 lvl | 321 | 2.02 | 18.00 | 36.34 | 183.90 | 371.29 | -0.56 | -1.13 |
| 70 | Outft Emerg diesel | 324 | 1.05 | 18.00 | 18.90 | 183.90 | 193.14 | -0.56 | -0.59 |
| 71 | Comp array blw 04 dk | 321 | 0.44 | 120.00 | 53.28 | 788.91 | 350.28 | -0.74 | -0.33 |
| 72 | Pwr sys lvl 04 | 321 | 0.47 | 124.90 | 58.45 | 793.50 | 371.36 | 0.00 | 0.00 |
| 73 | Comp array blw 04 dk | 324 | 0.11 | 120.00 | 12.84 | 772.00 | 82.60 | -0.75 | -0.08 |
| 74 | Arrg below H dk | 321 | 0.87 | 91.00 | 79.17 | 832.55 | 724.32 | 1.23 | 1.07 |
| 75 | Arrg below H dk | 321 | 1.26 | 91.00 | 115.02 | 854.09 | 1079.57 | -1.81 | -2.29 |
| 76 | Arrg below H dk | 321 | 0.59 | 91.00 | 53.60 | 877.25 | 516.70 | 0.00 | 0.00 |
| 77 | Pwr sys H dk | 321 | 0.47 | 60.00 | 28.08 | 893.50 | 418.16 | 0.00 | 0.00 |
| 78 | **TOTAL GROUP** | **320** | **7.28** | **62.60** | **455.69** | **564.26** | **4107.42** | **-0.46** | **-3.35** |
| 79 | Mchnery csge to 03 lvl | 331 | 0.03 | 18.00 | 0.61 | 183.90 | 6.21 | -0.56 | -0.02 |
| 80 | Light sys dk 04 | 331 | 0.10 | 98.99 | 9.70 | 734.50 | 71.98 | 0.00 | 0.00 |
| 81 | Comp array blw 04 dk | 332 | 0.77 | 98.99 | 75.83 | 795.73 | 609.53 | -4.17 | -3.19 |
| 82 | Arrg below 04 dk | 332 | 0.81 | 98.78 | 79.91 | 743.72 | 601.67 | 0.00 | 0.00 |
| 83 | Arrg below 04 dk | 332 | 0.88 | 99.12 | 87.23 | 770.38 | 677.93 | -8.79 | -7.74 |
| 84 | Arrg below 04 dk | 332 | 1.01 | 99.12 | 99.71 | 841.00 | 846.05 | 0.00 | 0.00 |
| 85 | Arrg below H dk | 332 | 0.29 | 99.14 | 28.35 | 832.94 | 238.22 | 0.57 | 0.16 |
| 86 | Arrg below H dk | 332 | 0.26 | 99.00 | 25.64 | 888.14 | 230.03 | 1.14 | 0.30 |
| 87 | Arrg below H dk | 332 | 0.86 | 98.99 | 85.33 | 861.50 | 742.61 | 0.00 | 0.00 |
| 88 | Comp & fltr house | 331 | 0.15 | 18.00 | 2.61 | 744.50 | 107.95 | 12.50 | 1.81 |
| 89 | Comp & fltr house | 331 | 0.15 | 18.00 | 2.61 | 744.50 | 107.95 | 12.50 | 1.81 |
| 0 | **TOTAL GROUP** | **330** | **5.29** | **94.06** | **497.53** | **801.58** | **4240.13** | **-1.30** | **-6.87** |
| 90 | Outft Emerg diesel | 342 | 12.40 | 18.00 | 223.20 | 183.90 | 2280.36 | -0.56 | -6.94 |
| 91 | Mchnery csge from 03 lvl | 342 | 10.16 | 18.00 | 182.88 | 183.90 | 1868.42 | -0.56 | -5.69 |
| 92 | Arrg H dk | 342 | 3.08 | 77.00 | 237.08 | 872.86 | 2687.78 | 12.42 | 38.24 |
| | **TOTAL GROUP** | **340** | **25.64** | **25.09** | **643.16** | **266.65** | **6836.56** | **1.00** | **25.61** |
| 93 | Outft Emerg diesel | 398 | 2.08 | 18.00 | 37.44 | 183.90 | 382.51 | 1.94 | 4.04 |
| | **TOTAL GROUP** | **390** | **2.08** | **18.00** | **37.44** | **183.90** | **382.51** | **1.94** | **4.04** |
| | **GROUP 300** | | **69.90** | **31.00** | **2166.81** | **300.61** | **21011.91** | **0.04** | **2.85** |
| 94 | Antenna arrgment | 421 | 0.10 | 47.70 | 4.77 | 727.25 | 72.73 | 0.00 | 0.00 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 95 | Antenna arrgment | 422 | 1.36 | 47.70 | 64.92 | 730.00 | 993.53 | -5.07 | -6.90 |
| 96 | Elec. arrgment | 421 | 0.10 | 39.70 | 3.97 | 727.25 | 72.73 | 0.00 | 0.00 |
| 97 | Elec. arrgment | 422 | 1.36 | 39.70 | 54.03 | 730.00 | 993.53 | -5.07 | -6.90 |
| | **TOTAL GROUP** | **420** | **2.92** | **43.70** | **127.69** | **729.81** | **2132.51** | **-4.72** | **-13.80** |
| 98 | Comp array blw 04 dk | 432 | 0.46 | 120.00 | 55.68 | 745.00 | 345.68 | -4.00 | -1.86 |
| 99 | General Alarm sys | 436 | 1.88 | 120.00 | 225.60 | 776.00 | 1458.88 | 0.00 | 0.00 |
| 100 | Fire & smoke det sys | 436 | 2.02 | 120.00 | 242.64 | 776.00 | 1569.07 | 0.00 | 0.00 |
| 101 | Antenna arrgment | 434 | 0.26 | 47.70 | 12.45 | 732.00 | 191.05 | 9.87 | 2.58 |
| 102 | Comp array C Dk | 432 | 0.46 | 47.70 | 22.13 | 745.00 | 345.68 | -4.00 | -1.86 |
| 103 | Gral Alarm sys | 436 | 1.88 | 47.70 | 89.68 | 776.00 | 1458.88 | 0.00 | 0.00 |
| 104 | Fire & smoke det sys | 436 | 2.02 | 47.70 | 96.45 | 776.00 | 1569.07 | 0.00 | 0.00 |
| 105 | Elec. arrgment | 434 | 0.26 | 39.70 | 10.36 | 732.00 | 191.05 | 9.87 | 2.58 |
| 106 | Comp array C Dk | 432 | 0.46 | 39.70 | 18.42 | 735.00 | 341.04 | -4.00 | -1.86 |
| 107 | Gral Alarm sys | 436 | 1.88 | 39.70 | 74.64 | 735.00 | 1381.80 | 0.00 | 0.00 |
| 108 | Fire & smoke det sys | 436 | 2.02 | 39.70 | 80.27 | 735.00 | 1486.17 | 0.00 | 0.00 |
| 109 | Comp array C Dk | 432 | 0.46 | 47.30 | 21.95 | 387.00 | 179.57 | -4.00 | -1.86 |
| 110 | Gral Alarm sys | 436 | 1.88 | 47.40 | 89.11 | 384.00 | 721.92 | 0.00 | 0.00 |
| 111 | Fire & smoke det sys | 436 | 0.20 | 47.20 | 9.44 | 386.00 | 77.20 | 0.00 | 0.00 |
| 112 | Comp array blw B dk | 432 | 0.76 | 39.70 | 30.33 | 369.00 | 281.92 | -4.00 | -3.06 |
| 113 | Boat crane STBD | 432 | 17.00 | 61.3 | 1042.10 | 369.00 | 6273.00 | 42.00 | 714.00 |
| 114 | Boat crane PORT | 432 | 17.00 | 61.3 | 1042.10 | 369.00 | 6273.00 | -42.00 | -714.00 |
| | **TOTAL GROUP** | **430** | **50.93** | **62.11** | **3163.35** | **474.10** | **24144.98** | **-0.10** | **-5.33** |
| 115 | Radio room | 441 | 1.83 | 47.70 | 87.34 | 738.55 | 1352.29 | 1.97 | 3.61 |
| 116 | Antenna arrgment | 441 | 0.75 | 47.70 | 35.78 | 729.07 | 546.80 | -5.22 | -3.92 |
| 117 | Radar Equipment | 445 | 0.20 | 47.70 | 9.54 | 743.36 | 148.67 | 0.00 | 0.00 |
| 118 | Satellite coms | 446 | 0.74 | 47.70 | 35.30 | 744.76 | 551.12 | 0.00 | 0.00 |
| 119 | Radio room | 441 | 1.83 | 39.70 | 72.69 | 748.55 | 1370.60 | 1.97 | 3.61 |
| 120 | Elec. arrgment | 441 | 0.75 | 39.70 | 29.78 | 739.07 | 554.30 | -5.22 | -3.92 |
| 121 | Satellite coms | 445 | 0.20 | 39.70 | 7.94 | 743.36 | 148.67 | 0.00 | 0.00 |
| 122 | Satellite coms | 446 | 0.74 | 39.70 | 29.38 | 744.76 | 551.12 | 0.00 | 0.00 |
| | **TOTAL GROUP** | **440** | **7.04** | **43.70** | **307.74** | **741.77** | **5223.57** | **-0.09** | **-0.62** |
| 123 | Shipboard PC cabling | 493 | 0.80 | 124.00 | 99.20 | 792.50 | 634.00 | 0.00 | 0.00 |
| 124 | Cmd & surv | 499 | 1.80 | 127.87 | 230.17 | 760.00 | 1368.00 | 0.00 | 0.00 |
| 125 | Shipboard PC cabling | 493 | 0.80 | 47.70 | 38.16 | 792.50 | 634.00 | 0.00 | 0.00 |
| 126 | Cmd & surv | 499 | 1.80 | 47.70 | 85.86 | 760.00 | 1368.00 | 0.00 | 0.00 |
| 127 | Shipboard PC cabling | 493 | 0.80 | 39.70 | 31.76 | 735.00 | 588.00 | 0.00 | 0.00 |
| 128 | Cmd & surv | 499 | 1.80 | 39.70 | 71.46 | 735.00 | 1323.00 | 0.00 | 0.00 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 129 | Shipboard PC cabling | 493 | 2.00 | 47.70 | 95.40 | 385.00 | 770.00 | 0.00 | 0.00 |
| 130 | METEOROLOGICAL SYSTEM | 494 | 0.70 | 123.00 | 86 | 798.00 | 558.60 | 0.00 | 0 |
| 131 | SPECIAL PURPOSE INTELLIGENCE | 495 | 1.20 | 119.00 | 143 | 810.00 | 972.00 | 0.00 | 0 |
| 132 | SPECIAL PURPOSE INTELLIGENCE | 495 | 1.80 | 121.50 | 219 | 803.00 | 1445.40 | -12.80 | -23 |
| 133 | Cmd & surv | 499 | 1.80 | 46.80 | 84.24 | 382.00 | 687.60 | 0.00 | 0.00 |
| 134 | **TOTAL GROUP** | **490** | **15.30** | **77.38** | **1183.85** | **676.38** | **10348.60** | **-1.51** | **-23.04** |
| | **GROUP 400** | | **76.19** | **62.77** | **4782.62** | **549.27** | **41849.67** | **-0.56** | **-42.78** |
| 135 | Mchnery csge to E DK | 511 | 0.18 | 18.00 | 3.24 | 183.84 | 33.09 | -0.76 | -0.14 |
| 136 | Outft Emerg diesel | 512 | 2.49 | 18.00 | 44.82 | 182.90 | 455.42 | 1.56 | 3.88 |
| 137 | Mchnery csge to E Dk | 512 | 2.04 | 18.00 | 36.72 | 183.67 | 374.69 | -0.56 | -1.14 |
| 138 | Mchnery csge to E DK | 514 | 0.33 | 18.00 | 5.94 | 189.90 | 62.67 | -0.56 | -0.18 |
| 139 | Mchnery csge to E DK | 514 | 0.33 | 18.00 | 5.85 | 766.76 | 249.20 | 4.15 | 1.35 |
| 140 | AIR CONDITIONING SYSTEM | 514 | 94.94 | 25.00 | 4568.00 | 628.17 | 59638.00 | 14.23 | 1351 |
| | **TOTAL GROUP** | **510** | **100.47** | **46.46** | **4667.45** | **606.32** | **60914.10** | **13.45** | **1351.69** |
| 141 | Outft Emerg diesel | 526 | 0.14 | 18.00 | | 183.84 | 25.74 | -0.76 | -0.11 |
| 142 | Mchnery csge E DK | 526 | 0.20 | 18.00 | 3.60 | 189.90 | 37.98 | -0.56 | -0.11 |
| 143 | WASHDOWN SYSTEM | 523 | 8.54 | 25.00 | 213.50 | 456.61 | 3899.43 | -14.56 | -124.3424 |
| 144 | PLUMBING DRAINAGE AFT | 528 | 28.03 | 25.78 | 723 | 657.90 | 18440.94 | 5.78 | 162 |
| 145 | PLUMBING DRAINAGE FWD | 528 | 32.00 | 15.00 | 480 | 134.89 | 4316.48 | 0.00 | 0 |
| 146 | DRAINAGE AND BALLASTING SYSTEM | 529 | 353.41 | 19.00 | 6715 | 346.89 | 122594 | 1.90 | 671 |
| | **TOTAL GROUP** | **520** | **422.32** | **19.27** | **8137.02** | **353.56** | **149314.96** | **1.68** | **708.93** |
| 147 | Miscellaneous tanks | 532 | 0.32 | 19.73 | 6.31 | 686.00 | 219.52 | 32.00 | 10.24 |
| 148 | Mchnery csge to E DK | 534 | 0.42 | 18.00 | 7.56 | 183.90 | 77.24 | 1.94 | 0.81 |
| 150 | Piping Diesel Emer. Mach Box | 534 | 3.04 | 38.69 | 117.62 | 675.50 | 2053.51 | -22.02 | -66.94 |
| | **TOTAL GROUP** | **530** | **3.78** | **34.79** | **131.49** | **621.76** | **2350.27** | **-14.78** | **-55.89** |
| 151 | Helo FUEL & FUEL COMPENSATING | 541 | 19.24 | 30.00 | 577.20 | 534.88 | 10291.00 | -7.95 | -<br>152.97164 |
| 152 | Helo FUEL & FUEL Purif. Sys | 541 | 35.00 | 15.00 | 525.00 | 134.96 | 4723.60 | 0.00 | 0 |
| | **TOTAL GROUP** | **540** | **54.24** | **20.32** | **1102.20** | **276.82** | **15014.60** | **-2.82** | **-152.97** |
| 153 | Comp array blw E Dk | 551 | 0.08 | 18.00 | 1.39 | 803.11 | 61.84 | 2.67 | 0.21 |
| 154 | Fire exstinguishing system | 555 | 72.00 | 15.00 | 1080.00 | 535.77 | 38575.44 | 0.00 | 0.00 |
| | **TOTAL GROUP** | **550** | **72.08** | **15.00** | **1081.39** | **536.06** | **38637.28** | **0.00** | **0.21** |
| 155 | REPLENISHMENT AT SEA SYSTEMS | 571 | 20.00 | 78.30 | 1566 | 345.64 | 6913 | 0.00 | 0 |
| | **TOTAL GROUP** | **570** | **20.00** | **78.30** | **1566.00** | **345.64** | **6912.80** | **0.00** | **0.00** |
| 156 | Aircraft Recov. Supp. Sys. | 586 | 196.20 | 78.00 | 15303.60 | 352.50 | 69160.50 | -15.95 | -3129.39 |
| 157 | Aircraft Launch. Supp. Sys. | 587 | 291.60 | 78.00 | 22744.80 | 326.25 | 95134.50 | 25.50 | 7435.80 |
| 158 | Aircraft Handling, serv, stowage | 588 | 100.00 | 76.00 | 7600.00 | 452.50 | 45250.00 | 0.00 | 0.00 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 159 | Liferafts | 583 | 9.42 | 94.50 | 890.28 | 166.45 | 1568.13 | 26.80 | 252.48 |
| 160 | Liferafts | 583 | 9.42 | 94.00 | 885.57 | 166.45 | 1568.13 | -26.80 | -252.48 |
| 161 | Environmental Polution Control Sys | 583 | 46.20 | 15.00 | 693.00 | 135.88 | 6277.66 | 0.00 | 0.00 |
| 162 | HELO Handling, serv, stowage | 588 | 100.00 | 71.00 | 7100.00 | 352.50 | 35250.00 | 3.56 | 356.00 |
| | **TOTAL GROUP** | **580** | **752.84** | **73.35** | **55217.26** | **337.67** | **254208.91** | **6.19** | **4662.41** |
| | **GROUP 500** | | **1425.72** | **49.33** | **70336.81** | **369.88** | **527352.92** | **4.57** | **6514.38** |
| 163 | Non structural balckheads | 621 | 205.23 | 15.00 | 3078.45 | 135.78 | 27866.13 | 0.00 | 0.00 |
| 164 | Ladders | 623 | 0.57 | 45.00 | 25.70 | 737.24 | 420.96 | 6.88 | 3.93 |
| 165 | Interior joiner stairs | 623 | 2.54 | 45.00 | 114.30 | 740.49 | 1880.84 | 11.85 | 30.10 |
| 166 | Loiner door & wind list | 624 | 19.67 | 45.00 | 885.24 | 738.12 | 14520.30 | -13.20 | -259.67 |
| 167 | Ladders | 623 | 4.56 | 45.00 | 205.20 | 737.24 | 3361.81 | 6.88 | 31.37 |
| 168 | Interior joiner stairs | 623 | 2.54 | 35.00 | 88.90 | 740.49 | 1880.84 | 11.85 | 30.10 |
| 169 | Auxiliary System fundation FWD | 623 | 158.63 | 15.00 | 2379.45 | 220.00 | 34898.60 | 6.79 | 1077.10 |
| 170 | Loiner door & wind list | 624 | 19.67 | 35.00 | 688.52 | 738.12 | 14520.30 | 1.75 | 34.43 |
| | **TOTAL GROUP** | **620** | **413.42** | **18.06** | **7465.76** | **240.31** | **99349.79** | **2.29** | **947.35** |
| 171 | refrig. Stores arr & dets | 638 | 18.51 | 18.00 | 333.23 | 581.00 | 10756.05 | 0.00 | 0.00 |
| | **TOTAL GROUP** | **630** | **18.51** | **18.00** | **333.23** | **581.00** | **10756.05** | **0.00** | **0.00** |
| 172 | Officer Berthing+messing | 641 | 11.40 | 59.70 | 680.58 | 531.00 | 6053.40 | 0.00 | 0.00 |
| 173 | Toilett & shower arrgment | 644 | 15.78 | 59.70 | 942.07 | 485.48 | 7660.87 | 0.79 | 12.47 |
| 174 | NON-COMM OFFICER BERTH & MESS | 642 | 6.45 | 34.98 | 225.621 | 403.78 | 2604.381 | 0 | 0.00 |
| 175 | ENLISTED PERSONNEL BERTH & MESS | 643 | 19.12 | 34.97 | 668.6264 | 405.98 | 7762.3376 | 0 | 5.74 |
| 176 | SANITARY SPACES & FIXTURES | 644 | 19.67 | 35.03 | 689.0401 | 408.76 | 8040.3092 | 0 | 0.00 |
| 177 | LEISURE & COMMUNITY SPACES | 645 | 3.12 | 34.89 | 108.8568 | 409.33 | 1277.1096 | 0 | 0.00 |
| 178 | NON-COMM OFFICER BERTH & MESS | 642 | 6.45 | 34.98 | 225.621 | 602.34 | 3885.093 | 0 | 0.00 |
| 179 | ENLISTED PERSONNEL BERTH & MESS | 643 | 19.12 | 34.97 | 668.6264 | 609.45 | 11652.684 | 0 | 5.74 |
| 180 | SANITARY SPACES & FIXTURES | 644 | 19.67 | 35.03 | 689.0401 | 604.67 | 11893.8589 | 0 | 0.00 |
| 181 | LEISURE & COMMUNITY SPACES | 645 | 3.12 | 35.00 | 109.2 | 605.89 | 1890.3768 | 0 | 0.00 |
| 182 | NON-COMM OFFICER BERTH & MESS | 642 | 6.45 | 34.98 | 225.621 | 602.34 | 3885.093 | 0 | 0.00 |
| 183 | ENLISTED PERSONNEL BERTH & MESS | 643 | 19.12 | 34.97 | 668.6264 | 609.45 | 11652.684 | 0 | 5.74 |
| 184 | SANITARY SPACES & FIXTURES | 644 | 19.67 | 35.03 | 689.0401 | 604.67 | 11893.8589 | 0 | 0.00 |
| 185 | LEISURE & COMMUNITY SPACES | 645 | 3.12 | 35.00 | 109.2 | 605.89 | 1890.3768 | 0 | 0.00 |
| 186 | NON-COMM OFFICER BERTH & MESS | 642 | 6.45 | 34.98 | 225.621 | 602.34 | 3885.093 | 0 | 0.00 |
| 187 | ENLISTED PERSONNEL BERTH & MESS | 643 | 19.12 | 34.97 | 668.6264 | 609.45 | 11652.684 | 0 | 5.74 |
| 188 | SANITARY SPACES & FIXTURES | 644 | 19.67 | 35.03 | 689.0401 | 604.67 | 11893.8589 | 0 | 0.00 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 189 | LEISURE & COMMUNITY SPACES | 645 | 3.12 | 35.00 | 109.2 | 605.89 | 1890.3768 | 0 | 0.00 |
| 190 | NON-COMM OFFICER BERTH & MESS | 642 | 6.45 | 34.98 | 225.621 | 403.78 | 2604.381 | 0 | 0.00 |
| 191 | ENLISTED PERSONNEL BERTH & MESS | 643 | 19.12 | 34.97 | 668.6264 | 405.98 | 7762.3376 | 0 | 5.74 |
| 192 | SANITARY SPACES & FIXTURES | 644 | 19.67 | 35.03 | 689.0401 | 408.76 | 8040.3092 | 0 | 0.00 |
| 193 | LEISURE & COMMUNITY SPACES | 645 | 3.12 | 35.00 | 109.2 | 409.33 | 1277.1096 | 0 | 0.00 |
| 194 | NON-COMM OFFICER BERTH & MESS | 642 | 6.45 | 34.98 | 225.621 | 403.78 | 2604.381 | 0 | 0.00 |
| 195 | MESS | 643 | 19.12 | 34.97 | 668.6264 | 405.98 | 7762.3376 | 0 | |
| 196 | SPACES & FIXTURES | 644 | 19.67 | 35.03 | 689.0401 | | 8040.3092 | 0 | 0.00 |
| 197 | LEISURE & COMMUNITY SPACES | 645 | 3.12 | 35.00 | 109.2 | 409.33 | 1277.1096 | 0 | 0.00 |
| | **TOTAL GROUP** | **640** | **317.34** | **37.11** | **11777.23** | **506.50** | **160732.72** | **0.15** | **46.88** |
| 198 | MEDICAL EQ | 652 | 18.90 | 47.70 | 901.53 | 382.00 | 7219.80 | 0.00 | 0.00 |
| 199 | Galley & scullery | 651 | 25.93 | 36.13 | 936.81 | 567.00 | 14701.74 | 33.51 | 868.88 |
| 200 | Joiner | 652 | 1.54 | 36.01 | 55.46 | 576.89 | 888.41 | -7.80 | -12.01 |
| 201 | Joiner 02-01 dks | 654 | 0.31 | 35.98 | 11.26 | 587.90 | 184.01 | 24.46 | 7.66 |
| 202 | Laundries | 655 | 13.47 | 35.97 | 484.55 | 586.45 | 7900.07 | -28.42 | -382.85 |
| 203 | trash & trash compactor | 656 | 7.40 | 36.09 | 266.99 | 845.60 | 6255.75 | 27.14 | 200.78 |
| 204 | COMMISSARY PROVISIONS | 651 | 16.56 | 20.00 | 331.20 | 576.90 | 9553.46 | 2.11 | 34.94 |
| | **TOTAL GROUP** | **650** | **84.11** | **35.52** | **2987.81** | **555.26** | **46703.25** | **8.53** | **717.40** |
| 205 | Offices | 661 | 12.90 | 65.04 | 839.02 | 631.00 | 8139.90 | 0.00 | 0.00 |
| 206 | Briefing rooms | 661 | 12.90 | 65.13 | 840.18 | 631.00 | 8139.90 | 0.00 | 0.00 |
| 207 | Decontam. Sta. | 664 | 20.09 | 64.78 | 1301.62 | 431.00 | 8660.08 | 0.00 | 0.00 |
| 208 | Workshops. Labs, test areas | 665 | 50.00 | 64.67 | 3233.50 | 631.00 | 31550.00 | 0.00 | 0.00 |
| 209 | Decontam. Sta. | 664 | 1.09 | 65.34 | 71.42 | 794.50 | 74.13 | 12.07 | 13.19 |
| 210 | OFFICES | 661 | 6.87 | 65.14 | 447.51 | 679.33 | 4667 | 2.77 | 19.0 |
| 211 | MACHINERY CTL CENTER FURNISHINGS | 662 | 2.09 | 35.00 | 73.15 | 728.23 | 1522 | 6.70 | 14.0 |
| 212 | ELEC. CONTROL CENTER FURNISHINGS | 663 | 2.09 | 35.00 | 272 | 657.42 | 1374 | 9.09 | 19.0 |
| 213 | DAMAGE CONTROL STATION | 664 | 31.25 | 65.00 | 2031.25 | 107.55 | 3361 | 33.44 | 1045.0 |
| 214 | WORKSHOPS,LAB,TEST AREA | 665 | 13.21 | 65.00 | 858.65 | 691.22 | 9131 | 7.80 | 103.0 |
| | **TOTAL GROUP** | **660** | | **65.37** | **9968.30** | **502.43** | **76619.01** | **7.96** | **1213.19** |
| 215 | Shore pwr cable | 671 | 0.70 | 83.00 | 58.10 | 431.00 | 301.70 | 0.00 | 0.00 |
| 216 | Stwg life saving eqpmt | 671 | 3.02 | 83.00 | 250.33 | 431.00 | 1299.90 | 0.00 | 0.00 |
| 217 | Battery stowage | 671 | 5.82 | 83.00 | 483.31 | 431.00 | 2509.71 | 2.67 | 15.55 |
| 218 | Lockers arr. & details | 671 | 4.73 | 50.00 | 236.70 | 431.00 | 2040.35 | 0.00 | 0.00 |
| 219 | Cargo securing fitting cov. | 671 | 16.09 | 43.87 | 705.82 | 331.00 | 5325.46 | 0.00 | 0.00 |
| 220 | Battery stowage | 671 | 0.82 | 47.70 | 39.26 | 382.00 | 314.39 | 12.51 | 10.30 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 221 | Auxiliary Equipment space | 673 | 153.80 | 15.00 | 2307.00 | 131.71 | 20257.00 | 1.89 | 290.68 |
| 222 | Store room and issue room | 673 | 165.00 | 14.99 | 2473.35 | 335.69 | 55388.85 | 8.67 | 1430.55 |
| 223 | Cargo securing fitting draw. | 673 | 5.09 | 47.70 | 242.75 | 231.20 | 1176.58 | 0.00 | 0.00 |
| | **TOTAL GROUP** | **670** | **355.07** | **19.14** | **6796.61** | **249.56** | **88613.93** | **4.92** | **1747.08** |
| 224 | Repair parts and special tools | 699 | 65.00 | 14.76 | 959.40 | 135.78 | 8825.70 | 0.00 | 0.00 |
| | **TOTAL GROUP** | **690** | **65.00** | **14.76** | **959.40** | **135.78** | **8825.70** | **0.00** | **0.00** |
| | **GROUP 600** | | **1405.95** | **28.66** | **40288.33** | **349.66** | **491600.46** | **3.32** | **4671.90** |
| 225 | PHALANX STDB | 721 | 6.29 | 153.78 | 967.28 | 774.00 | 4868.46 | -42.10 | -264.81 |
| 226 | PHALANX PORT | 721 | 6.29 | 153.78 | 967.28 | 771.00 | 4849.59 | 42.10 | 264.81 |
| 227 | RAM Launching Device STDB | 721 | 0.94 | 145.00 | 136.01 | 771.00 | 723.20 | -28.60 | -26.83 |
| 228 | RAM Launching Device PORT | 721 | 0.94 | 145.00 | 136.01 | 774.00 | 726.01 | 28.60 | 26.83 |
| 229 | MISSILE STOWAGE STDB (42) | 723 | 2.94 | 13.00 | 38.22 | 607.5 | 1786.05 | 0.00 | 0.00 |
| 230 | MISSILE STOWAGE PORT (42) | 723 | 2.94 | 13.00 | 38.22 | 607.5 | 1786.05 | 0.00 | 0.00 |
| | **TOTAL GROUP** | **720** | **20.34** | **112.26** | **2283.01** | **724.79** | **14739.36** | **0.00** | **0.00** |
| 231 | Lockers arr. & details | 763 | 12.86 | 44.12 | 567.56 | 631.00 | 8117.18 | 28.45 | 365.98 |
| 232 | Lockers arr. & details | 763 | 4.86 | 77.00 | 374.53 | 756.85 | 654.14 | 22.89 | 111.34 |
| | **TOTAL GROUP** | **760** | **17.73** | **53.14** | **942.09** | **494.77** | **8771.32** | **26.92** | **477.32** |
| | **GROUP 700** | | **38.06** | **84.73** | **3225.10** | **617.66** | **23510.68** | **12.54** | **477.32** |
| | **TOTAL MODIFICATION** | | **7421.54** | **58.09** | **431118.83** | **317.36** | **2355283.82** | **2.28** | **16957.08** |

| | | | |
|---|---|---|---|
| | **Total Disp** | **VCG** | **LCG** | **TCG** |
| **FINAL STABILITY PARAMETERS** | **37680.53** | **45.64061423** | **441.6572402** | **0.651093** |

# Appendix C
# Space Allocations

| SSCS | Mission Support Area GROUP | Area Required | Allocated | Difference |
|---|---|---|---|---|
| 1 | MISSION SUPPORT | 170476.7083 | 170476.7083 | 0 |
| 1.1 | COMMAND,COMMUNICATION+SURV | 23178.79637 | 23178.79637 | 0 |
| 1.11 | EXTERIOR COMMUNICATIONS | 1466.77315 | 1466.77315 | 0 |
| 1.12 | SURVEILLANCE SYS | 5481.00758 | 5481.00758 | 0 |
| 1.13 | | 12958.04112 | 12958.04112 | 0 |
| 1.131 | COMBAT INFO CENTER | 10000 | 10000 | 0 |
| 1.132 | CONNING STATIONS | 2958.04112 | 2958.04112 | 0 |
| 1.14 | COUNTERMEASURES | 758.173 | 758.173 | 0 |
| 1.15 | INTERIOR COMMUNICATIONS | 2393.49384 | 2393.49384 | 0 |
| 1.16 | ENVIORNMENTAL CNTL SUP SYS | 121.30768 | 121.30768 | 0 |
| 1.2 | WEAPONS | 5788.94246 | 5788.94246 | 0 |
| 1.3 | AVIATION | 141062.2306 | 141062.2306 | 0 |
| 1.311 | LAUNCHING+RECOVERY AREAS | 85000 | 85000 | 0 |
| 1.3123 | HELICOPTER RECOVERY | 40000 | 40000 | 0 |
| 1.32 | AVIATION CONTROL | 2000 | 2000 | 0 |
| 1.34002 | HELICOPTER HANGAR AFT | 2000 | 2000 | 0 |
| 1.35 | AVIATION ADMINISTRATION | 2000 | 2000 | 0 |
| 1.36 | AVIATION MAINTENANCE | 10000 | 10000 | 0 |
| 1.37 | AIRCRAFT ORDINANCE | 2062.23056 | 2062.23056 | 0 |
| 1.9 | SM ARMS,PYRO+SALU BAT | 446.73886 | 446.73886 | 0 |
| 1.91 | SM ARMS (LOCKER) | 374.42082 | 374.42082 | 0 |
| 1.94 | ARMORY | 72.31804 | 72.31804 | 0 |
| 2 | HUMAN SUPPORT | 103495.6943 | 103495.6943 | 0 |
| 2.1 | LIVING | 75000 | 75000 | 0 |
| 2.11 | OFFICER LIVING | 5500 | 5500 | 0 |
| 2.13 | CREW LIVING | 40000 | 40000 | 0 |
| 2.14 | GENERAL SANITARY FACILITIES | 145.8025 | 145.8025 | 0 |
| 2.14003 | DECK WASHRM&WC | 145.8025 | 145.8025 | 0 |
| 2.15 | SHIP RECREATION FAC | 2689 | 2689 | 0 |
| 2.16 | TRAINING | 1200 | 1200 | 0 |
| 2.2 | COMMISSARY | 21295.21 | 21295.21 | 0 |
| 2.22202 | WARD ROOM GALLEY | 1112 | 1112 | 0 |
| 2.22204 | CREW GALLEY | 10000 | 10000 | 0 |
| 2.22403 | CREW SCULLERY | 583.21 | 583.21 | 0 |
| 2.231 | CHILL PROVISIONS | 2400 | 2400 | 0 |
| 2.232 | FROZEN PROVISIONS | 3600 | 3600 | 0 |
| 2.233 | DRY PROVISIONS | 6000 | 6000 | 0 |
| 2.3 | MEDICAL+DENTAL (MEDICAL) | 1200 | 1200 | 0 |
| 2.4 | GENERAL SERVICES | 4350 | 4350 | 0 |
| 2.41 | SHIP STORE FACILITIES | 2000 | 2000 | 0 |
| 2.42001 | LAUNDRY | 650 | 650 | 0 |
| 2.44 | BARBER SERVICE | 450 | 450 | 0 |
| 2.46 | POSTAL SERVICE | 450 | 450 | 0 |
| 2.47 | BRIG | 1000 | 1000 | 0 |
| 2.48 | RELIGIOUS | 450 | 450 | 0 |
| 2.5 | PERSONNEL STORES | 76.98372 | 76.98372 | 0 |

| | | | | |
|---|---|---|---|---|
| 2.6 | CBR PROTECTION | 1456.85858 | 1456.85858 | 0 |
| 2.7 | LIFESAVING EQUIPMENT | 116.642 | 116.642 | 0 |
| 3 | SHIP SUPPORT | 40006.68643 | 40006.68643 | 0 |
| 3.1 | SHIP CNTL SYS(STEERING&DIVING) | 3723.79585 | 3723.79585 | 0 |
| 3.2 | DAMAGE CONTROL | 7139.07361 | 7139.07361 | 0 |
| 3.3 | SHIP ADMINISTRATION | 4360.30802 | 4360.30802 | 0 |
| 3.301 | GENERAL SHIP | 493.97887 | 493.97887 | 0 |
| 3.302 | EXECUTIVE DEPT | 1133.17703 | 1133.17703 | 0 |
| 3.304 | SUPPLY DEPT | 1817.86557 | 1817.86557 | 0 |
| 3.305 | DECK DEPT | 300.35315 | 300.35315 | 0 |
| 3.306 | OPERATIONS DEPT | 314.9334 | 314.9334 | 0 |
| 3.307 | WEAPONS DEPT | 300 | 300 | 0 |
| 3.5 | DECK AUXILIARIES | 4357.74512 | 4357.74512 | 0 |
| 3.6 | SHIP MAINTENANCE | 20425.76383 | 20425.76383 | 0 |
| 3.62 | OPERATIONS DEPT (ELECT SHOP) | 653.1952 | 653.1952 | 0 |
| 3.63 | WEAPONS DEPT (ORDINANCE SHOP) | 332.4297 | 332.4297 | 0 |
| 3.64 | DECK DEPT (CARPENTER SHOP) | 659.61051 | 659.61051 | 0 |
| 3.71 | SUPPLY DEPT | 13760.25674 | 13760.25674 | 0 |
| 3.73 | OPERATIONS DEPT | 428.07614 | 428.07614 | 0 |
| 3.74 | DECK DEPT (BOATSWAIN STORES) | 3796.6971 | 3796.6971 | 0 |
| 3.75 | WEAPONS DEPT | 273.52549 | 273.52549 | 0 |
| 3.76 | EXEC DEPT(MASTER-AT-ARMS STOR) | 317.26624 | 317.26624 | 0 |
| 3.78 | CLEANING GEAR STOWAGE | 204.70671 | 204.70671 | 0 |
| 3.8 | ACCESS (INTERIOR-NORMAL) | 10060.95571 | 10060.95571 | 0 |
| 3.9 | TANKS | 797.24807 | 797.24807 | 0 |
| 4 | SHIP MACHINERY SYSTEM | 52166.96808 | 52166.96808 | 0 |
| 4.1 | PROPULSION SYSTEM | 13545.63546 | 13545.63546 | 0 |
| 4.3 | AUX MACHINERY | 11549.30763 | 11549.30763 | 0 |
| 4.31 | GENERAL (AUX MACH DELTA) | 6679.50413 | 6679.50413 | 0 |
| 4.32 | A/C&REFRIGERATION | 4869.8035 | 4869.8035 | 0 |
| 4.321 | A/C(INCLUDE VENT) | 3586.15829 | 3586.15829 | 0 |
| 4.322 | REFRIGERATION | 999.62194 | 999.62194 | 0 |
| 4.341 | SEWAGE | 189.54325 | 189.54325 | 0 |
| 4.342 | TRASH | 94.48002 | 94.48002 | 0 |
| 4.35 | MECHANICAL SYSTEMS | 703.93447 | 703.93447 | 0 |
| 4.36 | | 15000 | 15000 | 0 |
| | SUM | 366146.0571 | 366146.0571 | 0 |

# Appendix D
# Tank Weights

# TANK WEIGHT SUMMARY
# FAIRED LINES PLAN

## ruel Oil Tanks

| TANK NAME | WEIGHT LTons | % Full | CAPACITY LTons | VOLUME Bbls | NET VOL. Bbls | API GRAV. | TEMP. oF | SP.VOL. Bbls/LT | KG ft-BL | LCG ft-FP | TCG ft-CL | F.S. ft-LTons |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| W3D 8-80-2 | 272 | 98.0 | 278 | 1,893 | 1,893 | ---- | 60.0 | 6.9465 | 6.82 | 545.63A | 41.58P | 157 |
| W3D 8-80-1 | 274 | 98.0 | 279 | 1,900 | 1,900 | ---- | 60.0 | 6.9465 | 6.75 | 545.37A | 41.47S | 149 |
| W3B 8-68-1 | 274 | 98.0 | 280 | 1,903 | 1,903 | ---- | 60.0 | 6.9465 | 6.71 | 444.04A | 41.30S | 149 |
| W3B 8-68-2 | 232 | 98.0 | 237 | 1,613 | 1,613 | ---- | 60.0 | 6.9465 | 6.04 | 443.87A | 41.05P | 53 |
| W3C 8-74-1 | 279 | 98.0 | 284 | 1,936 | 1,936 | ---- | 60.0 | 6.9465 | 6.67 | 494.78A | 41.41S | 149 |
| W3C 8-74-4 | 237 | 98.0 | 242 | 1,647 | 1,647 | ---- | 60.0 | 6.9465 | 6.01 | 494.37A | 41.18P | 53 |
| TOTALS | 1,568 | 98.0 | 1,600 | 10,891 | 10,891 | | | | 6.52 | 495.98A | 2.28S | 710 |

## Diesel Oil Tanks

| TANK NAME | WEIGHT LTons | % Full | CAPACITY LTons | VOLUME Bbls | NET VOL. Bbls | API GRAV. | TEMP. oF | SP.VOL. Bbls/LT | KG ft-BL | LCG ft-FP | TCG ft-CL | F.S. ft-LTons |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DP 8-32-1 | 662 | 98.0 | 675 | 4,596 | 4,596 | ---- | 60.0 | 6.9465 | 9.43 | 169.71A | 10.13S | 1,725 |
| DP 8-32-2 | 635 | 98.0 | 648 | 4,412 | 4,412 | ---- | 60.0 | 6.9465 | 9.46 | 168.92A | 10.31P | 1,640 |
| W3A 8-62-1 | 0 | 0.0 | 263 | 0 | 0 | ---- | 60.0 | 6.9465 | 7.60 | 393.80A | 40.84S | 0 |
| W3A 8-62-4 | 195 | 98.0 | 199 | 1,356 | 1,356 | ---- | 60.0 | 6.9465 | 6.57 | 393.87A | 40.48P | 80 |
| W4 8-86-3 | 447 | 98.0 | 456 | 3,106 | 3,106 | ---- | 60.0 | 6.9465 | 6.49 | 615.11A | 40.52S | 236 |
| W4 8-86-6 | 452 | 98.0 | 461 | 3,141 | 3,141 | ---- | 60.0 | 6.9465 | 6.45 | 615.71A | 40.40P | 236 |
| DB4A 8-98-01 | 166 | 98.0 | 170 | 1,155 | 1,155 | ---- | 60.0 | 6.9465 | 4.37 | 694.03A | 21.75S | 626 |
| B4A 8-98-2 | 150 | 98.0 | 153 | 1,043 | 1,043 | ---- | 60.0 | 6.9465 | 4.50 | 693.16A | 23.70P | 355 |
| DP 6-116-1 | 168 | 98.0 | 172 | 1,169 | 1,169 | ---- | 60.0 | 6.9465 | 30.16 | 837.48A | 30.61S | 557 |
| ST 5-116-3 | 409 | 98.0 | 418 | 2,843 | 2,843 | ---- | 60.0 | 6.9465 | 46.75 | 847.28A | 24.42S | 411 |
| ST 5-116-1 | 369 | 98.0 | 376 | 2,560 | 2,560 | ---- | 60.0 | 6.9465 | 46.75 | 851.50A | 11.00S | 188 |
| SV 5-116-0 | 750 | 98.0 | 765 | 5,209 | 5,209 | ---- | 60.0 | 6.9465 | 46.75 | 852.05A | 7.56P | 1,265 |
| DP 6-116-4 | 168 | 98.0 | 172 | 1,169 | 1,169 | ---- | 60.0 | 6.9465 | 30.16 | 837.48A | 30.61P | 557 |
| TOTALS | 4,572 | 92.8 | 4,928 | 31,760 | 31,760 | | | | 22.38 | 579.79A | 0.12S | 7,876 |

## Lube Oil Tanks

| TANK NAME | WEIGHT LTons | % Full | CAPACITY LTons | VOLUME ft3 | SP.VOL. ft3/LT | KG ft-BL | LCG ft-FP | TCG ft-CL | F.S. ft-LTons |
|---|---|---|---|---|---|---|---|---|---|
| RGS 5-116-11 | 71 | 98.0 | 72 | 2,988 | 42.2134 | 46.74 | 838.34A | 48.94S | 23 |
| SSDG 5-116-9 | 13 | 98.0 | 13 | 531 | 42.2134 | 46.71 | 831.00A | 45.50S | 1 |
| RGSL 5-116-7 | 50 | 98.0 | 51 | 2,129 | 42.2134 | 47.65 | 836.69A | 41.00S | 10 |
| TOTALS | 134 | 98.0 | 136 | 5,648 | | 47.08 | 837.03A | 45.62S | 34 |

# TANK WEIGHT SUMMARY
# FAIRED LINES PLAN

## Fresh Water Tanks

| TANK NAME | WEIGHT LTons | % Full | CAPACITY LTons | VOLUME ft3 | SP.VOL. ft3/LT | KG ft-BL | LCG ft-FP | TCG ft-CL | F.S. ft-LTons |
|---|---|---|---|---|---|---|---|---|---|
| POT 5-116-6 | 88 | 67.0 | 132 | 3,164 | 35.8814 | 48.21 | 838.50A | 30.50P | 42 |
| POT 5-116-8 | 88 | 67.0 | 132 | 3,164 | 35.8814 | 48.21 | 838.50A | 39.50P | 42 |
| DIS 5-116-10 | 57 | 67.0 | 85 | 2,054 | 35.8814 | 48.26 | 838.47A | 49.92P | 12 |
| DTA 6-116-0 | 194 | 67.0 | 290 | 6,801 | 35.0062 | 27.91 | 838.00A | 0.23S | 2,056 |
| APF 6-126-1 | 248 | 67.0 | 371 | 8,696 | 35.0062 | 33.90 | 862.98A | 20.78S | 7,980 |
| APF 6-126-2 | 248 | 67.0 | 371 | 8,696 | 35.0062 | 33.90 | 862.98A | 20.78P | 7,980 |
| TOTALS | 925 | 67.0 | 1,381 | 32,575 | | 36.26 | 851.55A | 9.72P | 18,114 |

