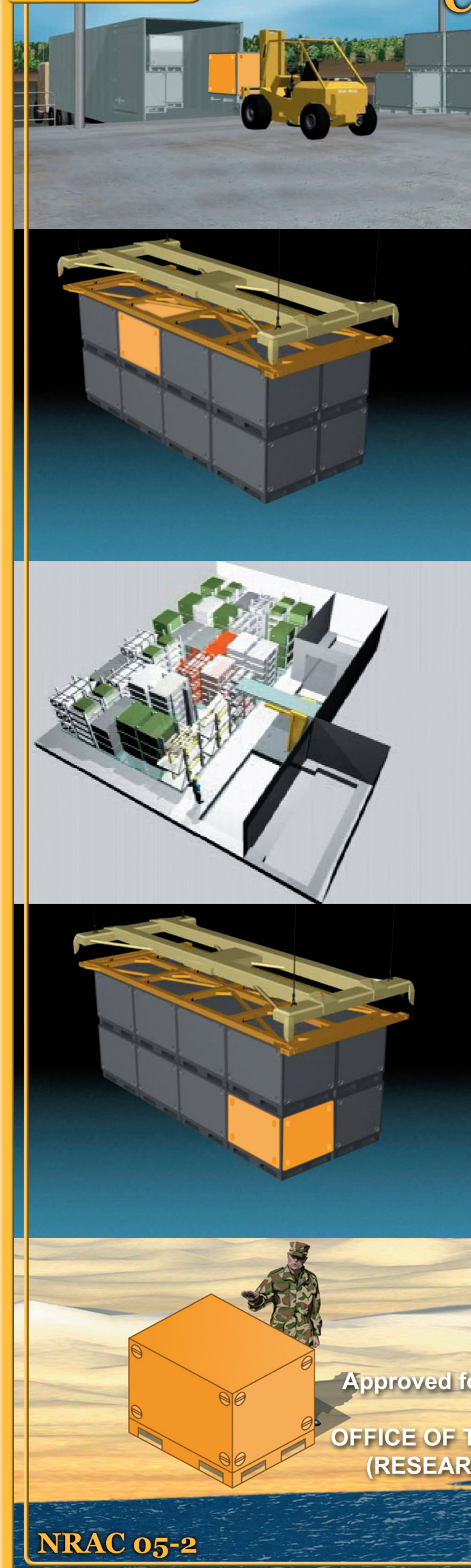
NRAC

Naval Research Advisory Committee Report



Sea Basing

March 2005

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OFFICE OF THE ASSISTANT SECRETARY OF THE NAVY
(RESEARCH, DEVELOPMENT AND ACQUISITION)

NRAC 05-2

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14. ABSTRACT

The Department of Defense conceives the Sea Base as a secure, soverign location that could support and defend the operations of an expeditionary force ashore. If Naval Forces are to establish and operate from a Sea Base, they will need a mix of best commercial practices, intelligently employed legacy vehicles, and new purpose-built systems. This Panel recommends: end-to-end material transport is a Sea Base core, critical function; high-speed surface connectors are a critical Sea Basing enabler; the MPF(F) will be the centerpiece of any Sea Base; and, the Navy should implement a fully operational and affordable interim Sea Basing capability and demonstrator platform.

15. SUBJECT TERMS

Sea Base, Sea Basing, Expeditionary Logistics, MPF(F), High Speed Connectors

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Executive Summary

The Department of Defense (DoD) conceives the Sea Base as a secure, sovereign location, well offshore, which could support and sustain the operations of an expeditionary force ashore. Crucial to the Sea Base, as presently conceived, is its ability to be established in ten days, support the operations of a Marine Expeditionary Brigade (MEB) ashore for thirty days, and recover and reconstitute that expeditionary force within thirty days.

If Naval forces are to establish and operate from a Sea Base, they will need a mix of best commercial practices, intelligently employed legacy vehicles, and new purpose-built systems. Specifically, this Panel finds and recommends that:

- End-to-end material transport will be the Sea Base's critical core function. It will need high throughput and great reliability. We note in particular the importance of rational materiel packaging in standardized containers.

- A high-speed surface connector (HSC)—a vessel that can move troops and materiel between the Sea Base and waters immediately offshore—will prove to be a critical enabler of Sea Basing. The HSC is essential to our ability to establish the Sea Base at a secure stand-off distance. We see no realistic near- or mid-term alternatives to an HSC if the Sea Base is to have the capability of moving heavy materiel—in particular armored combat vehicles—to forces ashore. A properly designed HSC will afford important synergies with the legacy landing craft air cushion (LCAC), which we also regard, for all its limitations, as an indispensable system offering unique heavy-lift capabilities over the beach. The HSC should be capable of loading, carrying, and discharging LCACs that would serve effectively as pallet-trucks. This would permit the Sea Base to retain the LCAC's unique advantages while minimizing its greatest limitation: high fuel consumption.

- The Maritime Prepositioning Force (Future) (MPF(F)) will be the centerpiece of any foreseeable Sea Base. It is not, however, ready to be designed and built. The Panel strongly believes that the MPF(F) should incorporate new connector interfaces that permit high-speed loading and unloading from an automated floating warehouse. The MPF(F) offers great opportunities to exploit best commercial practices.

- In the near-term, the Navy should implement an MPF(F) program, with a fully operational and affordable interim sea basing capability and demonstrator platform. The vessel will provide a cost effective "Spiral 0" platform for spiral development, near term testing and refinement of Sea Basing concepts and operational plans. Equally as important, the vessel provides an essential fully functional interim sea base asset for use in real world contingencies in the shortest timeframe possible with the lowest risk and least cost. An affordable converted vessel available within 18 months is achievable that will closely mimic the range of possible final capabilities and provide a flexible platform for development. The vessel will be able to be dry-docked in the U.S., have necessary port access, incorporate needed advanced ship design and operational technology, and support a strategic U.S. shipbuilding industrial base now. Appendix E discusses this topic in greater detail.

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Outline

- Sea Base Operational Scenario
- Terms of Reference
- Takeaways
- Study Approach
- Observations
- Critical Obstacles
- Solution Concepts
- Conclusions and Recommendations

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Report Outline

The figure above depicts the outline at the briefing as provided to the Assistant Secretary of the Navy (Research, Development and Acquisition) (ASN(RD&A)) during the original study presentation. It is included here for information and correlation with the original brief.

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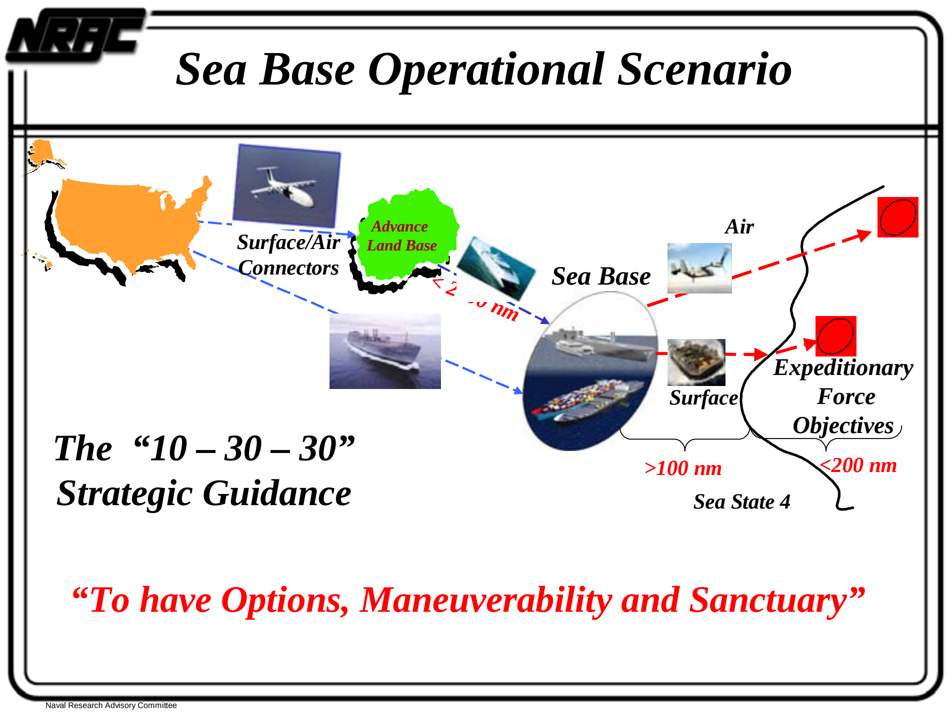