## SW Ballast Tanks

| TANK NAME | WEIGHT LTons | % Full | CAPACITY LTons | VOLUME ft3 | SP.VOL. ft3/LT | KG ft-BL | LCG ft-FP | TCG ft-CL | F.S. ft-LTons |
|---|---|---|---|---|---|---|---|---|---|
| FPK 6--12-0 | 0 | 0.0 | 733 | 0 | 35.0062 | 43.53 | 10.76A | 0.00 | 0 |
| NO1 8-25-0 | 0 | 0.0 | 1,090 | 0 | 35.0062 | 17.75 | 86.42A | 0.00 | 0 |
| W2A 8-44-01 | 0 | 0.0 | 310 | 0 | 35.0062 | 10.49 | 234.93A | 20.92S | 0 |
| W2A 8-44-4 | 0 | 0.0 | 309 | 0 | 35.0062 | 10.49 | 235.65A | 21.02P | 0 |
| W2B 8-50-1 | 0 | 0.0 | 244 | 0 | 35.0062 | 10.43 | 290.31A | 32.99S | 0 |
| W2B 8-50-2 | 0 | 0.0 | 232 | 0 | 35.0062 | 10.22 | 290.93A | 32.96P | 0 |
| W2C 8-56-1 | 0 | 0.0 | 224 | 0 | 35.0062 | 10.18 | 340.87A | 39.63S | 0 |
| 2C 8-56-2 | 132 | 60.0 | 219 | 4,605 | 35.0062 | 10.17 | 340.45A | 39.68P | 588 |
| DB3F 8-62-0 | 0 | 0.0 | 412 | 0 | 35.0062 | 2.75 | 415.07A | 11.46S | 0 |
| DB3F 8-62-2 | 342 | 98.0 | 349 | 11,980 | 35.0062 | 2.75 | 414.55A | 13.52P | 798 |
| DB4F 8-86-0 | 0 | 0.0 | 415 | 0 | 35.0062 | 2.76 | 621.99A | 11.49S | 0 |
| DB4F 8-86-2 | 345 | 98.0 | 352 | 12,085 | 35.0062 | 2.76 | 621.99A | 13.54P | 802 |
| LC 7-94-1 | 0 | 0.0 | 341 | 0 | 35.0062 | 11.72 | 687.09A | 38.73S | 0 |
| LC 7-94-2 | 334 | 98.0 | 341 | 11,695 | 35.0062 | 11.72 | 687.12A | 38.74P | 1,046 |
| DB3A 8-74-2 | 332 | 98.0 | 338 | 12,931 | 39.0015 | 2.75 | 520.00A | 14.00P | 744 |
| DB3A 8-74-0 | 257 | 65.0 | 395 | 10,006 | 39.0015 | 2.75 | 520.00A | 12.00S | 4,803 |
| TOTALS | 1,741 | 28.3 | 6,304 | 63,301 | | 5.03 | 538.00A | 16.67P | 8,780 |

## Misc. Tanks

| TANK NAME | WEIGHT LTons | % Full | CAPACITY LTons | VOLUME ft3 | SP.VOL. ft3/LT | KG ft-BL | LCG ft-FP | TCG ft-CL | F.S. ft-LTons |
|---|---|---|---|---|---|---|---|---|---|
| LOSM 8-104-1 | 53 | 98.0 | 54 | 1,911 | 35.8814 | 10.48 | 738.89A | 17.81S | 78 |
| LOSM 8-105-2 | 38 | 98.0 | 39 | 1,374 | 35.8814 | 10.71 | 742.30A | 17.74P | 58 |
| LORG 4-106-2 | 13 | 98.0 | 14 | 484 | 35.8814 | 52.33 | 746.50A | 10.00P | 7 |
| LORG 4-106-4 | 10 | 98.0 | 10 | 363 | 35.8814 | 52.33 | 746.50A | 17.00P | 4 |
| OWHT 8-98-0 | 21 | 98.0 | 21 | 743 | 35.8814 | 2.81 | 677.49A | 5.92S | 29 |
| WOT 8-98-02 | 49 | 98.0 | 50 | 1,765 | 35.8814 | 2.90 | 683.62A | 2.49P | 151 |
| LODT 8-103-4 | 50 | 98.0 | 51 | 1,796 | 35.8814 | 9.27 | 723.62A | 18.21P | 35 |
| ERMO 8-104-0 | 79 | 98.0 | 80 | 2,827 | 35.8814 | 8.05 | 732.90A | 0.00 | 102 |
| GTWD 8-107-0 | 18 | 98.0 | 18 | 643 | 35.8814 | 9.58 | 756.79A | 0.23P | 25 |
| 'OPS 7-112-2 | 11 | 98.0 | 12 | 411 | 35.8814 | 16.04 | 797.48A | 7.76P | 8 |
| /PST 7-112-1 | 11 | 98.0 | 11 | 399 | 35.8814 | 16.02 | 797.54A | 7.56S | 8 |

# TANK WEIGHT SUMMARY
# FAIRED LINES PLAN

## Misc. Tanks

| TANK NAME | WEIGHT LTons | % Full | CAPACITY LTons | VOLUME ft3 | SP.VOL. ft3/LT | KG ft-BL | LCG ft-FP | TCG ft-CL | F.S. ft-LTons |
|---|---|---|---|---|---|---|---|---|---|
| GWT 5-126-1 | 63 | 98.0 | 64 | 2,252 | 35.8814 | 45.76 | 854.50A | 39.40S | 139 |
| SWHT 5-130-1 | 39 | 98.0 | 40 | 1,408 | 35.8814 | 46.63 | 866.57A | 37.83S | 29 |
| TOTALS | 456 | 98.0 | 464 | 16,376 | | 19.15 | 758.59A | 6.57S | 674 |

CARGO SUMMARY

Misc. Weights

| ITEM | WEIGHT LTons | KG ft-BL | LCG ft-FP | TCG ft-CL | F.S. ft-LTons | FWD BND ft-FP | AFT BND ft-FP |
|---|---|---|---|---|---|---|---|
| CREW | 360 | 35.00 | 544.50A | 0.00 | 0 | 528.10A | 560.90A |
| MISS EXPENS | 120 | 32.00 | 522.50A | 0.00 | 0 | 506.10A | 538.90A |
| HELLO | 127 | 80.00 | 472.00A | 0.00 | 0 | 455.60A | 488.40A |
| BOATS | 117 | 80.00 | 472.00A | 0.00 | 0 | 455.60A | 488.40A |
| SHIPS STORES | 678 | 28.00 | 475.00A | 0.00 | 0 | 458.60A | 491.40A |
| MEDICAL | 19 | 47.40 | 365.50A | 0.00 | 0 | 349.10A | 381.90A |
| DRY STORES | 260 | 28.00 | 510.00A | 0.00 | 0 | 493.60A | 526.40A |
| FREEZE STORE | 180 | 28.00 | 509.30A | 0.00 | 0 | 492.90A | 525.70A |
| TOTALS | 1,861 | 36.63 | 498.20A | 0.00 | 0 | | |

TANK WEIGHT SUMMARY
FAIRED LINES PLAN

## Fuel Oil Tanks

| TANK NAME | WEIGHT LTons | % Full | CAPACITY LTons | VOLUME Bbls | NET VOL. Bbls | API GRAV. | TEMP. oF | SP.VOL. Bbls/LT | KG ft-BL | LCG ft-FP | TCG ft-CL | F.S. ft-LTons |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| W3D 8-80-2 | 186 | 67.0 | 278 | 1,294 | 1,294 | ---- | 60.0 | 6.9465 | 6.82 | 545.63A | 41.58P | 1,482 |
| W3D 8-80-1 | 187 | 67.0 | 279 | 1,299 | 1,299 | ---- | 60.0 | 6.9465 | 6.75 | 545.37A | 41.47S | 1,482 |
| W3B 8-68-1 | 187 | 67.0 | 280 | 1,301 | 1,301 | ---- | 60.0 | 6.9465 | 6.71 | 444.04A | 41.30S | 1,432 |
| W3B 8-68-2 | 159 | 67.0 | 237 | 1,103 | 1,103 | ---- | 60.0 | 6.9465 | 6.04 | 443.87A | 41.05P | 1,432 |
| W3C 8-74-1 | 191 | 67.0 | 284 | 1,324 | 1,324 | ---- | 60.0 | 6.9465 | 6.67 | 494.78A | 41.41S | 1,485 |
| W3C 8-74-4 | 162 | 67.0 | 242 | 1,126 | 1,126 | ---- | 60.0 | 6.9465 | 6.01 | 494.37A | 41.18P | 1,485 |
| TOTALS | 1,072 | 67.0 | 1,600 | 7,446 | 7,446 | | | | 6.52 | 495.98A | 2.28S | 8,799 |

## Diesel Oil Tanks

| TANK NAME | WEIGHT LTons | % Full | CAPACITY LTons | VOLUME Bbls | NET VOL. Bbls | API GRAV. | TEMP. oF | SP.VOL. Bbls/LT | KG ft-BL | LCG ft-FP | TCG ft-CL | F.S. ft-LTons |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DP 8-32-1 | 452 | 67.0 | 675 | 3,142 | 3,142 | ---- | 60.0 | 6.9465 | 9.43 | 169.71A | 10.13S | 4,038 |
| DP 8-32-2 | 434 | 67.0 | 648 | 3,017 | 3,017 | ---- | 60.0 | 6.9465 | 9.46 | 168.92A | 10.31P | 3,914 |
| W3A 8-62-1 | 0 | 0.0 | 263 | 0 | 0 | ---- | 60.0 | 6.9465 | 7.60 | 393.80A | 40.84S | 0 |
| W3A 8-62-4 | 133 | 67.0 | 199 | 927 | 927 | ---- | 60.0 | 6.9465 | 6.57 | 393.87A | 40.48P | 997 |
| W4 8-86-3 | 306 | 67.0 | 456 | 2,124 | 2,124 | ---- | 60.0 | 6.9465 | 6.49 | 615.11A | 40.52S | 2,428 |
| W4 8-86-6 | 309 | 67.0 | 461 | 2,147 | 2,147 | ---- | 60.0 | 6.9465 | 6.45 | 615.71A | 40.40P | 2,501 |
| DB4A 8-98-01 | 114 | 67.0 | 170 | 790 | 790 | ---- | 60.0 | 6.9465 | 4.37 | 694.03A | 21.75S | 6,065 |
| B4A 8-98-2 | 103 | 67.0 | 153 | 713 | 713 | ---- | 60.0 | 6.9465 | 4.50 | 693.16A | 23.70P | 4,508 |
| DP 6-116-1 | 115 | 67.0 | 172 | 799 | 799 | ---- | 60.0 | 6.9465 | 30.16 | 837.48A | 30.61S | 2,239 |
| ST 5-116-3 | 280 | 67.0 | 418 | 1,944 | 1,944 | ---- | 60.0 | 6.9465 | 46.75 | 847.28A | 24.42S | 429 |
| ST 5-116-1 | 252 | 67.0 | 376 | 1,750 | 1,750 | ---- | 60.0 | 6.9465 | 46.75 | 851.50A | 11.00S | 189 |
| SV 5-116-0 | 513 | 67.0 | 765 | 3,561 | 3,561 | ---- | 60.0 | 6.9465 | 46.75 | 852.05A | 7.56P | 1,702 |
| DP 6-116-4 | 115 | 67.0 | 172 | 799 | 799 | ---- | 60.0 | 6.9465 | 30.16 | 837.48A | 30.61P | 2,239 |
| TOTALS | 3,126 | 63.4 | 4,928 | 21,714 | 21,714 | | | | 22.38 | 579.79A | 0.12S | 31,249 |

## Lube Oil Tanks

| TANK NAME | WEIGHT LTons | % Full | CAPACITY LTons | VOLUME ft3 | SP.VOL. ft3/LT | KG ft-BL | LCG ft-FP | TCG ft-CL | F.S. ft-LTons |
|---|---|---|---|---|---|---|---|---|---|
| RGS 5-116-11 | 48 | 67.0 | 72 | 2,043 | 42.2134 | 46.74 | 838.34A | 48.94S | 23 |
| SSDG 5-116-9 | 9 | 67.0 | 13 | 363 | 42.2134 | 46.71 | 831.00A | 45.50S | 1 |
| RGSL 5-116-7 | 34 | 67.0 | 51 | 1,455 | 42.2134 | 47.65 | 836.69A | 41.00S | 53 |
| TOTALS | 91 | 67.0 | 136 | 3,861 | | 47.08 | 837.03A | 45.62S | 77 |

# TANK WEIGHT SUMMARY
FAIRED LINES PLAN

## rresh Water Tanks

| TANK NAME | WEIGHT LTons | % Full | CAPACITY LTons | VOLUME ft3 | SP.VOL. ft3/LT | KG ft-BL | LCG ft-FP | TCG ft-CL | F.S. ft-LTons |
|---|---|---|---|---|---|---|---|---|---|
| POT 5-116-6 | 43 | 33.0 | 132 | 1,558 | 35.8814 | 48.21 | 838.50A | 30.50P | 42 |
| POT 5-116-8 | 43 | 33.0 | 132 | 1,558 | 35.8814 | 48.21 | 838.50A | 39.50P | 42 |
| DIS 5-116-10 | 28 | 33.0 | 85 | 1,012 | 35.8814 | 48.26 | 838.47A | 49.92P | 12 |
| DTA 6-116-0 | 96 | 33.0 | 290 | 3,350 | 35.0062 | 27.91 | 838.00A | 0.23S | 2,056 |
| APF 6-126-1 | 122 | 33.0 | 371 | 4,283 | 35.0062 | 33.90 | 862.98A | 20.78S | 7,980 |
| APF 6-126-2 | 122 | 33.0 | 371 | 4,283 | 35.0062 | 33.90 | 862.98A | 20.78P | 7,980 |
| TOTALS | 455 | 33.0 | 1,381 | 16,044 | | 36.26 | 851.55A | 9.72P | 18,114 |

## SW Ballast Tanks

| TANK NAME | WEIGHT LTons | % Full | CAPACITY LTons | VOLUME ft3 | SP.VOL. ft3/LT | KG ft-BL | LCG ft-FP | TCG ft-CL | F.S. ft-LTons |
|---|---|---|---|---|---|---|---|---|---|
| FPK 6--12-0 | 0 | 0.0 | 733 | 0 | 35.0062 | 43.53 | 10.76A | 0.00 | 0 |
| NO1 8-25-0 | 0 | 0.0 | 1,090 | 0 | 35.0062 | 17.75 | 86.42A | 0.00 | 0 |
| W2A 8-44-01 | 0 | 0.0 | 310 | 0 | 35.0062 | 10.49 | 234.93A | 20.92S | 0 |
| W2A 8-44-4 | 0 | 0.0 | 309 | 0 | 35.0062 | 10.49 | 235.65A | 21.02P | 0 |
| W2B 8-50-1 | 0 | 0.0 | 244 | 0 | 35.0062 | 10.43 | 290.31A | 32.99S | 0 |
| W2B 8-50-2 | 228 | 98.0 | 232 | 7,968 | 35.0062 | 10.22 | 290.93A | 32.96P | 399 |
| W2C 8-56-1 | 0 | 0.0 | 224 | 0 | 35.0062 | 10.18 | 340.87A | 39.63S | 0 |
| 2C 8-56-2 | 136 | 62.0 | 219 | 4,758 | 35.0062 | 10.17 | 340.45A | 39.68P | 588 |
| DB3F 8-62-0 | 0 | 0.0 | 412 | 0 | 35.0062 | 2.75 | 415.07A | 11.46S | 0 |
| DB3F 8-62-2 | 342 | 98.0 | 349 | 11,980 | 35.0062 | 2.75 | 414.55A | 13.52P | 798 |
| DB4F 8-86-0 | 249 | 60.0 | 415 | 8,718 | 35.0062 | 2.76 | 621.99A | 11.49S | 4,949 |
| DB4F 8-86-2 | 345 | 98.0 | 352 | 12,085 | 35.0062 | 2.76 | 621.99A | 13.54P | 802 |
| LC 7-94-1 | 334 | 98.0 | 341 | 11,708 | 35.0062 | 11.72 | 687.09A | 38.73S | 1,033 |
| LC 7-94-2 | 334 | 98.0 | 341 | 11,695 | 35.0062 | 11.72 | 687.12A | 38.74P | 1,046 |
| DB3A 8-74-2 | 332 | 98.0 | 338 | 12,931 | 39.0015 | 2.75 | 520.00A | 14.00P | 744 |
| DB3A 8-74-0 | 387 | 98.0 | 395 | 15,086 | 39.0015 | 2.75 | 520.00A | 12.00S | 1,033 |
| TOTALS | 2,687 | 43.3 | 6,304 | 96,929 | | 5.99 | 542.22A | 7.19P | 11,392 |

## Misc. Tanks

| TANK NAME | WEIGHT LTons | % Full | CAPACITY LTons | VOLUME ft3 | SP.VOL. ft3/LT | KG ft-BL | LCG ft-FP | TCG ft-CL | F.S. ft-LTons |
|---|---|---|---|---|---|---|---|---|---|
| LOSM 8-104-1 | 36 | 66.0 | 54 | 1,287 | 35.8814 | 10.48 | 738.89A | 17.81S | 261 |
| LOSM 8-105-2 | 26 | 66.0 | 39 | 925 | 35.8814 | 10.71 | 742.30A | 17.74P | 212 |
| LORG 4-106-2 | 9 | 66.0 | 14 | 326 | 35.8814 | 52.33 | 746.50A | 10.00P | 11 |
| LORG 4-106-4 | 7 | 66.0 | 10 | 244 | 35.8814 | 52.33 | 746.50A | 17.00P | 5 |
| OWHT 8-98-0 | 14 | 66.0 | 21 | 500 | 35.8814 | 2.81 | 677.49A | 5.92S | 86 |
| WOT 8-98-02 | 33 | 66.0 | 50 | 1,189 | 35.8814 | 2.90 | 683.62A | 2.49P | 595 |
| LODT 8-103-4 | 34 | 66.0 | 51 | 1,209 | 35.8814 | 9.27 | 723.62A | 18.21P | 94 |
| ERWO 8-104-0 | 53 | 66.0 | 80 | 1,904 | 35.8814 | 8.05 | 732.90A | 0.00 | 194 |
| GTWD 8-107-0 | 12 | 66.0 | 18 | 433 | 35.8814 | 9.58 | 756.79A | 0.23P | 61 |
| 'OPS 7-112-2 | 8 | 66.0 | 12 | 277 | 35.8814 | 16.04 | 797.48A | 7.76P | 33 |
| PST 7-112-1 | 7 | 66.0 | 11 | 268 | 35.8814 | 16.02 | 797.54A | 7.56S | 29 |

TANK WEIGHT SUMMARY
FAIRED LINES PLAN

Misc. Tanks

| TANK NAME | WEIGHT LTons | % Full | CAPACITY LTons | VOLUME ft3 | SP.VOL. ft3/LT | KG ft-BL | LCG ft-FP | TCG ft-CL | F.S. ft-LTons |
|---|---|---|---|---|---|---|---|---|---|
| GWT 5-126-1 | 42 | 66.0 | 64 | 1,517 | 35.8814 | 45.76 | 854.50A | 39.40S | 317 |
| SWHT 5-130-1 | 26 | 66.0 | 40 | 948 | 35.8814 | 46.63 | 866.57A | 37.83S | 40 |
| TOTALS | 307 | 66.0 | 464 | 11,029 | | 19.15 | 758.59A | 6.57S | 1,937 |

SOF -- SOF
Rev. 1 (by: WOLF-BAB)

OOC POSSE-LOAD V2.2
01-23-03

CARGO SUMMARY

**Misc. Weights**

| ITEM | WEIGHT LTons | KG ft-BL | LCG ft-FP | TCG ft-CL | F.S. ft-LTons | FWD BND ft-FP | AFT BND ft-FP |
|---|---|---|---|---|---|---|---|
| CREW | 360 | 35.00 | 544.50A | 0.00 | 0 | 528.10A | 560.90A |
| MISS EXPENS | 40 | 32.00 | 522.50A | 0.00 | 0 | 506.10A | 538.90A |
| HELO | 127 | 80.00 | 472.00A | 0.00 | 0 | 455.60A | 488.40A |
| BOATS | 117 | 80.00 | 472.00A | 0.00 | 0 | 455.60A | 488.40A |
| SHIP'S STORE | 224 | 28.00 | 475.00A | 0.00 | 0 | 458.60A | 491.40A |
| MEDICAL | 19 | 47.40 | 465.40A | 0.00 | 0 | 449.00A | 481.80A |
| DRY STORES | 86 | 28.00 | 510.00A | 0.00 | 0 | 493.60A | 526.40A |
| FREEZE STORE | 59 | 28.00 | 509.30A | 0.00 | 0 | 492.90A | 525.70A |
| TOTALS | 1,032 | 43.25 | 505.08A | 0.00 | 0 | | |

# Appendix E
# POSSE Intact Stability Analysis

## STILL WATER FULL LOAD

**TRIM & STABILITY SUMMARY**
**FAIRED LINES PLAN**

| ITEM | WEIGHT LTons | KG ft-BL | LCG ft-FP | TCG ft-CL | FSmom ft-LTons |
|---|---|---|---|---|---|
| Light Ship | 37,681 | 45.57 | 441.70A | 0.65S | |
| Constant | 0 | 0.00 | 452.50A | 0.00 | 0 |
| RoRo Cargo | 0 | 0.00 | 452.50A | 0.00 | |
| Misc. Weight | 1,861 | 36.63 | 437.82A | 0.00 | 0 |
| Fuel Oil | 546 | 6.78 | 545.50A | 0.02S | 306 |
| Diesel Oil | 5,404 | 19.97 | 547.16A | 0.65P | 8,265 |
| Lube Oil | 134 | 47.08 | 837.03A | 45.62S | 34 |
| Fresh Water | 230 | 48.22 | 838.49A | 38.66P | 97 |
| SW Ballast | 2,625 | 12.68 | 645.23A | 7.86P | 7,737 |
| Misc. | 456 | 19.15 | 758.59A | 6.57S | 674 |
| TOTALS | 48,937 | 39.98 | 471.18A | 0.01S | 17,112 |

**STABILITY CALCULATION**

| | |
|---|---|
| KMt | 52.27 ft |
| KG | 39.98 ft |
| GMt | 12.29 ft |
| FSc | 0.35 ft |
| GMt Corrected | 11.94 ft |
| GMt Required | 5.25 ft |
| GMt Margin | 6.69 ft |

**TRIM CALCULATION**

| | |
|---|---|
| LCF Draft | 27.82 ft |
| LCB (even keel) | 470.69 ft-AFT |
| LCF | 482.80 ft-AFT |
| MT1in | 9,776 ft-LT/in |
| Trim | 0.20 ft-AFT |
| Prop. Immersion | 114 % |
| List | 0.06 deg-STBD |

**DRAFTS**

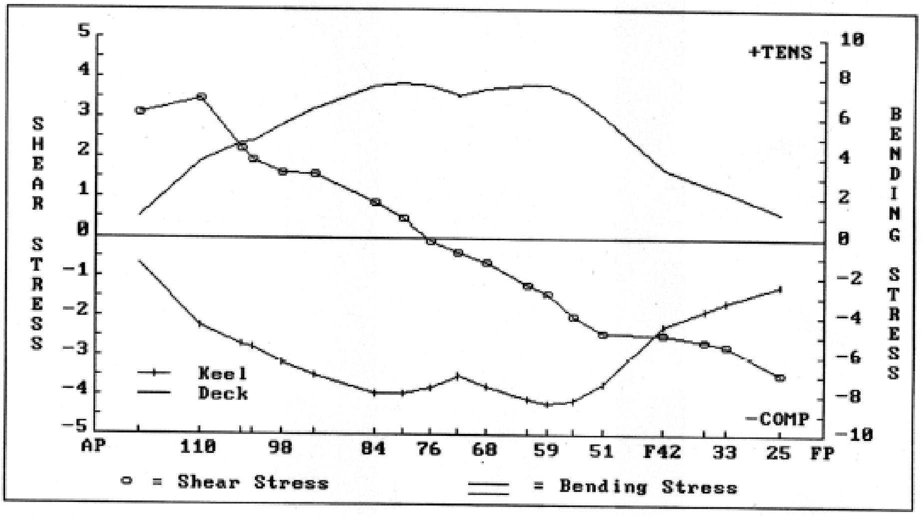
| | |
|---|---|
| F.P. 27ft- 8.5in ( 8.45m) | Fwd Marks 27ft- 8.6in ( 8.45m) |
| M.S. 27ft- 9.7in ( 8.48m) | M.S.Marks 27ft- 9.8in ( 8.48m) |
| A.P. 27ft-11.0in ( 8.51m) | Aft Marks 27ft-10.9in ( 8.51m) |

**STRENGTH CALCULATIONS**

| | |
|---|---|
| Shear Force at 110 | 4,585 LT |
| Bending Moment at 76 | 1,107,598 ft-LTons [HOG] |

## SHEAR & LONGITUDINAL BENDING STRESS SUMMARY
Stresses in ksi

### FAIRED LINES PLAN



o = Shear Stress ═ = Bending Stress

| | | SHEAR FORCES | | BENDING MOMENTS | | |
|---|---|---|---|---|---|---|
| | LOCATION | SHEAR | SHEAR STRESS | MOMENT | DK STRESS | KL STRESS |
| No. | ft-FP | LTons | ksi | ft-LTons | ksi | ksi |
| 25 | 55.00A | -1,429 | -3.47 | 49,265H | 1.18 | -2.39 |
| 33 | 121.00A | -2,644 | -2.73 | 185,367H | 2.22 | -3.27 |
| 36 | 148.00A | -3,161 | -2.65 | 264,029H | 2.63 | -3.70 |
| F42 | 199.00A | -3,998 | -2.46 | 447,575H | 3.37 | -4.51 |
| 51 | 274.00A | -3,529 | -2.41 | 743,701H | 6.08 | -7.39 |
| 55 | 310.00A | -2,827 | -1.99 | 859,240H | 7.15 | -8.27 |
| 59 | 343.00A | -2,071 | -1.43 | 940,011H | 7.65 | -8.46 |
| 62 | 367.00A | -1,807 | -1.19 | 985,371H | 7.63 | -8.19 |
| 68 | 418.00A | -1,043 | -0.61 | 1,064,676H | 7.39 | -7.53 |
| MS | 452.50A | -657 | -0.36 | 1,089,776H | 7.07 | -7.00 |
| 72 | 454.00A | -656 | -0.36 | 1,090,745H | 7.10 | -7.03 |
| 76 | 487.00A | -140 | -0.08 | 1,107,598H | 7.56 | -7.61 |
| 80 | 520.00A | 736 | 0.43 | 1,097,524H | 7.72 | -7.92 |
| 84 | 556.00A | 1,411 | 0.84 | 1,068,446H | 7.55 | -7.91 |
| 93 | 631.00A | 2,660 | 1.57 | 885,618H | 6.39 | -7.01 |
| 98 | 673.00A | 2,765 | 1.61 | 776,889H | 5.60 | -6.31 |
| F98 | 709.00A | 3,348 | 1.93 | 667,409H | 4.80 | -5.54 |
| 104 | 724.00A | 3,642 | 2.21 | 615,177H | 4.67 | -5.42 |
| 110 | 775.00A | 4,585 | 3.46 | 404,154H | 3.76 | -4.50 |
| 126 | 851.00A | 2,619 | 3.08 | 70,660H | 1.00 | -1.30 |

Maximum Shear Stress at 25: -3.47 ksi
Maximum Deck Bending Stress at 80: 7.72 ksi
Maximum Keel Bending Stress at 59: -8.46 ksi

# STILL WATER FULL LOAD
# WIND

**TRIM & STABILITY SUMMARY**
**FAIRED LINES PLAN**

| ITEM | WEIGHT LTons | KG ft-BL | LCG ft-FP | TCG ft-CL | FSmom ft-LTons |
|---|---|---|---|---|---|
| Light Ship | 37,681 | 45.57 | 441.70A | 0.65S | |
| Constant | 0 | 0.00 | 452.50A | 0.00 | 0 |
| RoRo Cargo | 0 | 0.00 | 452.50A | 0.00 | |
| Misc. Weight | 1,861 | 36.63 | 437.82A | 0.00 | 0 |
| Fuel Oil | 546 | 6.78 | 545.50A | 0.02S | 306 |
| Diesel Oil | 5,404 | 19.97 | 547.16A | 0.65P | 8,265 |
| Lube Oil | 134 | 47.08 | 837.03A | 45.62S | 34 |
| Fresh Water | 230 | 48.22 | 838.49A | 38.66P | 97 |
| SW Ballast | 2,625 | 12.68 | 645.23A | 7.86P | 7,737 |
| Misc. | 456 | 19.15 | 758.59A | 6.57S | 674 |
| TOTALS | 48,937 | 39.98 | 471.18A | 0.01S | 17,112 |

**STABILITY CALCULATION**

| | |
|---|---|
| KMt | 52.27 ft |
| KG | 39.98 ft |
| GMt | 12.29 ft |
| FSc | 0.35 ft |
| GMt Corrected | 11.94 ft |
| GMt Required | 5.25 ft |
| GMt Margin | 6.69 ft |

**TRIM CALCULATION**

| | |
|---|---|
| LCF Draft | 27.82 ft |
| LCB (even keel) | 470.69 ft-AFT |
| LCF | 482.80 ft-AFT |
| MT1in | 9,776 ft-LT/in |
| Trim | 0.20 ft-AFT |
| Prop. Immersion | 114 % |
| List | 0.06 deg-STBD |

**DRAFTS**

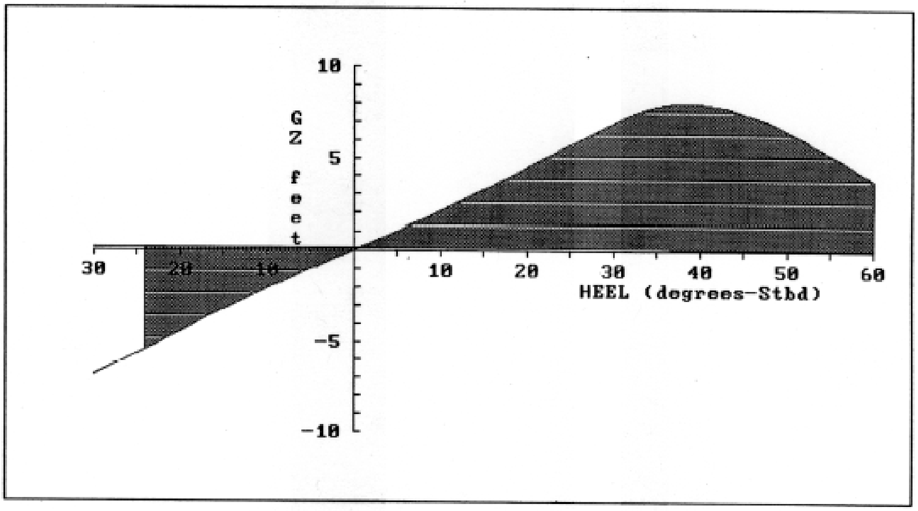
| | |
|---|---|
| F.P. 27ft- 8.5in ( 8.45m) | Fwd Marks 27ft- 8.6in ( 8.45m) |
| M.S. 27ft- 9.7in ( 8.48m) | M.S.Marks 27ft- 9.8in ( 8.48m) |
| A.P. 27ft-11.0in ( 8.51m) | Aft Marks 27ft-10.9in ( 8.51m) |

**STRENGTH CALCULATIONS**

Shear Force at 110 4,585 LT
Bending Moment at 76 1,107,598 ft-LTons [HOG]

**BEAM WIND with ROLLING STABILITY EVALUATION**
**(per U.S. Navy DDS079-1)**

FAIRED LINES PLAN



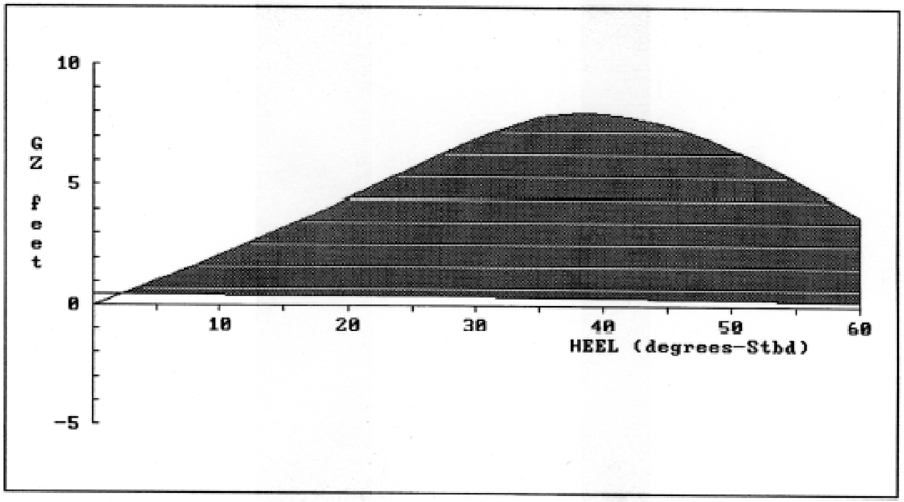

| | Available | Required |
|---|---|---|
| Wind Heeling Arm Lw | 0.18 ft | |
| Maximum Righting Arm | 8.00 ft | 0.30 ft |
| Capsizing Area A2 | 67.3 ft-deg | |
| Righting Area A1 | 295.1 ft-deg | 94.2 ft-deg |

| | | | |
|---|---|---|---|
| Wind Velocity | = 100 knots | Mean Draft | = 27.81 ft |
| Wind Pressure Factor | = 0.0035 | Displacement | = 48,937 LTons |
| Wind Pressure | = 0.0156 LT/ft2 | GMt (corrected) | = 11.94 ft |
| Projected Sail Area | = 19409.7 ft2 | Roll Angle | = 25.0 deg |
| Vertical Arm | = 43.09 ft ABL | | |
| Heeling Arm at 0 deg | = 0.18 ft | Angle at Intercept | = 60.0 deg |
| Wind Heel Arm Lw | = 0.18 ft | Maximum GZ | = 8.00 ft |
| Wind Heel Angle | = 0.9 deg | Angle at Max. GZ | = 38.4 deg |

# STILL WATER FULL LOAD TURN

**EFFECT on STABILITY of HIGH SPEED TURNING**
**(per U.S. Navy DDS079-1)**

FAIRED LINES PLAN




| | Available | Required |
|---|---|---|
| Angle of Heel | 2.2 deg | 15.0 deg |
| Heeling Arm Lc | 0.44 ft | |
| Maximum Righting Arm | 8.00 ft | 0.74 ft |
| Total Righting Area | 302.6 ft-deg | |
| Reserve Righting Area | 281.1 ft-deg | 121.0 ft-deg |

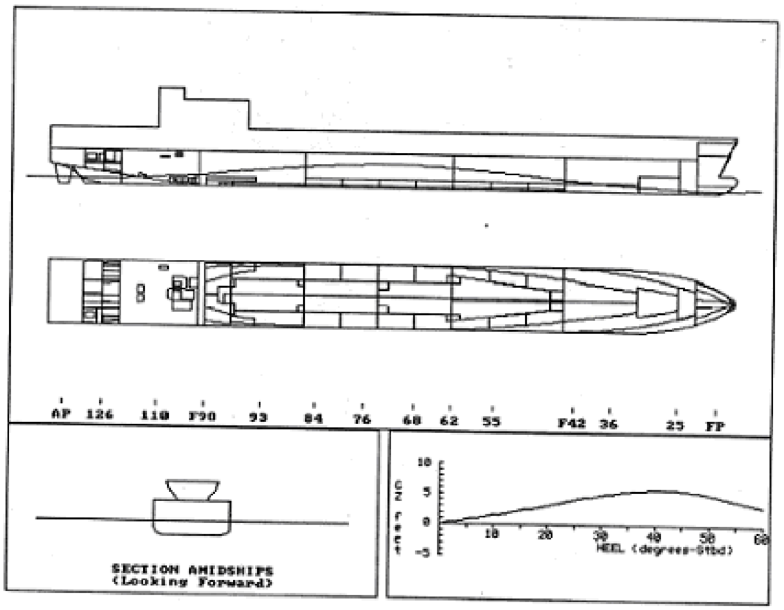
| | | | |
|---|---|---|---|
| Ship Speed in Turn = | 24.0 knots | Displacement = | 48,937 LTons |
| Turn Circle Radius = | 3000 ft | VCG = | 39.98 ft |
| Heeling Arm at 0 deg= | 0.44 ft | Mean Draft = | 27.81 ft |
| Angle at Max. GZ = | 38.4 deg | Positive GZ Range = | 60.0 deg |
| | | Angle at Intercept= | 60.0 deg |

# INTACT STABILITY FULL LOAD HOGGING-SAGGING

**FREE-FLOATING DAMAGED CONDITION**

**Damaged Compartments:**
LORG 4-106-2

| | DISPLACEMENT LTons | DRAFT FWD ft | DRAFT AFT ft | TRIM ft | HEEL deg. | UPRIGHT GMt ft |
|---|---|---|---|---|---|---|
| INTACT | 48,937 | 27.71 | 27.91 | 0.20A | 0.1S | 11.94 |
| DAMAGED | 48,923 | 22.06 | 26.59 | 4.53A | 0.1S | 8.01 |



CVT-1 -- SOF
Rev. -

OOC POSSE-SALV V2.2

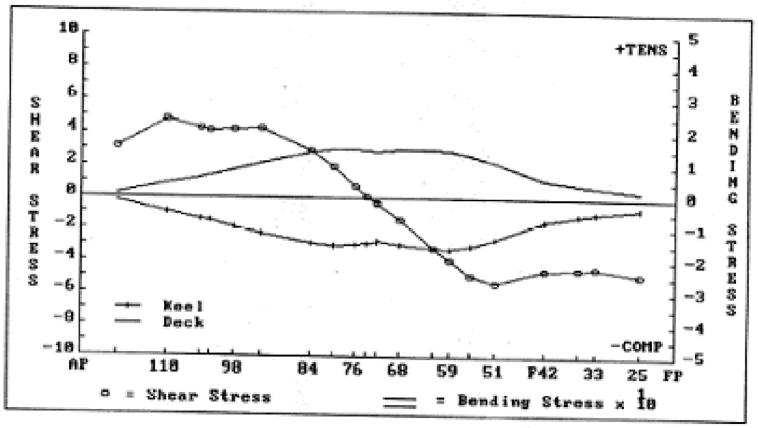
SHEAR & LONGITUDINAL BENDING STRESS SUMMARY
Stresses in ksi

FAIRED LINES PLAN

Wave Height: 33.09 ft
Wave Length: 905.00 ft

Wave Position: 452.50A ft-FP

(Based on Direct Calculation from Hull Offsets)



## SHEAR & LONGITUDINAL BENDING STRESS SUMMARY
### Stresses in ksi

### FAIRED LINES PLAN

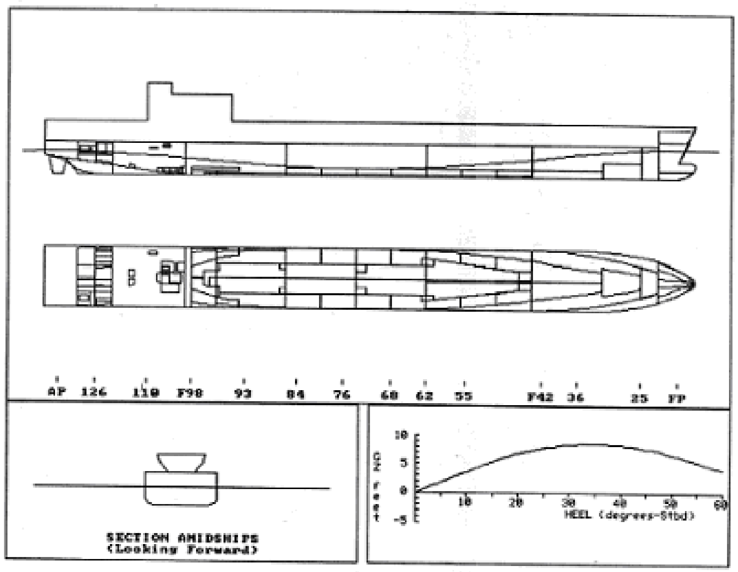
| | | SHEAR FORCES | | BENDING MOMENTS | | |
|---|---|---|---|---|---|---|
| | LOCATION | SHEAR | SHEAR STRESS | MOMENT | DK STRESS | KL STRESS |
| No. | ft-FP | LTons | ksi | ft-LTons | ksi | ksi |
| 25 | 55.00A | -1,988 | -4.82 | 66,784H | 2.10 | -3.25 |
| 33 | 121.00A | -4,263 | -4.41 | 271,310H | 3.26 | -4.80 |
| 36 | 148.00A | -5,369 | -4.50 | 401,515H | 4.01 | -5.64 |
| F42 | 199.00A | -7,353 | -4.53 | 727,348H | 5.49 | -7.35 |
| 51 | 274.00A | -7,838 | -5.36 | 1,320,602H | 10.82 | -13.16 |
| 55 | 310.00A | -6,977 | -4.90 | 1,590,264H | 13.26 | -15.34 |
| 59 | 343.00A | -5,701 | -3.94 | 1,799,801H | 14.68 | -16.23 |
| 62 | 367.00A | -4,854 | -3.19 | 1,925,682H | 14.95 | -16.04 |
| 68 | 418.00A | -2,415 | -1.42 | 2,120,795H | 14.76 | -15.03 |
| MS | 452.50A | -706 | -0.39 | 2,169,448H | 14.11 | -13.97 |
| 72 | 454.00A | -647 | -0.36 | 2,170,452H | 14.15 | -14.02 |
| Mx | 469.75A | 0 | 0.00 | 2,176,067H | 14.62 | -14.49 |
| 76 | 487.00A | 1,148 | 0.66 | 2,166,954H | 14.83 | -14.93 |
| 80 | 520.00A | 3,210 | 1.90 | 2,094,060H | 14.77 | -15.14 |
| 84 | 556.00A | 4,947 | 2.94 | 1,945,092H | 13.91 | -14.56 |
| 93 | 631.00A | 7,270 | 4.28 | 1,456,078H | 10.53 | -11.56 |
| 98 | 673.00A | 7,177 | 4.17 | 1,155,805H | 8.34 | -9.41 |
| F98 | 709.00A | 7,127 | 4.10 | 897,635H | 6.47 | -7.47 |
| 104 | 724.00A | 7,039 | 4.28 | 791,509H | 6.02 | -6.99 |
| 110 | 775.00A | 6,290 | 4.75 | 448,274H | 4.18 | -5.00 |
| 126 | 851.00A | 2,645 | 3.11 | 67,331H | 0.95 | -1.24 |

Maximum Shear Stress at 51: -5.36 ksi
Maximum Deck Bending Stress at 62: 14.95 ksi
Maximum Keel Bending Stress at 59: -16.23 ksi

## FREE-FLOATING DAMAGED CONDITION

**Damaged Compartments:**
LORG 4-106-2

| | DISPLACEMENT LTons | DRAFT FWD ft | DRAFT AFT ft | TRIM ft | HEEL deg. | UPRIGHT GMt ft |
|---|---|---|---|---|---|---|
| INTACT | 48,937 | 27.71 | 27.91 | 0.20A | 0.1S | 11.94 |
| DAMAGED | 48,923 | 36.77 | 25.93 | 10.85F | 0.0S | 20.55 |

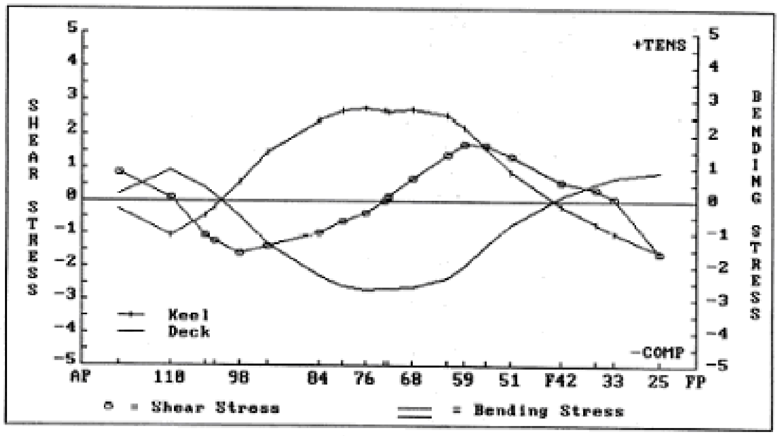


SHEAR & LONGITUDINAL BENDING STRESS SUMMARY
Stresses in ksi

PAIRED LINES PLAN

Wave Height: 33.09 ft    Wave Position: 0.00 ft-FP
Wave Length: 905.00 ft

(Based on Direct Calculation from Hull Offsets)



## SHEAR & LONGITUDINAL BENDING STRESS SUMMARY
Stresses in ksi

### FAIRED LINES PLAN

| | | SHEAR FORCES | | BENDING MOMENTS | | |
|---|---|---|---|---|---|---|
| | LOCATION | SHEAR | SHEAR STRESS | MOMENT | DK STRESS | KL STRESS |
| No. | ft-FP | LTons | ksi | ft-LTons | ksi | ksi |
| 25 | 55.00A | -656 | -1.59 | 32,258H | 0.87 | -1.57 |
| 33 | 121.00A | 66 | 0.07 | 56,724H | 0.68 | -1.00 |
| 36 | 148.00A | 399 | 0.33 | 50,651H | 0.50 | -0.71 |
| P42 | 199.00A | 873 | 0.54 | 16,856H | 0.13 | -0.17 |
| 51 | 274.00A | 1,984 | 1.36 | 87,756S | -0.72 | 0.87 |
| 55 | 310.00A | 2,352 | 1.65 | 166,520S | -1.39 | 1.60 |
| 59 | 343.00A | 2,467 | 1.70 | 246,393S | -2.01 | 2.22 |
| 62 | 367.00A | 2,097 | 1.38 | 302,491S | -2.34 | 2.52 |
| 68 | 418.00A | 1,152 | 0.68 | 381,173S | -2.65 | 2.70 |
| MS | 452.50A | 212 | 0.12 | 408,341S | -2.65 | 2.63 |
| 72 | 454.00A | 154 | 0.08 | 408,634S | -2.66 | 2.64 |
| Mx | 457.95A | -0 | -0.00 | 409,000S | -2.68 | 2.66 |
| 76 | 487.00A | -643 | -0.37 | 397,695S | -2.72 | 2.74 |
| 80 | 520.00A | -1,046 | -0.62 | 369,547S | -2.60 | 2.67 |
| 84 | 556.00A | -1,656 | -0.98 | 320,452S | -2.29 | 2.40 |
| 93 | 631.00A | -2,363 | -1.39 | 182,432S | -1.32 | 1.45 |
| 98 | 673.00A | -2,748 | -1.60 | 68,355S | -0.49 | 0.55 |
| P98 | 709.00A | -2,171 | -1.25 | 22,140H | 0.16 | -0.18 |
| 104 | 724.00A | -1,761 | -1.07 | 51,922H | 0.39 | -0.46 |
| 110 | 775.00A | 100 | 0.08 | 96,313H | 0.90 | -1.07 |
| 126 | 851.00A | 725 | 0.85 | 14,105H | 0.20 | -0.26 |

Maximum Shear Stress at 59: 1.70 ksi
Maximum Deck Bending Stress at 76: -2.72 ksi
Maximum Keel Bending Stress at 76: 2.74 ksi

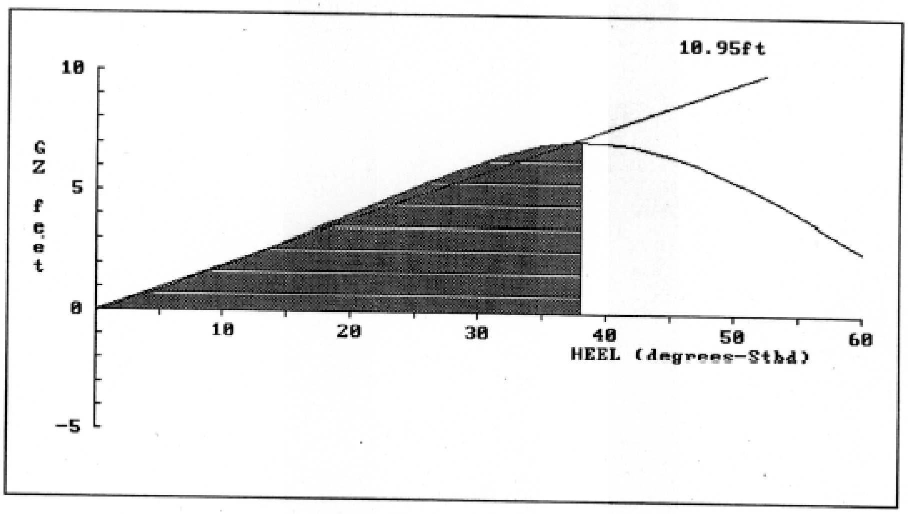
# STILLWATER MOC

SOF -- SOF
Rev. - (by: WOLF-BAB)

OOC POSSE-LOAD V2.2
01-23-03

STATICAL STABILITY

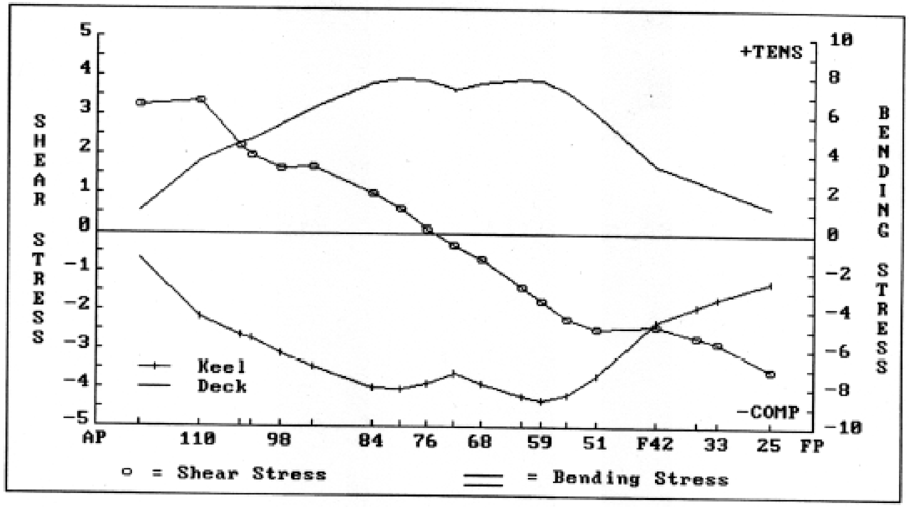
FAIRED LINES PLAN




| | |
|---|---|
| Angle of Heel | 0.4 deg-S |
| Angle at Maximum GZ | 38.3 deg |
| Area to 38.3 degrees | 145.93 ft-deg |
| Maximum GZ | 7.13 ft |

**SHEAR & LONGITUDINAL BENDING STRESS SUMMARY**
**Stresses in ksi**

**FAIRED LINES PLAN**



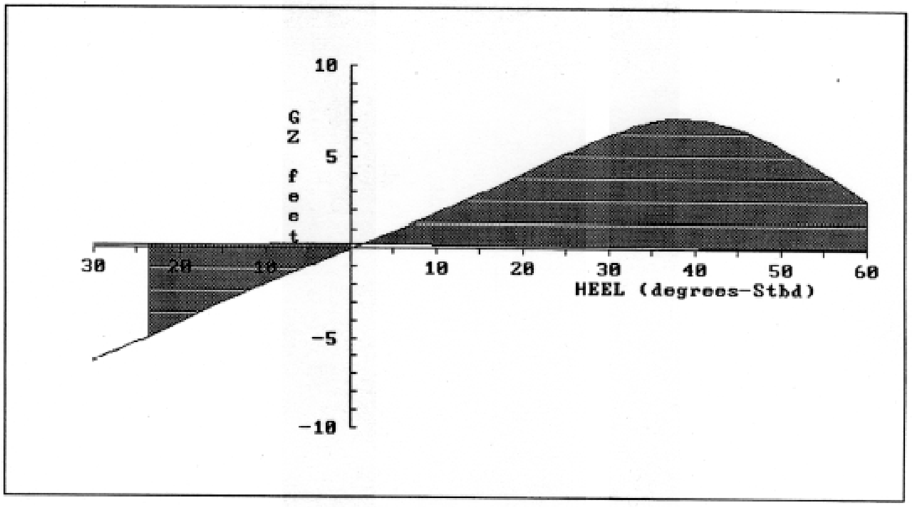

| | | SHEAR FORCES | | | BENDING MOMENTS | |
|---|---|---|---|---|---|---|
| No. | LOCATION ft-FP | SHEAR LTons | SHEAR STRESS ksi | MOMENT ft-LTons | DK STRESS ksi | KL STRESS ksi |
| 25 | 55.00A | -1,455 | -3.53 | 50,711H | 1.22 | -2.46 |
| 33 | 121.00A | -2,712 | -2.80 | 190,359H | 2.28 | -3.36 |
| 36 | 148.00A | -3,183 | -2.66 | 270,258H | 2.69 | -3.79 |
| F42 | 199.00A | -3,893 | -2.40 | 451,894H | 3.40 | -4.56 |
| 51 | 274.00A | -3,577 | -2.45 | 741,861H | 6.06 | -7.38 |
| 55 | 310.00A | -3,143 | -2.21 | 863,861H | 7.18 | -8.32 |
| 59 | 343.00A | -2,519 | -1.74 | 957,613H | 7.79 | -8.62 |
| 62 | 367.00A | -2,090 | -1.37 | 1,012,554H | 7.84 | -8.42 |
| 68 | 418.00A | -1,132 | -0.67 | 1,097,733H | 7.62 | -7.76 |
| MS | 452.50A | -564 | -0.31 | 1,124,474H | 7.30 | -7.23 |
| 72 | 454.00A | -546 | -0.30 | 1,125,291H | 7.32 | -7.25 |
| 76 | 487.00A | 137 | 0.08 | 1,134,199H | 7.75 | -7.80 |
| 80 | 520.00A | 1,009 | 0.60 | 1,115,046H | 7.85 | -8.04 |
| 84 | 556.00A | 1,683 | 1.00 | 1,066,152H | 7.61 | -7.97 |
| 93 | 631.00A | 2,814 | 1.66 | 876,269H | 6.32 | -6.94 |
| 98 | 673.00A | 2,811 | 1.63 | 763,270H | 5.50 | -6.20 |
| F98 | 709.00A | 3,367 | 1.94 | 652,299H | 4.69 | -5.42 |
| 104 | 724.00A | 3,630 | 2.21 | 600,003H | 4.55 | -5.29 |
| 110 | 775.00A | 4,452 | 3.36 | 391,831H | 3.65 | -4.37 |
| 126 | 851.00A | 2,748 | 3.23 | 72,141H | 1.02 | -1.32 |

Maximum Shear Stress at 25: -3.53 ksi
Maximum Deck Bending Stress at 80: 7.85 ksi
Maximum Keel Bending Stress at 59: -8.62 ksi

**STILLWATER MOC**
**WIND**

**BEAM WIND with ROLLING STABILITY EVALUATION**
**(per U.S. Navy DDS079-1)**

FAIRED LINES PLAN



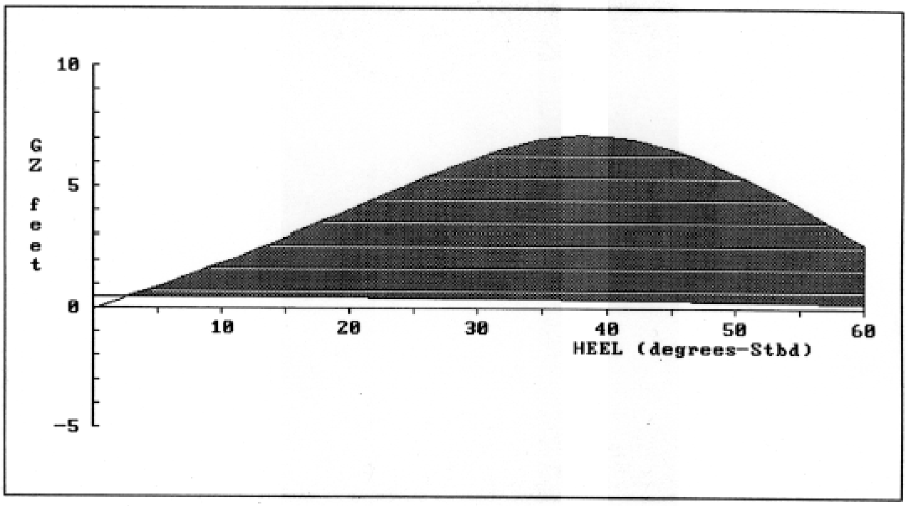

| | Available | Required |
|---|---|---|
| Wind Heeling Arm Lw | 0.20 ft | |
| Maximum Righting Arm | 7.13 ft | 0.33 ft |
| Capsizing Area A2 | 58.7 ft-deg | |
| Righting Area A1 | 256.0 ft-deg | 82.2 ft-deg |

| | | | |
|---|---|---|---|
| Wind Velocity = | 100 knots | Mean Draft = | 26.69 ft |
| Wind Pressure Factor= | 0.0035 | Displacement = | 46,452 LTons |
| Wind Pressure = | 0.0156 LT/ft2 | GMt (corrected) = | 10.95 ft |
| Projected Sail Area = | 20421.9 ft2 | Roll Angle = | 25.0 deg |
| Vertical Arm = | 42.31 ft ABL | | |
| Heeling Arm at 0 deg= | 0.20 ft | Angle at Intercept= | 60.0 deg |
| Wind Heel Arm Lw = | 0.20 ft | Maximum GZ = | 7.13 ft |
| Wind Heel Angle = | 1.4 deg | Angle at Max. GZ = | 38.3 deg |

**STILLWATER MOC TURN**

**EFFECT on STABILITY of HIGH SPEED TURNING**
**(per U.S. Navy DDS079-1)**

FAIRED LINES PLAN




| | Available | Required |
|---|---|---|
| Angle of Heel | 2.8 deg | 15.0 deg |
| Heeling Arm Lc | 0.47 ft | |
| Maximum Righting Arm | 7.13 ft | 0.78 ft |
| Total Righting Area | 264.2 ft-deg | |
| Reserve Righting Area | 241.7 ft-deg | 105.7 ft-deg |

Ship Speed in Turn = 24.0 knots
Turn Circle Radius = 3000 ft
Heeling Arm at 0 deg= 0.47 ft

Angle at Max. GZ = 38.3 deg

Displacement = 46,452 LTons
VCG = 40.92 ft
Mean Draft = 26.69 ft

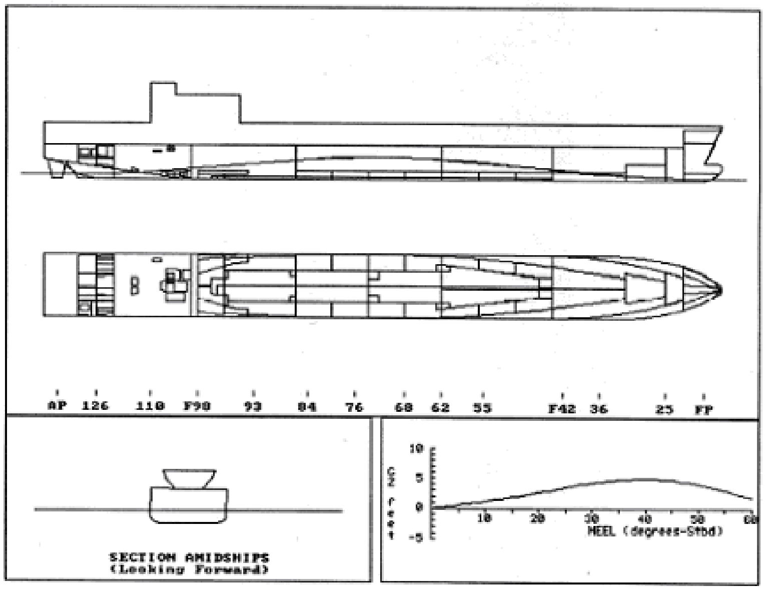
Positive GZ Range = 60.0 deg
Angle at Intercept= 60.0 deg

# INTACT MOC

FREE-FLOATING DAMAGED CONDITION

**Damaged Compartments:**
LORG 4-106-2

| | DISPLACEMENT LTons | DRAFT FWD ft | DRAFT AFT ft | TRIM ft | HEEL deg. | UPRIGHT GMt ft |
|---|---|---|---|---|---|---|
| INTACT | 46,452 | 26.87 | 26.52 | 0.35F | 0.4S | 10.95 |
| DAMAGED | 46,443 | 21.48 | 24.55 | 3.06A | 0.6S | 6.79 |

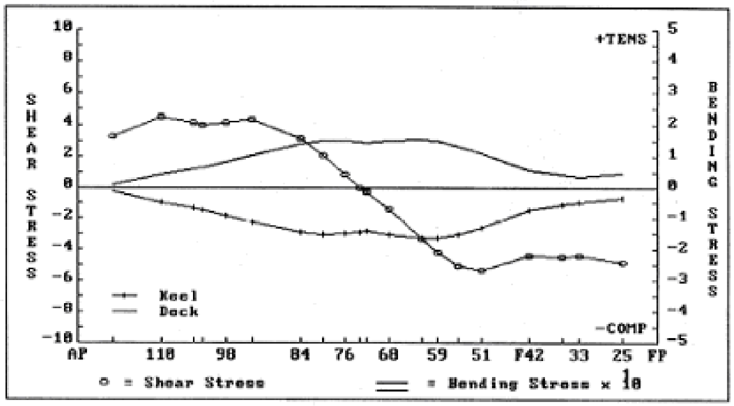


SHEAR & LONGITUDINAL BENDING STRESS SUMMARY
Stresses in ksi

FAIRED LINES PLAN

Wave Height: 33.09 ft        Wave Position: 452.50A ft-FP
Wave Length: 905.00 ft

(Based on Direct Calculation from Hull Offsets)



## SHEAR & LONGITUDINAL BENDING STRESS SUMMARY
Stresses in ksi

### FAIRED LINES PLAN

| | | SHEAR FORCES | | BENDING MOMENTS | | |
|---|---|---|---|---|---|---|
| | LOCATION | SHEAR | SHEAR STRESS | MOMENT | DK STRESS | KL STRESS |
| No. | ft-FP | LTons | ksi | ft-LTons | ksi | ksi |
| 25 | 55.00A | -1,996 | -4.85 | 66,977H | 4.37 | -3.31 |
| 33 | 121.00A | -4,274 | -4.42 | 272,679H | 3.33 | -4.87 |
| 36 | 148.00A | -5,313 | -4.45 | 402,301H | 4.07 | -5.70 |
| F42 | 199.00A | -7,139 | -4.40 | 721,417H | 5.51 | -7.35 |
| 51 | 274.00A | -7,759 | -5.31 | 1,299,450H | 10.77 | -13.08 |
| 55 | 310.00A | -7,171 | -5.04 | 1,571,067H | 13.35 | -15.31 |
| 59 | 343.00A | -6,034 | -4.17 | 1,785,686H | 14.76 | -16.31 |
| 62 | 367.00A | -5,030 | -3.31 | 1,922,502H | 15.09 | -16.18 |
| 68 | 418.00A | -2,418 | -1.42 | 2,118,542H | 14.90 | -15.17 |
| MS | 452.50A | -547 | -0.30 | 2,166,205H | 14.23 | -14.09 |
| 72 | 454.00A | -471 | -0.26 | 2,166,956H | 14.27 | -14.14 |
| Mx | 463.34A | -0 | -0.00 | 2,169,283H | 14.48 | -14.41 |
| 76 | 487.00A | 1,449 | 0.85 | 2,153,703H | 14.89 | -14.98 |
| 80 | 520.00A | 3,501 | 2.07 | 2,070,690H | 14.75 | -15.12 |
| 84 | 556.00A | 5,206 | 3.09 | 1,911,810H | 13.81 | -14.45 |
| 93 | 631.00A | 7,332 | 4.32 | 1,409,583H | 10.30 | -11.29 |
| 98 | 673.00A | 7,079 | 4.12 | 1,109,981H | 8.09 | -9.11 |
| F98 | 709.00A | 6,953 | 4.00 | 856,377H | 6.23 | -7.19 |
| 104 | 724.00A | 6,813 | 4.14 | 753,236H | 5.78 | -6.71 |
| 110 | 775.00A | 5,904 | 4.46 | 425,364H | 4.01 | -4.79 |
| 126 | 851.00A | 2,747 | 3.23 | 68,790H | 0.99 | -1.28 |

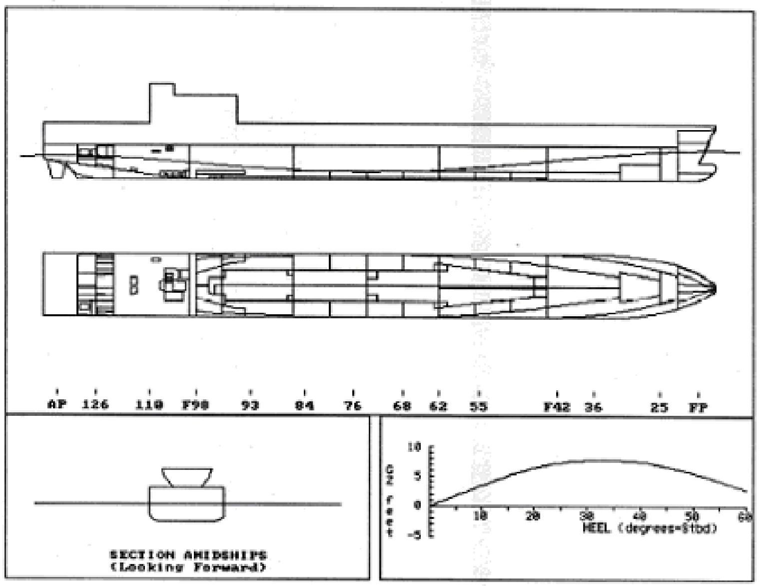
Maximum Shear Stress at 51: -5.31 ksi
Maximum Deck Bending Stress at 62: 15.09 ksi
Maximum Keel Bending Stress at 59: -16.31 ksi

FREE-FLOATING DAMAGED CONDITION

**Damaged Compartments:**

LORD 4-104-2

| | DISPLACEMENT LTons | DRAFT FWD ft | DRAFT AFT ft | TRIM ft | HEEL deg. | UPRIGHT GMt ft |
|---|---|---|---|---|---|---|
| INTACT | 46,452 | 26.87 | 26.52 | 0.35F | 0.4S | 10.95 |
| DAMAGED | 46,443 | 35.82 | 24.90 | 10.92F | 0.2S | 19.99 |

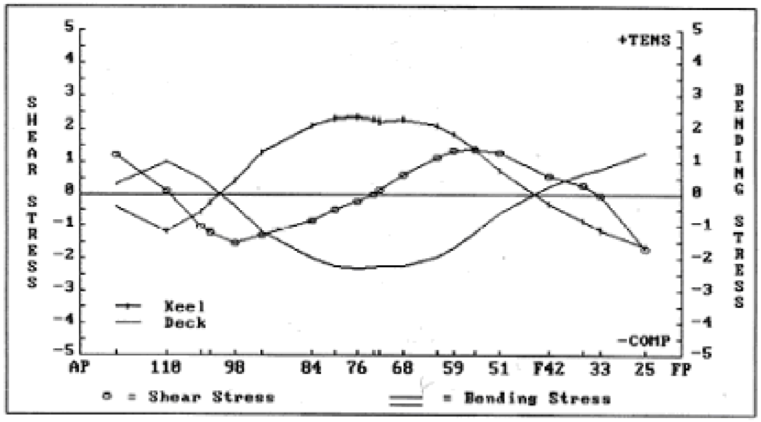


**SHEAR & LONGITUDINAL BENDING STRESS SUMMARY**
**Stresses in ksi**

**FAIRED LINES PLAN**

Wave Height: 33.09 ft     Wave Position: 0.00 ft-FP
Wave Length: 905.00 ft

(Based on Direct Calculation from Hull Offsets)



## SHEAR & LONGITUDINAL BENDING STRESS SUMMARY
Stresses in ksi

### FAIRED LINES PLAN

| | | SHEAR FORCES | | BENDING MOMENTS | | |
|---|---|---|---|---|---|---|
| | LOCATION | SHEAR | SHEAR STRESS | MOMENT | DK STRESS | KL STRESS |
| No. | ft-FP | LTons | ksi | ft-LTons | ksi | ksi |
| 25 | 55.00A | -701 | -1.70 | 33,382H | 1.26 | -1.62 |
| 33 | 121.00A | -64 | -0.07 | 63,967H | 0.77 | -1.13 |
| 36 | 148.00A | 300 | 0.25 | 61,027H | 0.61 | -0.86 |
| F42 | 199.00A | 880 | 0.54 | 29,856H | 0.23 | -0.30 |
| 51 | 274.00A | 1,835 | 1.26 | 73,260S | -0.60 | 0.73 |
| 55 | 310.00A | 1,941 | 1.36 | 141,993S | -1.19 | 1.37 |
| 59 | 343.00A | 1,934 | 1.34 | 205,912S | -1.68 | 1.86 |
| 62 | 367.00A | 1,735 | 1.14 | 250,464S | -1.95 | 2.09 |
| 68 | 418.00A | 999 | 0.59 | 319,621S | -2.23 | 2.27 |
| MS | 452.50A | 253 | 0.14 | 343,142S | -2.24 | 2.21 |
| 72 | 454.00A | 213 | 0.12 | 343,509S | -2.24 | 2.22 |
| Mx | 461.79A | -0 | -0.00 | 344,480S | -2.28 | 2.26 |
| 76 | 487.00A | -403 | -0.23 | 339,037S | -2.32 | 2.34 |
| 80 | 520.00A | -796 | -0.47 | 318,956S | -2.25 | 2.31 |
| 84 | 556.00A | -1,389 | -0.82 | 279,163S | -2.00 | 2.09 |
| 93 | 631.00A | -2,170 | -1.28 | 159,394S | -1.16 | 1.27 |
| 98 | 673.00A | -2,636 | -1.53 | 51,580S | -0.37 | 0.42 |
| F98 | 709.00A | -2,059 | -1.18 | 34,371H | 0.25 | -0.29 |
| 104 | 724.00A | -1,670 | -1.02 | 62,616H | 0.48 | -0.55 |
| 110 | 775.00A | 107 | 0.08 | 103,655H | 0.97 | -1.16 |
| 126 | 851.00A | 1,027 | 1.21 | 22,660H | 0.32 | -0.42 |

Maximum Shear Stress at 25: -1.70 ksi
Maximum Deck Bending Stress at 76: -2.32 ksi
Maximum Keel Bending Stress at 76: 2.34 ksi

# Appendix F
# POSSE Damaged Strength Analysis

# STILLWATER FULL LOAD
# FWD DAMAGE

FREE-FLOATING DAMAGED CONDITION

| ITEM | WEIGHT LTons | KG ft-BL | LCG ft-FP | TCG ft-CL | FSmom ft-LTons |
|---|---|---|---|---|---|
| Light Ship | 37,681 | 45.57 | 441.70A | 0.65S | |
| Constant | 0 | 0.00 | 452.50A | 0.00 | 0 |
| RoRo Cargo | 0 | 0.00 | 452.50A | 0.00 | |
| Misc. Weight | 1,861 | 36.63 | 437.82A | 0.00 | 0 |
| Fuel Oil | 546 | 6.78 | 545.50A | 0.02S | 306 |
| Diesel Oil | 5,404 | 19.97 | 547.16A | 0.65P | 8,265 |
| Lube Oil | 134 | 47.08 | 837.03A | 45.62S | 34 |
| Fresh Water | 230 | 48.22 | 838.49A | 38.66P | 97 |
| SW Ballast | 2,625 | 12.68 | 645.23A | 7.86P | 7,737 |
| Misc. | 456 | 19.15 | 758.59A | 6.57S | 674 |
| TOTALS | 48,937 | 39.98 | 471.18A | 0.01S | 17,112 |

| | | INTACT | AFTER OUTFLOW | AS DAMAGED |
|---|---|---|---|---|
| Draft at F.P. | (ft) | 27.71 | ---- | 26.97 |
| Draft at A.P. | (ft) | 27.91 | ---- | 30.23 |
| Trim | (ft) | 0.20A | ---- | 3.26A |
| Draft at Fwd Marks | (ft) | 27.72 | ---- | 27.04 |
| Draft at Aft Marks | (ft) | 27.91 | ---- | 30.14 |
| Static Heel Angle | (deg) | 0.1S | ---- | 0.1P |
| Total Weight | (LT) | 48,937 | 45,675 | 50,943 |
| KG | (ft) | 39.98 | 40.03 | 38.02 |
| LCG | (ft-FP) | 471.18A | 444.91A | 479.00A |
| TCG | (ft-CL) | 0.01S | 0.01P | 0.02P |
| Buoyancy | (LT) | 48,937 | ---- | 50,943 |
| KB | (ft) | ---- | ---- | 15.95 |
| LCB | (ft-FP) | 470.69A | ---- | 479.08A |
| TCB | (ft-CL) | ---- | ---- | 0.06P |
| KMt | (ft) | 52.27 | ---- | 48.69 |
| FSc | (ft) | 0.35 | ---- | 0.24 |
| GMt | (ft) | 11.94 | ---- | 8.12 |
| Shear Force | (LT) | ---- | ---- | 4,449 |
| Bending Moment | (ft-LT) | ---- | ---- | 1,086,867H |

AFTER OUTFLOW CONDITION:

Displacement, KG, LCG, TCG include the effects of fluid outflow & flooding without free-communication.

AS DAMAGED CONDITION:

Displacement, KG, LCG, TCG include the effects of the flooded water at the equilibrium trim/heel.

Buoyancy, KB, LCB, TCB are for an intact hull at the equilibrium heel and drafts.

KMt is for the damaged hull at the upright flooded drafts. GMt is the slope of the GZ curve at 0 degrees.

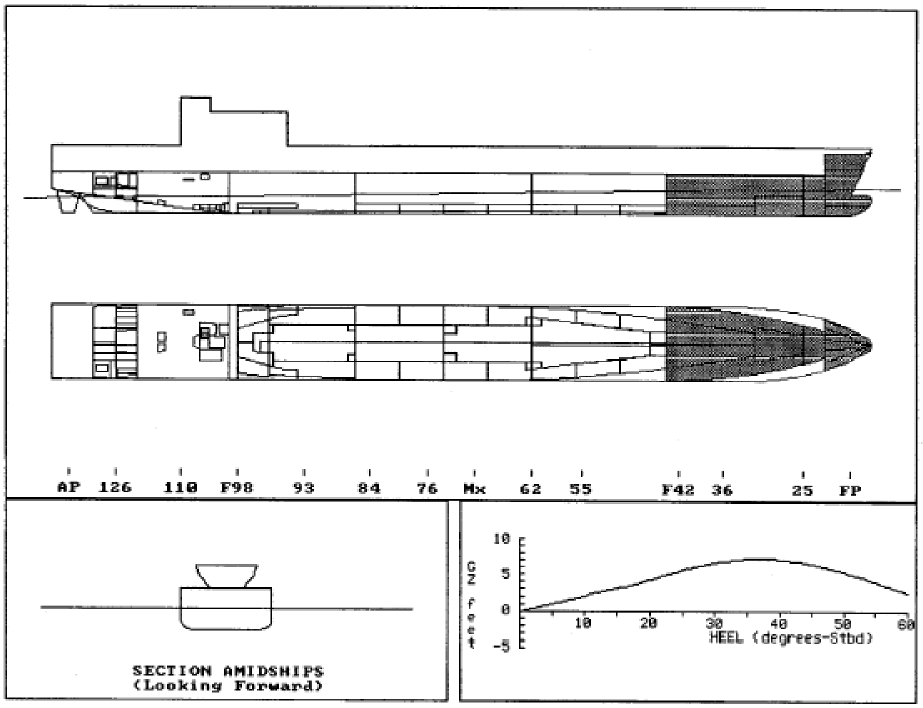
F.S. correction accounts for the free surface of intact tanks and is corrected for outflow.

FREE-FLOATING DAMAGED CONDITION

**Damaged Compartments:**

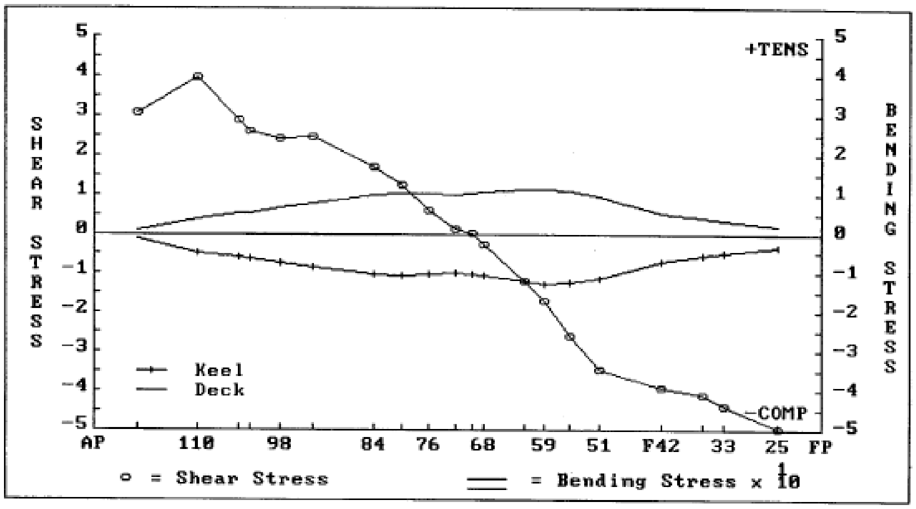
FOCSLE FPK 6--12-0 FB 8--11-0 HOLD 1 BOW THRUSTER NO1 8-25-0
DP 8-32-1 DP 8-32-2

| | DISPLACEMENT LTons | DRAFT FWD ft | DRAFT AFT ft | TRIM ft | HEEL deg. | UPRIGHT GMt ft |
|---|---|---|---|---|---|---|
| INTACT | 48,937 | 27.71 | 27.91 | 0.20A | 0.1S | 11.94 |
| DAMAGED | 54,325 | 38.92 | 22.46 | 16.46F | 0.1S | 11.16 |



**SHEAR & LONGITUDINAL BENDING STRESS SUMMARY**
Stresses in ksi

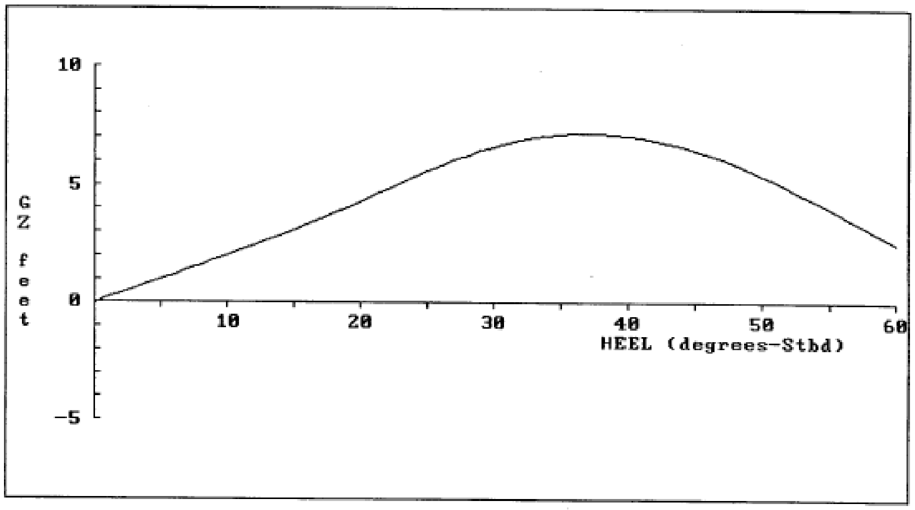
**FAIRED LINES PLAN**
(Based on Direct Calculation from Hull Offsets)




| | | SHEAR FORCES | | BENDING MOMENTS | | |
|---|---|---|---|---|---|---|
| | LOCATION | SHEAR | SHEAR STRESS | MOMENT | DK STRESS | KL STRESS |
| No. | ft-FP | LTons | ksi | ft-LTons | ksi | ksi |
| 25 | 55.00A | -2,040 | -4.95 | 67,248H | 1.86 | -3.26 |
| 33 | 121.00A | -4,230 | -4.37 | 274,630H | 3.30 | -4.86 |
| 36 | 148.00A | -4,893 | -4.10 | 397,816H | 3.96 | -5.58 |
| F42 | 199.00A | -6,361 | -3.92 | 683,609H | 5.15 | -6.90 |
| 51 | 274.00A | -5,049 | -3.45 | 1,141,902H | 9.34 | -11.37 |
| 55 | 310.00A | -3,721 | -2.61 | 1,300,856H | 10.83 | -12.54 |
| 59 | 343.00A | -2,448 | -1.69 | 1,402,372H | 11.42 | -12.63 |
| 62 | 367.00A | -1,844 | -1.21 | 1,452,545H | 11.26 | -12.09 |
| 68 | 418.00A | -473 | -0.28 | 1,517,658H | 10.55 | -10.75 |
| Mx | 432.45A | 1 | 0.00 | 1,520,793H | 10.27 | -10.33 |
| MS | 452.50A | 240 | 0.13 | 1,517,254H | 9.86 | -9.76 |
| 72 | 454.00A | 253 | 0.14 | 1,516,868H | 9.88 | -9.79 |
| 76 | 487.00A | 1,015 | 0.58 | 1,499,482H | 10.25 | -10.32 |
| 80 | 520.00A | 2,078 | 1.23 | 1,448,080H | 10.20 | -10.46 |
| 84 | 556.00A | 2,881 | 1.71 | 1,358,169H | 9.70 | -10.16 |
| 93 | 631.00A | 4,161 | 2.45 | 1,071,918H | 7.74 | -8.50 |
| 98 | 673.00A | 4,142 | 2.41 | 902,411H | 6.51 | -7.34 |
| F98 | 709.00A | 4,538 | 2.61 | 746,500H | 5.37 | -6.21 |
| 104 | 724.00A | 4,733 | 2.88 | 677,145H | 5.14 | -5.98 |
| 110 | 775.00A | 5,241 | 3.95 | 420,944H | 3.92 | -4.69 |
| 126 | 851.00A | 2,611 | 3.07 | 67,219H | 0.95 | -1.24 |

Maximum Shear Stress at 25: -4.95 ksi
Maximum Deck Bending Stress at 59: 11.42 ksi
Maximum Keel Bending Stress at 59: -12.63 ksi

RIGHTING ARM (GZ)




**Stability Evaluation:**

| | | |
|---|---|---|
| Static Heel Angle | 0.1S deg | |
| Freeboard to Margin Line | 53.65 ft | 0.00 ft |
| Wind Heel Angle | 0.9S deg | |
| Angle at Maximum GZ | 37.0S deg | |
| Maximum GZ | 7.19 ft | |
| Range of Positive GZ | >59.9 deg | |
| Gmt (upright damaged) | 11.16 ft | |

(Based on Direct Calculation from Hull Offsets)
Freeboards are calculated perpendicular to the water surface

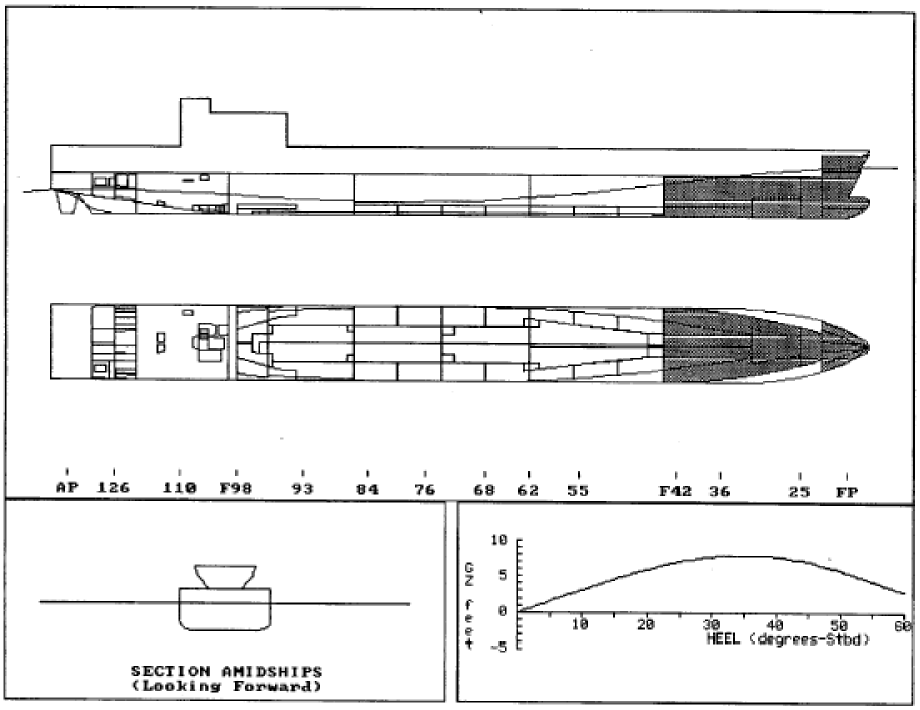
**SAGGING FULL LOAD**
**FWD DAMAGE**

FREE-FLOATING DAMAGED CONDITION

**Damaged Compartments:**

FOCSLE FPK 6--12-0 FB 8--11-0 HOLD 1 BOW THRUSTER NO1 8-25-0
DP 8-32-1 DP 8-32-2

| | DISPLACEMENT LTons | DRAFT FWD ft | DRAFT AFT ft | TRIM ft | HEEL deg. | UPRIGHT GMt ft |
|---|---|---|---|---|---|---|
| INTACT | 48,937 | 27.71 | 27.91 | 0.20A | 0.1S | 11.94 |
| DAMAGED | 60,247 | 56.55 | 18.21 | 38.34F | 0.0S | 17.28 |

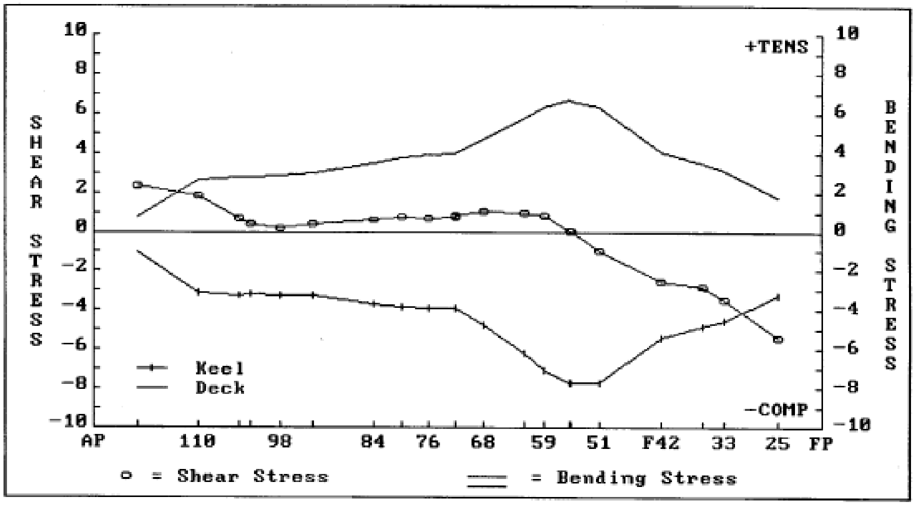


SHEAR & LONGITUDINAL BENDING STRESS SUMMARY
Stresses in ksi

**FAIRED LINES PLAN**

Wave Height: 33.09 ft    Wave Position: 0.00 ft-FP
Wave Length: 905.00 ft

(Based on Direct Calculation from Hull Offsets)



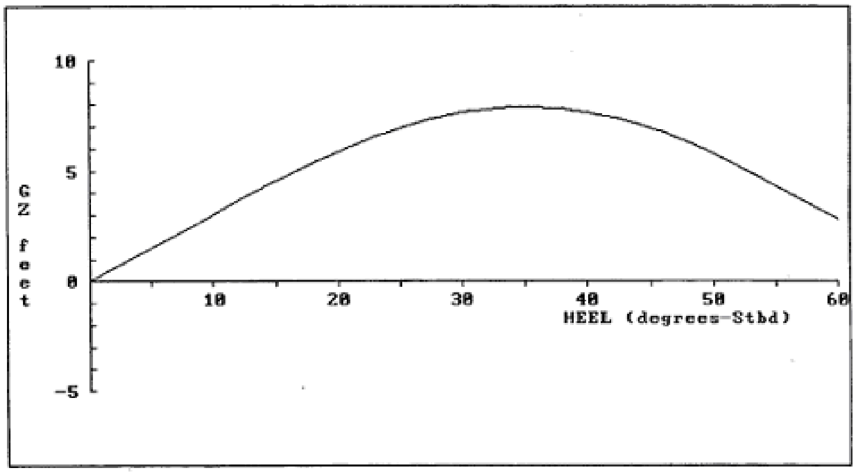
## SHEAR & LONGITUDINAL BENDING STRESS SUMMARY
Stresses in ksi

## FAIRED LINES PLAN

| | SHEAR FORCES | | | BENDING MOMENTS | | |
|---|---|---|---|---|---|---|
| | LOCATION | SHEAR | SHEAR STRESS | MOMENT | DK STRESS | KL STRESS |
| No. | ft-FP | LTons | ksi | ft-LTons | ksi | ksi |
| 25 | 55.00A | -2,243 | -5.44 | 67,306H | 1.77 | -3.27 |
| 33 | 121.00A | -3,343 | -3.46 | 257,087H | 3.09 | -4.54 |
| 36 | 148.00A | -3,351 | -2.81 | 347,472H | 3.46 | -4.87 |
| F42 | 199.00A | -4,148 | -2.56 | 533,250H | 4.02 | -5.38 |
| 51 | 274.00A | -1,457 | -1.00 | 777,749H | 6.36 | -7.74 |
| Mx | 308.08A | 0 | 0.00 | 801,738H | 6.67 | -7.74 |
| 55 | 310.00A | 75 | 0.05 | 801,671H | 6.67 | -7.72 |
| 59 | 343.00A | 1,165 | 0.80 | 780,572H | 6.35 | -7.03 |
| 62 | 367.00A | 1,445 | 0.95 | 747,783H | 5.80 | -6.22 |
| 68 | 418.00A | 1,711 | 1.01 | 670,492H | 4.66 | -4.75 |
| MS | 452.50A | 1,456 | 0.80 | 611,909H | 3.97 | -3.93 |
| 72 | 454.00A | 1,424 | 0.78 | 609,731H | 3.97 | -3.93 |
| 76 | 487.00A | 1,176 | 0.68 | 569,419H | 3.89 | -3.92 |
| 80 | 520.00A | 1,221 | 0.72 | 529,870H | 3.73 | -3.82 |
| 84 | 556.00A | 987 | 0.59 | 490,218H | 3.50 | -3.66 |
| 93 | 631.00A | 682 | 0.40 | 411,727H | 2.97 | -3.26 |
| 98 | 673.00A | 297 | 0.17 | 397,558H | 2.87 | -3.23 |
| F98 | 709.00A | 745 | 0.43 | 380,197H | 2.74 | -3.16 |
| 104 | 724.00A | 1,066 | 0.65 | 366,872H | 2.78 | -3.24 |
| 110 | 775.00A | 2,459 | 1.86 | 278,021H | 2.59 | -3.10 |
| 126 | 851.00A | 1,967 | 2.32 | 55,726H | 0.79 | -1.02 |