Sea Basing Operational Scenario

The Sea Base is designed to provide the force with options, maneuvering room, and sanctuary while it operates in an area of generally hostile or non-cooperative states. The scenario derives from our most recent experiences in the Middle East, where the ability to project forces relied, often tenuously, on basing and access from neighboring countries that were in some degree reluctant to collaborate with the United States and its allies. The Sea Base provides a means for projecting military power when the United States must go-it-alone with respect to basing combat forces near military objectives, and it forms an essential part of the Secretary of Defense's 10-30-30 strategic guidance: commence military operations in theater 10 days after the order to do so, achieve the military objectives in 30 days, and reconstitute the force in 30 days to be ready to address the next threat.

The scenario begins in peacetime with forces and material present in the continental United States (CONUS), at an Advance Base (principally for maritime preposition equipment), and within deployed Expeditionary Strike Groups (ESGs) that consist of an amphibious group and assigned force-defense Aegis ships and submarines. When the execute order is given, the Sea Base forms from one or more ESGs and a Maritime Prepositioning Group (MPG), consisting of six to eight Maritime Prepositioning Force (Future) (MPF(F)) ships. Each ESG brings an augmented battalion-sized Marine Air Ground Task Force (MAGTF) to the fight, and the MPG brings an additional MEB. When combined as a Sea Base, these ships form the installation from which military operations are launched, sustained, and reconstituted. Consequently, the air and surface connectors to the Sea Base are key elements in enabling it.

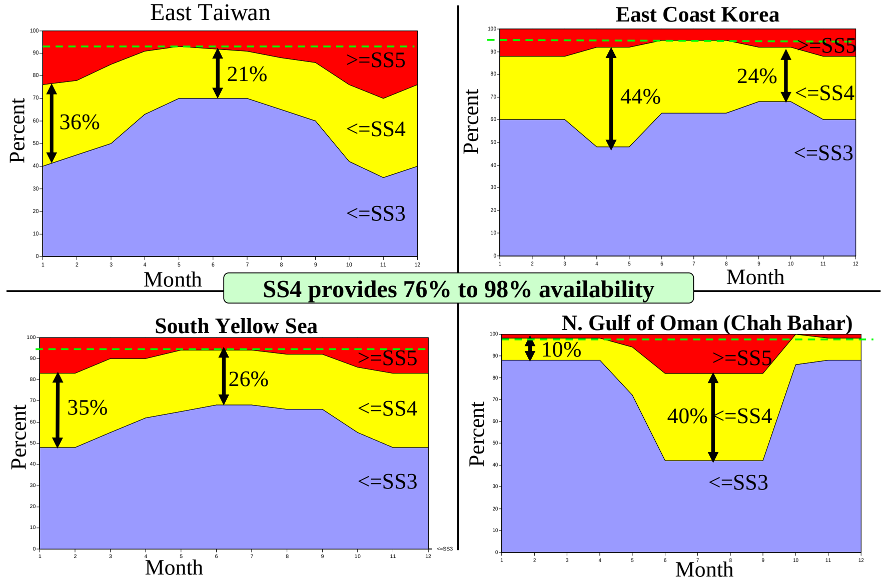
The principal flow of troops and material from CONUS is directed toward the Advance Base and the Sea Base. In some instances, troops and materiel may be dispatched directly to the objectives, but such deployments will be small in both number and total cargo weight. Both air and surface connectors will be used to re-supply the Advance Base. Surface connectors will be used when delivery is from CONUS or the Advance Base to the Sea Base. The movement of troops and materiel from the Sea Base to the objectives ashore will depend on tactical air transport (MV-22, CH-53) and tactical surface HSCs and LCACs.