Maximum Shear Stress at 25: -5.44 ksi
Maximum Deck Bending Stress at 55: 6.67 ksi
Maximum Keel Bending Stress at 51: -7.74 ksi

RIGHTING ARM (GZ)




**Stability Evaluation:**

| | | |
|---|---|---|
| Static Heel Angle | 0.0S deg | |
| Freeboard to Margin Line | 35.43 ft | 0.00 ft |
| Wind Heel Angle | 0.4S deg | |
| Angle at Maximum GZ | 35.1S deg | |
| Maximum GZ | 7.90 ft | |
| Range of Positive GZ | >60.0 deg | |
| Gmt (upright damaged) | 17.28 ft | |

(Based on Direct Calculation from Hull Offsets)

Freeboards are calculated perpendicular to the water surface

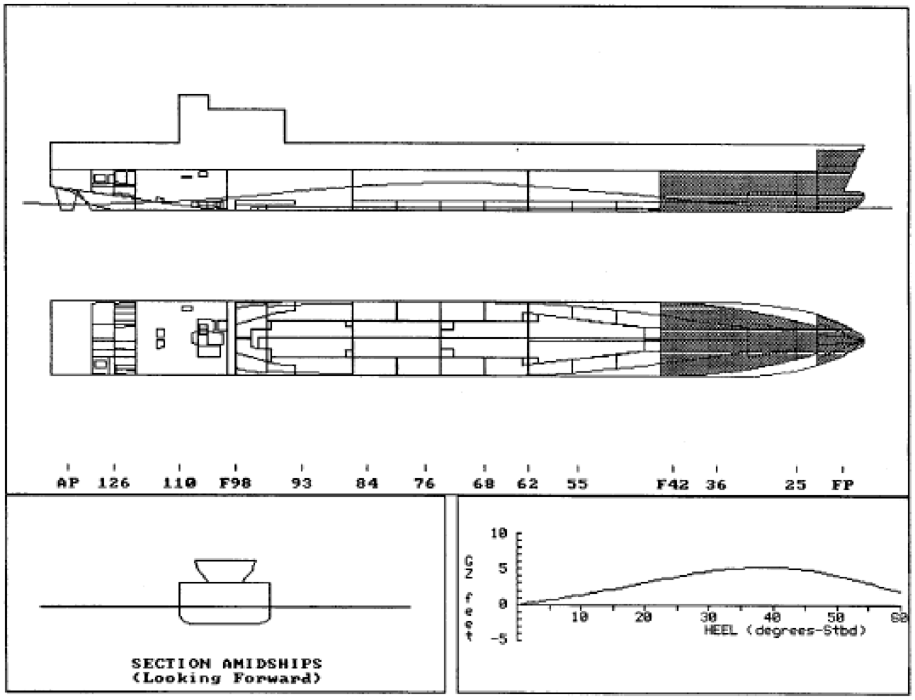
# HOGGING FULL LOAD
# FWD DAMAGE

FREE-FLOATING DAMAGED CONDITION

**amaged Compartments:**

FOCSLE    FPK 6--12-0    FB 8--11-0    HOLD 1    BOW THRUSTER    NO1 8-25-0
DP 8-32-1    DP 8-32-2

| | DISPLACEMENT LTons | DRAFT FWD ft | DRAFT AFT ft | TRIM ft | HEEL deg. | UPRIGHT GMt ft |
|---|---|---|---|---|---|---|
| INTACT | 48,937 | 27.71 | 27.91 | 0.20A | 0.1S | 11.94 |
| DAMAGED | 49,452 | 23.48 | 25.80 | 2.32A | 0.1S | 7.85 |

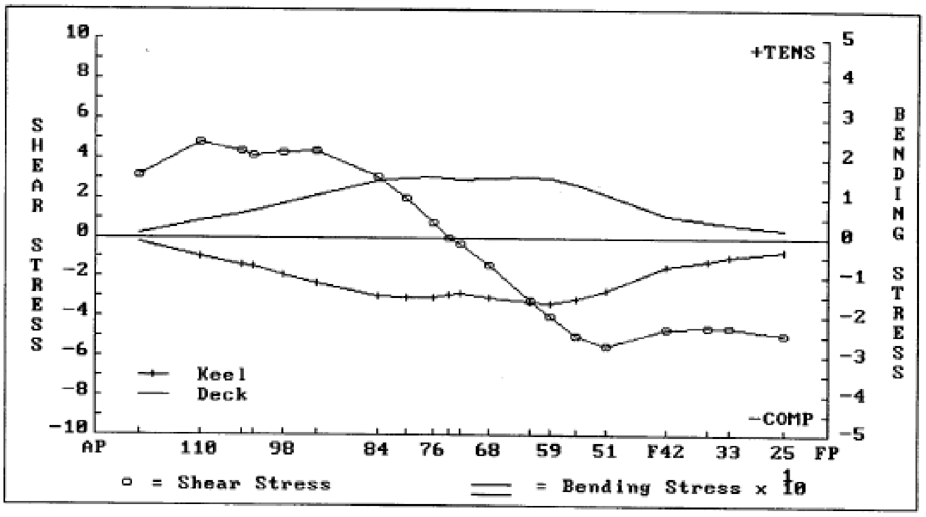


SHEAR & LONGITUDINAL BENDING STRESS SUMMARY
Stresses in ksi

FAIRED LINES PLAN

Wave Height: 33.09 ft    Wave Position: 452.50A ft-FP
Wave Length: 905.00 ft

(Based on Direct Calculation from Hull Offsets)



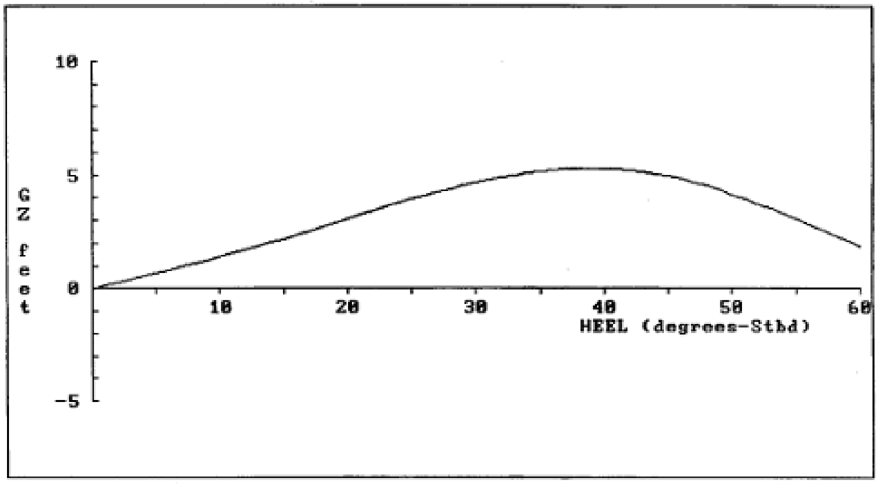
## SHEAR & LONGITUDINAL BENDING STRESS SUMMARY
Stresses in ksi

### FAIRED LINES PLAN

| | | SHEAR FORCES | | BENDING MOMENTS | | |
|---|---|---|---|---|---|---|
| | LOCATION | SHEAR | SHEAR STRESS | MOMENT | DK STRESS | KL STRESS |
| No. | ft-FP | LTons | ksi | ft-LTons | ksi | ksi |
| 25 | 55.00A | -2,031 | -4.93 | 67,641H | 1.97 | -3.29 |
| 33 | 121.00A | -4,428 | -4.58 | 279,632H | 3.36 | -4.95 |
| 36 | 148.00A | -5,474 | -4.58 | 413,398H | 4.12 | -5.80 |
| F42 | 199.00A | -7,542 | -4.65 | 744,788H | 5.62 | -7.52 |
| 51 | 274.00A | -8,024 | -5.49 | 1,356,654H | 11.11 | -13.51 |
| 55 | 310.00A | -7,088 | -4.98 | 1,631,656H | 13.59 | -15.73 |
| 59 | 343.00A | -5,749 | -3.97 | 1,843,795H | 15.02 | -16.62 |
| 62 | 367.00A | -4,863 | -3.20 | 1,970,339H | 15.28 | -16.40 |
| 68 | 418.00A | -2,353 | -1.38 | 2,164,020H | 15.05 | -15.33 |
| MS | 452.50A | -608 | -0.33 | 2,209,874H | 14.37 | -14.22 |
| 72 | 454.00A | -546 | -0.30 | 2,210,728H | 14.41 | -14.27 |
| MX | 467.47A | -0 | -0.00 | 2,214,672H | 14.72 | -14.67 |
| 76 | 487.00A | 1,275 | 0.73 | 2,203,456H | 15.07 | -15.17 |
| 80 | 520.00A | 3,356 | 1.98 | 2,126,035H | 14.99 | -15.36 |
| 84 | 556.00A | 5,105 | 3.03 | 1,971,578H | 14.09 | -14.75 |
| 93 | 631.00A | 7,421 | 4.37 | 1,470,757H | 10.63 | -11.67 |
| 98 | 673.00A | 7,306 | 4.25 | 1,164,573H | 8.40 | -9.47 |
| F98 | 709.00A | 7,226 | 4.16 | 902,263H | 6.50 | -7.50 |
| 104 | 724.00A | 7,124 | 4.33 | 794,749H | 6.04 | -7.02 |
| 110 | 775.00A | 6,308 | 4.76 | 449,007H | 4.19 | -5.01 |
| 126 | 851.00A | 2,649 | 3.12 | 67,471H | 0.95 | -1.24 |

Maximum Shear Stress at 51: -5.49 ksi
Maximum Deck Bending Stress at 62: 15.28 ksi
Maximum Keel Bending Stress at 59: -16.62 ksi

**RIGHTING ARM (GZ)**




**Stability Evaluation:**

| | | |
|---|---|---|
| Static Heel Angle | 0.1S deg | |
| Freeboard to Margin Line | 67.08 ft | 0.00 ft |
| Wind Heel Angle | 1.6S deg | |
| Angle at Maximum GZ | 39.0S deg | |
| Maximum GZ | 5.29 ft | |
| Range of Positive GZ | >59.9 deg | |
| Gmt (upright damaged) | 7.85 ft | |

(Based on Direct Calculation from Hull Offsets)
Freeboards are calculated perpendicular to the water surface

## STILLWATER FULL LOAD
## MD DAMAGE

CVT-1 -- SOF
Rev. 1 (by: WOLF-BAB)

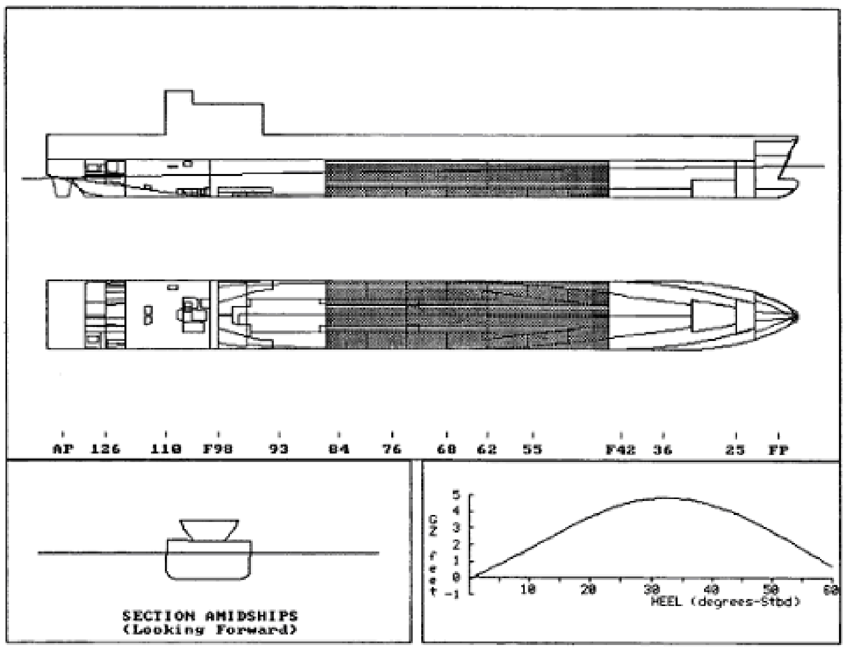
OOC POSSE-SALV V2.2
01-23-03

FREE-FLOATING DAMAGED CONDITION

**Damaged Compartments:**

| | | | | | |
|---|---|---|---|---|---|
| HOLD 2 | W2A 8-44-01 | FB 8-44-1 | W2A 8-44-4 | FB 8-44-2 | W2B 8-50-1 |
| W2B 8-50-2 | W2C 8-56-1 | W2C 8-56-2 | HOLD 3 | W3A 8-62-1 | DB3F 8-62-0 |
| DB3F 8-62-2 | W3A 8-62-4 | W3B 8-68-1 | W3B 8-68-2 | W3C 8-74-1 | DB3A 8-74-0 |
| DB3A 8-74-2 | W3C 8-74-4 | W3D 8-80-1 | W3D 8-80-2 | | |

| | DISPLACEMENT LTons | DRAFT FWD ft | DRAFT AFT ft | TRIM ft | HEEL deg. | UPRIGHT GMt ft |
|---|---|---|---|---|---|---|
| INTACT | 48,937 | 27.71 | 27.91 | 0.20A | 0.1S | 11.94 |
| DAMAGED | 77,652 | 50.70 | 31.07 | 19.64F | 0.6S | 10.34 |



FREE-FLOATING DAMAGED CONDITION

| ITEM | WEIGHT LTons | KG ft-BL | LCG ft-FP | TCG ft-CL | FSmom ft-LTons |
|---|---|---|---|---|---|
| Light Ship | 37,681 | 45.57 | 441.70A | 0.65S | |
| Constant | 0 | 0.00 | 452.50A | 0.00 | 0 |
| RoRo Cargo | 0 | 0.00 | 452.50A | 0.00 | |
| Misc. Weight | 1,861 | 36.63 | 437.82A | 0.00 | 0 |
| Fuel Oil | 546 | 6.78 | 545.50A | 0.02S | 306 |
| Diesel Oil | 5,404 | 19.97 | 547.16A | 0.65P | 8,265 |
| Lube Oil | 134 | 47.08 | 837.03A | 45.62S | 34 |
| Fresh Water | 230 | 48.22 | 838.49A | 38.66P | 97 |
| SW Ballast | 2,625 | 12.68 | 645.23A | 7.86P | 7,737 |
| Misc. | 456 | 19.15 | 758.59A | 6.57S | 674 |
| TOTALS | 48,937 | 39.98 | 471.18A | 0.01S | 17,112 |

| | | INTACT | AFTER OUTFLOW | AS DAMAGED |
|---|---|---|---|---|
| Draft at F.P. | (ft) | 27.71 | ---- | 38.92 |
| Draft at A.P. | (ft) | 27.91 | ---- | 22.46 |
| Trim | (ft) | 0.20A | ---- | 16.46F |
| Draft at Fwd Marks | (ft) | 27.72 | ---- | 38.55 |
| Draft at Aft Marks | (ft) | 27.91 | ---- | 22.91 |
| Static Heel Angle | (deg) | 0.1S | ---- | 0.1S |
| Total Weight | (LT) | 48,937 | 47,640 | 54,325 |
| KG | (ft) | 39.98 | 40.81 | 38.37 |
| LCG | (ft-FP) | 471.18A | 479.39A | 436.54A |
| TCG | (ft-CL) | 0.01S | 0.01S | 0.01S |
| Buoyancy | (LT) | 48,937 | ---- | 54,325 |
| KB | (ft) | ---- | ---- | 17.10 |
| LCB | (ft-FP) | 470.69A | ---- | 436.15A |
| TCB | (ft-CL) | ---- | ---- | 0.03S |
| KMt | (ft) | 52.27 | ---- | 52.53 |
| FSc | (ft) | 0.35 | ---- | 0.29 |
| GMt | (ft) | 11.94 | ---- | 11.16 |
| Shear Force | (LT) | ---- | ---- | -6,361 |
| Bending Moment | (ft-LT) | ---- | ---- | 1,520,793H |

AFTER OUTFLOW CONDITION:

Displacement, KG, LCG, TCG include the effects of fluid outflow & flooding without free-communication.

AS DAMAGED CONDITION:

Displacement, KG, LCG, TCG include the effects of the flooded water at the equilibrium trim/heel.

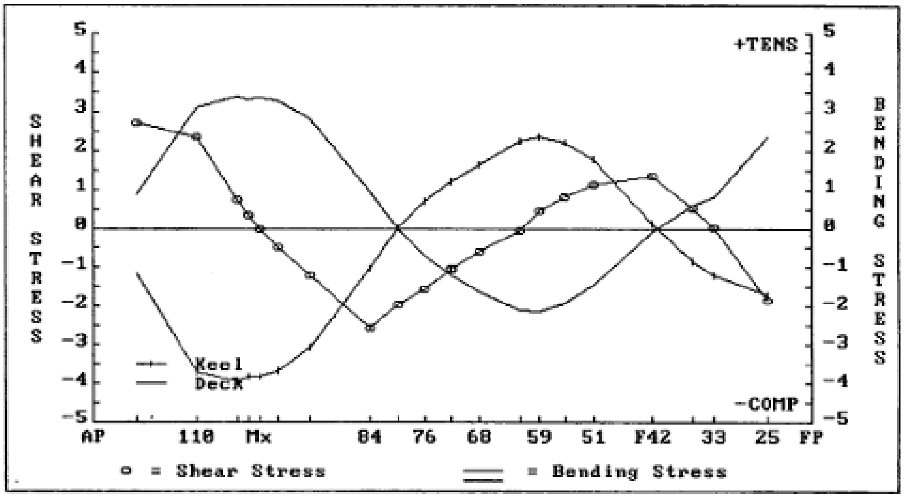
Buoyancy, KB, LCB, TCB are for an intact hull at the equilibrium heel and drafts.

KMt is for the damaged hull at the upright flooded drafts. GMt is the slope of the GZ curve at 0 degrees.

F.S. correction accounts for the free surface of intact tanks and is corrected for outflow.

**SHEAR & LONGITUDINAL BENDING STRESS SUMMARY**
Stresses in ksi

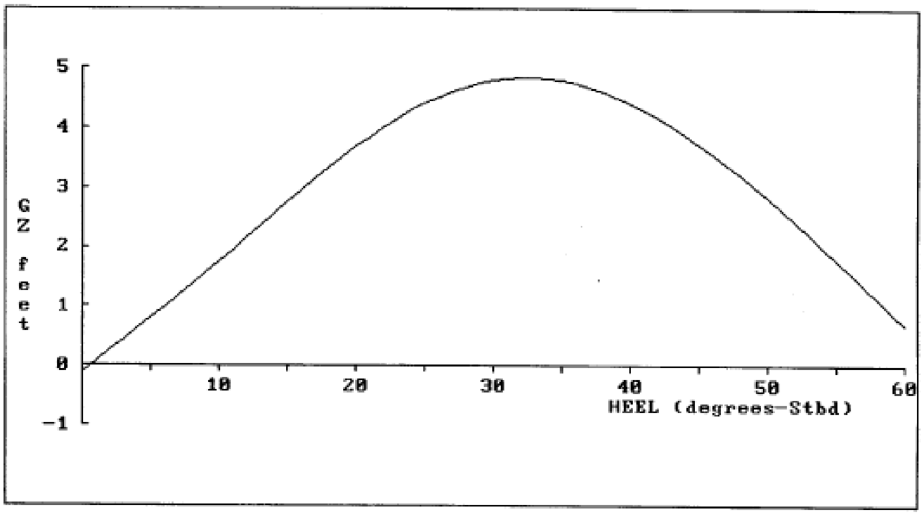
**FAIRED LINES PLAN**
(Based on Direct Calculation from Hull Offsets)




| | | SHEAR FORCES | | BENDING MOMENTS | | |
|---|---|---|---|---|---|---|
| | LOCATION | SHEAR | SHEAR STRESS | MOMENT | DK STRESS | KL STRESS |
| No. | ft-FP | LTons | ksi | ft-LTons | ksi | ksi |
| 25 | 55.00A | -758 | -1.84 | 34,808H | 2.35 | -1.72 |
| 33 | 121.00A | 32 | 0.03 | 66,808H | 0.82 | -1.19 |
| 36 | 148.00A | 626 | 0.52 | 58,525H | 0.59 | -0.83 |
| F42 | 199.00A | 2,182 | 1.34 | 10,824S | -0.08 | 0.11 |
| 51 | 274.00A | 1,675 | 1.15 | 176,824S | -1.47 | 1.78 |
| 55 | 310.00A | 1,135 | 0.80 | 226,890S | -1.92 | 2.21 |
| 59 | 343.00A | 650 | 0.45 | 256,661S | -2.12 | 2.34 |
| 62 | 367.00A | -100 | -0.07 | 264,782S | -2.08 | 2.23 |
| 68 | 418.00A | -1,028 | -0.60 | 230,003S | -1.62 | 1.65 |
| MS | 452.50A | -1,867 | -1.03 | 184,472S | -1.21 | 1.20 |
| 72 | 454.00A | -1,921 | -1.06 | 181,646S | -1.20 | 1.19 |
| 76 | 487.00A | -2,724 | -1.57 | 102,080S | -0.71 | 0.71 |
| 80 | 520.00A | -3,303 | -1.95 | 3,022S | -0.02 | 0.02 |
| 84 | 556.00A | -4,304 | -2.56 | 133,218H | 0.96 | -1.01 |
| 93 | 631.00A | -2,023 | -1.19 | 383,910H | 2.81 | -3.08 |
| 98 | 673.00A | -835 | -0.49 | 448,711H | 3.27 | -3.69 |
| Mx | 694.37A | -0 | -0.00 | 457,877H | 3.34 | -3.81 |
| F98 | 709.00A | 580 | 0.33 | 453,587H | 3.30 | -3.81 |
| 104 | 724.00A | 1,196 | 0.73 | 440,442H | 3.38 | -3.93 |
| 110 | 775.00A | 3,116 | 2.35 | 328,533H | 3.10 | -3.70 |
| 126 | 851.00A | 2,304 | 2.71 | 61,978H | 0.89 | -1.16 |

Maximum Shear Stress at 126: 2.71 ksi
Maximum Deck Bending Stress at 104: 3.38 ksi
Maximum Keel Bending Stress at 104: -3.93 ksi

RIGHTING ARM (GZ)




**Stability Evaluation:**

| | | |
|---|---|---|
| Static Heel Angle | 0.6S deg | |
| Freeboard to Margin Line | 41.78 ft | 0.00 ft |
| Wind Heel Angle | 1.1S deg | |
| Angle at Maximum GZ | 32.3S deg | |
| Maximum GZ | 4.83 ft | |
| Range of Positive GZ | >59.4 deg | |
| Gmt (upright damaged) | 10.34 ft | |

(Based on Direct Calculation from Hull Offsets)
Freeboards are calculated perpendicular to the water surface

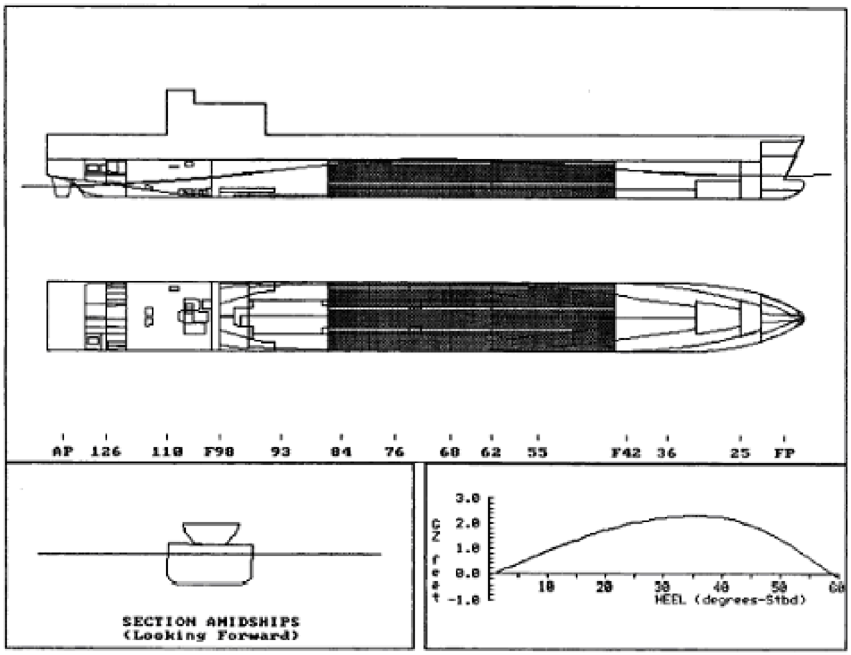
**HOGGING FULL LOAD**
**MD DAMAGE**

## FREE-FLOATING DAMAGED CONDITION

**Damaged Compartments:**

| | | | | | |
|---|---|---|---|---|---|
| HOLD 2 | W2A 8-44-01 | FB 8-44-1 | W2A 8-44-4 | FB 8-44-2 | W2B 8-50-1 |
| W2B 8-50-2 | W2C 8-56-1 | W2C 8-56-2 | HOLD 3 | W3A 8-62-1 | DB3F 8-62-0 |
| DB3F 8-62-2 | W3A 8-62-4 | W3B 8-68-1 | W3B 8-68-2 | W3C 8-74-1 | DB3A 8-74-0 |
| DB3A 8-74-2 | W3C 8-74-4 | W3D 8-80-1 | W3D 8-80-2 | | |

| | DISPLACEMENT LTons | DRAFT FWD ft | DRAFT AFT ft | TRIM ft | HEEL deg. | UPRIGHT GMt ft |
|---|---|---|---|---|---|---|
| INTACT | 48,937 | 27.71 | 27.91 | 0.20A | 0.1S | 11.94 |
| DAMAGED | 87,412 | 53.25 | 33.62 | 19.63F | 1.0S | 6.55 |

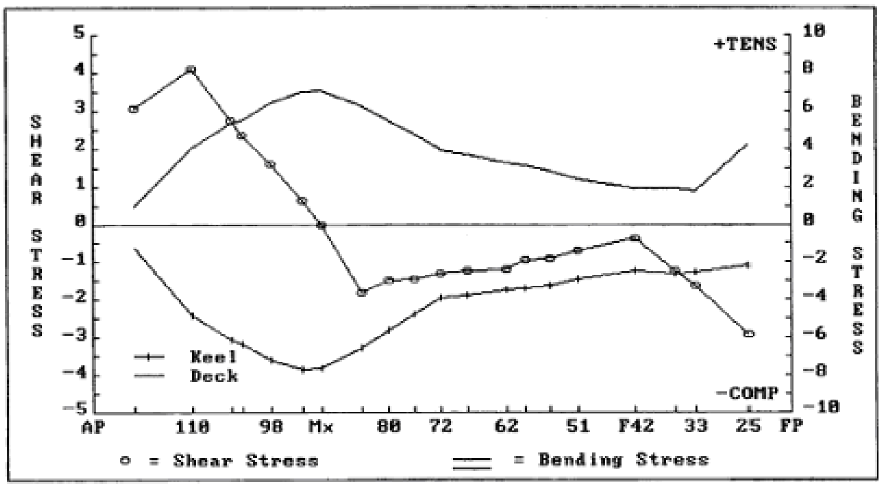


SHEAR & LONGITUDINAL BENDING STRESS SUMMARY
Stresses in ksi

FAIRED LINES PLAN

Wave Height: 33.09 ft  Wave Position: 452.50A ft-FP
Wave Length: 905.00 ft

(Based on Direct Calculation from Hull Offsets)



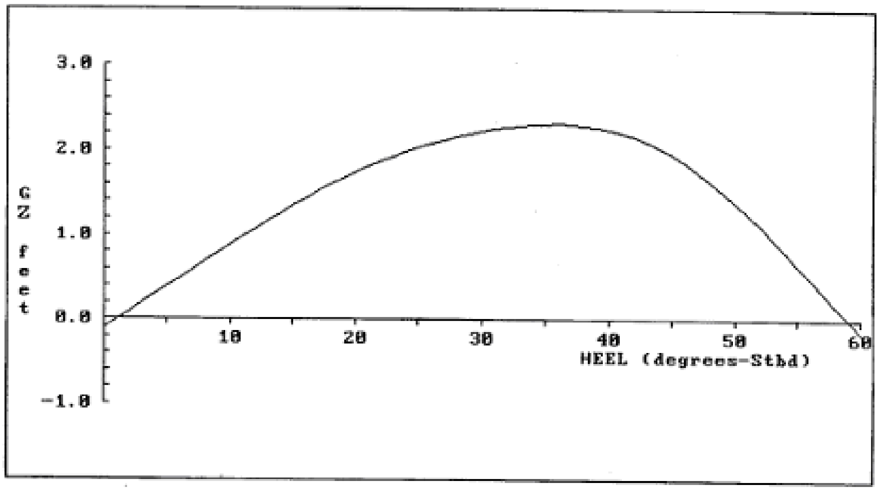
## SHEAR & LONGITUDINAL BENDING STRESS SUMMARY
Stresses in ksi

### FAIRED LINES PLAN

| | | SHEAR FORCES | | BENDING MOMENTS | | |
|---|---|---|---|---|---|---|
| | LOCATION | SHEAR | SHEAR STRESS | MOMENT | DK STRESS | KL STRESS |
| No. | ft-FP | LTons | ksi | ft-LTons | ksi | ksi |
| 25 | 55.00A | -1,205 | -2.92 | 44,044H | 4.17 | -2.20 |
| 33 | 121.00A | -1,585 | -1.64 | 142,082H | 1.76 | -2.56 |
| 36 | 148.00A | -1,494 | -1.25 | 184,348H | 1.89 | -2.63 |
| F42 | 199.00A | -584 | -0.36 | 241,986H | 1.87 | -2.49 |
| 51 | 274.00A | -1,023 | -0.70 | 286,288H | 2.40 | -2.91 |
| 55 | 310.00A | -1,279 | -0.90 | 329,171H | 2.81 | -3.24 |
| 59 | 343.00A | -1,390 | -0.96 | 372,991H | 3.11 | -3.43 |
| 62 | 367.00A | -1,851 | -1.22 | 410,014H | 3.25 | -3.48 |
| 68 | 418.00A | -2,129 | -1.25 | 518,426H | 3.68 | -3.74 |
| MS | 452.50A | -2,378 | -1.31 | 592,667H | 3.93 | -3.89 |
| 72 | 454.00A | -2,403 | -1.32 | 596,250H | 3.96 | -3.92 |
| 76 | 487.00A | -2,547 | -1.47 | 682,483H | 4.76 | -4.79 |
| 80 | 520.00A | -2,500 | -1.48 | 764,343H | 5.49 | -5.63 |
| 84 | 556.00A | -3,030 | -1.80 | 860,981H | 6.27 | -6.56 |
| Mx | 607.17A | -53 | -0.03 | 966,288H | 7.09 | -7.66 |
| 93 | 631.00A | 1,072 | 0.63 | 952,019H | 7.01 | -7.68 |
| 98 | 673.00A | 2,735 | 1.59 | 874,682H | 6.43 | -7.24 |
| F98 | 709.00A | 4,076 | 2.34 | 751,056H | 5.51 | -6.35 |
| 104 | 724.00A | 4,537 | 2.76 | 686,555H | 5.32 | -6.16 |
| 110 | 775.00A | 5,447 | 4.11 | 426,914H | 4.07 | -4.85 |
| 126 | 851.00A | 2,594 | 3.05 | 65,540H | 0.95 | -1.23 |

Maximum Shear Stress at 110: 4.11 ksi
Maximum Deck Bending Stress at Mx: 7.09 ksi
Maximum Keel Bending Stress at 93: -7.68 ksi

RIGHTING ARM (GZ)




**Stability Evaluation:**

| | | | |
|---|---|---|---|
| Static Heel Angle | 1.0S | deg | |
| Freeboard to Margin Line | 39.22 | ft | 0.00 ft |
| Wind Heel Angle | 1.7S | deg | |
| Angle at Maximum GZ | 35.7S | deg | |
| Maximum GZ | 2.31 | ft | |
| Range of Positive GZ | 58.0 | deg | |
| Gmt (upright damaged) | 6.55 | ft | |

(Based on Direct Calculation from Hull Offsets)
Freeboards are calculated perpendicular to the water surface

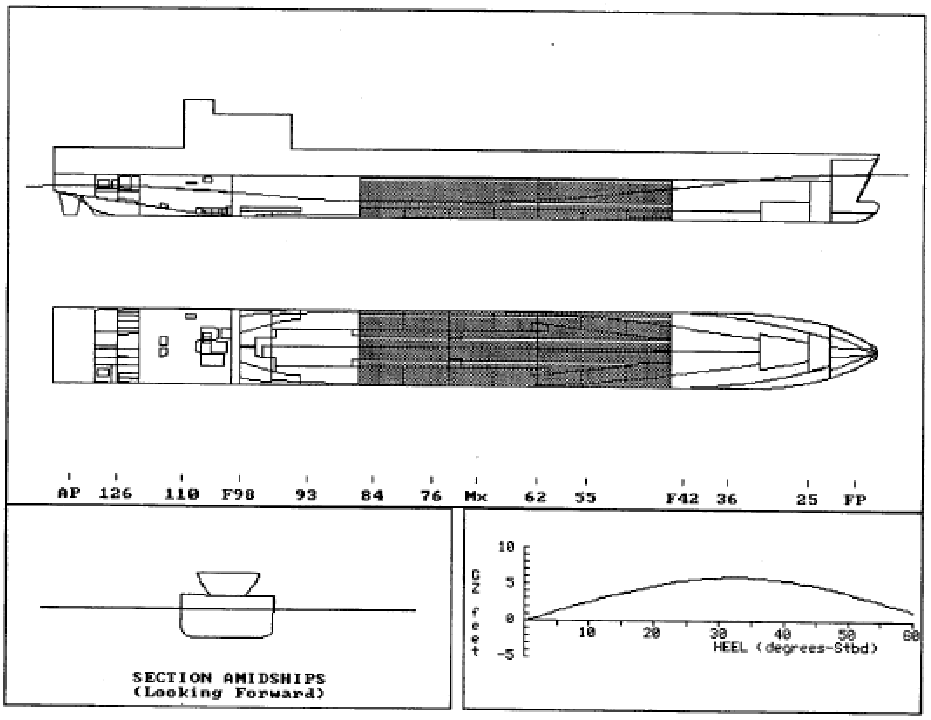
**SAGGING FULL LOAD**
**MD DAMAGE**

FREE-FLOATING DAMAGED CONDITION

**Damaged Compartments:**

| | | | | | |
|---|---|---|---|---|---|
| HOLD 2 | W2A 8-44-01 | FB 8-44-1 | W2A 8-44-4 | FB 8-44-2 | W2B 8-50-1 |
| W2B 8-50-2 | W2C 8-56-1 | W2C 8-56-2 | HOLD 3 | W3A 8-62-1 | DB3F 8-62-0 |
| DB3F 8-62-2 | W3A 8-62-4 | W3B 8-68-1 | W3B 8-68-2 | W3C 8-74-1 | DB3A 8-74-0 |
| DB3A 8-74-2 | W3C 8-74-4 | W3D 8-80-1 | W3D 8-80-2 | | |

| | DISPLACEMENT LTons | DRAFT FWD ft | DRAFT AFT ft | TRIM ft | HEEL deg. | UPRIGHT GMt ft |
|---|---|---|---|---|---|---|
| INTACT | 48,937 | 27.71 | 27.91 | 0.20A | 0.1S | 11.94 |
| DAMAGED | 67,749 | 52.41 | 26.89 | 25.52F | 0.4S | 15.52 |

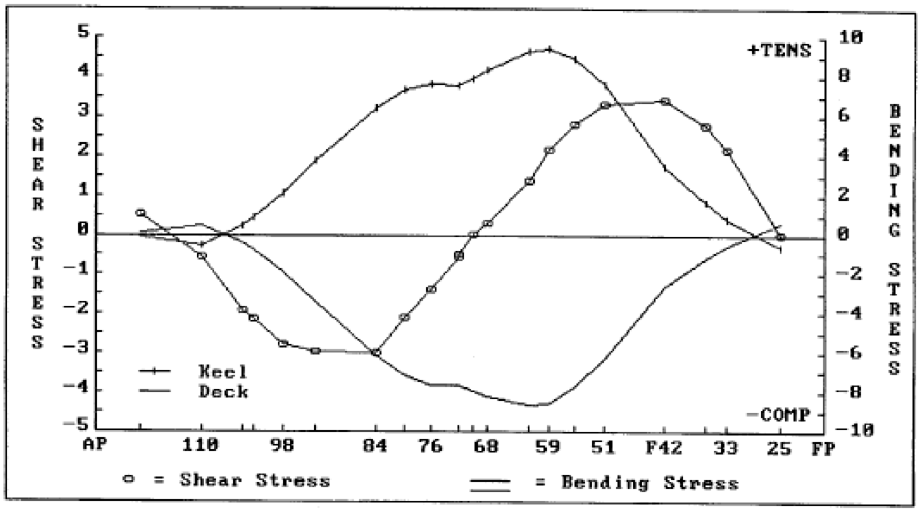


SHEAR & LONGITUDINAL BENDING STRESS SUMMARY
Stresses in ksi

FAIRED LINES PLAN

Wave Height: 33.09 ft    Wave Position: 0.00 ft-FP
Wave Length: 905.00 ft

(Based on Direct Calculation from Hull Offsets)



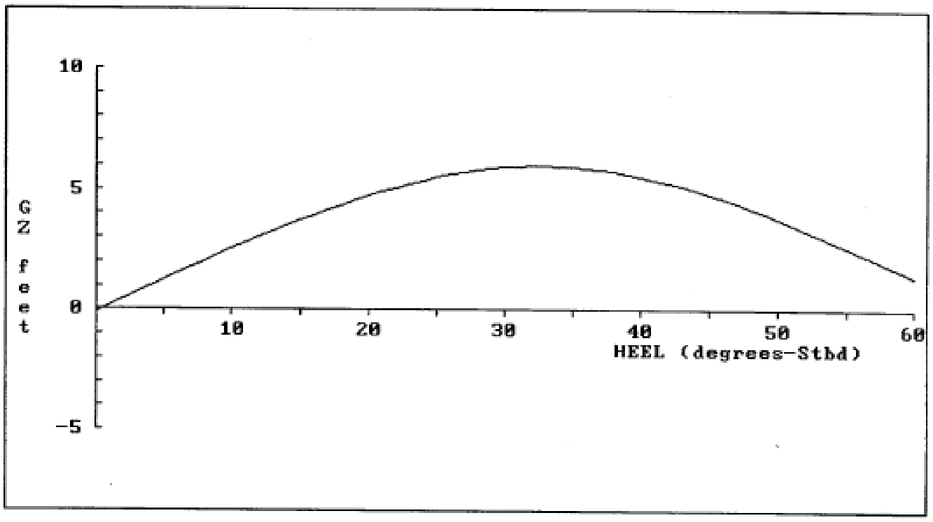
## SHEAR & LONGITUDINAL BENDING STRESS SUMMARY
Stresses in ksi

### FAIRED LINES PLAN

| | | SHEAR FORCES | | BENDING MOMENTS | | |
|---|---|---|---|---|---|---|
| | LOCATION | SHEAR | SHEAR STRESS | MOMENT | DK STRESS | KL STRESS |
| No. | ft-FP | LTons | ksi | ft-LTons | ksi | ksi |
| 25 | 55.00A | 2 | 0.01 | 11,836H | 0.63 | -0.58 |
| 33 | 121.00A | 2,088 | 2.16 | 44,647S | -0.54 | 0.80 |
| 36 | 148.00A | 3,308 | 2.77 | 117,193S | -1.18 | 1.66 |
| F42 | 199.00A | 5,528 | 3.41 | 343,718S | -2.61 | 3.49 |
| 51 | 274.00A | 4,872 | 3.33 | 759,918S | -6.27 | 7.62 |
| 55 | 310.00A | 4,012 | 2.82 | 920,392S | -7.73 | 8.94 |
| 59 | 343.00A | 3,158 | 2.18 | 1,038,607S | -8.53 | 9.43 |
| 62 | 367.00A | 2,126 | 1.40 | 1,103,348S | -8.63 | 9.25 |
| 68 | 418.00A | 539 | 0.32 | 1,167,652S | -8.18 | 8.33 |
| Mx | 436.04A | 13 | 0.01 | 1,172,478S | -7.92 | 7.95 |
| MS | 452.50A | -899 | -0.49 | 1,165,243S | -7.63 | 7.55 |
| 72 | 454.00A | -980 | -0.54 | 1,163,850S | -7.64 | 7.57 |
| 76 | 487.00A | -2,388 | -1.38 | 1,106,164S | -7.62 | 7.67 |
| 80 | 520.00A | -3,530 | -2.08 | 1,008,395S | -7.16 | 7.34 |
| 84 | 556.00A | -5,017 | -2.98 | 854,314S | -6.15 | 6.44 |
| 93 | 631.00A | -5,038 | -2.97 | 471,215S | -3.43 | 3.76 |
| 98 | 673.00A | -4,779 | -2.78 | 258,397S | -1.88 | 2.11 |
| F98 | 709.00A | -3,719 | -2.14 | 103,884S | -0.75 | 0.87 |
| 104 | 724.00A | -3,126 | -1.90 | 52,279S | -0.40 | 0.46 |
| 110 | 775.00A | -739 | -0.56 | 47,782H | 0.45 | -0.54 |
| 126 | 851.00A | 454 | 0.53 | 5,948H | 0.08 | -0.11 |

Maximum Shear Stress at F42: 3.41 ksi
Maximum Deck Bending Stress at 62: -8.63 ksi
Maximum Keel Bending Stress at 59: 9.43 ksi

RIGHTING ARM (GZ)




**Stability Evaluation:**

| | | | |
|---|---|---|---|
| Static Heel Angle | 0.4S | deg | |
| Freeboard to Margin Line | 39.91 | ft | 0.00 ft |
| Wind Heel Angle | 0.8S | deg | |
| Angle at Maximum GZ | 32.5S | deg | |
| Maximum GZ | 5.98 | ft | |
| Range of Positive GZ | >59.6 | deg | |
| Gmt (upright damaged) | 15.52 | ft | |

(Based on Direct Calculation from Hull Offsets)
Freeboards are calculated perpendicular to the water surface

FREE-FLOATING DAMAGED CONDITION

| ITEM | WEIGHT LTons | KG ft-BL | LCG ft-FP | TCG ft-CL | FSmom ft-LTons |
|---|---|---|---|---|---|
| Light Ship | 37,681 | 45.57 | 441.70A | 0.65S | |
| Constant | 0 | 0.00 | 452.50A | 0.00 | 0 |
| RoRo Cargo | 0 | 0.00 | 452.50A | 0.00 | |
| Misc. Weight | 1,861 | 36.63 | 437.82A | 0.00 | 0 |
| Fuel Oil | 546 | 6.78 | 545.50A | 0.02S | 306 |
| Diesel Oil | 5,404 | 19.97 | 547.16A | 0.65P | 8,265 |
| Lube Oil | 134 | 47.08 | 837.03A | 45.62S | 34 |
| Fresh Water | 230 | 48.22 | 838.49A | 38.66P | 97 |
| SW Ballast | 2,625 | 12.68 | 645.23A | 7.86P | 7,737 |
| Misc. | 456 | 19.15 | 758.59A | 6.57S | 674 |
| TOTALS | 48,937 | 39.98 | 471.18A | 0.01S | 17,112 |

| | | INTACT | AFTER OUTFLOW | AS DAMAGED |
|---|---|---|---|---|
| Draft at F.P. | (ft) | 27.71 | ---- | 50.70 |
| Draft at A.P. | (ft) | 27.91 | ---- | 31.07 |
| Trim | (ft) | 0.20A | ---- | 19.64F |
| Draft at Fwd Marks | (ft) | 27.72 | ---- | 50.27 |
| Draft at Aft Marks | (ft) | 27.91 | ---- | 31.61 |
| Static Heel Angle | (deg) | 0.1S | ---- | 0.6S |
| Total Weight | (LT) | 48,937 | 46,359 | 77,652 |
| KG | (ft) | 39.98 | 41.84 | 33.50 |
| LCG | (ft-FP) | 471.18A | 472.12A | 441.50A |
| TCG | (ft-CL) | 0.01S | 0.16S | 0.16S |
| Buoyancy | (LT) | 48,937 | ---- | 77,652 |
| KB | (ft) | ---- | ---- | 22.74 |
| LCB | (ft-FP) | 470.69A | ---- | 441.27A |
| TCB | (ft-CL) | ---- | ---- | 0.28S |
| KMt | (ft) | 52.27 | ---- | 52.78 |
| FSc | (ft) | 0.35 | ---- | 0.32 |
| GMt | (ft) | 11.94 | ---- | 10.34 |
| Shear Force | (LT) | ---- | ---- | -4,304 |
| Bending Moment | (ft-LT) | ---- | ---- | 457,877H |

AFTER OUTFLOW CONDITION:
Displacement, KG, LCG, TCG include the effects of fluid outflow & flooding without free-communication.
AS DAMAGED CONDITION:
Displacement, KG, LCG, TCG include the effects of the flooded water at the equilibrium trim/heel.
Buoyancy, KB, LCB, TCB are for an intact hull at the equilibrium heel and drafts.
KMt is for the damaged hull at the upright flooded drafts. GMt is the slope of the GZ curve at 0 degrees.
F.S. correction accounts for the free surface of intact tanks and is corrected for outflow

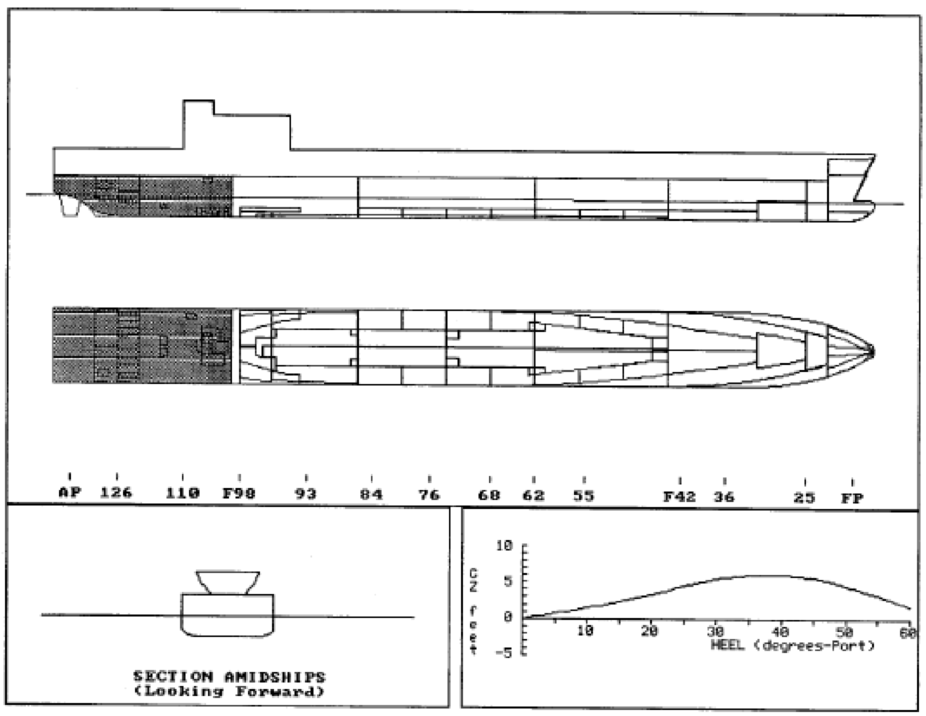
**STILLWATER FULL LOAD**
**AFT DAMAGE**

## FREE-FLOATING DAMAGED CONDITION

**Damaged Compartments:**

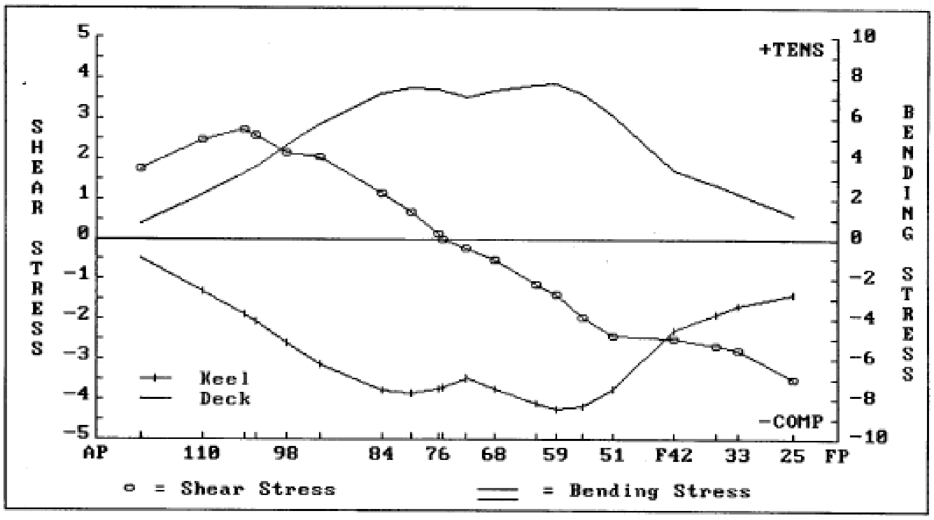
| | | | | | |
|---|---|---|---|---|---|
| MACHY | LODT 8-103-4 | ERWO 8-104-0 | LOSM 8-104-1 | LOSM 8-105-2 | LORG 4-106-2 |
| LORG 4-106-4 | GTWD 8-107-0 | BOLR CASCADE | FPST 7-112-1 | LOPS 7-112-2 | AFT |
| RGS 5-116-11 | DP 6-116-1 | SSDG 5-116-9 | RGSL 5-116-7 | ST 5-116-3 | DTA 6-116-0 |
| ST 5-116-1 | SV 5-116-0 | DP 6-116-4 | POT 5-116-6 | POT 5-116-8 | DIS 5-116-10 |
| GWT 5-126-1 | APF 6-126-1 | APF 6-126-2 | SMHT 5-130-1 | | |

| | DISPLACEMENT LTons | DRAFT FWD ft | DRAFT AFT ft | TRIM ft | HEEL deg. | UPRIGHT GMt ft |
|---|---|---|---|---|---|---|
| INTACT | 48,937 | 27.71 | 27.91 | 0.20A | 0.1S | 11.94 |
| DAMAGED | 50,943 | 26.97 | 30.23 | 3.26A | 0.1P | 8.12 |



**SHEAR & LONGITUDINAL BENDING STRESS SUMMARY**
Stresses in ksi

**FAIRED LINES PLAN**
(Based on Direct Calculation from Hull Offsets)




| | | SHEAR FORCES | | BENDING MOMENTS | | |
|---|---|---|---|---|---|---|
| No. | LOCATION ft-FP | SHEAR LTons | SHEAR STRESS ksi | MOMENT ft-LTons | DK STRESS ksi | KL STRESS ksi |
| 25 | 55.00A | -1,445 | -3.51 | 49,824H | 1.21 | -2.75 |
| 33 | 121.00A | -2,671 | -2.76 | 187,306H | 2.25 | -3.32 |
| 36 | 148.00A | -3,193 | -2.67 | 266,758H | 2.66 | -3.75 |
| F42 | 199.00A | -4,031 | -2.48 | 452,011H | 3.41 | -4.57 |
| 51 | 274.00A | -3,536 | -2.42 | 749,899H | 6.14 | -7.47 |
| 55 | 310.00A | -2,803 | -1.97 | 865,169H | 7.21 | -8.35 |
| 59 | 343.00A | -2,011 | -1.39 | 944,587H | 7.70 | -8.52 |
| 62 | 367.00A | -1,714 | -1.13 | 988,120H | 7.67 | -8.23 |
| 68 | 418.00A | -865 | -0.51 | 1,060,611H | 7.38 | -7.52 |
| MS | 452.50A | -409 | -0.22 | 1,078,393H | 7.01 | -6.94 |
| 72 | 454.00A | -405 | -0.22 | 1,078,988H | 7.04 | -6.97 |
| Mx | 480.86A | -0 | -0.00 | 1,086,867H | 7.37 | -7.39 |
| 76 | 487.00A | 187 | 0.11 | 1,086,318H | 7.43 | -7.48 |
| 80 | 520.00A | 1,152 | 0.68 | 1,064,044H | 7.50 | -7.69 |
| 84 | 556.00A | 1,930 | 1.15 | 1,008,171H | 7.21 | -7.55 |
| 93 | 631.00A | 3,429 | 2.02 | 787,317H | 5.69 | -6.25 |
| 98 | 673.00A | 3,695 | 2.15 | 642,959H | 4.64 | -5.23 |
| F98 | 709.00A | 4,427 | 2.55 | 497,355H | 3.58 | -4.14 |
| 104 | 724.00A | 4,449 | 2.71 | 429,470H | 3.26 | -3.79 |
| 110 | 775.00A | 3,254 | 2.46 | 235,499H | 2.20 | -2.63 |
| 126 | 851.00A | 1,487 | 1.75 | 54,076H | 0.76 | -0.99 |

Maximum Shear Stress at 25: -3.51 ksi
Maximum Deck Bending Stress at 59: 7.70 ksi
Maximum Keel Bending Stress at 59: -8.52 ksi

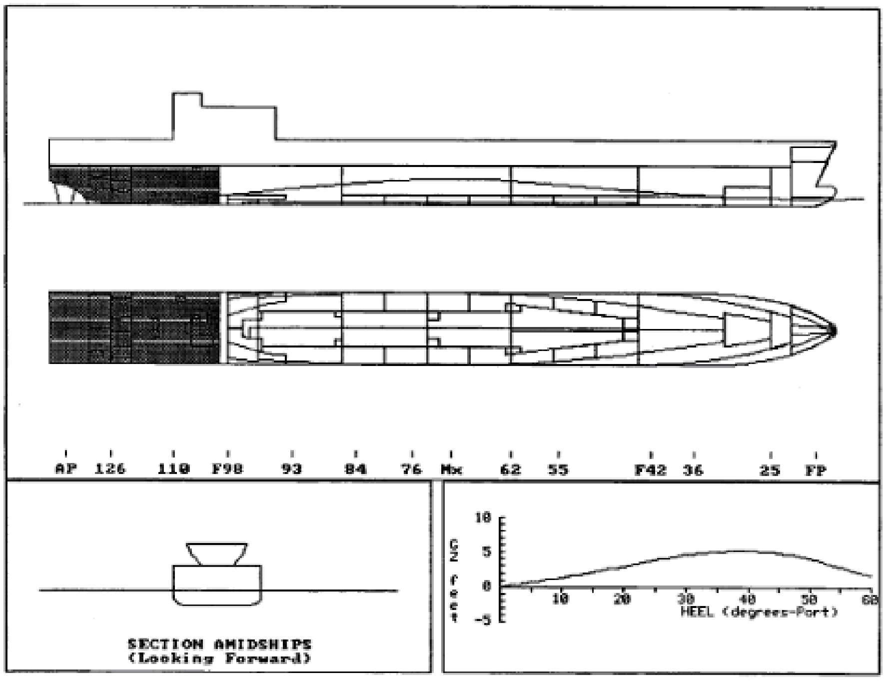
**HOGGING FULL LOAD**
**AFT DAMAGE**

**FREE-FLOATING DAMAGED CONDITION**

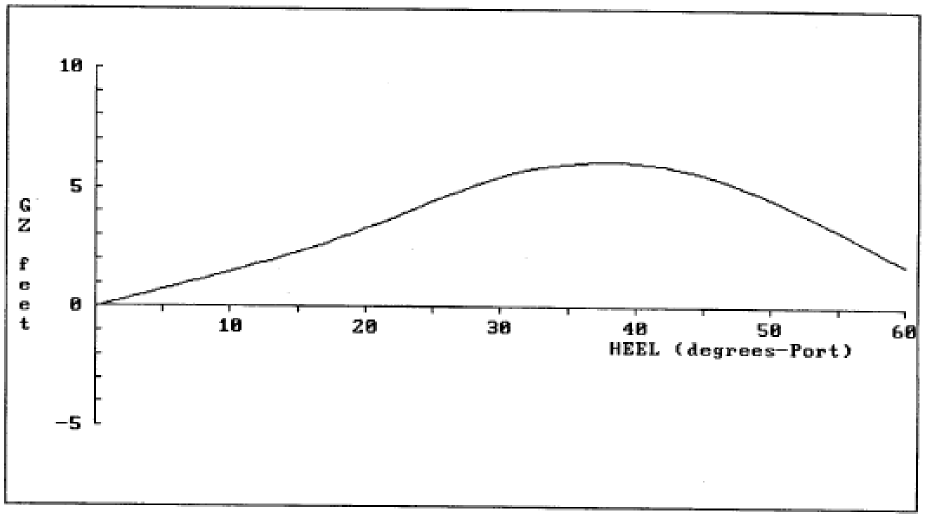
**Jamaged Compartments:**

| | | | | | |
|---|---|---|---|---|---|
| MACHY | LODT 8-103-4 | ERWO 8-104-0 | LOSM 8-104-1 | LOSM 8-105-2 | LORG 4-106-2 |
| LORG 4-106-4 | GTWD 8-107-0 | BOLR CASCADE | PPST 7-112-1 | LOPS 7-112-2 | AFT |
| RGS 5-116-11 | DP 6-116-1 | SSDG 5-116-9 | RGSL 5-116-7 | ST 5-116-3 | DTA 6-116-0 |
| ST 5-116-1 | SV 5-116-0 | DP 6-116-4 | POT 5-116-6 | POT 5-116-8 | DIS 5-116-10 |
| GWT 5-126-1 | APP 6-126-1 | APP 6-126-2 | SWHT 5-130-1 | | |

| | DISPLACEMENT LTons | DRAFT FWD ft | DRAFT AFT ft | TRIM ft | HEEL deg. | UPRIGHT GMt ft |
|---|---|---|---|---|---|---|
| INTACT | 48,937 | 27.71 | 27.91 | 0.20A | 0.1S | 11.94 |
| DAMAGED | 46,207 | 28.28 | 17.62 | 10.66F | 0.1P | 7.61 |



RIGHTING ARM (GZ)




**Stability Evaluation:**

| | | |
|---|---|---|
| Static Heel Angle | 0.1P deg | |
| Freeboard to Margin Line | 62.62 ft | 0.00 ft |
| Wind Heel Angle | 1.4P deg | |
| Angle at Maximum GZ | 37.9P deg | |
| Maximum GZ | 6.11 ft | |
| Range of Positive GZ | >59.9 deg | |
| Gmt (upright damaged) | 8.12 ft | |

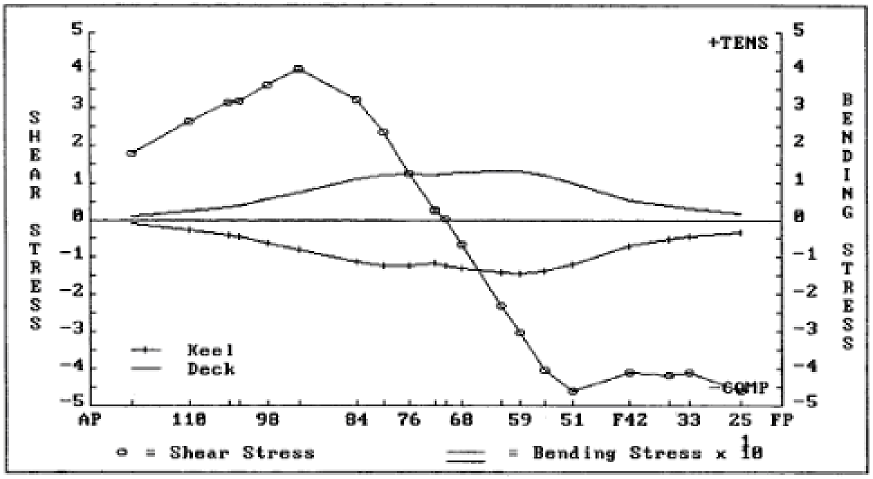
(Based on Direct Calculation from Hull Offsets)
Freeboards are calculated perpendicular to the water surface

SHEAR & LONGITUDINAL BENDING STRESS SUMMARY
Stresses in ksi

FAIRED LINES PLAN

Wave Height: 33.09 ft Wave Position: 452.50A ft-FP
Wave Length: 905.00 ft

(Based on Direct Calculation from Hull Offsets)



## SHEAR & LONGITUDINAL BENDING STRESS SUMMARY
Stresses in ksi

### FAIRED LINES PLAN

| | | SHEAR FORCES | | BENDING MOMENTS | | |
|---|---|---|---|---|---|---|
| | LOCATION | SHEAR | SHEAR STRESS | MOMENT | DK STRESS | KL STRESS |
| No. | ft-FP | LTons | ksi | ft-LTons | ksi | ksi |
| 25 | 55.00A | -1,895 | -4.60 | 64,218H | 1.55 | -3.56 |
| 33 | 121.00A | -3,979 | -4.11 | 256,994H | 3.09 | -4.55 |
| 36 | 148.00A | -4,967 | -4.16 | 377,985H | 3.77 | -5.31 |
| F42 | 199.00A | -6,673 | -4.11 | 676,430H | 5.11 | -6.83 |
| 51 | 274.00A | -6,746 | -4.61 | 1,202,450H | 9.85 | -11.98 |
| 55 | 310.00A | -5,747 | -4.04 | 1,430,198H | 11.92 | -13.80 |
| 59 | 343.00A | -4,398 | -3.04 | 1,597,789H | 13.03 | -14.41 |
| 62 | 367.00A | -3,533 | -2.32 | 1,692,094H | 13.13 | -14.09 |
| 68 | 418.00A | -1,153 | -0.68 | 1,820,794H | 12.67 | -12.91 |
| Mx | 439.35A | 1 | 0.00 | 1,831,078H | 12.21 | -12.22 |
| MS | 452.50A | 442 | 0.24 | 1,827,694H | 11.89 | -11.77 |
| 72 | 454.00A | 495 | 0.27 | 1,826,981H | 11.91 | -11.80 |
| 76 | 487.00A | 2,122 | 1.22 | 1,788,420H | 12.24 | -12.32 |
| 80 | 520.00A | 3,961 | 2.34 | 1,686,907H | 11.90 | -12.19 |
| 84 | 556.00A | 5,393 | 3.20 | 1,516,197H | 10.84 | -11.35 |
| 93 | 631.00A | 6,869 | 4.05 | 1,023,755H | 7.40 | -8.12 |
| 98 | 673.00A | 6,177 | 3.59 | 752,604H | 5.43 | -6.13 |
| F98 | 709.00A | 5,545 | 3.19 | 540,730H | 3.90 | -4.50 |
| 104 | 724.00A | 5,150 | 3.13 | 460,415H | 3.50 | -4.07 |
| 110 | 775.00A | 3,490 | 2.63 | 240,599H | 2.25 | -2.69 |
| 126 | 851.00A | 1,499 | 1.76 | 54,638H | 0.77 | -1.01 |

Maximum Shear Stress at 51: -4.61 ksi
Maximum Deck Bending Stress at 62: 13.13 ksi
Maximum Keel Bending Stress at 59: -14.41 ksi

**SAGGING FULL LOAD**
**AFT DAMAGE**

CVT-1 -- SOF
Rev. 1 (by: WOLF-BAB)

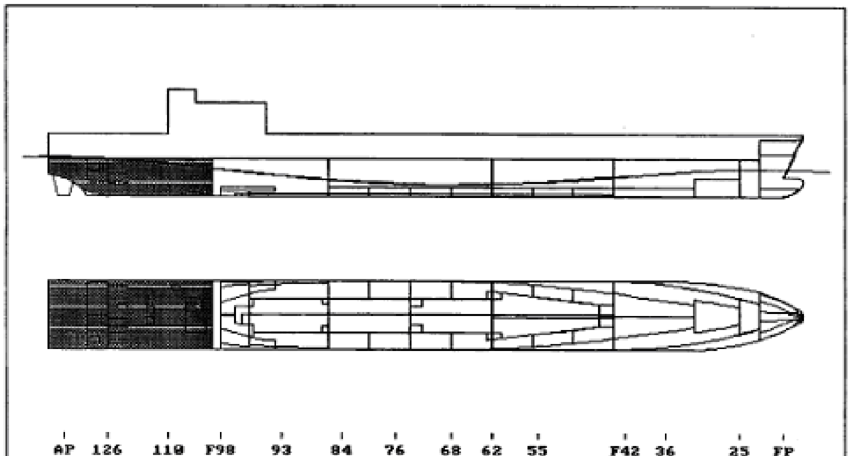
GOC POSSE-SALV V2.2
01-23-03

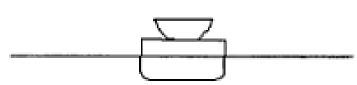
## FREE-FLOATING DAMAGED CONDITION

**Jamaged Compartments:**

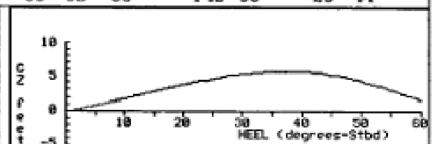
| | | | | | |
|---|---|---|---|---|---|
| MACHY | LODT 8-103-4 | ERWO 8-104-0 | LOSM 8-104-1 | LOSM 8-105-2 | LORG 4-106-2 |
| LORG 4-106-4 | GTWD 8-107-0 | BOLR CASCADE | FPST 7-112-1 | LOPS 7-112-2 | AFT |
| RGS 5-116-11 | DP 6-116-1 | SSDG 5-116-9 | RGSL 5-116-7 | ST 5-116-3 | DTA 6-116-0 |
| ST 5-116-1 | SV 5-116-0 | DP 6-116-4 | POT 5-116-6 | POT 5-116-8 | DIS 5-116-10 |
| GWT 5-126-1 | APF 6-126-1 | APF 6-126-2 | SWHT 5-130-1 | | |

| | DISPLACEMENT LTons | DRAFT FWD ft | DRAFT AFT ft | TRIM ft | HEEL deg. | UPRIGHT GMt ft |
|---|---|---|---|---|---|---|
| INTACT | 48,937 | 27.71 | 27.91 | 0.20A | 0.1S | 11.94 |
| DAMAGED | 64,300 | 26.83 | 45.00 | 18.17A | 0.8S | 10.40 |



SECTION AMIDSHIPS
(Looking Forward)

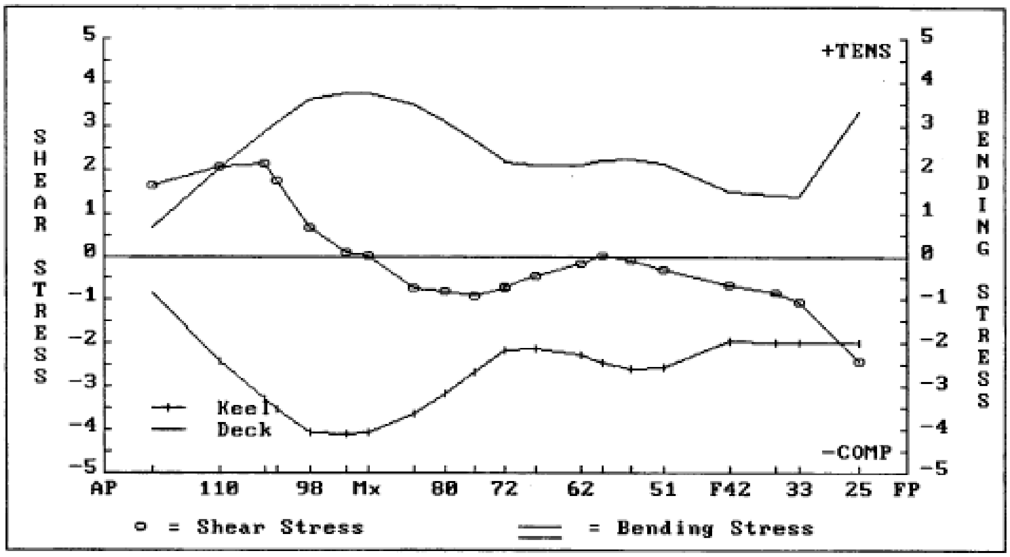


SHEAR & LONGITUDINAL BENDING STRESS SUMMARY
Stresses in ksi

FAIRED LINES PLAN

Wave Height: 33.09 ft    Wave Position: 0.00 ft-FP
Wave Length: 905.00 ft

(Based on Direct Calculation from Hull Offsets)



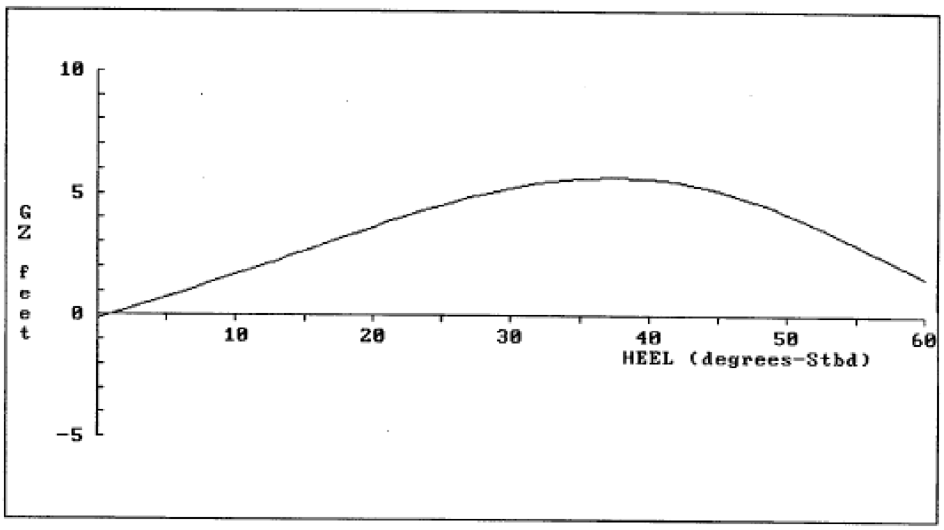
# SHEAR & LONGITUDINAL BENDING STRESS SUMMARY
Stresses in ksi

## FAIRED LINES PLAN

| | | SHEAR FORCES | | BENDING MOMENTS | | |
|---|---|---|---|---|---|---|
| | LOCATION | SHEAR | SHEAR STRESS | MOMENT | DK STRESS | KL STRESS |
| No. | ft-FP | LTons | ksi | ft-LTons | ksi | ksi |
| 25 | 55.00A | -1,004 | -2.44 | 40,050H | 3.30 | -1.99 |
| 33 | 121.00A | -1,032 | -1.07 | 111,306H | 1.37 | -2.00 |
| 36 | 148.00A | -1,022 | -0.86 | 139,264H | 1.42 | -1.98 |
| F42 | 199.00A | -1,082 | -0.67 | 192,134H | 1.48 | -1.97 |
| 51 | 274.00A | -442 | -0.30 | 254,683H | 2.12 | -2.58 |
| 55 | 310.00A | -132 | -0.09 | 264,607H | 2.25 | -2.59 |
| 59 | 343.00A | 36 | 0.03 | 266,136H | 2.21 | -2.44 |
| 62 | 367.00A | -230 | -0.15 | 267,283H | 2.11 | -2.26 |
| 68 | 418.00A | -767 | -0.45 | 297,942H | 2.11 | -2.14 |
| MS | 452.50A | -1,287 | -0.71 | 330,060H | 2.18 | -2.16 |
| 72 | 454.00A | -1,325 | -0.73 | 332,001H | 2.20 | -2.18 |
| 76 | 487.00A | -1,608 | -0.93 | 383,555H | 2.66 | -2.68 |
| 80 | 520.00A | -1,393 | -0.82 | 433,638H | 3.10 | -3.18 |
| 84 | 556.00A | -1,208 | -0.72 | 481,284H | 3.49 | -3.66 |
| Mx | 606.98A | 1 | 0.00 | 514,027H | 3.76 | -4.06 |
| 93 | 631.00A | 144 | 0.08 | 511,903H | 3.76 | -4.12 |
| 98 | 673.00A | 1,148 | 0.67 | 492,315H | 3.61 | -4.06 |
| F98 | 709.00A | 3,052 | 1.76 | 418,819H | 3.06 | -3.53 |
| 104 | 724.00A | 3,485 | 2.12 | 367,551H | 2.84 | -3.29 |
| 110 | 775.00A | 2,719 | 2.05 | 212,632H | 2.02 | -2.41 |
| 126 | 851.00A | 1,375 | 1.62 | 44,730H | 0.65 | -0.84 |

Maximum Shear Stress at 25: -2.44 ksi
Maximum Deck Bending Stress at Mx: 3.76 ksi
Maximum Keel Bending Stress at 93: -4.12 ksi

RIGHTING ARM (GZ)




**Stability Evaluation:**

| | | | |
|---|---|---|---|
| Static Heel Angle | 0.8S | deg | |
| Freeboard to Margin Line | 46.88 | ft | 0.00 ft |
| Wind Heel Angle | 1.6S | deg | |
| Angle at Maximum GZ | 37.5S | deg | |
| Maximum GZ | 5.68 | ft | |
| Range of Positive GZ | >59.2 | deg | |
| Gmt (upright damaged) | 10.40 | ft | |

(Based on Direct Calculation from Hull Offsets)
Freeboards are calculated perpendicular to the water surface

# STILLWATER MOC
# FWD DAMAGE

## FREE-FLOATING DAMAGED CONDITION

| ITEM | WEIGHT LTons | KG ft-BL | LCG ft-FP | TCG ft-CL | FSmom ft-LTons |
|---|---|---|---|---|---|
| Light Ship | 37,681 | 45.57 | 441.70A | 0.65S | |
| Constant | 0 | 0.00 | 452.50A | 0.00 | 0 |
| RoRo Cargo | 0 | 0.00 | 452.50A | 0.00 | |
| Misc. Weight | 1,032 | 43.27 | 464.10A | 0.00 | 0 |
| Fuel Oil | 368 | 6.78 | 545.50A | 0.02S | 2,965 |
| Diesel Oil | 3,639 | 19.97 | 547.16A | 0.65P | 35,656 |
| Lube Oil | 90 | 47.08 | 837.03A | 45.62S | 77 |
| Fresh Water | 119 | 48.22 | 838.49A | 38.66P | 97 |
| SW Ballast | 3,216 | 14.90 | 644.76A | 6.40P | 9,930 |
| Misc. | 307 | 19.15 | 758.59A | 6.57S | 1,937 |
| TOTALS | 46,452 | 40.92 | 469.22A | 0.07S | 50,662 |

| | | INTACT | AFTER OUTFLOW | AS DAMAGED |
|---|---|---|---|---|
| Draft at F.P. | (ft) | 26.87 | ---- | 25.86 |
| Draft at A.P. | (ft) | 26.52 | ---- | 29.25 |
| Trim | (ft) | 0.35F | ---- | 3.39A |
| Draft at Fwd Marks | (ft) | 26.86 | ---- | 25.93 |
| Draft at Aft Marks | (ft) | 26.53 | ---- | 29.16 |
| Static Heel Angle | (deg) | 0.4S | ---- | 0.6P |
| Total Weight | (LT) | 46,452 | 43,743 | 48,621 |
| KG | (ft) | 40.92 | 41.12 | 38.99 |
| LCG | (ft-FP) | 469.22A | 446.08A | 478.85A |
| TCG | (ft-CL) | 0.07S | 0.07P | 0.13P |
| Buoyancy | (LT) | 46,452 | ---- | 48,621 |
| KB | (ft) | ---- | ---- | 15.37 |
| LCB | (ft-FP) | 470.07A | ---- | 478.93A |
| TCB | (ft-CL) | ---- | ---- | 0.39P |
| KMt | (ft) | 52.96 | ---- | 49.38 |
| FSc | (ft) | 1.09 | ---- | 0.87 |
| GMt | (ft) | 10.95 | ---- | 7.09 |
| Shear Force | (LT) | ---- | ---- | 4,519 |
| Bending Moment | (ft-LT) | ---- | ---- | 1,136,941H |

AFTER OUTFLOW CONDITION:

Displacement, KG, LCG, TCG include the effects of fluid outflow & flooding without free-communication.

AS DAMAGED CONDITION:

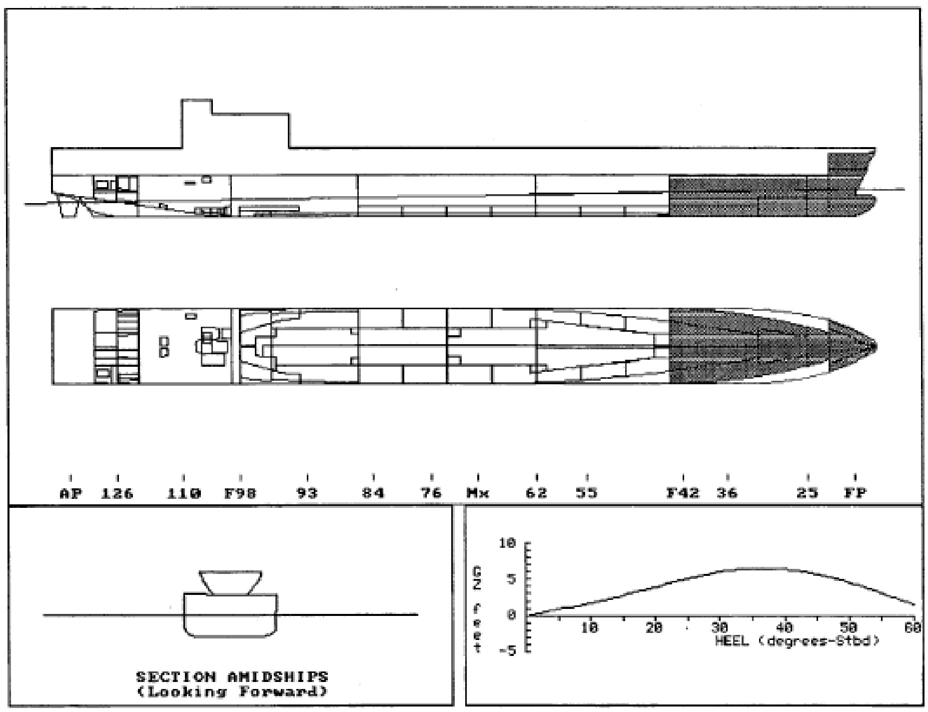
Displacement, KG, LCG, TCG include the effects of the flooded water at the equilibrium trim/heel.
Buoyancy, KB, LCB, TCB are for an intact hull at the equilibrium heel and drafts.
KMt is for the damaged hull at the upright flooded drafts. GMt is the slope of the GZ curve at 0 degrees.
F.S. correction accounts for the free surface of intact tanks and is corrected for outflow.

FREE-FLOATING DAMAGED CONDITION

**Damaged Compartments:**

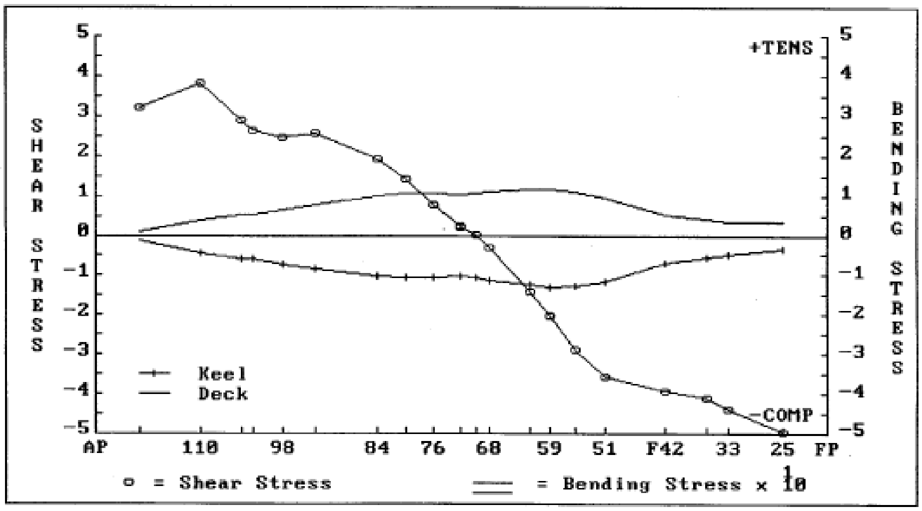
FOCSLE    FPK 6--12-0    FB 8--11-0    HOLD 1    BOW THRUSTER    NO1 8-25-0
DP 8-32-1    DP 8-32-2

| | DISPLACEMENT LTons | DRAFT FWD ft | DRAFT AFT ft | TRIM ft | HEEL deg. | UPRIGHT GMt ft |
|---|---|---|---|---|---|---|
| INTACT | 46,452 | 26.87 | 26.52 | 0.35F | 0.4S | 10.95 |
| DAMAGED | 52,197 | 38.93 | 20.55 | 18.38F | 0.4S | 10.32 |



SHEAR & LONGITUDINAL BENDING STRESS SUMMARY
Stresses in ksi

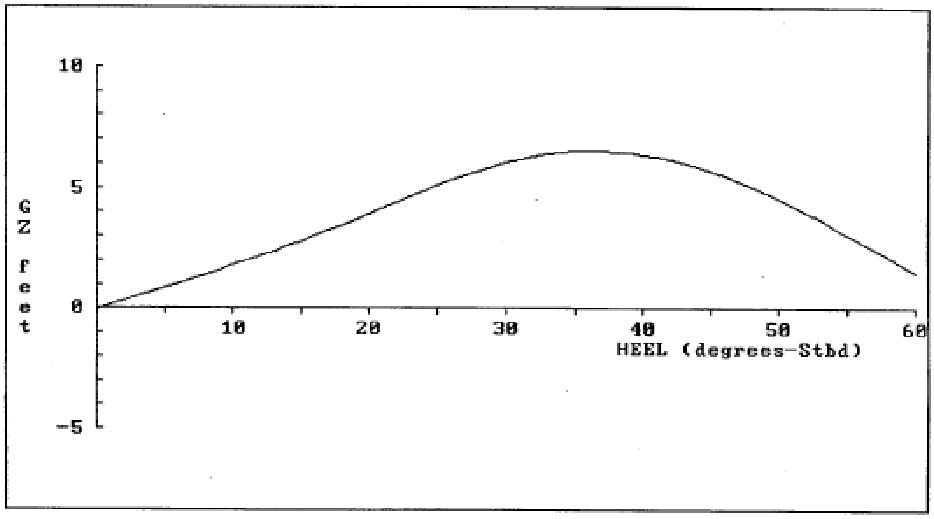
**FAIRED LINES PLAN**
(Based on Direct Calculation from Hull Offsets)




| | SHEAR FORCES | | | BENDING MOMENTS | | |
|---|---|---|---|---|---|---|
| | LOCATION | SHEAR | SHEAR STRESS | MOMENT | DK STRESS | KL STRESS |
| No. | ft-FP | LTons | ksi | ft-LTons | ksi | ksi |
| 25 | 55.00A | -2,041 | -4.95 | 67,269H | 3.38 | -3.30 |
| 33 | 121.00A | -4,237 | -4.38 | 274,906H | 3.34 | -4.89 |
| 36 | 148.00A | -4,904 | -4.11 | 398,330H | 4.01 | -5.62 |
| F42 | 199.00A | -6,386 | -3.93 | 685,001H | 5.20 | -6.96 |
| 51 | 274.00A | -5,206 | -3.56 | 1,148,211H | 9.47 | -11.50 |
| 55 | 310.00A | -4,105 | -2.88 | 1,316,839H | 11.05 | -12.78 |
| 59 | 343.00A | -2,928 | -2.02 | 1,432,990H | 11.76 | -13.00 |
| 62 | 367.00A | -2,138 | -1.41 | 1,493,252H | 11.66 | -12.51 |
| 68 | 418.00A | -533 | -0.31 | 1,563,716H | 10.95 | -11.15 |
| Mx | 434.08A | 0 | 0.00 | 1,567,683H | 10.63 | -10.67 |
| MS | 452.50A | 381 | 0.21 | 1,563,599H | 10.23 | -10.13 |
| 72 | 454.00A | 413 | 0.23 | 1,562,988H | 10.25 | -10.15 |
| 76 | 487.00A | 1,355 | 0.78 | 1,535,791H | 10.57 | -10.64 |
| 80 | 520.00A | 2,422 | 1.43 | 1,473,083H | 10.45 | -10.71 |
| 84 | 556.00A | 3,228 | 1.92 | 1,370,710H | 9.86 | -10.32 |
| 93 | 631.00A | 4,377 | 2.58 | 1,062,100H | 7.72 | -8.47 |
| 98 | 673.00A | 4,232 | 2.46 | 886,057H | 6.43 | -7.25 |
| F98 | 709.00A | 4,579 | 2.63 | 727,452H | 5.27 | -6.08 |
| 104 | 724.00A | 4,731 | 2.88 | 657,784H | 5.03 | -5.84 |
| 110 | 775.00A | 5,074 | 3.83 | 404,969H | 3.80 | -4.54 |
| 126 | 851.00A | 2,718 | 3.20 | 68,754H | 0.98 | -1.27 |

Maximum Shear Stress at 25: -4.95 ksi
Maximum Deck Bending Stress at 59: 11.76 ksi
Maximum Keel Bending Stress at 59: -13.00 ksi

RIGHTING ARM (GZ)




**Stability Evaluation:**

| | | |
|---|---|---|
| Static Heel Angle | 0.4S deg | |
| Freeboard to Margin Line | 53.59 ft | 0.00 ft |
| Wind Heel Angle | 1.4S deg | |
| Angle at Maximum GZ | 36.4S deg | |
| Maximum GZ | 6.53 ft | |
| Range of Positive GZ | >59.6 deg | |
| Gmt (upright damaged) | 10.32 ft | |

(Based on Direct Calculation from Hull Offsets)
Freeboards are calculated perpendicular to the water surface

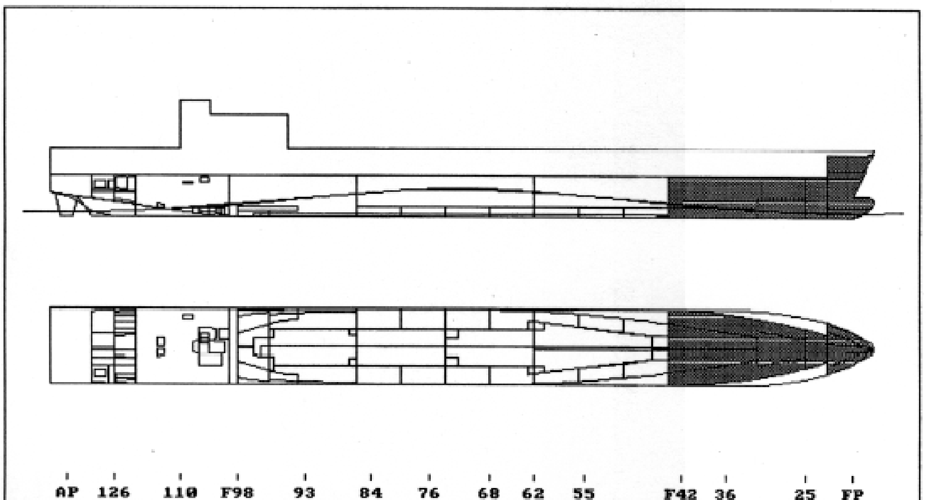
**HOGGING MOC**
**FWD DAMAGE**

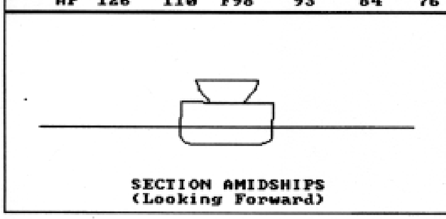
**FREE-FLOATING DAMAGED CONDITION**

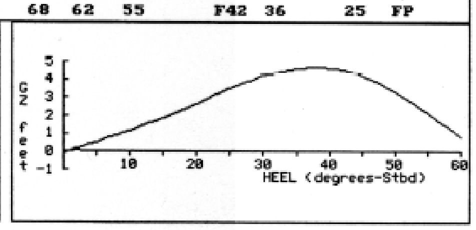
**Damaged Compartments:**

FOCSLE FPK 6--12-0 FB 8--11-0 HOLD 1 BOW THRUSTER NO1 8-25-0
DP 8-32-1 DP 8-32-2

| | DISPLACEMENT LTons | DRAFT FWD ft | DRAFT AFT ft | TRIM ft | HEEL deg. | UPRIGHT GMt ft |
|---|---|---|---|---|---|---|
| INTACT | 46,452 | 26.87 | 26.52 | 0.35F | 0.4S | 10.95 |
| DAMAGED | 47,412 | 24.14 | 23.02 | 1.12F | 0.6S | 6.85 |



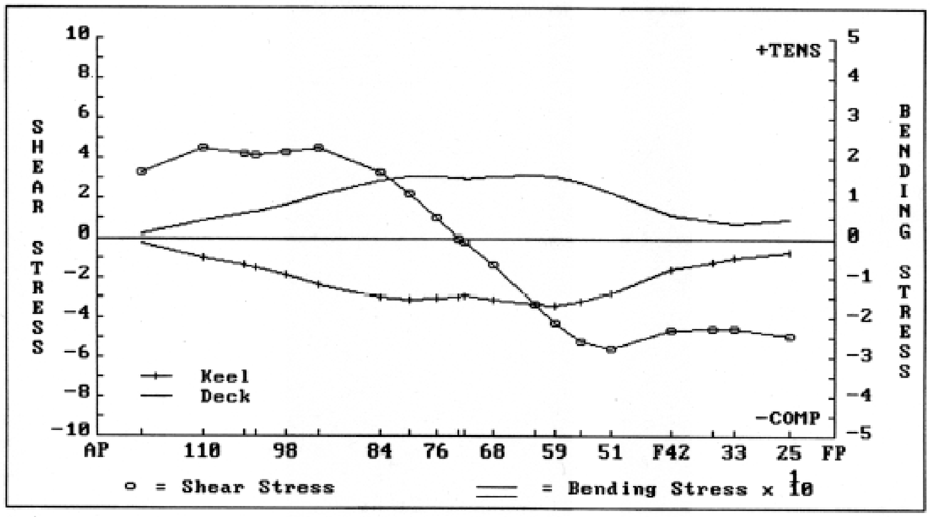



**SHEAR & LONGITUDINAL BENDING STRESS SUMMARY**
Stresses in ksi

**FAIRED LINES PLAN**

Wave Height: 33.09 ft Wave Position: 452.50A ft-FP
Wave Length: 905.00 ft

(Based on Direct Calculation from Hull Offsets)