The figure, on the previous page, depicts the principal entities (CONUS, Advance Base, and Sea Base) as well as the connectors. Connector solutions, both airlift and surface, will be critical to the successful operation of the Sea Base. These are described in terms of inter-theater connectors which are responsible for transporting material and personnel from either CONUS or advanced land bases to the Sea Base, and also intra-theater or tactical assault and sustainment connectors which transport material and personnel from the Sea Base to the objectives ashore. The operational interfaces between these connectors and Sea Base ships, i.e. MPF(F) ships, will also be critical functional elements in effective Sea Base operations. The figure also shows typical expected distances from the Advance Base to the Sea Base and distances from the Sea Base to the shore and from the shore to the military objectives. These distances have been defined as operational capability requirements in the Draft Sea Base CONOPS and in the Defense Science Board (DSB) Study on Sea Basing.

The DSB Study has also suggested a number of minimum conditions under which the Sea Base must operate. These were adopted for the Sea Base Concept of Operations, now in draft. The most challenging of these requirements are:

- Operation through sea state 4
- Operation from a stand-off distance from the shore of 100 NM or more for defense against cruise missiles
- Insertion of two Marine battalions in an 8-hour period of darkness
- Capability to project and sustain forces up to 200 nm inland

Current Navy capability for amphibious operations is sea state 3 and below. The following figure shows that increasing operational capability through sea state 4 substantially increases access to a greater number of potential future operational theaters. However, imposing this requirement imposes a corresponding need to take a new look at both processes and equipment.



In particular, equipment transfers from large logistics ships, both military and commercial, to Sea Base ships in high sea states (for the purpose of this report, "high sea states" is defined as the top at sea state 4 and greater), as well as the subsequent transfer of assault and sustainment material from the Sea Base to the shore objectives, make this high sea state requirement especially difficult to achieve. It is the primary environmental obstacle to the successful implementation of the Sea Base concept.

The Sea Base standoff distance requirement also conflicts with the range limitations of both current airlift and surface tactical connectors. The airlift connectors are limited in payload (up to an absolute maximum of 25,000 pounds for the CH-53E) and in range (absolute maximum no-load range of the CH-53E is 250 NM). Round trip loaded cargo carrying range of the CH53E is more typically on the order of 150 nm and is temperature and altitude dependent. LCAC maximum speed and range are strongly affected by sea state. With a cargo payload of 111,232 lbs and a fuel load of 40,000 lbs, the SLEP LCAC radius (1/2 range) in calm seas is 140 NM at 50 knots. In mid- sea state 4 with the same payload, maximum speed is 18 knots and radius drops to 40 NM. Also, the capability of troops to maintain battle readiness after long transits in LCACs is very problematic. Consequently, the distance and sea state problems are inextricably linked. Clearly the LCACs by themselves are currently not capable of supporting Sea Base standoffs of over 100 nm. Any solution to these problems must address the potential for higher-performance air connectors, primarily in terms of range, as well as addressing means of extending the range of the LCACs or other selected surface connectors. Finally, the constraint for insertion in 8 hours is currently very problematic and not only impacts the performance capabilities of the connectors themselves, but also imposes very high throughput performance requirements on the connector interfaces with the Sea Base MPF(F) ships so that loading and unloading delays are absolutely minimized.