## SHEAR & LONGITUDINAL BENDING STRESS SUMMARY
Stresses in ksi

### FAIRED LINES PLAN

| | | SHEAR FORCES | | BENDING MOMENTS | | |
|---|---|---|---|---|---|---|
| | LOCATION | SHEAR | SHEAR STRESS | MOMENT | DK STRESS | KL STRESS |
| No. | ft-FP | LTons | ksi | ft-LTons | ksi | ksi |
| 25 | 55.00A | -2,239 | -5.43 | 66,662H | 2.64 | -3.25 |
| 33 | 121.00A | -3,323 | -3.44 | 255,952H | 3.09 | -4.54 |
| 36 | 148.00A | -3,337 | -2.79 | 345,744H | 3.46 | -4.87 |
| F42 | 199.00A | -4,175 | -2.57 | 531,901H | 4.03 | -5.39 |
| 51 | 274.00A | -1,666 | -1.14 | 783,195H | 6.44 | -7.82 |
| 55 | 310.00A | -381 | -0.27 | 819,038H | 6.85 | -7.92 |
| Mx | 322.30A | 1 | 0.00 | 821,435H | 6.81 | -7.74 |
| 59 | 343.00A | 600 | 0.41 | 815,154H | 6.67 | -7.37 |
| 62 | 367.00A | 1,061 | 0.70 | 794,554H | 6.18 | -6.64 |
| 68 | 418.00A | 1,553 | 0.91 | 727,457H | 5.08 | -5.17 |
| MS | 452.50A | 1,502 | 0.82 | 672,501H | 4.39 | -4.34 |
| 72 | 454.00A | 1,488 | 0.82 | 670,240H | 4.38 | -4.34 |
| 76 | 487.00A | 1,427 | 0.83 | 623,174H | 4.28 | -4.30 |
| 80 | 520.00A | 1,487 | 0.88 | 575,094H | 4.07 | -4.17 |
| 84 | 556.00A | 1,272 | 0.76 | 525,520H | 3.77 | -3.94 |
| 93 | 631.00A | 888 | 0.52 | 427,520H | 3.10 | -3.40 |
| 98 | 673.00A | 415 | 0.24 | 406,464H | 2.94 | -3.32 |
| F98 | 709.00A | 853 | 0.49 | 384,706H | 2.78 | -3.21 |
| 104 | 724.00A | 1,150 | 0.70 | 369,931H | 2.82 | -3.27 |
| 110 | 775.00A | 2,443 | 1.84 | 278,494H | 2.61 | -3.12 |
| 126 | 851.00A | 2,210 | 2.60 | 60,571H | 0.86 | -1.12 |

Maximum Shear Stress at 25: -5.43 ksi
Maximum Deck Bending Stress at 55: 6.85 ksi
Maximum Keel Bending Stress at 55: -7.92 ksi

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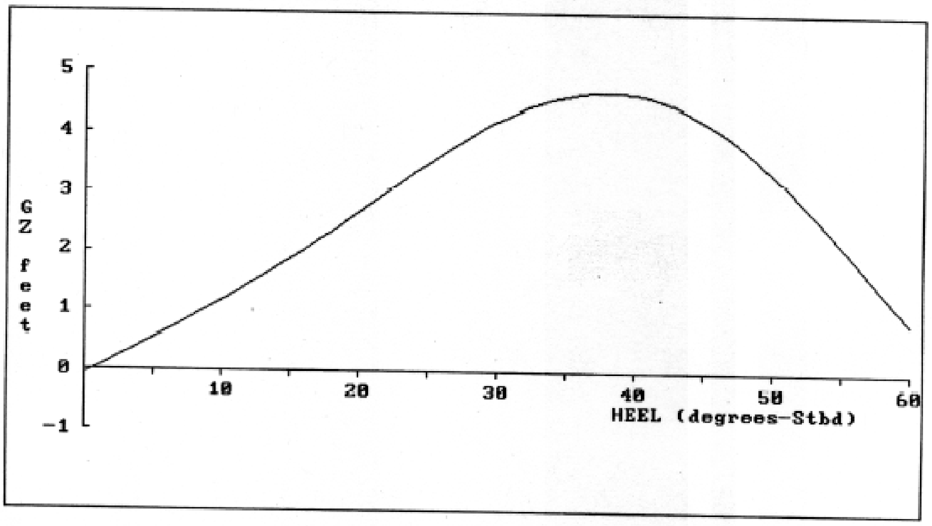
01-23-03

**RIGHTING ARM (GZ)**




**Stability Evaluation:**

| | | |
|---|---|---|
| Static Heel Angle | 0.6S deg | |
| Freeboard to Margin Line | 68.52 ft | 0.00 ft |
| Wind Heel Angle | 2.5S deg | |
| Angle at Maximum GZ | 38.0S deg | |
| Maximum GZ | 4.67 ft | |
| Range of Positive GZ | >59.4 deg | |
| Gmt (upright damaged) | 6.85 ft | |

(Based on Direct Calculation from Hull Offsets)
Freeboards are calculated perpendicular to the water surface

**SAGGING MOC**
**FWD DAMAGE**

CVT-1 -- SOF
Rev. 1 (by: WOLF-BAB)

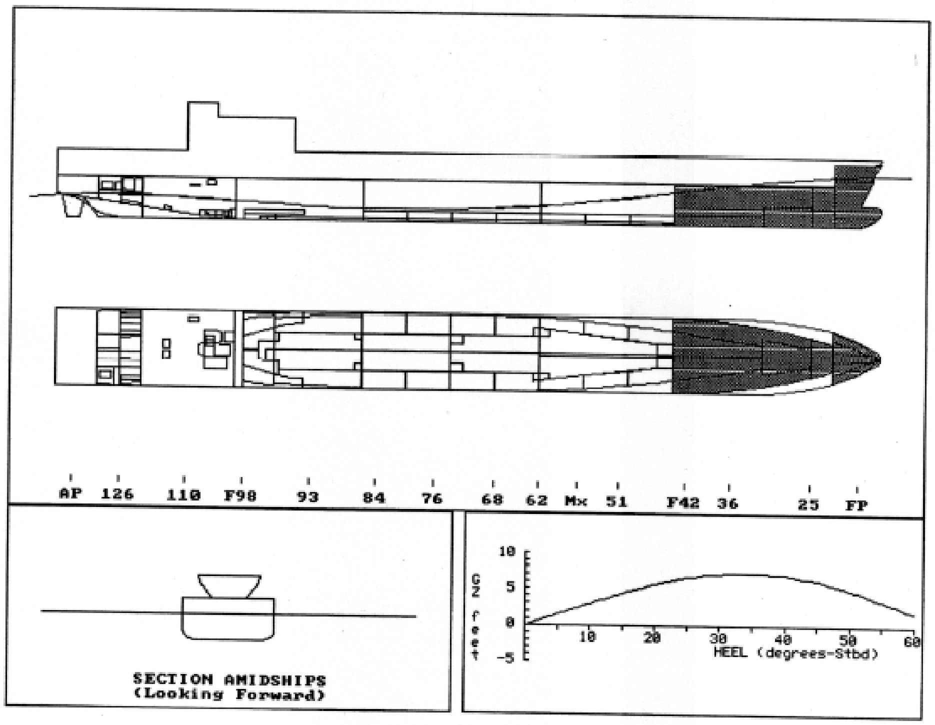
OOC POSSE-SALV V2.2
01-23-03

## FREE-FLOATING DAMAGED CONDITION

**Damaged Compartments:**

FOCSLE | FPK G--12-0 | FB 8--11-0 | HOLD 1 | BOW THRUSTER | NO1 8-25-0
DP 8-32-1 | DP 8-32-2

| | DISPLACEMENT LTons | DRAFT FWD ft | DRAFT AFT ft | TRIM ft | HEEL deg. | UPRIGHT GMt ft |
|---|---|---|---|---|---|---|
| INTACT | 46,452 | 26.87 | 26.52 | 0.35F | 0.4S | 10.95 |
| DAMAGED | 58,038 | 55.99 | 16.95 | 39.04F | 0.2S | 17.42 |

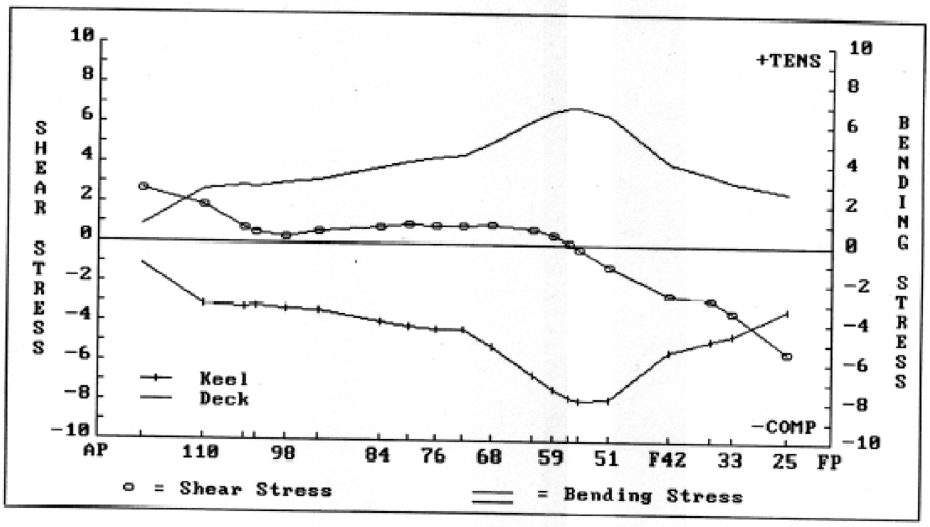


**SHEAR & LONGITUDINAL BENDING STRESS SUMMARY**
Stresses in ksi

**FAIRED LINES PLAN**

Wave Height: 33.09 ft
Wave Length: 905.00 ft
Wave Position: 0.00 ft-FP

(Based on Direct Calculation from Hull Offsets)



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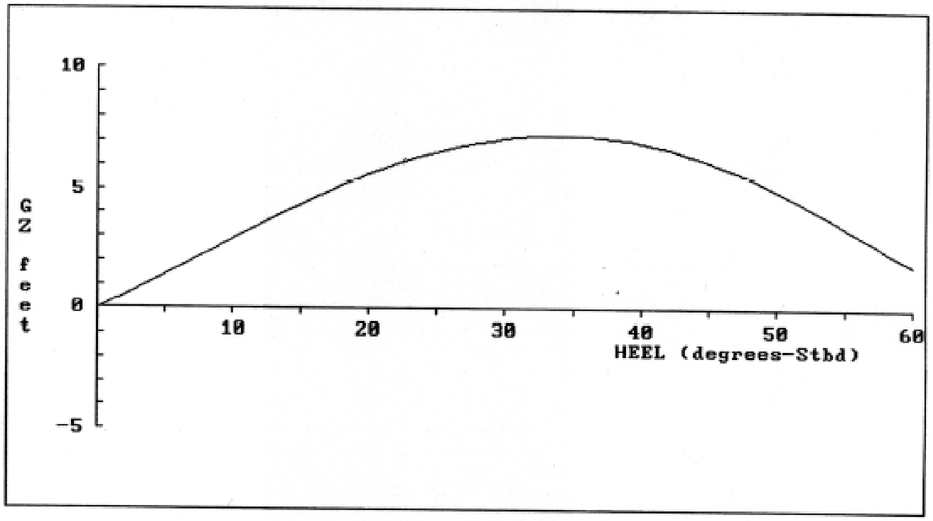
Rev. 1 (by: WOLF-BAB)

OOC POSSE-SALV V2.2
01-23-03

**RIGHTING ARM (GZ)**




**Stability Evaluation:**

| | | | |
|---|---|---|---|
| Static Heel Angle | 0.2S | deg | |
| Freeboard to Margin Line | 35.97 | ft | 0.00 ft |
| Wind Heel Angle | 0.6S | deg | |
| Angle at Maximum GZ | 34.1S | deg | |
| Maximum GZ | 7.26 | ft | |
| Range of Positive GZ | >59.8 | deg | |
| Gmt (upright damaged) | 17.42 | ft | |

(Based on Direct Calculation from Hull Offsets)

Freeboards are calculated perpendicular to the water surface

# FREE-FLOATING DAMAGED CONDITION

| ITEM | WEIGHT LTons | KG ft-BL | LCG ft-FP | TCG ft-CL | FSmom ft-LTons |
|---|---|---|---|---|---|
| Light Ship | 37,681 | 45.57 | 441.70A | 0.65S | |
| Constant | 0 | 0.00 | 452.50A | 0.00 | 0 |
| RoRo Cargo | 0 | 0.00 | 452.50A | 0.00 | |
| Misc. Weight | 1,032 | 43.27 | 464.10A | 0.00 | 0 |
| Fuel Oil | 368 | 6.78 | 545.50A | 0.02S | 2,965 |
| Diesel Oil | 3,639 | 19.97 | 547.16A | 0.65P | 35,656 |
| Lube Oil | 90 | 47.08 | 837.03A | 45.62S | 77 |
| Fresh Water | 119 | 48.22 | 838.49A | 38.66P | 97 |
| SW Ballast | 3,216 | 14.90 | 644.76A | 6.40P | 9,930 |
| Misc. | 307 | 19.15 | 758.59A | 6.57S | 1,937 |
| TOTALS | 46,452 | 40.92 | 469.22A | 0.07S | 50,662 |

| | | INTACT | AFTER OUTFLOW | AS DAMAGED |
|---|---|---|---|---|
| Draft at F.P. | (ft) | 26.87 | ---- | 38.93 |
| Draft at A.P. | (ft) | 26.52 | ---- | 20.55 |
| Trim | (ft) | 0.35F | ---- | 18.38F |
| Draft at Fwd Marks | (ft) | 26.86 | ---- | 38.52 |
| Draft at Aft Marks | (ft) | 26.53 | ---- | 21.06 |
| Static Heel Angle | (deg) | 0.4S | ---- | 0.4S |
| Total Weight | (LT) | 46,452 | 45,579 | 52,197 |
| KG | (ft) | 40.92 | 41.52 | 38.90 |
| LCG | (ft-FP) | 469.22A | 474.96A | 431.34A |
| TCG | (ft-CL) | 0.07S | 0.07S | 0.07S |
| Buoyancy | (LT) | 46,452 | ---- | 52,197 |
| KB | (ft) | ---- | ---- | 16.66 |
| LCB | (ft-FP) | 470.07A | ---- | 430.89A |
| TCB | (ft-CL) | ---- | ---- | 0.22S |
| KMt | (ft) | 52.96 | ---- | 53.06 |
| FSc | (ft) | 1.09 | ---- | 0.94 |
| GMt | (ft) | 10.95 | ---- | 10.32 |
| Shear Force | (LT) | ---- | ---- | -6,386 |
| Bending Moment | (ft-LT) | ---- | ---- | 1,567,683H |

AFTER OUTFLOW CONDITION:

Displacement, KG, LCG, TCG include the effects of fluid outflow & flooding without free-communication.

AS DAMAGED CONDITION:

Displacement, KG, LCG, TCG include the effects of the flooded water at the equilibrium trim/heel.

Buoyancy, KB, LCB, TCB are for an intact hull at the equilibrium heel and drafts.

KMt is for the damaged hull at the upright flooded drafts. GMt is the slope of the GZ curve at 0 degrees.

F.S. correction accounts for the free surface of intact tanks and is corrected for outflow.

**STILLWATER MOC**
**MD DAMAGE**

CVT-1 -- SOF
Rev. 1 (by: WOLF-BAB)

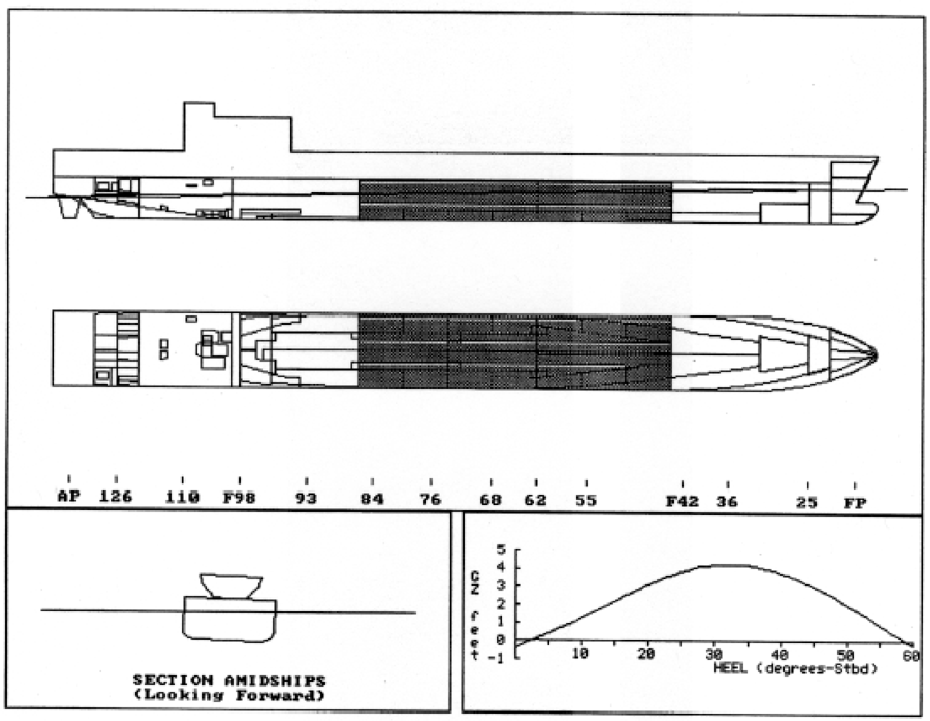
OOC POSSE-SALV V2.2
01-23-03

## FREE-FLOATING DAMAGED CONDITION

**Damaged Compartments:**

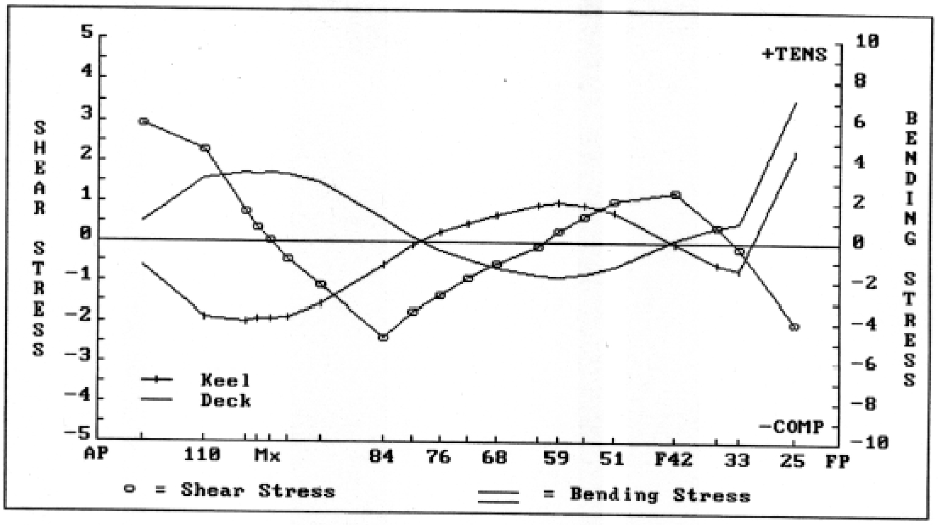
| | | | | | |
|---|---|---|---|---|---|
| HOLD 2 | W2A 8-44-01 | FD 8-44-1 | W2A 8-44-4 | FB 8-44-2 | W2B 8-50-1 |
| W2B 8-50-2 | W2C 8-56-1 | W2C 8-56-2 | HOLD 3 | W3A 8-62-1 | DB3F 8-62-0 |
| DB3F 8-62-2 | W3A 8-62-4 | W3B 8-68-1 | W3B 8-68-2 | W3C 8-74-1 | DB3A 8-74-0 |
| DB3A 8-74-2 | W3C 8-74-4 | W3D 8-80-1 | W3D 8-80-2 | | |

| | DISPLACEMENT LTons | DRAFT FWD ft | DRAFT AFT ft | TRIM ft | HEEL deg. | UPRIGHT GMt ft |
|---|---|---|---|---|---|---|
| INTACT | 46,452 | 26.87 | 26.52 | 0.35F | 0.4S | 10.95 |
| DAMAGED | 74,620 | 49.28 | 29.92 | 19.36F | 2.5S | 9.09 |



## SHEAR & LONGITUDINAL BENDING STRESS SUMMARY
Stresses in ksi

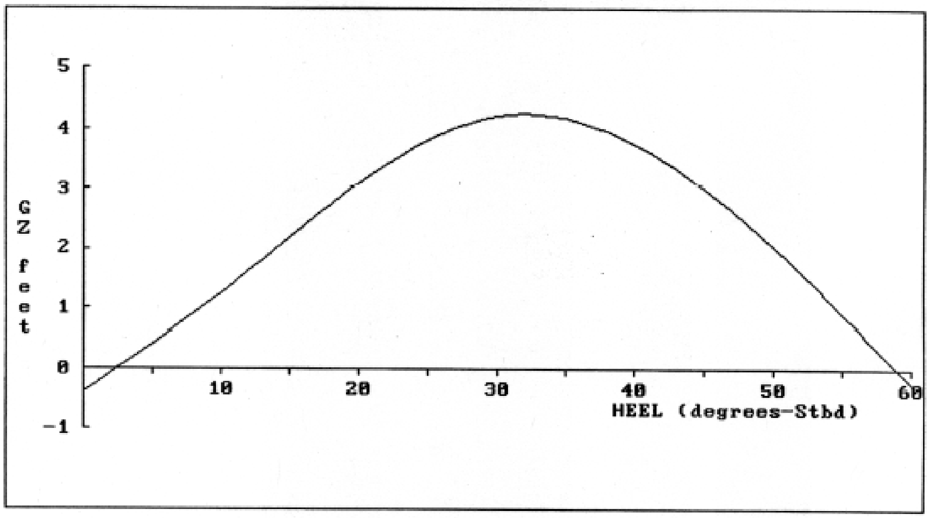
### FAIRED LINES PLAN
(Based on Direct Calculation from Hull Offsets)




| | | SHEAR FORCES | | BENDING MOMENTS | | |
|---|---|---|---|---|---|---|
| No. | LOCATION ft-FP | SHEAR LTons | SHEAR STRESS ksi | MOMENT ft-LTons | DK STRESS ksi | KL STRESS ksi |
| 25 | 55.00A | -818 | -1.98 | 36,132H | 7.12 | 4.51 |
| 33 | 121.00A | -161 | -0.17 | 76,702H | 1.00 | -1.42 |
| 36 | 148.00A | 436 | 0.36 | 73,620H | 0.78 | -1.08 |
| F42 | 199.00A | 2,035 | 1.25 | 13,120H | 0.10 | -0.14 |
| 51 | 274.00A | 1,478 | 1.01 | 141,187S | -1.22 | 1.47 |
| 55 | 310.00A | 894 | 0.63 | 183,262S | -1.62 | 1.86 |
| 59 | 343.00A | 370 | 0.26 | 204,520S | -1.76 | 1.94 |
| 62 | 367.00A | -168 | -0.11 | 207,657S | -1.70 | 1.82 |
| 68 | 418.00A | -944 | -0.56 | 177,098S | -1.29 | 1.32 |
| MS | 452.50A | -1,636 | -0.90 | 135,328S | -0.92 | 0.91 |
| 72 | 454.00A | -1,674 | -0.92 | 132,862S | -0.91 | 0.90 |
| 76 | 487.00A | -2,346 | -1.35 | 65,153S | -0.47 | 0.47 |
| 80 | 520.00A | -2,963 | -1.75 | 22,042H | 0.16 | -0.17 |
| 84 | 556.00A | -4,005 | -2.38 | 146,767H | 1.10 | -1.15 |
| 93 | 631.00A | -1,865 | -1.10 | 379,719H | 2.88 | -3.15 |
| 98 | 673.00A | -785 | -0.46 | 440,087H | 3.33 | -3.73 |
| Mx | 693.17A | 3 | 0.00 | 448,130H | 3.38 | -3.85 |
| F98 | 709.00A | 609 | 0.35 | 443,238H | 3.34 | -3.84 |
| 104 | 724.00A | 1,195 | 0.73 | 429,873H | 3.42 | -3.95 |
| 110 | 775.00A | 3,008 | 2.27 | 319,890H | 3.14 | -3.73 |
| 126 | 851.00A | 2,468 | 2.91 | 64,473H | 0.98 | -1.26 |

Maximum Shear Stress at 126: 2.91 ksi
Maximum Deck Bending Stress at 25: 7.12 ksi
Maximum Keel Bending Stress at 25: 4.51 ksi

**RIGHTING ARM (GZ)**




**Stability Evaluation:**

| | | |
|---|---|---|
| Static Heel Angle | 2.5S deg | |
| Freeboard to Margin Line | 42.90 ft | 0.00 ft |
| Wind Heel Angle | 3.1S deg | |
| Angle at Maximum GZ | 32.1S deg | |
| Maximum GZ | 4.25 ft | |
| Range of Positive GZ | 56.5 deg | |
| Gmt (upright damaged) | 9.09 ft | |

(Based on Direct Calculation from Hull Offsets)
Freeboards are calculated perpendicular to the water surface

**HOGGING MOC**
**MD DAMAGE**

CVT-1 -- SOF
Rev. 1 (by: WOLF-BAB)

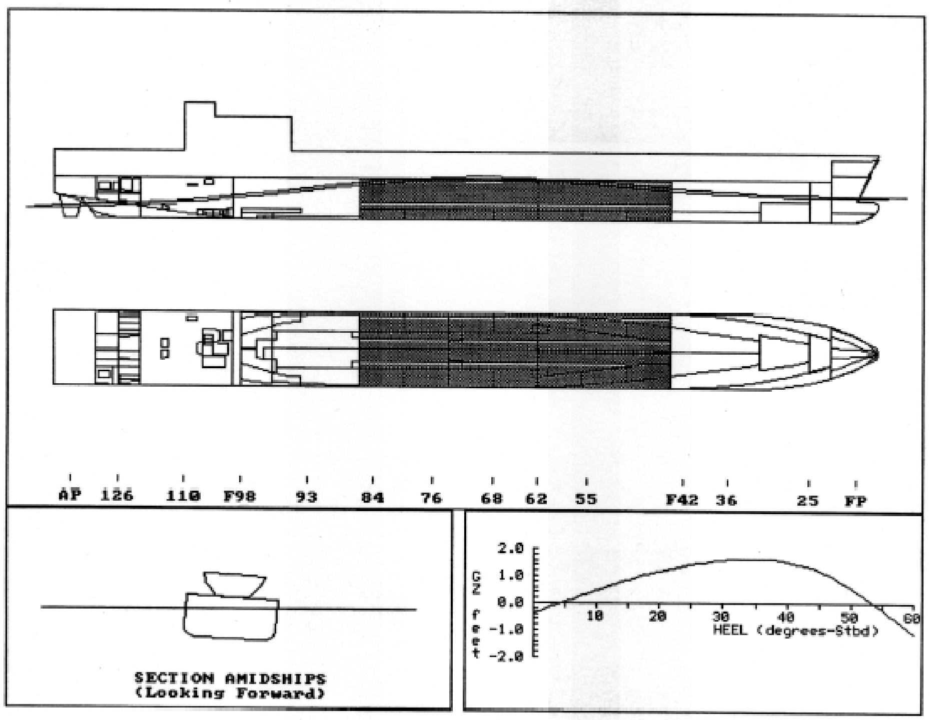
OOG POSSE-SALV V2.2
01-23-03

## FREE-FLOATING DAMAGED CONDITION

**Damaged Compartments:**

| | | | | | |
|---|---|---|---|---|---|
| HOLD 3 | W2A 0-44-01 | FB 8-44-1 | W2A 8-44-4 | FB 8-44-2 | W2B 8-50-1 |
| W2B 8-50-2 | W2C 8-56-1 | W2C 8-56-2 | HOLD 3 | W3A 8-62-1 | DB3F 8-62-0 |
| DB3F 8-62-2 | W3A 8-62-4 | W3B 8-68-1 | W3B 8-68-2 | W3C 8-74-1 | DB3A 8-74-0 |
| DB3A 8-74-2 | W3C 8-74-4 | W3D 8-80-1 | W3D 8-80-2 | | |

| | DISPLACEMENT LTons | DRAFT FWD ft | DRAFT AFT ft | TRIM ft | HEEL deg. | UPRIGHT GMt ft |
|---|---|---|---|---|---|---|
| INTACT | 46,452 | 26.87 | 26.52 | 0.35F | 0.4S | 10.95 |
| DAMAGED | 84,321 | 51.84 | 32.07 | 19.77F | 4.1S | 6.19 |

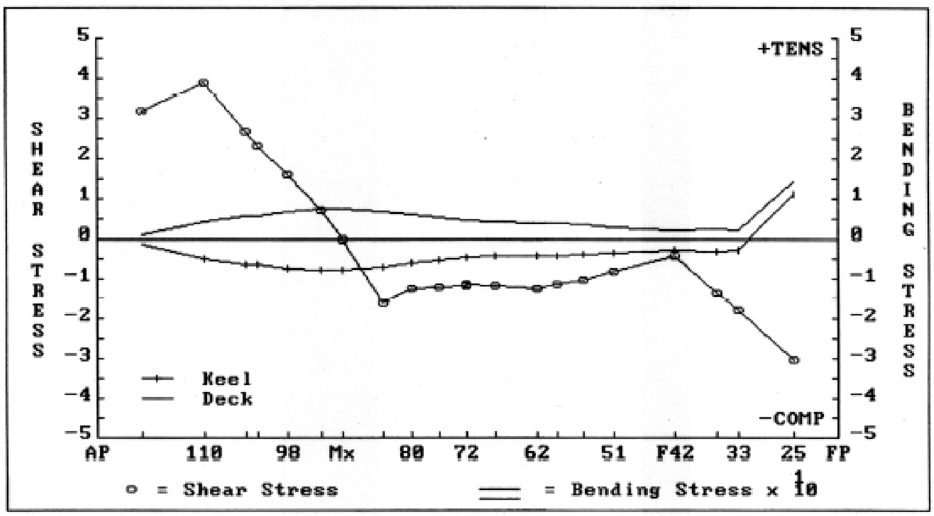


**SHEAR & LONGITUDINAL BENDING STRESS SUMMARY**
**Stresses in ksi**

**FAIRED LINES PLAN**

Wave Height: 33.09 ft Wave Position: 452.50A ft-FP
Wave Length: 905.00 ft

(Based on Direct Calculation from Hull Offsets)



# SHEAR & LONGITUDINAL BENDING STRESS SUMMARY
## Stresses in ksi

## FAIRED LINES PLAN

| | | SHEAR FORCES | | BENDING MOMENTS | | |
|---|---|---|---|---|---|---|
| | LOCATION | SHEAR | SHEAR STRESS | MOMENT | DK STRESS | KL STRESS |
| No. | ft-FP | LTons | ksi | ft-LTons | ksi | ksi |
| 25 | 55.00A | -1,241 | -3.01 | 44,765H | 14.07 | 10.84 |
| 33 | 121.00A | -1,724 | -1.78 | 148,795H | 2.03 | -2.84 |
| 36 | 148.00A | -1,622 | -1.36 | 194,699H | 2.17 | -2.94 |
| F42 | 199.00A | -666 | -0.41 | 257,835H | 2.14 | -2.79 |
| 51 | 274.00A | -1,164 | -0.80 | 309,241H | 2.78 | -3.33 |
| 55 | 310.00A | -1,464 | -1.03 | 358,137H | 3.28 | -3.74 |
| 59 | 343.00A | -1,625 | -1.12 | 408,514H | 3.64 | -4.00 |
| 62 | 367.00A | -1,873 | -1.23 | 449,696H | 3.81 | -4.06 |
| 68 | 418.00A | -2,001 | -1.18 | 553,149H | 4.17 | -4.24 |
| MS | 452.50A | -2,075 | -1.14 | 620,212H | 4.36 | -4.32 |
| 72 | 454.00A | -2,084 | -1.15 | 623,339H | 4.39 | -4.35 |
| 76 | 487.00A | -2,105 | -1.21 | 695,425H | 5.15 | -5.18 |
| 80 | 520.00A | -2,122 | -1.25 | 763,916H | 5.83 | -5.96 |
| 84 | 556.00A | -2,711 | -1.61 | 848,289H | 6.56 | -6.85 |
| Mx | 604.91A | -25 | -0.02 | 939,985H | 7.32 | -7.86 |
| 93 | 631.00A | 1,200 | 0.71 | 921,599H | 7.21 | -7.85 |
| 98 | 673.00A | 2,717 | 1.58 | 841,896H | 6.56 | -7.34 |
| F98 | 709.00A | 4,002 | 2.30 | 719,610H | 5.60 | -6.40 |
| 104 | 724.00A | 4,420 | 2.69 | 656,532H | 5.39 | -6.20 |
| 110 | 775.00A | 5,173 | 3.90 | 406,074H | 4.13 | -4.87 |
| 126 | 851.00A | 2,692 | 3.17 | 66,950H | 1.07 | -1.35 |

Maximum Shear Stress at 110: 3.90 ksi
Maximum Deck Bending Stress at 25: 14.07 ksi
Maximum Keel Bending Stress at 25: 10.84 ksi

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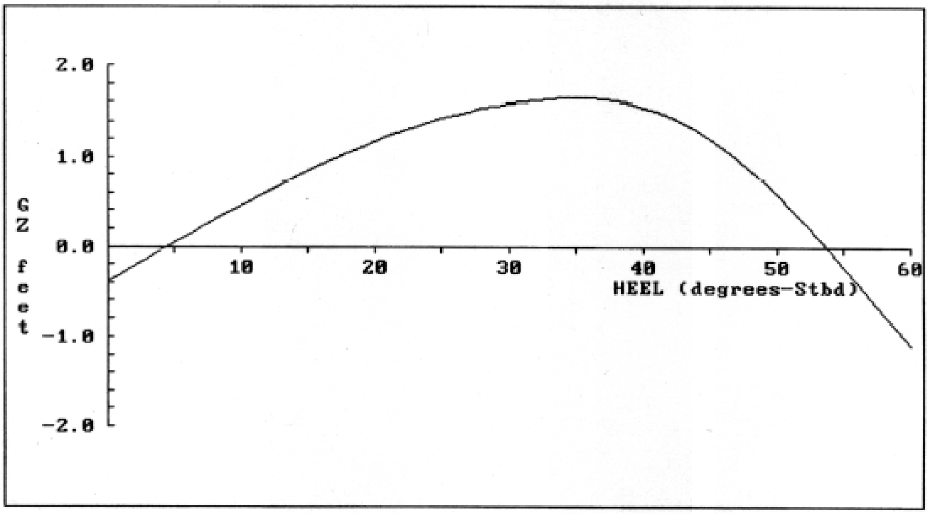
OOC POSSE-SALV V2.2
01-23-03

**RIGHTING ARM (GZ)**




**Stability Evaluation:**

| | | |
|---|---|---|
| Static Heel Angle | 4.1S deg | |
| Freeboard to Margin Line | 39.38 ft | 0.00 ft |
| Wind Heel Angle | 5.2S deg | |
| Angle at Maximum GZ | 34.8S deg | |
| Maximum GZ | 1.65 ft | |
| Range of Positive GZ | 49.5 deg | |
| Gmt (upright damaged) | 6.19 ft | |

(Based on Direct Calculation from Hull Offsets)
Freeboards are calculated perpendicular to the water surface

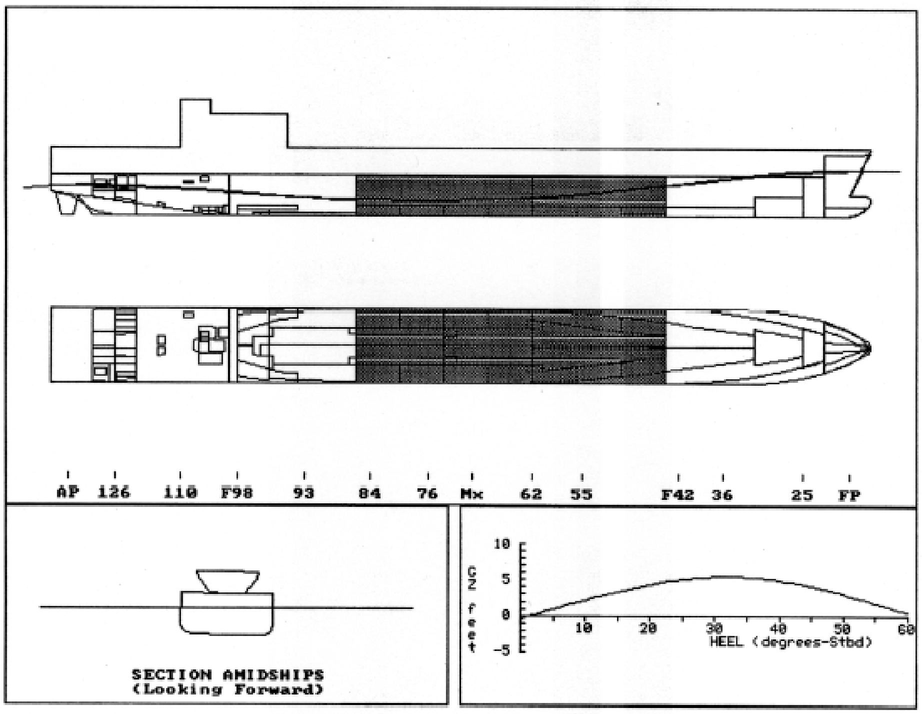
**SAGGING MOC**
**MD DAMAGE**

## FREE-FLOATING DAMAGED CONDITION

**Damaged Compartments:**

| | | | | | |
|---|---|---|---|---|---|
| HOLD 2 | W2A 8-44-01 | FD 8-44-1 | W2A 8-44-4 | FB 8-44-2 | W2B 8-50-1 |
| W2B 8-50-2 | W2C 8-56-1 | W2C 8-56-2 | HOLD 3 | W3A 8-62-1 | DB3F 8-62-0 |
| DB3F 8-62-2 | W3A 8-62-4 | W3B 8-68-1 | W3B 8-68-2 | W3C 8-74-1 | DB3A 8-74-0 |
| DB3A 8-74-2 | W3C 8-74-4 | W3D 8-80-1 | W3D 8-80-2 | | |

| | DISPLACEMENT LTons | DRAFT FWD ft | DRAFT AFT ft | TRIM ft | HEEL deg. | UPRIGHT GMt ft |
|---|---|---|---|---|---|---|
| INTACT | 46,452 | 26.87 | 26.52 | 0.35F | 0.4S | 10.95 |
| DAMAGED | 64,620 | 50.48 | 26.11 | 24.36F | 1.5S | 15.22 |

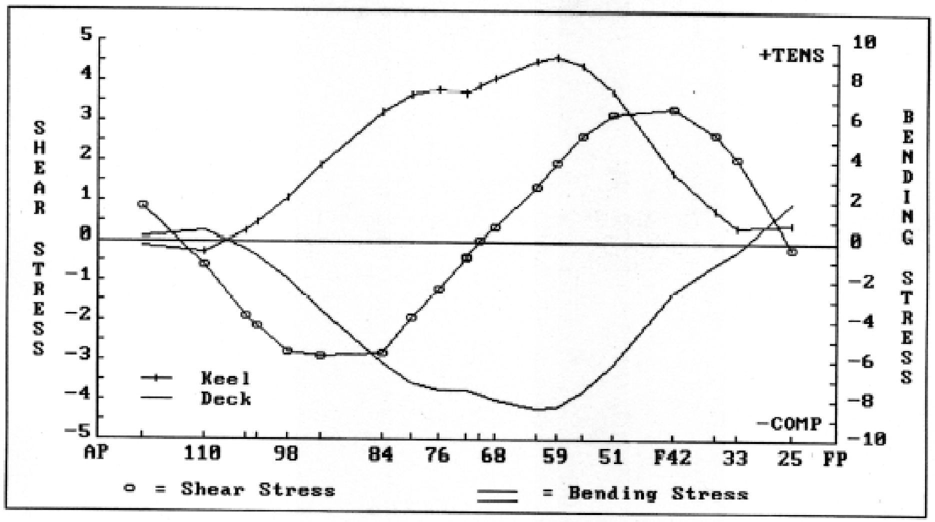


**SHEAR & LONGITUDINAL BENDING STRESS SUMMARY**
Stresses in ksi

**FAIRED LINES PLAN**

Wave Height: 33.09 ft Wave Position: 0.00 ft-FP
Wave Length: 905.00 ft

(Based on Direct Calculation from Hull Offsets)



# SHEAR & LONGITUDINAL BENDING STRESS SUMMARY
## Stresses in ksi

## FAIRED LINES PLAN

| | | SHEAR FORCES | | BENDING MOMENTS | | |
|---|---|---|---|---|---|---|
| | LOCATION | SHEAR | SHEAR STRESS | MOMENT | DK STRESS | KL STRESS |
| No. | ft-FP | LTons | ksi | ft-LTons | ksi | ksi |
| 25 | 55.00A | -69 | -0.17 | 14,825H | 1.89 | 0.81 |
| 33 | 121.00A | 1,998 | 2.07 | 36,686S | -0.46 | 0.67 |
| 36 | 148.00A | 3,187 | 2.67 | 106,375S | -1.10 | 1.53 |
| F42 | 199.00A | 5.389 | 3.32 | 325.934S | -2.54 | 3.38 |
| 51 | 274.00A | 4,655 | 3.18 | 729,714S | -6.18 | 7.47 |
| 55 | 310.00A | 3,743 | 2.63 | 881,458S | -7.59 | 8.75 |
| 59 | 343.00A | 2,844 | 1.96 | 990,058S | -8.34 | 9.19 |
| 62 | 367.00A | 2,021 | 1.33 | 1,048,967S | -8.40 | 8.99 |
| 68 | 418.00A | 581 | 0.34 | 1,115,442S | -7.99 | 8.13 |
| Mx | 436.77A | 0 | 0.00 | 1,120,818S | -7.73 | 7.74 |
| MS | 452.50A | -714 | -0.39 | 1,115,252S | -7.46 | 7.38 |
| 72 | 454.00A | -779 | -0.43 | 1,114,151S | -7.47 | 7.40 |
| 76 | 487.00A | -2,057 | -1.19 | 1,066,769S | -7.51 | 7.55 |
| 80 | 520.00A | -3,238 | -1.91 | 979,272S | -7.10 | 7.28 |
| 84 | 556.00A | -4,766 | -2.83 | 834,960S | -6.14 | 6.42 |
| 93 | 631.00A | -4,915 | -2.90 | 466,346S | -3.47 | 3.80 |
| 98 | 673.00A | -4,748 | -2.76 | 256,802S | -1.91 | 2.14 |
| F98 | 709.00A | -3,692 | -2.12 | 103,611S | -0.77 | 0.88 |
| 104 | 724.00A | -3,120 | -1.90 | 52,255S | -0.41 | 0.47 |
| 110 | 775.00A | -807 | -0.61 | 48,603H | 0.47 | -0.56 |
| 126 | 851.00A | 709 | 0.84 | 12,762H | 0.19 | -0.24 |

Maximum Shear Stress at F42: 3.32 ksi
Maximum Deck Bending Stress at 62: -8.40 ksi
Maximum Keel Bending Stress at 59: 9.19 ksi

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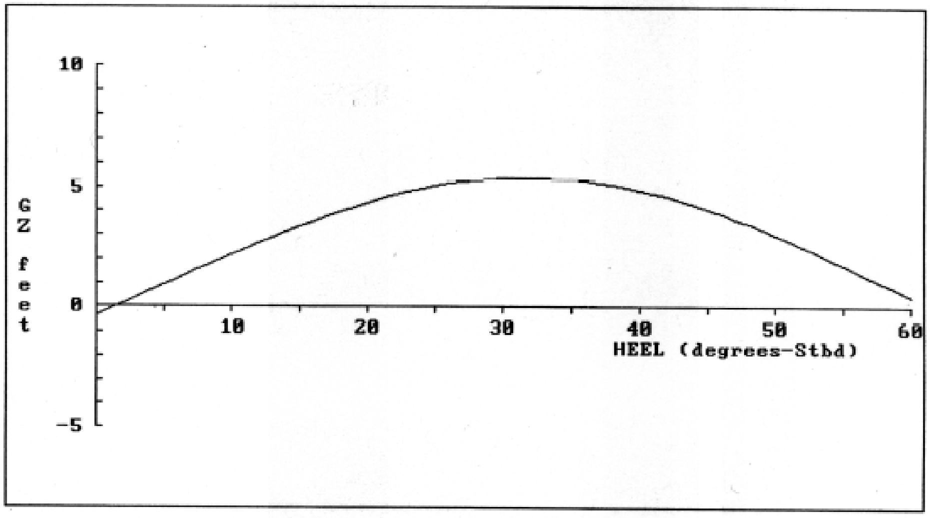
RIGHTING ARM (GZ)




**Stability Evaluation:**

| | | | |
|---|---|---|---|
| Static Heel Angle | 1.5S | deg | |
| Freeboard to Margin Line | 41.86 | ft | 0.00 ft |
| Wind Heel Angle | 1.9S | deg | |
| Angle at Maximum GZ | 31.7S | deg | |
| Maximum GZ | 5.40 | ft | |
| Range of Positive GZ | >58.5 | deg | |
| Gmt (upright damaged) | 15.22 | ft | |

(Based on Direct Calculation from Hull Offsets)

Freeboards are calculated perpendicular to the water surface

## FREE-FLOATING DAMAGED CONDITION

| ITEM | WEIGHT LTons | KG ft-BL | LCG ft-FP | TCG ft-CL | FSmom ft-LTons |
|---|---|---|---|---|---|
| Light Ship | 37,681 | 45.57 | 441.70A | 0.65S | |
| Constant | 0 | 0.00 | 452.50A | 0.00 | 0 |
| RoRo Cargo | 0 | 0.00 | 452.50A | 0.00 | |
| Misc. Weight | 1,032 | 43.27 | 464.10A | 0.00 | 0 |
| Fuel Oil | 368 | 6.78 | 545.50A | 0.02S | 2,965 |
| Diesel Oil | 3,639 | 19.97 | 547.16A | 0.65P | 35,656 |
| Lube Oil | 90 | 47.08 | 837.03A | 45.62S | 77 |
| Fresh Water | 119 | 48.22 | 838.49A | 38.66P | 97 |
| SW Ballast | 3,216 | 14.90 | 644.76A | 6.40P | 9,930 |
| Misc. | 307 | 19.15 | 758.59A | 6.57S | 1,937 |
| TOTALS | 46,452 | 40.92 | 469.22A | 0.07S | 50,662 |

| | | INTACT | AFTER OUTFLOW | AS DAMAGED |
|---|---|---|---|---|
| Draft at F.P. | (ft) | 26.87 | ---- | 49.28 |
| Draft at A.P. | (ft) | 26.52 | ---- | 29.92 |
| Trim | (ft) | 0.35F | ---- | 19.36F |
| Draft at Fwd Marks | (ft) | 26.86 | ---- | 48.85 |
| Draft at Aft Marks | (ft) | 26.53 | ---- | 30.46 |
| Static Heel Angle | (deg) | 0.4S | ---- | 2.5S |
| Total Weight | (LT) | 46,452 | 44,307 | 74,620 |
| KG | (ft) | 40.92 | 42.57 | 33.61 |
| LCG | (ft-FP) | 469.22A | 471.06A | 440.71A |
| TCG | (ft-CL) | 0.07S | 0.44S | 0.63S |
| Buoyancy | (LT) | 46,452 | ---- | 74,620 |
| KB | (ft) | ---- | ---- | 22.06 |
| LCB | (ft-FP) | 470.07A | ---- | 440.47A |
| TCB | (ft-CL) | ---- | ---- | 1.15S |
| KMt | (ft) | 52.96 | ---- | 52.80 |
| FSc | (ft) | 1.09 | ---- | 0.87 |
| GMt | (ft) | 10.95 | ---- | 9.09 |
| Shear Force | (LT) | ---- | ---- | -4,005 |
| Bending Moment | (ft-LT) | ---- | ---- | 448,130H |

AFTER OUTFLOW CONDITION:

Displacement, KG, LCG, TCG include the effects of fluid outflow & flooding without free-communication.

AS DAMAGED CONDITION:

Displacement, KG, LCG, TCG include the effects of the flooded water at the equilibrium trim/heel.

Buoyancy, KB, LCB, TCB are for an intact hull at the equilibrium heel and drafts.

KMt is for the damaged hull at the upright flooded drafts. GMt is the slope of the GZ curve at 0 degrees.

F.S. correction accounts for the free surface of intact tanks and is corrected for outflow.

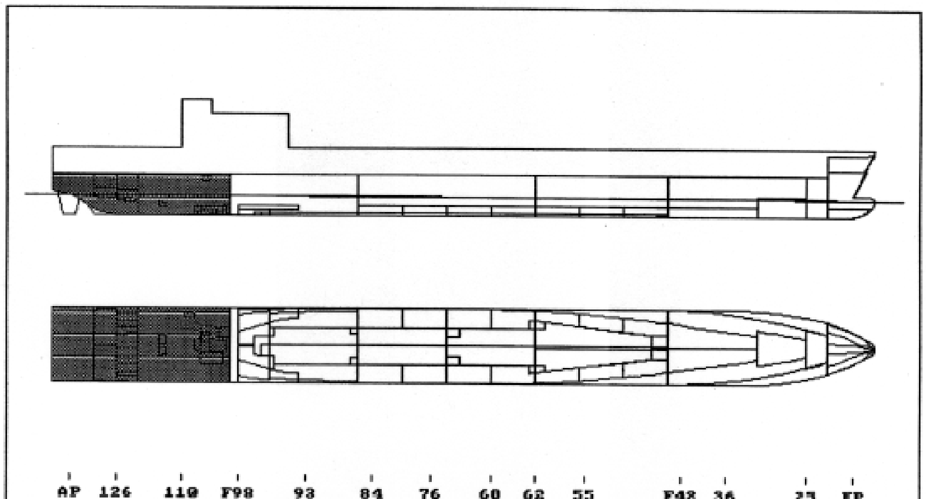
**STILLWATER MOC**
**AFT DAMAGE**

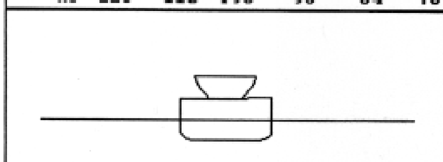
## FREE-FLOATING DAMAGED CONDITION

**Damaged Compartments:**

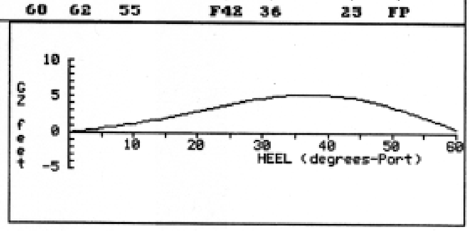
| | | | | | |
|---|---|---|---|---|---|
| MACHY | LODT 8-103-4 | ERMO 8-104-0 | LOSM 8-104-1 | LOSM 8-105-2 | LORG 4-106-2 |
| LORG 4-106-4 | GTWD 8-107-0 | BOLR CASCADE | FPST 7-112-1 | LOPS 7-112-2 | AFT |
| RGS 5-116-11 | DP 6-116-1 | SSDG 5-116-9 | RGSL 5-116-7 | ST 5-116-3 | DTA 6-116-0 |
| ST 5-116-1 | SV 5-116-0 | DP 6-116-4 | POT 5-116-6 | POT 5-116-8 | DIS 5-116-10 |
| GWT 5-126-1 | APF 6-126-1 | APF 6-126-2 | | | |

| | DISPLACEMENT LTons | DRAFT FWD ft | DRAFT AFT ft | TRIM ft | HEEL deg. | UPRIGHT GMt ft |
|---|---|---|---|---|---|---|
| INTACT | 46,452 | 26.87 | 26.52 | 0.35F | 0.4S | 10.95 |
| DAMAGED | 48,621 | 25.86 | 29.25 | 3.39A | 0.6P | 7.09 |



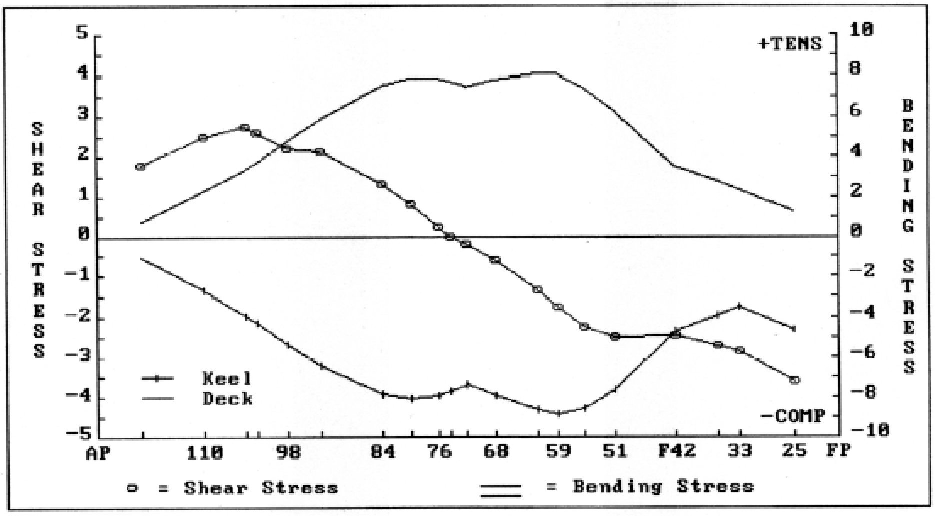



SECTION AMIDSHIPS
(Looking Forward)



## SHEAR & LONGITUDINAL BENDING STRESS SUMMARY
Stresses in ksi

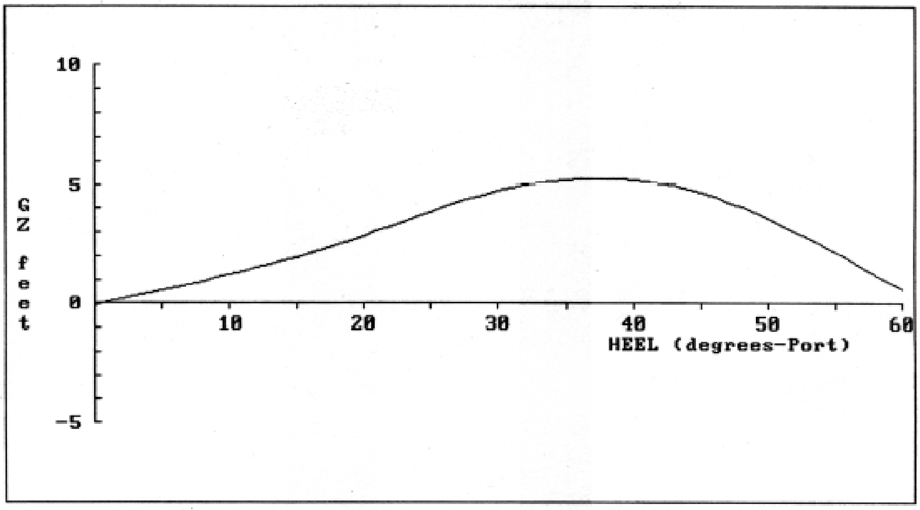
### FAIRED LINES PLAN
(Based on Direct Calculation from Hull Offsets)




| | | SHEAR FORCES | | BENDING MOMENTS | | |
|---|---|---|---|---|---|---|
| | LOCATION | SHEAR | SHEAR STRESS | MOMENT | DK STRESS | KL STRESS |
| No. | ft-FP | LTons | ksi | ft-LTons | ksi | ksi |
| 25 | 55.00A | -1,480 | -3.59 | 50,980H | 1.27 | -4.63 |
| 33 | 121.00A | -2,762 | -2.86 | 193,015H | 2.36 | -3.46 |
| 36 | 148.00A | -3,244 | -2.72 | 274,422H | 2.78 | -3.89 |
| F42 | 199.00A | -3,971 | -2.45 | 459,671H | 3.51 | -4.69 |
| 51 | 274.00A | -3,645 | -2.49 | 755,461H | 6.27 | -7.60 |
| 55 | 310.00A | -3,187 | -2.24 | 879,529H | 7.42 | -8.58 |
| 59 | 343.00A | -2,528 | -1.75 | 974,198H | 8.04 | -8.88 |
| 62 | 367.00A | -2,067 | -1.36 | 1,028,989H | 8.08 | -8.66 |
| 68 | 418.00A | -1,020 | -0.60 | 1,110,839H | 7.81 | -7.96 |
| MS | 452.50A | -376 | -0.21 | 1,132,444H | 7.44 | -7.37 |
| 72 | 454.00A | -355 | -0.20 | 1,132,977H | 7.46 | -7.39 |
| Mx | 473.51A | -0 | -0.00 | 1,136,941H | 7.71 | -7.70 |
| 76 | 487.00A | 413 | 0.24 | 1,134,208H | 7.84 | -7.89 |
| 80 | 520.00A | 1,383 | 0.82 | 1,104,393H | 7.87 | -8.06 |
| 84 | 556.00A | 2,175 | 1.29 | 1,039,943H | 7.51 | -7.86 |
| 93 | 631.00A | 3,595 | 2.12 | 802,709H | 5.87 | -6.43 |
| 98 | 673.00A | 3,779 | 2.20 | 653,060H | 4.76 | -5.36 |
| F98 | 709.00A | 4,510 | 2.59 | 504,137H | 3.67 | -4.23 |
| 104 | 724.00A | 4,519 | 2.75 | 435,120H | 3.34 | -3.88 |
| 110 | 775.00A | 3,301 | 2.49 | 238,163H | 2.25 | -2.68 |
| 126 | 851.00A | 1,511 | 1.78 | 54,389H | 0.78 | -1.01 |

Maximum Shear Stress at 25: -3.59 ksi
Maximum Deck Bending Stress at 62: 8.08 ksi
Maximum Keel Bending Stress at 59: -8.88 ksi

**RIGHTING ARM (GZ)**




**Stability Evaluation:**

| | | |
|---|---|---|
| Static Heel Angle | 0.6P deg | |
| Freeboard to Margin Line | 63.15 ft | 0.00 ft |
| Wind Heel Angle | 2.3P deg | |
| Angle at Maximum GZ | 37.4P deg | |
| Maximum GZ | 5.28 ft | |
| Range of Positive GZ | >59.4 deg | |
| Gmt (upright damaged) | 7.09 ft | |

(Based on Direct Calculation from Hull Offsets)
Freeboards are calculated perpendicular to the water surface

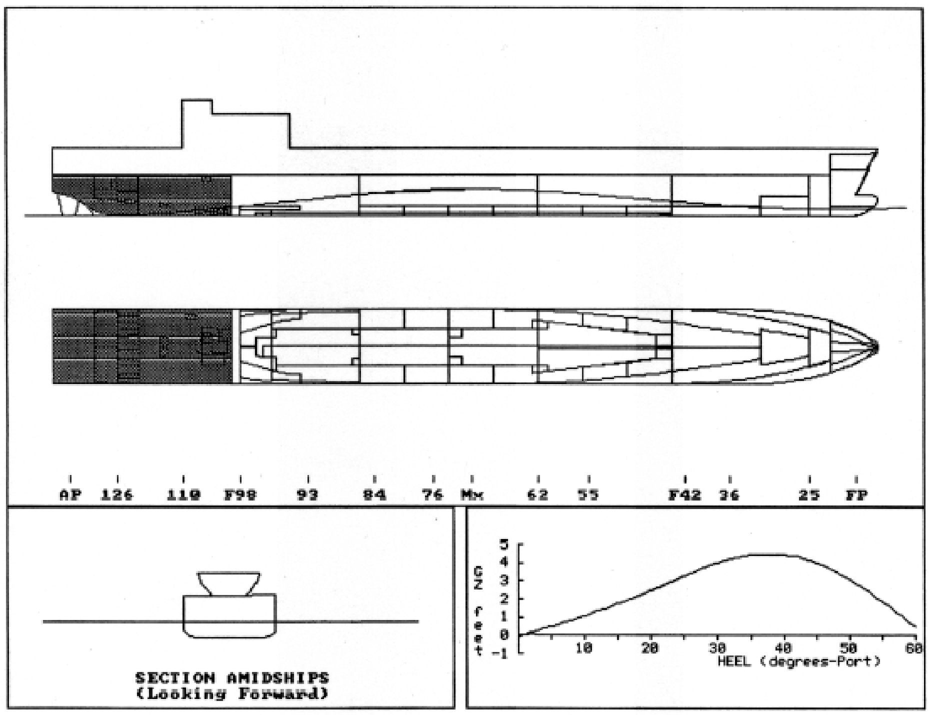
**HOGGING MOC**
**AFT DAMAGE**

## FREE-FLOATING DAMAGED CONDITION

**Damaged Compartments:**

| | | | | | |
|---|---|---|---|---|---|
| MACHY | LODT 8-103-4 | ERWO 8-104-0 | LOSM 8-104-1 | LOSM 8-105-2 | LORG 4-106-2 |
| LORG 4-106-4 | GTWD 8-107-0 | BOLR CASCADE | FPST 7-112-1 | LOPS 7-112-2 | AFT |
| RGS 5-116-11 | DP 6-116-1 | SSDG 5-116-9 | RGSL 5-116-7 | ST 5-116-3 | DTA 6-116-0 |
| ST 5-116-1 | SV 5-116-0 | DP 6-116-4 | POT 5-116-6 | POT 5-116-8 | DIS 5-116-10 |
| GWT 5-126-1 | APF 6-126-1 | APF 6-126-2 | | | |

| | DISPLACEMENT LTons | DRAFT FWD ft | DRAFT AFT ft | TRIM ft | HEEL deg. | UPRIGHT GMt ft |
|---|---|---|---|---|---|---|
| INTACT | 46,452 | 26.87 | 26.52 | 0.35F | 0.4S | 10.95 |
| DAMAGED | 44,178 | 26.96 | 16.73 | 10.23F | 0.7P | 6.44 |

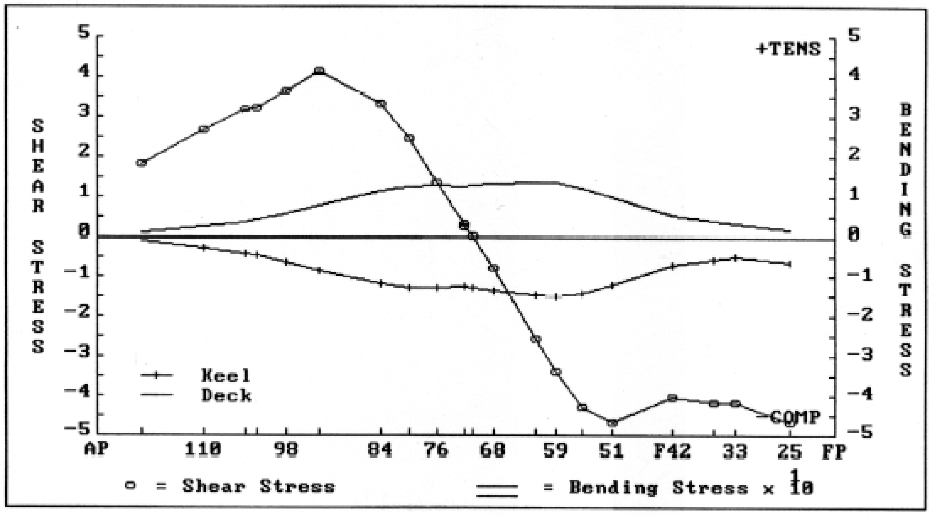


**SHEAR & LONGITUDINAL BENDING STRESS SUMMARY**
Stresses in ksi

**FAIRED LINES PLAN**

Wave Height: 33.09 ft    Wave Position: 452.50A ft-FP
Wave Length: 905.00 ft

(Based on Direct Calculation from Hull Offsets)



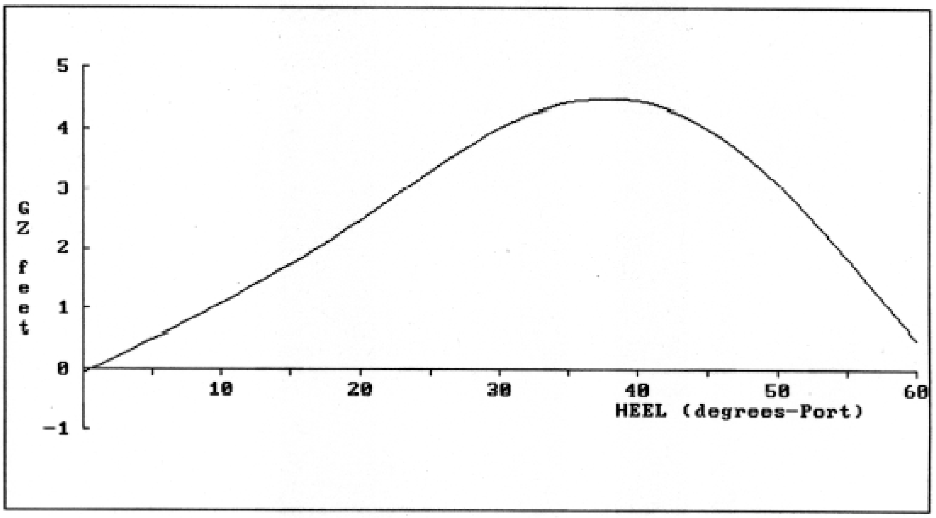
## SHEAR & LONGITUDINAL BENDING STRESS SUMMARY
### Stresses in ksi

### FAIRED LINES PLAN

| | | SHEAR FORCES | | BENDING MOMENTS | | |
|---|---|---|---|---|---|---|
| | LOCATION | SHEAR | SHEAR STRESS | MOMENT | DK STRESS | XL STRESS |
| No. | ft-FP | LTons | ksi | ft-LTons | ksi | ksi |
| 25 | 55.00A | -1,923 | -4.67 | 64,991H | 1.63 | -6.16 |
| 33 | 121.00A | -4,041 | -4.18 | 261,160H | 3.19 | -4.68 |
| 36 | 148.00A | -4,980 | -4.17 | 383,193H | 3.88 | -5.44 |
| F42 | 199.00A | -6,567 | -4.05 | 679,458H | 5.20 | -6.94 |
| 51 | 274.00A | -6,825 | -4.67 | 1,200,427H | 9.97 | -12.10 |
| 55 | 310.00A | -6,113 | -4.30 | 1,436,113H | 12.14 | -14.02 |
| 59 | 343.00A | -4,909 | -3.39 | 1,618,562H | 13.37 | -14.77 |
| 62 | 367.00A | -3,886 | -2.55 | 1,724,052H | 13.55 | -14.53 |
| 68 | 418.00A | -1,319 | -0.78 | 1,862,408H | 13.12 | -13.35 |
| Mx | 442.36A | 2 | 0.00 | 1,876,285H | 12.59 | -12.56 |
| MS | 452.50A | 457 | 0.25 | 1,873,646H | 12.33 | -12.20 |
| 72 | 454.00A | 527 | 0.29 | 1,872,897H | 12.35 | -12.24 |
| 76 | 487.00A | 2,324 | 1.34 | 1,828,928H | 12.66 | -12.74 |
| 80 | 520.00A | 4,165 | 2.46 | 1,720,716H | 12.28 | -12.58 |
| 84 | 556.00A | 5,608 | 3.33 | 1,542,476H | 11.16 | -11.68 |
| 93 | 631.00A | 7,001 | 4.13 | 1,036,064H | 7.58 | -8.31 |
| 98 | 673.00A | 6,229 | 3.62 | 760,985H | 5.56 | -6.26 |
| F98 | 709.00A | 5,600 | 3.22 | 546,892H | 3.99 | -4.60 |
| 104 | 724.00A | 5,191 | 3.16 | 465,855H | 3.58 | -4.16 |
| 110 | 775.00A | 3,528 | 2.66 | 244,115H | 2.31 | -2.75 |
| 126 | 851.00A | 1,528 | 1.80 | 55,218H | 0.80 | -1.03 |

Maximum Shear Stress at 51: -4.67 ksi
Maximum Deck Bending Stress at 62: 13.55 ksi
Maximum Keel Bending Stress at 59: -14.77 ksi

**RIGHTING ARM (GZ)**




**Stability Evaluation:**

| | | |
|---|---|---|
| Static Heel Angle | 0.7P deg | |
| Freeboard to Margin Line | 65.76 ft | 0.00 ft |
| Wind Heel Angle | 2.9P deg | |
| Angle at Maximum GZ | 37.9P deg | |
| Maximum GZ | 4.49 ft | |
| Range of Positive GZ | >59.3 deg | |
| Gmt (upright damaged) | 6.44 ft | |

(Based on Direct Calculation from Hull Offsets)
Freeboards are calculated perpendicular to the water surface

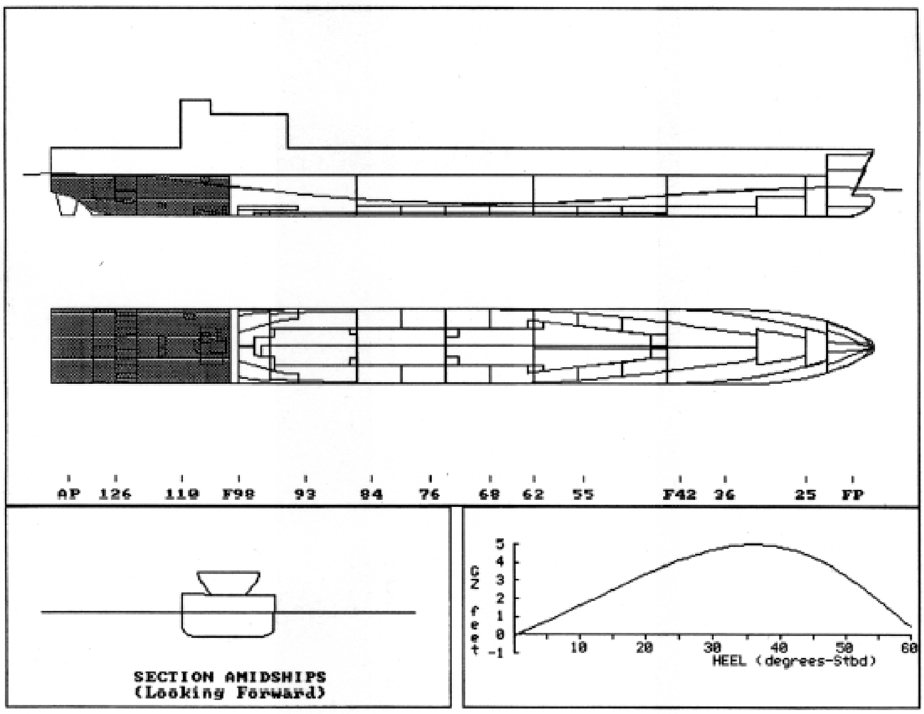
**SAGGING MOC**
**AFT DAMAGE**

FREE-FLOATING DAMAGED CONDITION

Damaged Compartments:

| | | | | | |
|---|---|---|---|---|---|
| MACHY | LODT 8-103-4 | ERWO 8-104-0 | LOSM 8-104-1 | LOSM 8-105-2 | LORG 4-106-2 |
| LORG 4-106-4 | GTWD 8-107-0 | BOLR CASCADE | FPST 7-112-1 | LOPS 7-112-2 | AFT |
| RGS 5-116-11 | DP 6-116-1 | SSDG 5-116-9 | RGSL 5-116-7 | ST 5-116-3 | DTA 6-116-0 |
| ST 5-116-1 | SV 5-116-0 | DP 6-116-4 | POT 5-116-6 | POT 5-116-8 | DIS 5-116-10 |
| GWT 5-126-1 | APF 6-126-1 | APF 6-126-2 | | | |

| | DISPLACEMENT LTons | DRAFT FWD ft | DRAFT AFT ft | TRIM ft | HEEL deg. | UPRIGHT GMt ft |
|---|---|---|---|---|---|---|
| INTACT | 46,452 | 26.87 | 26.52 | 0.35F | 0.4S | 10.95 |
| DAMAGED | 61,850 | 25.96 | 43.73 | 17.77A | 0.3S | 8.88 |

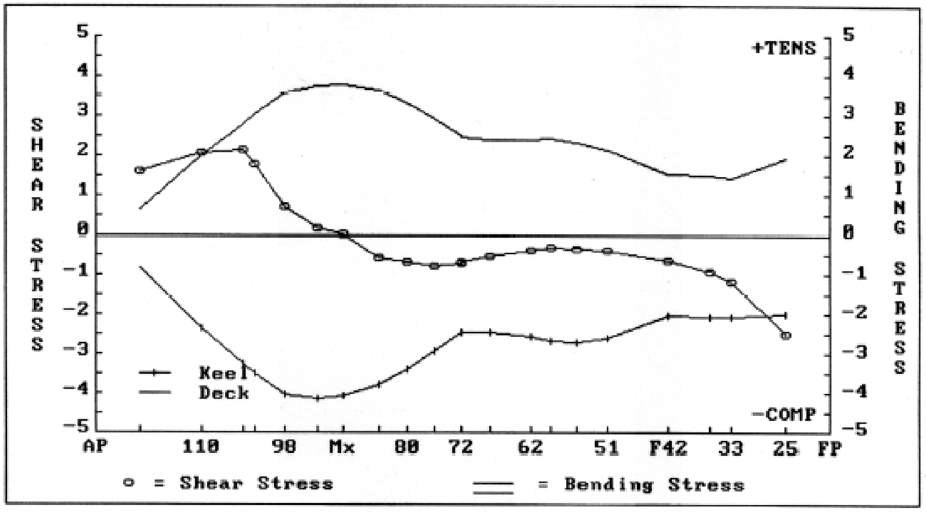


**SHEAR & LONGITUDINAL BENDING STRESS SUMMARY**
**Stresses in ksi**

**FAIRED LINES PLAN**

Wave Height: 33.09 ft  Wave Position: 0.00 ft-FP
Wave Length: 905.00 ft

(Based on Direct Calculation from Hull Offsets)



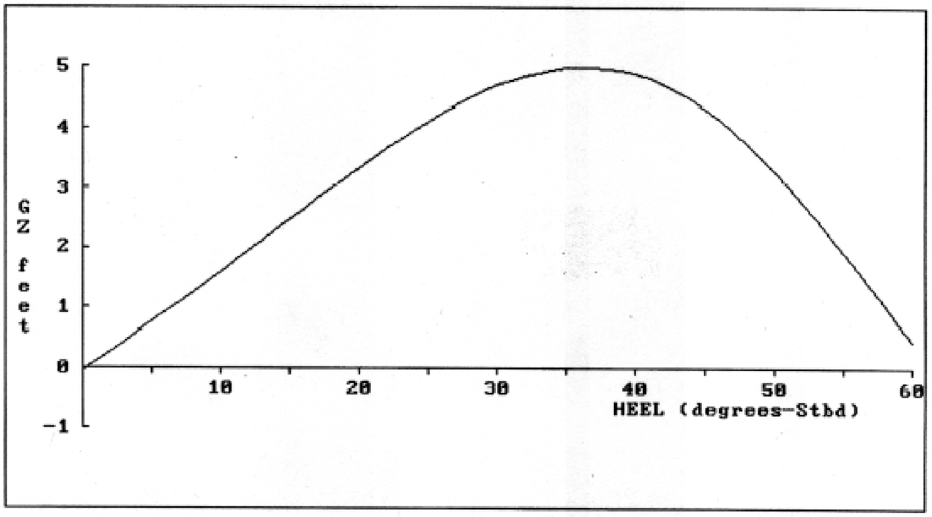
## SHEAR & LONGITUDINAL BENDING STRESS SUMMARY
Stresses in ksi

### FAIRED LINES PLAN

| | | SHEAR FORCES | | BENDING MOMENTS | | |
|---|---|---|---|---|---|---|
| No. | LOCATION ft-FP | SHEAR LTons | SHEAR STRESS ksi | MOMENT ft-LTons | DK STRESS ksi | KL STRESS ksi |
| 25 | 55.00A | -1,033 | -2.51 | 40,637H | 1.93 | -1.99 |
| 33 | 121.00A | -1,127 | -1.17 | 116,379H | 1.41 | -2.07 |
| 36 | 148.00A | -1,079 | -0.90 | 146,435H | 1.47 | -2.07 |
| F42 | 199.00A | -1,025 | -0.63 | 199,572H | 1.51 | -2.03 |
| 51 | 274.00A | -537 | -0.37 | 259,648H | 2.14 | -2.60 |
| 55 | 310.00A | -492 | -0.35 | 277,686H | 2.33 | -2.69 |
| 59 | 343.00A | -449 | -0.31 | 293,529H | 2.41 | -2.66 |
| 62 | 367.00A | -548 | -0.36 | 305,114H | 2.38 | -2.55 |
| 68 | 418.00A | -885 | -0.52 | 343,282H | 2.40 | -2.45 |
| MS | 452.50A | -1,219 | -0.67 | 377,968H | 2.47 | -2.45 |
| 72 | 454.00A | -1,239 | -0.68 | 379,795H | 2.49 | -2.47 |
| 76 | 487.00A | -1,350 | -0.78 | 424,134H | 2.92 | -2.94 |
| 80 | 520.00A | -1,134 | -0.67 | 465,708H | 3.30 | -3.38 |
| 84 | 556.00A | -945 | -0.56 | 503,955H | 3.62 | -3.79 |
| Mx | 599.15A | 6 | 0.00 | 524,928H | 3.80 | -4.08 |
| 93 | 631.00A | 304 | 0.18 | 517,640H | 3.76 | -4.13 |
| 98 | 673.00A | 1,209 | 0.70 | 493,348H | 3.58 | -4.03 |
| F98 | 709.00A | 3,095 | 1.78 | 417,681H | 3.02 | -3.49 |
| 104 | 724.00A | 3,508 | 2.13 | 365,947H | 2.79 | -3.25 |
| 110 | 775.00A | 2,716 | 2.05 | 210,547H | 1.98 | -2.36 |
| 126 | 851.00A | 1,352 | 1.59 | 44,273H | 0.63 | -0.82 |

Maximum Shear Stress at 25: -2.51 ksi
Maximum Deck Bending Stress at Mx: 3.80 ksi
Maximum Keel Bending Stress at 93: -4.13 ksi

**RIGHTING ARM (GZ)**



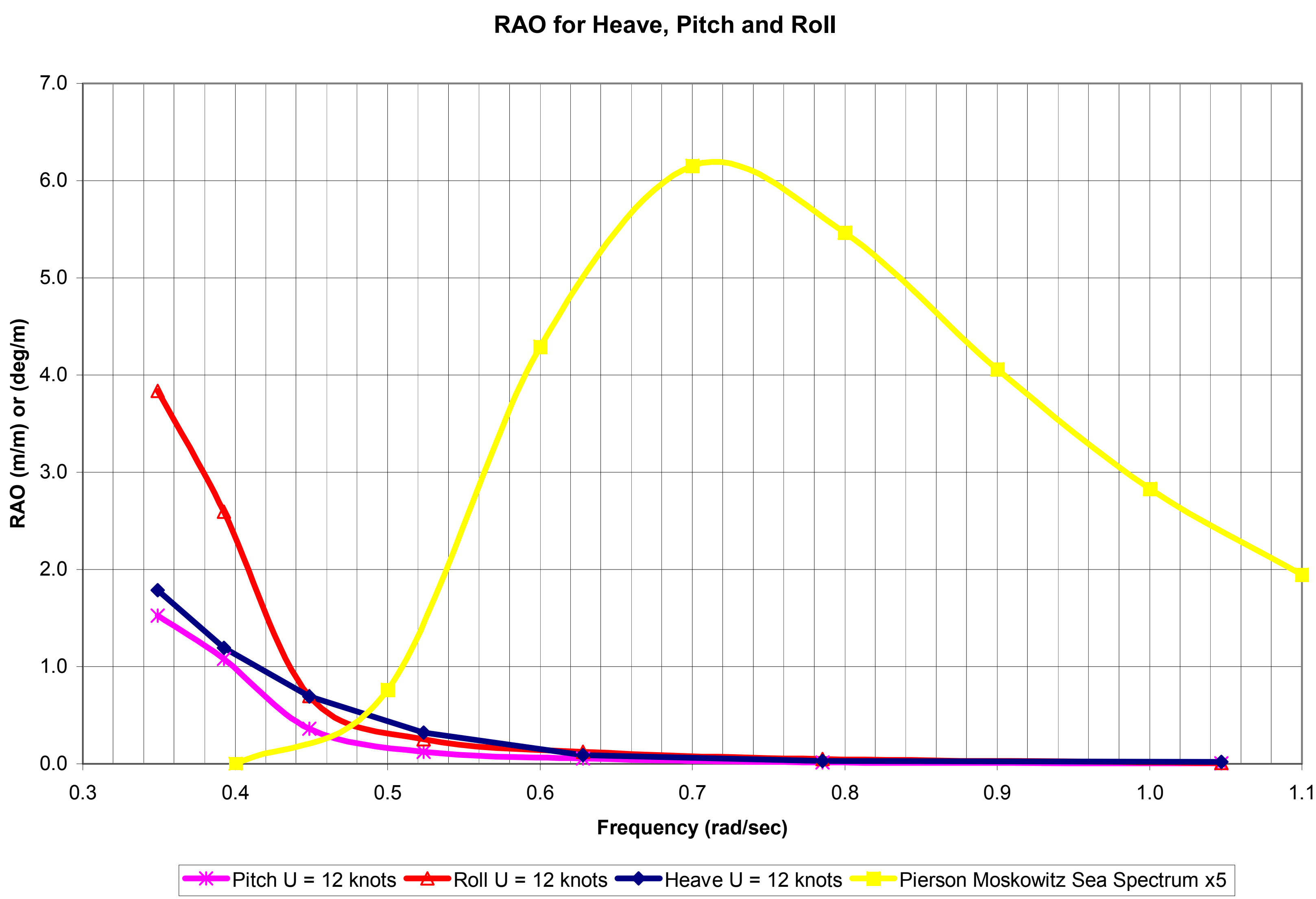

**Stability Evaluation:**

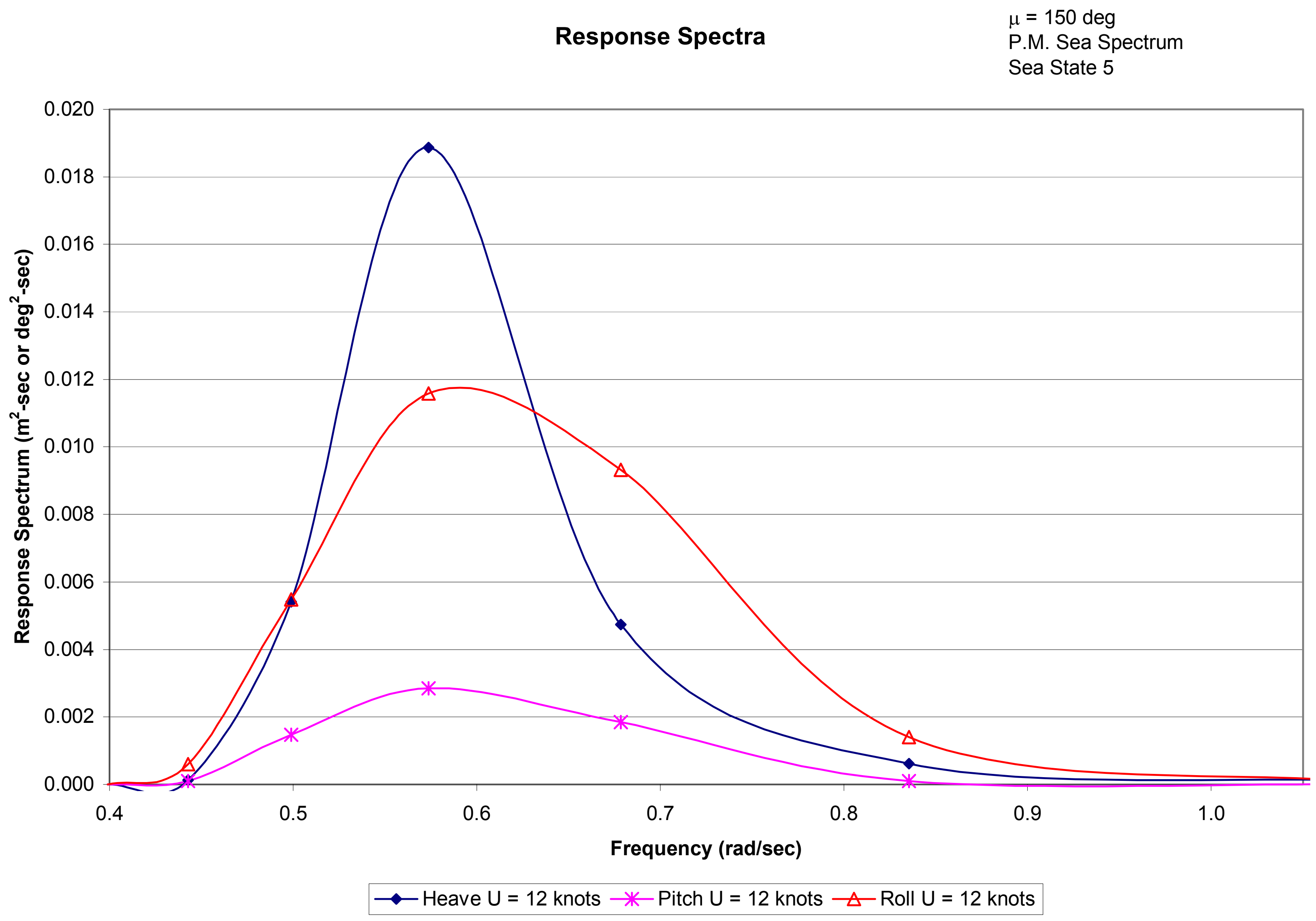
| | | | |
|---|---|---|---|
| Static Heel Angle | 0.3S | deg | |
| Freeboard to Margin Line | 48.59 | ft | 0.00 ft |
| Wind Heel Angle | 1.3S | deg | |
| Angle at Maximum GZ | 36.4S | deg | |
| Maximum GZ | 4.98 | ft | |
| Range of Positive GZ | >59.7 | deg | |
| Gmt (upright damaged) | 8.88 | ft | |

(Based on Direct Calculation from Hull Offsets)
Freeboards are calculated perpendicular to the water surface

# Appendix G
# SWAN Seakeeping Analysis

# 12 KNOTS


RAO for Heave, Pitch and Roll
RAO (m/m) or (deg/m)
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
Frequency (rad/sec)
Pitch U = 12 knots
Roll U = 12 knots
Heave U = 12 knots
Pierson Moskowitz Sea Spectrum x5

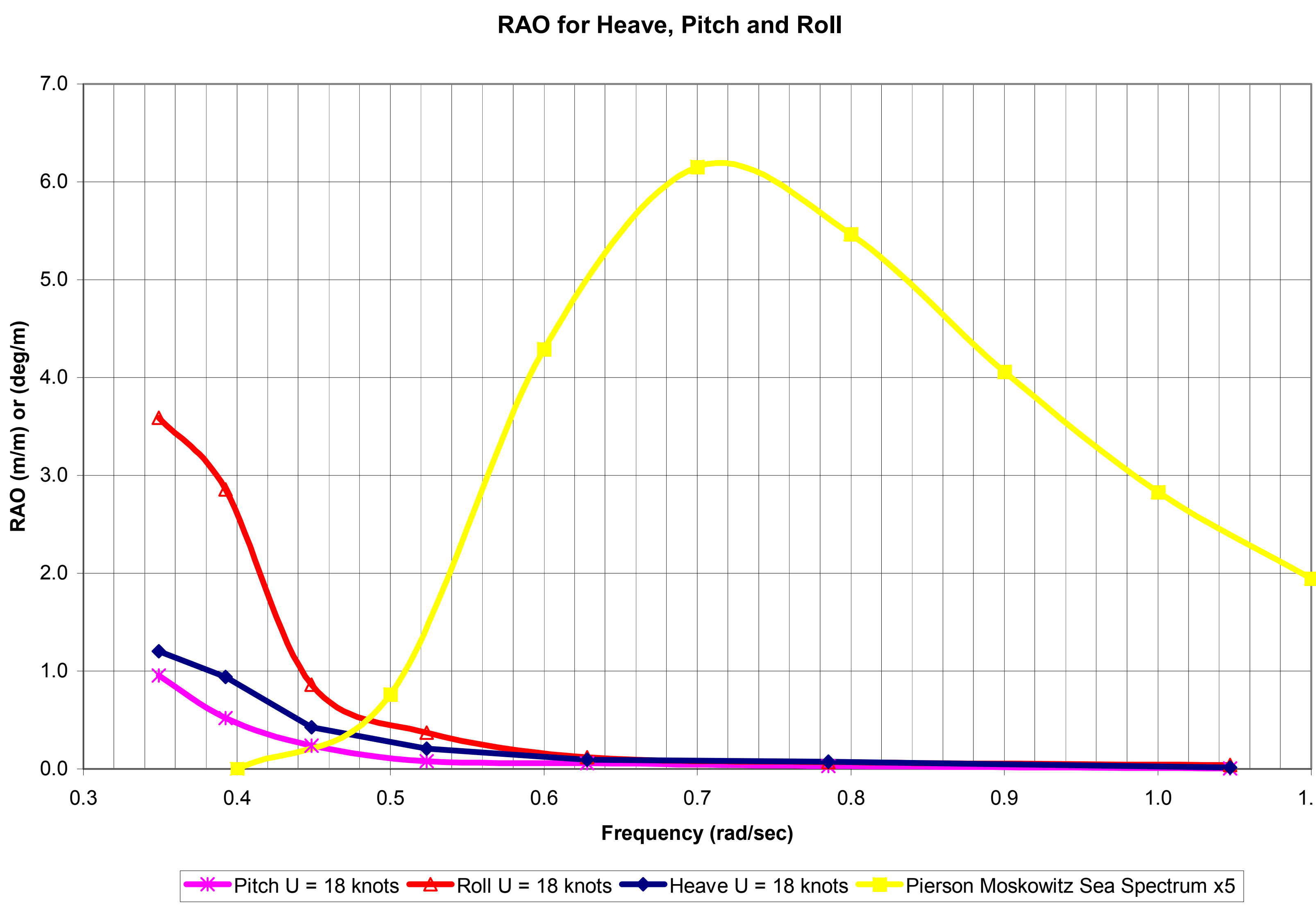

Response Spectra
μ = 150 deg
P.M. Sea Spectrum
Sea State 5
Response Spectrum (m2-sec or deg2-sec)
0.020
0.018
0.016
0.014
0.012
0.010
0.008
0.006
0.004
0.002
0.000
0.4
0.5
0.6
0.7
0.8
0.9
1.0
Frequency (rad/sec)
Heave U = 12 knots
Pitch U = 12 knots
Roll U = 12 knots