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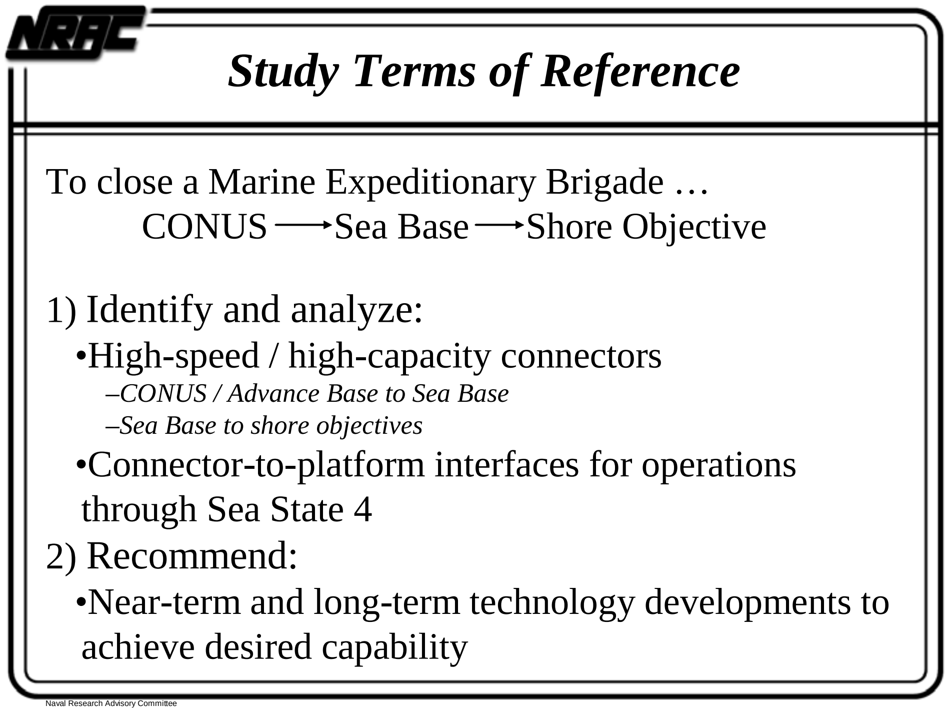

Study Terms of Reference

The above figure summarizes the study terms of reference (TOR). The complete TOR can be found at Appendix B.

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Study Panel and Sponsor

Dr. George Webber—Chair
Prof. William Weldon—Vice-Chair
LtCol Kent Hansen, USMC—Executive Secretary

MajGen (Ret.) Paul Fratarangelo, USMC
Mr. Peter Gale
VADM (Ret.) William Hancock, USN
VADM (Ret.) Douglas Katz, USN
VADM (Ret.) E.R. Kohn, USN

Mr. Norman Polmar
Dr. William Neal, MD
Mr. Robert Ness
RADM (Ret.) John Tozzi, USCG
Dr. Patrick Winston

Study Sponsor : OPNAV N75 MajGen J.R. Battaglini
"What are the critical impacts on MPF(F) design?"

Naval Research Advisory Committee

Study Panel and Sponsor

The Sea Basing Study Panel was able to take advantage of the combined operational experience of retired senior officers from the Marine Corp, the Navy and the Coast Guard together with several leading technology authorities from both industry and academia. The Panel was also fortunate to have Mr. Peter Gale as a member, who was a retired Chief Naval Architect from the Naval Sea Systems Command (NAVSEA). In addition, it was fortunate to have Lt.Col. Kent Hansen from the Office of the Chief of Naval Operations (OPNAV) N75, Expeditionary Warfare Division, as the Panel's Executive Secretary. Through his direct personal experience and knowledge of expeditionary operations, Lt.Col Hansen was a major contributor to the study. Dr. George Webber and Professor Bill Weldon served as the study Panel chairman and vice-chairman, respectively.

The study sponsor was OPNAV N75, Major General Jim Battaglini, USMC, who made the keynote presentation on the Sea Basing concept of operations (CONOPS) at the study kick-off. At that time he indicated that one of his primary interests in the Sea Basing Study was to better understand the critical impacts that connectors would have on the requirements for the MPF(F) ship design.

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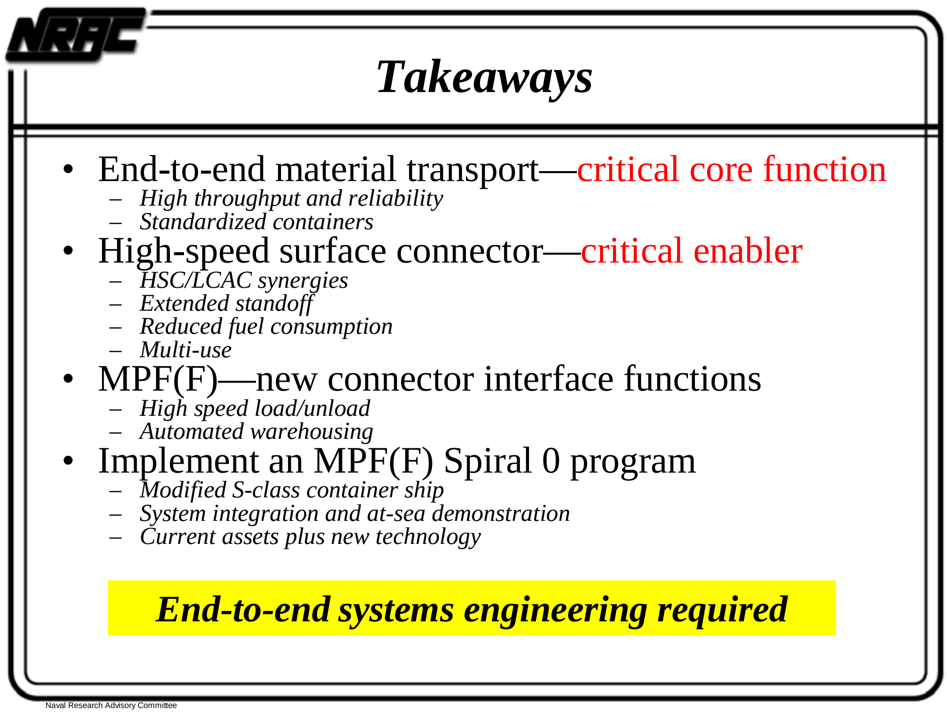

Takeaways

Before presenting the details of the report it is useful to summarize the major "takeaways" or conclusions that were developed as part of this study. The first of these is recognition that the Sea Base connectors are really sub-elements of a larger critical core function being performed by the Sea Base. That function is the "end-to-end" material transport from producer factories in CONUS to the Expeditionary Force users ashore. Connector technologies and implementations need to be analyzed as an integral part of this high throughput and reliable process. As such, connectors must be designed and developed to be compatible with standardized container strategies and with ship-borne automated warehousing and material loading and un-loading techniques. Standardized container strategies should be compatible with existing commercial shipping standards and also should be compatible with existing military transport formats such as the C-130 aircraft. At the "user end" of the process the standardized container should be decomposable into sub-units which are small enough to be transported by either a single individual or a small group of personnel ("multi-man portable"). Such a standardized container strategy has been developed by the Joint Modular Inter-modal Container (JMIC) Working Group.

Because of the limitations on load size and weight capabilities for tactical airlift connector technologies in the forseeable future, particularly with regards to heavy armor; high speed surface connector ships (HSCs) are a critical Sea Basing enabler for both the inter-theater and the intra-theater tactical roles. "Multiple-use" HSC ships could move cargo and troops expeditiously from the advanced base to the Sea Base and from the Sea Base to either improved or un-improved beaches. In their tactical intra-theater role they should be capable of carrying LCAC vehicles. During the course of this study the LCAC was determined to have capabilities for heavy cargo loads, including armor, and over-the-beach operation which will be irreplaceable in the near- to mid-term. Neither conventional landing craft nor existing rotary airlift can do this. The critical limitations in LCAC capability are its high fuel consumption and its large loss of speed in sea state 4. Taken together, the effective LCAC operational radius in sea state 4 is much less than the required 100 NM.

This study develops surface connector solution concepts which exploit the synergies between new HSC ship technology and existing LCAC vehicles. In these concepts, HSCs would perform as large "flat-bed" trucks and would be capable of carrying at least three LCACs. These LCACs could be either pre-loaded or rapidly loaded aboard the MPF(F) ship. The loaded LCACs would power away from the MPF(F) ship and be taken aboard a nearby HSC for transport at high speed to an area near the planned shore insertion point. The LCACs would then disembark from the HSC and proceed up and over the beach. The synergies between the HSC and LCAC connectors offer many advantages including the following:

- allow the Sea Base to stand-off at greater ranges
- substantially decrease the overall amount of fuel used by surface connectors
- increase effective surface connector range
- provide potential for operation through sea state 4 conditions
- maintain capabilities for carrying heavy equipment loads (i.e. heavy armor) over the beach.