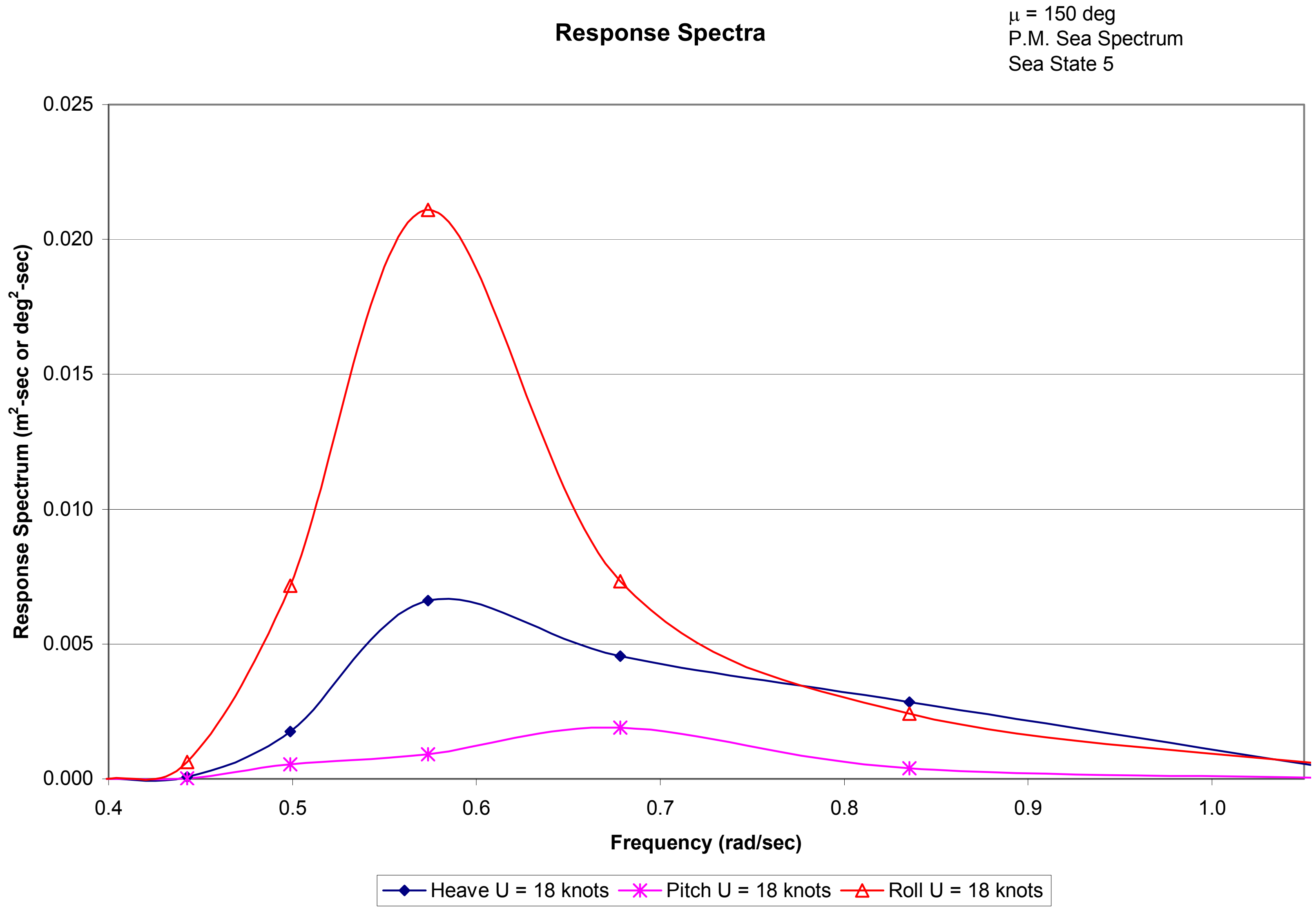
```
**********************************************************
*                                                        *
*                    SWAN2 2002  SOLVE                   *
*                                                        *
*                                                        *
*                     Copyright (C) 2002                 *
*            Massachusetts Institute of Technology       *
*                                                        *
**********************************************************

----------------------------------------------------------
                    GRID INFORMATION
          Name    :    SOF
----------------------------------------------------------
       Sheet#    NP1     NP2      NP       KP      MP
          1       16      58     928        3       0
          2        4      30     120        3       0
          3       21      30     630        2       1
          4       30      30     900        1       0
----------------------------------------------------------

----------------------------------------------------------
            PRINCIPAL HYDROSTATIC PARTICULARS
   density (kg/m^3)= 1025.000  gravity (m/s^2)=   9.800
----------------------------------------------------------
         Waterline Length      (m)  :    2.525E+2
         Waterline Beam        (m)  :    3.224E+1
         Maximum Draft         (m)  :    6.888E+0
         Displacement        (m^3)  :    2.496E+4
         Wetted Surface Area (m^2)  :    7.148E+3
         LCB (from origin)     (m)  :   -1.997E+0
         TCB (from origin)     (m)  :    0.000E+0
         VCB (from origin)     (m)  :   -2.526E+0
----------------------------------------------------------
         Waterplane Area     (m^2)  :    6.070E+3
         LCF (from origin)     (m)  :   -1.333E+1
         Metacentric height    (m)  :    6.865E+0
----------------------------------------------------------
         Mass                 (kg)  :    3.992E+7
         Mass/density        (m^3)  :    3.895E+4
         LCG (from origin)     (m)  :    1.347E+2
         TCG (from origin)     (m)  :    1.545E-1
         VCG (from origin)     (m)  :    2.720E+0
         Radii of Gyration     (m)  :    1.689E+1 (roll)
            (about CG)         (m)  :    8.068E+1 (pitch)
                               (m)  :    2.816E+1 (yaw)
----------------------------------------------------------
```

# 18 KNOTS


RAO for Heave, Pitch and Roll
RAO (m/m) or (deg/m)
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
Frequency (rad/sec)
Pitch U = 18 knots
Roll U = 18 knots
Heave U = 18 knots
Pierson Moskowitz Sea Spectrum x5

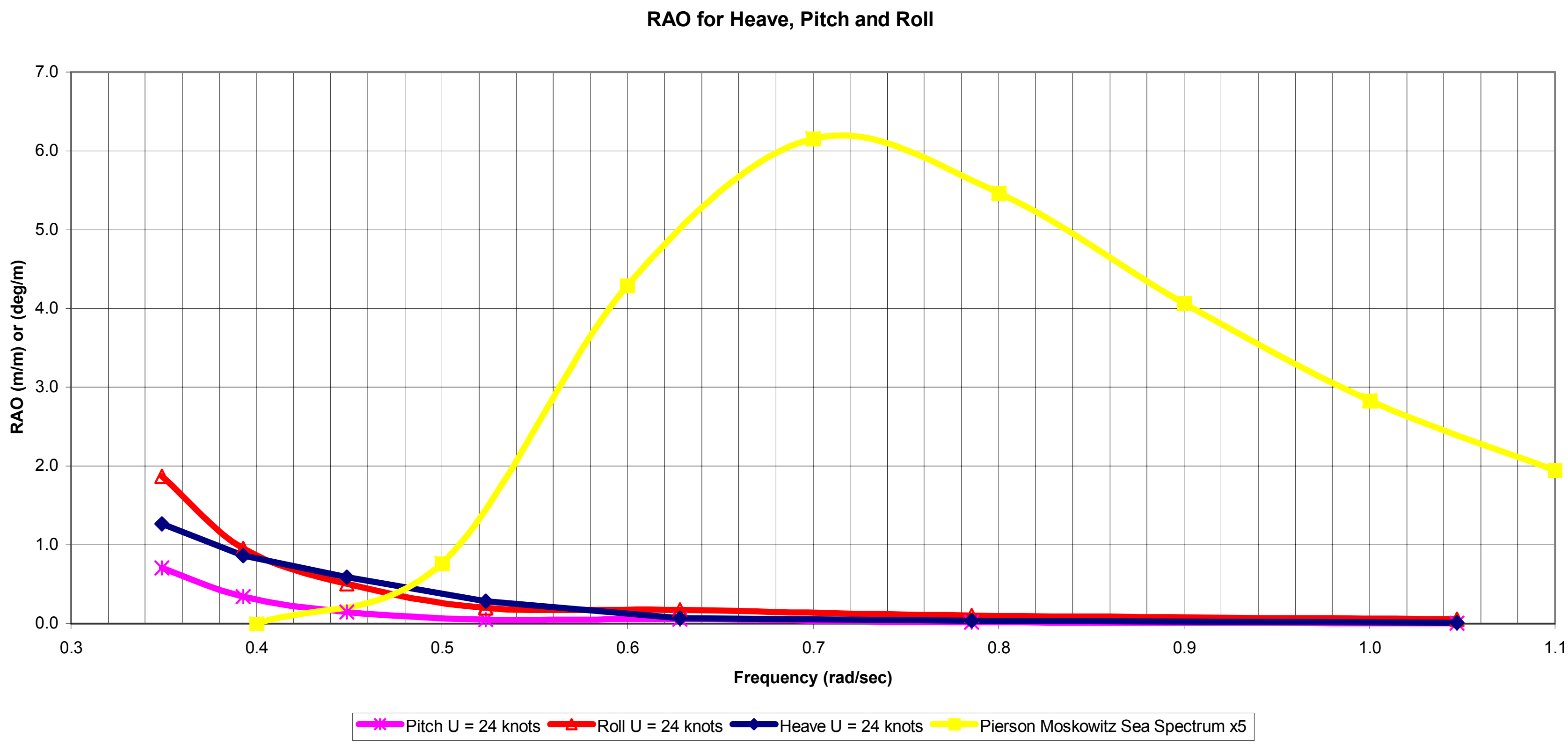

Response Spectra
μ = 150 deg
P.M. Sea Spectrum
Sea State 5
Response Spectrum (m2-sec or deg2-sec)
0.025
0.020
0.015
0.010
0.005
0.000
0.4
0.5
0.6
0.7
0.8
0.9
1.0
Frequency (rad/sec)
Heave U = 18 knots
Pitch U = 18 knots
Roll U = 18 knots

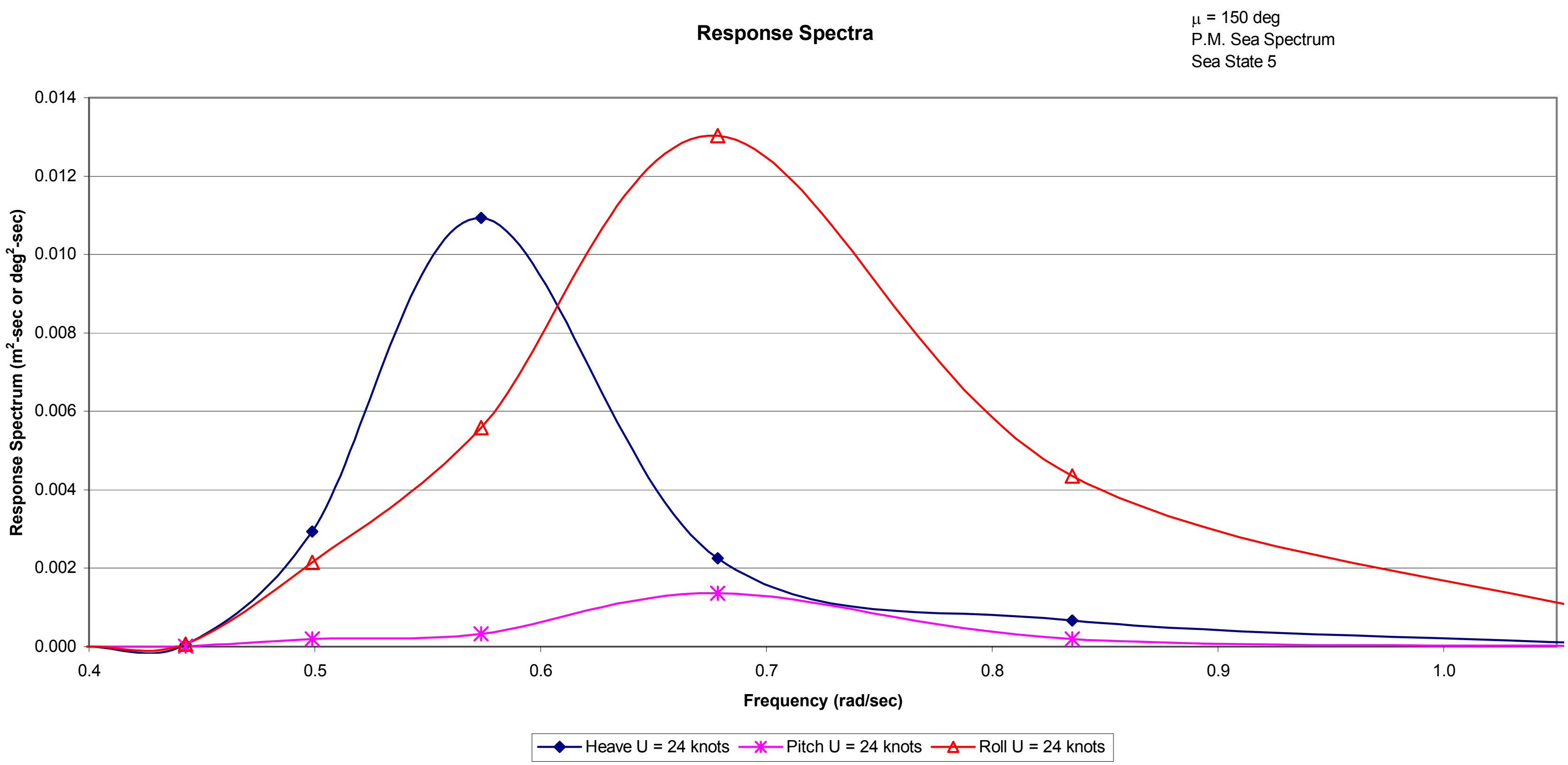
```
*********************************************************
*                                                       *
*                  SWAN2 2002  SOLVE                    *
*                                                       *
*                                                       *
*                   Copyright (C) 2002                  *
*          Massachusetts Institute of Technology        *
*                                                       *
*********************************************************

---------------------------------------------------------
                    GRID INFORMATION
          Name    :    SOF
---------------------------------------------------------
      Sheet#    NP1     NP2      NP     KP      MP
         1       16      58     928      3       0
         2        4      30     120      3       0
         3       21      30     630      2       1
         4       30      30     900      1       0
---------------------------------------------------------

---------------------------------------------------------
          PRINCIPAL HYDROSTATIC PARTICULARS
   density (kg/m^3)= 1025.000  gravity (m/s^2)=   9.800
---------------------------------------------------------
        Waterline Length      (m)  :    2.525E+2
        Waterline Beam        (m)  :    3.224E+1
        Maximum Draft         (m)  :    6.888E+0
        Displacement        (m^3)  :    2.496E+4
        Wetted Surface Area (m^2)  :    7.148E+3
        LCB (from origin)     (m)  :   -1.997E+0
        TCB (from origin)     (m)  :    0.000E+0
        VCB (from origin)     (m)  :   -2.526E+0
---------------------------------------------------------
        Waterplane Area     (m^2)  :    6.070E+3
        LCF (from origin)     (m)  :   -1.333E+1
        Metacentric height    (m)  :    6.865E+0
---------------------------------------------------------
        Mass                 (kg)  :    3.992E+7
        Mass/density        (m^3)  :    3.895E+4
        LCG (from origin)     (m)  :    1.347E+2
        TCG (from origin)     (m)  :    1.545E-1
        VCG (from origin)     (m)  :    2.720E+0
        Radii of Gyration     (m)  :    1.689E+1 (roll)
           (about CG)         (m)  :    8.068E+1 (pitch)
                              (m)  :    2.816E+1 (yaw)
---------------------------------------------------------
```

# 24 KNOTS


RAO for Heave, Pitch and Roll
RAO (m/m) or (deg/m)
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
Frequency (rad/sec)
Pitch U = 24 knots
Roll U = 24 knots
Heave U = 24 knots
Pierson Moskowitz Sea Spectrum x5


μ = 150 deg
P.M. Sea Spectrum
Sea State 5
Response Spectra
Response Spectrum (m2-sec or deg2-sec)
0.014
0.012
0.010
0.008
0.006
0.004
0.002
0.000
0.4
0.5
0.6
0.7
0.8
0.9
1.0
Frequency (rad/sec)
Heave U = 24 knots
Pitch U = 24 knots
Roll U = 24 knots

```
**********************************************************
*                                                        *
*                    SWAN2 2002  SOLVE                   *
*                                                        *
*                                                        *
*                   Copyright (C) 2002                   *
*          Massachusetts Institute of Technology         *
*                                                        *
**********************************************************

----------------------------------------------------------
                    GRID INFORMATION
           Name    :    SOF
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          3       21      30     630      2      1
          4       30      30     900      1      0
----------------------------------------------------------

----------------------------------------------------------
            PRINCIPAL HYDROSTATIC PARTICULARS
   density (kg/m^3)= 1025.000  gravity (m/s^2)=   9.800
----------------------------------------------------------
         Waterline Length      (m)  :    2.525E+2
         Waterline Beam        (m)  :    3.224E+1
         Maximum Draft         (m)  :    6.888E+0
         Displacement        (m^3)  :    2.496E+4
         Wetted Surface Area (m^2)  :    7.148E+3
         LCB (from origin)     (m)  :   -1.997E+0
         TCB (from origin)     (m)  :    0.000E+0
         VCB (from origin)     (m)  :   -2.526E+0
----------------------------------------------------------
         Waterplane Area     (m^2)  :    6.070E+3
         LCF (from origin)     (m)  :   -1.333E+1
         Metacentric height    (m)  :    6.865E+0
----------------------------------------------------------
         Mass                 (kg)  :    3.992E+7
         Mass/density        (m^3)  :    3.895E+4
         LCG (from origin)     (m)  :    1.347E+2
         TCG (from origin)     (m)  :    1.545E-1
         VCG (from origin)     (m)  :    2.720E+0
         Radii of Gyration     (m)  :    1.689E+1 (roll)
            (about CG)         (m)  :    8.068E+1 (pitch)
                               (m)  :    2.816E+1 (yaw)
----------------------------------------------------------
```

# Appendix H
# Cost Models

# COST MODEL--Construction LMSR

MIT 13A

Definitions (units): $Mdol := coul$ $\quad Bdol := 1000 \cdot Mdol$ $\quad Kdol := \frac{Mdol}{1000}$ $\quad dol := \frac{Kdol}{1000}$

$lton := 2240 \cdot lb$

$CNA := 2.2 \quad CND := 0.5$

## 1. Single Digit Weight Summary:

$i1 := 100, 200 .. 700$

Base Weight

$WA_{100} := 25332.18 \cdot lton$ $\quad WA_{400} := 61.06 \cdot lton$ $\quad WA_{700} := 4.15 \cdot lton$

$WA_{200} := 1984.52 \cdot lton$ $\quad WA_{500} := 4074.85 \cdot lton$

$WA_{300} := 668.04 \cdot lton$ $\quad WA_{600} := 1771.71 \cdot lton$

## 2. Additional Characteristics:

Total Weight Added:

$$WAdd := \left( \sum_{i1} WA_{i1} \right) \qquad WAdd = 31911.99 lton$$

Manning: (crew + air detachment + staff) Officers: $N_O := 8$ Enlisted: $N_E := 22$

Officers: CPO's: $N_{C_2} := 0$ Enlisted: $N_{C_3} := N_E - N_{C_2}$

Ship Service Life: $L_S := 30$ Initial Operational Capability: $Y_{IOC} := 2004$

Total Ship Acquisition: $N_S := 1$ Production Rate (per year): $R_P := 1$

## 3. Inflation:

Base Year: $Y_B := 2003$ $\quad iy := 1 .. Y_B - 1998$

Average Inflation Rate (%): (from 1981) $R_I := 3.$

$$F_I := \prod_{iy} \left( 1 + \frac{R_I}{100} \right) \qquad F_I = ▮$$

## 4. Lead Ship Cost:

*Lead Ship Addition Cost - Shipbuilder Portion:*

SWBS costs: includes escalation estimate

Structure

$$K_{N1} := \frac{.55 \cdot Mdol}{lton^{.772}} \qquad CA_{L_{100}} := .03395 \cdot F_I \cdot K_{N1} \cdot 2.2 \cdot \left(WA_{100}\right)^{.772} \qquad CA_{L_{100}} = ▮\ Mdol$$

\+ Propulsion

$$K_{N2} := \frac{1.2 \cdot Mdol}{lton^{.808}} \qquad CA_{L_{200}} := .00186 \cdot F_I \cdot K_{N2} \cdot 2.2 \cdot \left(WA_{200}\right)^{.808} \qquad CA_{L_{200}} = ▮\ Mdol$$

\+ Electric

$$K_{N3} := \frac{1.0 \cdot Mdol}{lton^{.91}} \qquad CA_{L_{300}} := .07505 \cdot F_I \cdot K_{N3} \cdot 2.2 \cdot \left(WA_{300}\right)^{.91} \qquad CA_{L_{300}} = ▮\ Mdol$$

\+ Command, Control, Surveillance

$$K_{N4} := \frac{2.0 \cdot Mdol}{lton^{.617}} \qquad CA_{L_{400}} := .10857 \cdot F_I \cdot K_{N4} \cdot 2.2 \cdot \left(WA_{400}\right)^{.617} \qquad CA_{L_{400}} = ▮\ Mdol$$

(less payload GFM cost)

\+ Auxiliary

$$K_{N5} := \frac{1.5 \cdot Mdol}{lton^{.782}} \qquad CA_{L_{500}} := .09487 \cdot F_I \cdot K_{N5} \cdot 2.2 \cdot \left(WA_{500}\right)^{.782} \qquad CA_{L_{500}} = ▮\ Mdol$$

\+ Outfit

$$K_{N6} := \frac{1.0 \cdot Mdol}{lton^{.784}} \qquad CA_{L_{600}} := .09859 \cdot F_I \cdot K_{N6} \cdot 2.2 \cdot \left(WA_{600}\right)^{.784} \qquad CA_{L_{600}} = ▮\ Mdol$$

\+ Armament

$$K_{N7} := \frac{1.0 \cdot Mdol}{lton^{.987}} \qquad CA_{L_{700}} := .00838 \cdot F_I \cdot K_{N7} \cdot 2.2 \cdot \left(WA_{700}\right)^{.987} \qquad CA_{L_{700}} = ▮\ Mdol$$

(Less payload GFM cost)

\+ Integration/Engineering: (Lead ship includes detail design engineering + plans for class)

$$K_{N8} := \frac{10. \cdot Mdol}{Mdol^{1.099}} \qquad CA_{L_{800}} := .034 \cdot K_{N8} \cdot 0.5 \cdot \left(\left(\sum_{i1} CA_{L_{i1}}\right)\right)^{1.099} \qquad CA_{L_{800}} = ▮\ Mdol$$

\+ Ship Assembly + Support: (Lead ship includes all tooling, jigs, special facilities for class)

$$K_{N9} := \frac{2.0 \cdot Mdol}{(Mdol)^{.839}} \qquad CA_{L_{900}} := .135 \cdot K_{N9} \cdot 0.5 \cdot \left(\left(\sum_{i1} CA_{L_{i1}}\right)\right)^{.839} \qquad CA_{L_{900}} = ▮\ Mdol$$

= Total Cost for addition of all strutures

$$CAtot := \sum_{i1} CA_{L_{i1}} + CA_{L_{800}} + CA_{L_{900}}$$

$$CAtot = ▮\ Mdol$$

= Total Cost for conversion of SOF

$CTOT := CAtot$ $CTOT = ▮ Mdol$

+ Profit:

$F_P := .10$ $C_{LP} := F_P \cdot CTOT$ $C_{LP} = ▮ Mdol$

= Lead Ship Price:

$P_L := CTOT + C_{LP}$ $P_L = ▮ Mdol$

= *Total Shipbuilder Portion:*

$C_{SB} := P_L$ $C_{SB} = ▮ Mdol$

## *b. Lead Ship Cost - Government Portion*

This is where the cost of SOF equipment would go. Zeroed for this evaluation.
**SOF will provide for their own equipment.**

+ Ordnance and Electrical GFE:
(Military Payload GFE)

$C_{LMPG} := 0 \cdot Mdol$

$C_{LMPG} = ▮ Mdol$ (or incl actual cost if known)

+ Outfittimg Cost : $C_{LOUT} := .02 \cdot P_L$ $C_{LOUT} = ▮ Mdol$

= *Total Government Portion:*

$C_{LGOV} := C_{LMPG} + C_{LOUT}$ $C_{LGOV} = ▮ Mdol$

## *c. Total Lead Ship End Cost:* *(Must always be less than appropriation)*

* *Total End Cost:* $C_{LEND} := C_{SB}$ $C_{LEND} = ▮ Mdol$

## d. Total Lead Ship Acquisition Cost:

+ Post-Delivery Cost (PSA): $C_{LPDEL} := .05 \cdot P_L$ $C_{LPDEL} = ▮ Mdol$

= Total Lead Ship Acquisition Cost:

$$C_{LA} := 0.5(C_{LEND} + C_{LPDEL}) + C_{LGOV}$$

$C_{LA} =$ ■ Mdol

## e.Introduction of the correction factor

This factor introduces a correction to the price of a follow on LMSR new construction ship, which is $250 million according to Avondale Industrie's seventh ship contract.
The cost that our math model calculates is $434.292million. (based on a weight break down for Navy Combatants)

= Correction Factor: ε

$$\varepsilon := \frac{250}{434.292}$$

$\varepsilon =$ ■

Total Lead Ship Acquisition Cost (corrected):

$$C_{LAc} := C_{LA} \cdot \varepsilon$$

$C_{LAc} =$ ■ Mdol

# COST MODEL--Construction SOF

MIT 13A

Definitions (units): $Mdol := coul$ $Bdol := 1000 \cdot Mdol$ $Kdol := \frac{Mdol}{1000}$ $dol := \frac{Kdol}{1000}$

$lton := 2240 \cdot lb$

$CNA := 2.2$ $CND := 0.5$

## 1. Single Digit Weight Summary:

$i1 := 100, 200 .. 700$

Base Weight

$WA_{100} := 29114.79 \cdot lton$ $WA_{400} := 137.25 \cdot lton$ $WA_{700} := 42.21 \cdot lton$

$WA_{200} := 1984.52 \cdot lton$ $WA_{500} := 4831.93 \cdot lton$

$WA_{300} := 707.75 \cdot lton$ $WA_{600} := 3078.57 \cdot lton$

## 2. Additional Characteristics:

Total Weight Added:

$WAdd := \left( \sum_{i1} WA_{i1} \right)$ $WAdd = \blacksquare \; lton$

Manning: (crew + air detachment + staff) Officers: $N_O := 8$ Enlisted: $N_E := 22$

Officers: CPO's: $N_{C_2} := 0$ Enlisted: $N_{C_3} := N_E - N_{C_2}$

Ship Service Life: $L_S := 30$ Initial Operational Capability: $Y_{IOC} := 2004$

Total Ship Acquisition: $N_S := 1$ Production Rate (per year): $R_P := 1$

## 3. Inflation:

Base Year: $Y_B := 2003$ $iy := 1 .. Y_B - 1998$

Average Inflation Rate (%): (from 1981) $R_I := 3.$ $F_I := \prod_{iy} \left( 1 + \frac{R_I}{100} \right)$ $F_I = \blacksquare$

## 4. Lead Ship Cost:

*Lead Ship Addition Cost - Shipbuilder Portion:*

SWBS costs: includes escalation estimate

Structure

$$K_{N1} := \frac{.55 \cdot Mdol}{lton^{.772}} \qquad CA_{L_{100}} := .03395 \cdot F_I \cdot K_{N1} \cdot 2.2 \cdot \left(WA_{100}\right)^{.772} \qquad CA_{L_{100}} = \blacksquare\ Mdol$$

\+ Propulsion

$$K_{N2} := \frac{1.2 \cdot Mdol}{lton^{.808}} \qquad CA_{L_{200}} := .00186 \cdot F_I \cdot K_{N2} \cdot 2.2 \cdot \left(WA_{200}\right)^{.808} \qquad CA_{L_{200}} = \blacksquare\ Mdol$$

\+ Electric

$$K_{N3} := \frac{1.0 \cdot Mdol}{lton^{.91}} \qquad CA_{L_{300}} := .07505 \cdot F_I \cdot K_{N3} \cdot 2.2 \cdot \left(WA_{300}\right)^{.91} \qquad CA_{L_{300}} = \blacksquare\ Mdol$$

\+ Command, Control, Surveillance

$$K_{N4} := \frac{2.0 \cdot Mdol}{lton^{.617}} \qquad CA_{L_{400}} := .10857 \cdot F_I \cdot K_{N4} \cdot 2.2 \cdot \left(WA_{400}\right)^{.617} \qquad CA_{L_{400}} = \blacksquare\ Mdol$$

(less payload GFM cost)

\+ Auxiliary

$$K_{N5} := \frac{1.5 \cdot Mdol}{lton^{.782}} \qquad CA_{L_{500}} := .09487 \cdot F_I \cdot K_{N5} \cdot 2.2 \cdot \left(WA_{500}\right)^{.782} \qquad CA_{L_{500}} = \blacksquare\ Mdol$$

\+ Outfit

$$K_{N6} := \frac{1.0 \cdot Mdol}{lton^{.784}} \qquad CA_{L_{600}} := .09859 \cdot F_I \cdot K_{N6} \cdot 2.2 \cdot \left(WA_{600}\right)^{.784} \qquad CA_{L_{600}} = \blacksquare\ Mdol$$

\+ Armament

$$K_{N7} := \frac{1.0 \cdot Mdol}{lton^{.987}} \qquad CA_{L_{700}} := .00838 \cdot F_I \cdot K_{N7} \cdot 2.2 \cdot \left(WA_{700}\right)^{.987} \qquad CA_{L_{700}} = \blacksquare\ Mdol$$

(Less payload GFM cost)

\+ Integration/Engineering: (Lead ship includes detail design engineering + plans for class)

$$K_{N8} := \frac{10. \cdot Mdol}{Mdol^{1.099}} \qquad CA_{L_{800}} := .034 \cdot K_{N8} \cdot 0.5 \cdot \left(\left(\sum_{i1} CA_{L_{i1}}\right)\right)^{1.099} \qquad CA_{L_{800}} = \blacksquare\ Mdol$$

\+ Ship Assembly + Support: (Lead ship includes all tooling, jigs, special facilities for class)

$$K_{N9} := \frac{2.0 \cdot Mdol}{(Mdol)^{.839}} \qquad CA_{L_{900}} := .135 \cdot K_{N9} \cdot 0.5 \cdot \left(\left(\sum_{i1} CA_{L_{i1}}\right)\right)^{.839} \qquad CA_{L_{900}} = \blacksquare\ Mdol$$

= Total Cost for addition of all strutures

$$CAtot := \sum_{i1} CA_{L_{i1}} + CA_{L_{800}} + CA_{L_{900}}$$

$$CAtot = \blacksquare\ Mdol$$

= Total Cost for conversion of SOF

$CTOT := CAtot$ $CTOT = ▮\ Mdol$

+ Profit:

$F_P := .10$ $C_{LP} := F_P \cdot CTOT$ $C_{LP} = ▮\ Mdol$

= Lead Ship Price:

$P_L := CTOT + C_{LP}$ $P_L = ▮\ Mdol$

= *Total Shipbuilder Portion:*

$C_{SB} := P_L$ $C_{SB} = ▮\ Mdol$

## *b. Lead Ship Cost - Government Portion*

This is where the cost of SOF equipment would go. Zeroed for this evaluation.
**SOF will provide for their own equipment.**

+ Ordnance and Electrical GFE:
(Military Payload GFE)

$C_{LMPG} := 0 \cdot Mdol$

$C_{LMPG} = ▮\ Mdol$ (or incl actual cost if known)

+ Outfittimg Cost : $C_{LOUT} := .02 \cdot P_L$ $C_{LOUT} = ▮\ Mdol$

= *Total Government Portion:*

$C_{LGOV} := C_{LMPG} + C_{LOUT}$ $C_{LGOV} = ▮\ Mdol$

## *c. Total Lead Ship End Cost:* *(Must always be less than appropriation)*

* *Total End Cost:* $C_{LEND} := C_{SB}$ $C_{LEND} = ▮\ Mdol$

## d. Total Lead Ship Acquisition Cost:

+ Post-Delivery Cost (PSA): $C_{LPDEL} := .05 \cdot P_L$ $C_{LPDEL} = ▮\ Mdol$

= Total Lead Ship Acquisition Cost:

$$C_{LA} := 0.5\left(C_{LEND} + C_{LPDEL}\right) + C_{LGOV}$$

$C_{LA} = ▮$ Mdol

## e.Introduction of the correction factor

This factor introduces a correction to the price of a follow on LMSR new construction ship, which is $250 million according to Avondale Industrie's seventh ship contract.
The cost that our math model calculates is $434.292million. (based on a weight break down for Navy Combatants)

= Correction Factor: $\varepsilon$

$$\varepsilon := \frac{250}{434.292}$$

$\varepsilon = ▮$

Total Lead Ship Acquisition Cost (corrected):

$$C_{LAc} := C_{LA} \cdot \varepsilon$$

$C_{LAc} = ▮$ Mdol

# COST MODEL--Conversion of LMSR to SOF

MIT 13A

Definitions (units): $Mdol := coul$ $\quad Bdol := 1000 \cdot Mdol$ $\quad Kdol := \frac{Mdol}{1000}$ $\quad dol := \frac{Kdol}{1000}$

$lton := 2240 \cdot lb$

$CNA := 2.2 \quad CND := 0.5$

## 1. Single Digit Weight Summary:

$i1 := 100, 200 .. 700$

**Removed Weight**

$WD_{100} := 607.37 \cdot lton \quad WD_{400} := 0 \cdot lton \quad WD_{700} := 0 \cdot lton$

$WD_{200} := 15.74 \cdot lton \quad WD_{500} := 695.63 \cdot lton$

$WD_{300} := 34.19 \cdot lton \quad WD_{600} := 99.09 \cdot lton$

**Added Weight**

$WA_{100} := 5703.21 \cdot lton \quad WA_{400} := 76.19 \cdot lton \quad WA_{700} := 38.06 \cdot lton$

$WA_{200} := 15.74 \cdot lton \quad WA_{500} := 859.08 \cdot lton$

$WA_{300} := 69.9 \cdot lton \quad WA_{600} := 658.29 \cdot lton$

## 2. Additional Characteristics:

Total Weight Removed:

$$WDel := \left(\sum_{i1} WD_{i1}\right) \qquad WDel = \blacksquare\ lton$$

Total Weight Added:

$$WAdd := \left(\sum_{i1} WA_{i1}\right) \qquad WAdd = \blacksquare\ lton$$

Manning: (crew + air detachment + staff) Officers: $N_O := 8$ Enlisted: $N_E := 22$

Officers: CPO's: $N_{C_2} := 0$ Enlisted: $N_{C_3} := N_E - N_{C_2}$

Ship Service Life: $L_S := 30$ Initial Operational Capability: $Y_{IOC} := 2004$

Total Ship Acquisition: $N_S := 1$ Production Rate (per year): $R_P := 1$

## 3. Inflation:

Base Year: $Y_B := 2003 \quad iy := 1 .. Y_B - 1998$

Average Inflation Rate (%): (from 1981) $R_I := 3.$

$$F_I := \prod_{iy} \left(1 + \frac{R_I}{100}\right) \qquad F_I = \blacksquare$$

# 4. Lead Ship Cost:

*a. Lead Ship Removal Cost - Shipbuilder Portion:*

SWBS costs: includes escalation estimate

Structure

$$K_{N1} := \frac{.55 \cdot Mdol}{lton^{.772}} \qquad CD_{L_{100}} := .03395 \cdot F_I \cdot K_{N1} \cdot 0.5 \cdot \left(WD_{100}\right)^{.772} \qquad CD_{L_{100}} = \blacksquare\ Mdol$$

\+ Propulsion

$$K_{N2} := \frac{1.2 \cdot Mdol}{lton^{.808}} \qquad CD_{L_{200}} := .00186 \cdot F_I \cdot K_{N2} \cdot 0.5 \cdot \left(WD_{200}\right)^{.808} \qquad CD_{L_{200}} = \blacksquare\ Mdol$$

\+ Electric

$$K_{N3} := \frac{1.0 \cdot Mdol}{lton^{.91}} \qquad CD_{L_{300}} := .07505 \cdot F_I \cdot K_{N3} \cdot 0.5 \cdot \left(WD_{300}\right)^{.91} \qquad CD_{L_{300}} = \blacksquare\ Mdol$$

\+ Command, Control, Surveillance

$$K_{N4} := \frac{2.0 \cdot Mdol}{lton^{.617}} \qquad CD_{L_{400}} := .10857 \cdot F_I \cdot K_{N4} \cdot 0.5 \cdot \left(WD_{400}\right)^{.617} \qquad CD_{L_{400}} = \blacksquare\ Mdol$$

(less payload GFM cost)

\+ Auxiliary

$$K_{N5} := \frac{1.5 \cdot Mdol}{lton^{.782}} \qquad CD_{L_{500}} := .09487 \cdot F_I \cdot K_{N5} \cdot 0.5 \cdot \left(WD_{500}\right)^{.782} \qquad CD_{L_{500}} = \blacksquare\ Mdol$$

\+ Outfit

$$K_{N6} := \frac{1.0 \cdot Mdol}{lton^{.784}} \qquad CD_{L_{600}} := .09859 \cdot F_I \cdot K_{N6} \cdot 0.5 \cdot \left(WD_{600}\right)^{.784} \qquad CD_{L_{600}} = \blacksquare\ Mdol$$

\+ Armament

$$K_{N7} := \frac{1.0 \cdot Mdol}{lton^{.987}} \qquad CD_{L_{700}} := .00838 \cdot F_I \cdot K_{N7} \cdot 0.5 \cdot \left(WD_{700}\right)^{.987} \qquad CD_{L_{700}} = \blacksquare\ Mdol$$

(Less payload GFM cost)

\+ Integration/Engineering: (Lead ship includes detail design engineering + plans for class)

$$K_{N8} := \frac{10. \cdot Mdol}{Mdol^{1.099}} \qquad CD_{L_{800}} := .034 \cdot K_{N8} \cdot 0.5 \cdot \left(\left(\sum_{i1} CD_{L_{i1}}\right)\right)^{1.099} \qquad CD_{L_{800}} = \blacksquare\ Mdol$$

\+ Ship Assembly + Support: (Lead ship includes all tooling, jigs, special facilities for class)

$$K_{N9} := \frac{2.0 \cdot Mdol}{(Mdol)^{.839}} \qquad CD_{L_{900}} := .135 \cdot K_{N9} \cdot 0.5 \cdot \left(\left(\sum_{i1} CD_{L_{i1}}\right)\right)^{.839} \qquad CD_{L_{900}} = \blacksquare\ Mdol$$

= Total Cost for removal of all strutures

$$CDtot := \sum_{i1} \left(CD_L\right)_{i1} + CD_{L_{800}} + CD_{L_{900}}$$

$$CDtot = \blacksquare\ Mdol$$

*b. Lead Ship Addition Cost - Shipbuilder Portion:*

SWBS costs: includes escalation estimate

Structure $K_{N1} := \frac{.55 \cdot Mdol}{lton^{.772}}$ $CA_{L_{100}} := .03395 \cdot F_I \cdot K_{N1} \cdot 2.2 \cdot \left(WA_{100}\right)^{.772}$ $CA_{L_{100}} = ▮\ Mdol$

\+ Propulsion $K_{N2} := \frac{1.2 \cdot Mdol}{lton^{.808}}$ $CA_{L_{200}} := .00186 \cdot F_I \cdot K_{N2} \cdot 2.2 \cdot \left(WA_{200}\right)^{.808}$ $CA_{L_{200}} = ▮\ Mdol$

\+ Electric $K_{N3} := \frac{1.0 \cdot Mdol}{lton^{.91}}$ $CA_{L_{300}} := .07505 \cdot F_I \cdot K_{N3} \cdot 2.2 \cdot \left(WA_{300}\right)^{.91}$ $CA_{L_{300}} = ▮\ Mdol$

\+ Command, Control, Surveillance

$K_{N4} := \frac{2.0 \cdot Mdol}{lton^{.617}}$ $CA_{L_{400}} := .10857 \cdot F_I \cdot K_{N4} \cdot 2.2 \cdot \left(WA_{400}\right)^{.617}$ $CA_{L_{400}} = ▮\ Mdol$

(less payload GFM cost)

\+ Auxiliary $K_{N5} := \frac{1.5 \cdot Mdol}{lton^{.782}}$ $CA_{L_{500}} := .09487 \cdot F_I \cdot K_{N5} \cdot 2.2 \cdot \left(WA_{500}\right)^{.782}$ $CA_{L_{500}} = ▮\ Mdol$

\+ Outfit $K_{N6} := \frac{1.0 \cdot Mdol}{lton^{.784}}$ $CA_{L_{600}} := .09859 \cdot F_I \cdot K_{N6} \cdot 2.2 \cdot \left(WA_{600}\right)^{.784}$ $CA_{L_{600}} = ▮\ Mdol$

\+ Armament $K_{N7} := \frac{1.0 \cdot Mdol}{lton^{.987}}$ $CA_{L_{700}} := .00838 \cdot F_I \cdot K_{N7} \cdot 2.2 \cdot \left(WA_{700}\right)^{.987}$ $CA_{L_{700}} = ▮\ Mdol$

(Less payload GFM cost)

\+ Integration/Engineering: (Lead ship includes detail design engineering + plans for class)

$K_{N8} := \frac{10. \cdot Mdol}{Mdol^{1.099}}$ $CA_{L_{800}} := .034 \cdot K_{N8} \cdot 0.5 \cdot \left(\left(\sum_{i1} CA_{L_{i1}}\right)\right)^{1.099}$ $CA_{L_{800}} = ▮\ Mdol$

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= Total Cost for addition of all strutures

$$CAtot := \sum_{i1} CA_{L_{i1}} + CA_{L_{800}} + CA_{L_{900}}$$

$CAtot = ▮\ Mdol$

= Total Cost for conversion of SOF

$CTOT := CDtot + CAtot$ $CTOT = ▮ \; Mdol$

+ Profit:

$F_P := .10$ $C_{LP} := F_P \cdot CTOT$ $C_{LP} = ▮ \; Mdol$

= Lead Ship Price:

$P_L := CTOT + C_{LP}$ $P_L = ▮ \; Mdol$

= *Total Shipbuilder Portion:*

$C_{SB} := P_L$ $C_{SB} = ▮ \; Mdol$

## *b. Lead Ship Cost - Government Portion*

This is where the cost of SOF equipment would go. Zeroed for this evaluation.
**SOF will provide for their own equipment.**

+ Ordnance and Electrical GFE:
(Military Payload GFE)

$C_{LMPG} := 0 \cdot Mdol$

$C_{LMPG} = ▮ \; Mdol$ (or incl actual cost if known)

+ Outfittimg Cost : $C_{LOUT} := .02 \cdot P_L$ $C_{LOUT} = ▮ \; Mdol$

= *Total Government Portion:*

$C_{LGOV} := C_{LMPG} + C_{LOUT}$ $C_{LGOV} = ▮ \; Mdol$

## *c. Total Lead Ship End Cost:* *(Must always be less than appropriation)*

* *Total End Cost:* $C_{LEND} := C_{SB}$ $C_{LEND} = ▮ \; Mdol$

## d. Total Lead Ship Acquisition Cost:

+ Post-Delivery Cost (PSA): $C_{LPDEL} := .05 \cdot P_L$ $C_{LPDEL} = ▮ \; Mdol$

= Total Lead Ship Acquisition Cost:

$$C_{LA} := 0.5(C_{LEND} + C_{LPDEL}) + C_{LGOV}$$

$$C_{LA} = \blacksquare \text{ Mdol}$$

## e.Introduction of the correction factor

This factor introduces a correction to the price of a follow on LMSR new construction ship, which is $250 million according to Avondale Industrie's seventh ship contract.
The cost that our math model calculates is $434.292million. (based on a weight break down for Navy Combatants)

= Correction Factor: $\varepsilon$

$$\varepsilon := \frac{250}{434.292}$$

$$\varepsilon = \blacksquare$$

Total Lead Ship Acquisition Cost (corrected):

$$C_{LAc} := C_{LA} \cdot \varepsilon$$

$$C_{LAc} = \blacksquare \text{ Mdol}$$