The study proposes a multi-use HSC, i.e. that a common design be used for HSCs to full three shuttle roles: between an advanced base and the sea base, between the sea base and an unimproved beach (carrying loaded LCACs), and between the sea base and a beach improved by a causeway or pier or sheltered harbor. A common HSC design could produce significant cost savings due to series production.

As a third "takeaway" the study recognizes that the future MPF(F) ships must be designed to accommodate automated material handling, high-throughput selective loading and new connector loading interfaces particularly as regards the rapid loading of surface connectors for Sea Base-to-shore operations. Commercial systems already used by Federal Express and by Wal-Mart could be leveraged as models for use in MPF(F) ship development. Coupled with a computerized tracking and load ordering program, automated warehousing would expedite material handling for both surface and airlift connectors.

Candidate solution concepts developed in this study for high-throughput loading of LCAC surface connectors have suggested the incorporation of "transverse tunnel" dry wells with internal overhead gantry craning for rapidly loading and unloading LCACs. In this concept, pre-loaded pallets would be lowered onto the LCAC vehicle while inside the "transverse tunnel" dry well. This would virtually eliminate all problems associated with sea state induced relative motions between the MPF(F) and the LCAC. A second interface concept worthy of consideration is a stern elevator like that used in commercial SEABEE Class ships. An empty LCAC could be raised on the elevator to align with a cargo deck on the MPF(F) and then be loaded by RO/RO or crane. Another possibility is the use of an Intermediate Transfer Platform (ITP). LCACs could "fly" onto the ITP and then be loaded by RO/RO or crane with cargo previously off-loaded from the MPF(F) ship by crane or RO/RO via a stern ramp.

The MPF(F) should also have appropriate airlift interfaces including pallet lifting elevators to the flight deck and pallet movement mechanizations similar to those used by commercial carriers, i.e. FEDEX Also the MPF(F) ship design should include adequate numbers of flight deck loading spots for aircraft so that aircraft queuing delays are eliminated.. All four interface concepts, - - - "transverse tunnel" dry well, stern elevator/ramp, and airlift interfaces should be prototyped and evaluated as part of feasibility demonstrations.

Finally, the study concludes that an MPF(F) "Spiral 0" demonstration program should be undertaken to demonstrate the feasibility and integration of critical functions including connector interfaces and automated material handling systems as part of refining overall operational requirements. Maersk, Ltd., has already designed, under a DoD contract issued through Maritime Sealift Command, a modified version of their S-Class container ship suitable for use as an Afloat Forward Staging Base (AFSB). The Panel believes this ship could be used for MPF(F) "Spiral 0" demonstration and development. It would afford a near term, relatively low cost ($300M) platform for systems integration and at-sea demonstration. The Navy could demonstrate the "transverse tunnel" dry well, automated warehousing, modular spaces, and both JSF and rotary aircraft deck loading and stowage capabilities. In addition to performing as an MPF(F) "Spiral 0" development and demonstration platform, this ship, which would include huge flight deck and hangar facilities, could also be used operationally. Using a converted S-Class ship would capitalize on both current assets and new technology to achieve the operational goals envisioned for Sea Basing.

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Study Approach

- Draw from stakeholders and guidance
- Frame the connector problem
  - –*Critical functions*
  - –*Modeling and simulation (MCCDC)*
  - –*Obstacles*
- Review technology and practice
- Develop solutions

Assumptions: Sea Shield provides force protection
FORCEnet provides communications

Naval Research Advisory Committee

Study Approach

The Sea Basing Study was initiated in April of 2004. Based upon the Study Terms of Reference the approach taken was to conduct fact-finding with principal stake-holders including the sponsor organization OPNAV N75 to develop background information relating to Sea Base operations and connector issues. The study also utilized available guidance documents including the drafts of the Sea Base and Logistics CONOPS, the Defense Science Board's 2003 Study on Sea Basing the Naval Ship-to-Objective Maneuver (STOM) CONOPS and the MPF(Future) Ship Assessment of Alternatives (AOA).

In framing the connector problem it was necessary for the Panel to develop an understanding of the critical functions and capabilities required of the connectors and particularly the flow rates of materials and personnel that would need to be supported. In developing this understanding, the Panel relied heavily on flow rate modeling of the 2015 Marine Expeditionary Brigade (MEB) Ship-to-Objective Maneuver (STOM) analysis which had been done in the context of the MPF(F) AOA ship definitions by the Marine Corps Combat Development Center (MCCDC). This analysis and related analyses done by MCCDC helped to define performance trade-offs and identify critical issues associated with both airlift connector and surface connector implementations.

The study also reviewed both existing and emerging technologies and practices that were applicable to the Sea Base connector problem including commercial technologies and practices. Finally, solutions concepts for near-term Sea Base connector implementations were developed and longer range areas for technology investment were identified and recommended.

This study did not attempt to address issues of self-defense as regards the Sea Base connectors. The Panel felt that this would be worthy of a major separate study in itself and was beyond the scope of the current connector study. It was assumed that Sea Shield would provide force protection for the Sea Base including the connector platforms. Similarly it was quickly recognized that a very reliable communications and data network capability would be mandatory to enable the Sea Base material ordering and delivery operations as part of an integrated logistics command and control capability. Again this study made the assumption that such a reliable data network communications infrastructure would be available as part of the Naval FORCEnet capability.

Briefings and Visits

- OPNAV: N75, N42
- Marine Corps: HQMC, MCCDC
- ONR: CNR, EXLOG FNC
- Fleet Visits: FFC, Ship tours
- System Commands: PMS 325, NAVSEA 05D, NAVAIR
- Other Government: CNA, Army, DARPA
- Industry: Bell/Textron, Sikorsky, Maersk, Lockheed, UMOE, FEDEX, Navatek

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Briefings and Visits

The Sea Base Connector Study drew heavily on fact-finding from principal stakeholders associated with future Sea Base planning and operations. In the course of the study the Panel gathered information from briefings and visits. A complete list of organizations and commercial industry groups is located in Appendix D.

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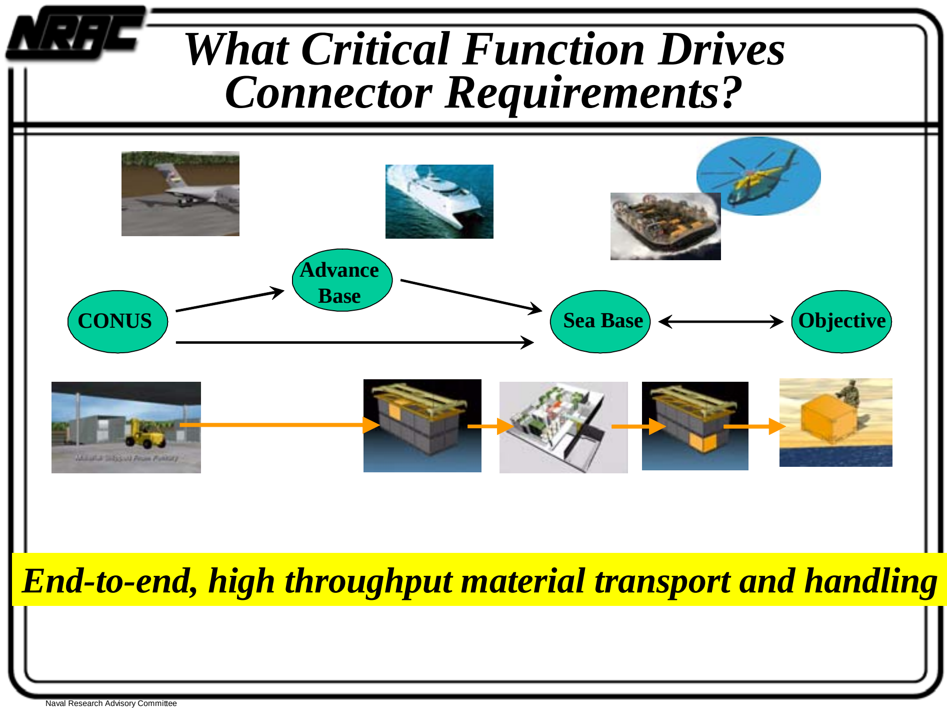
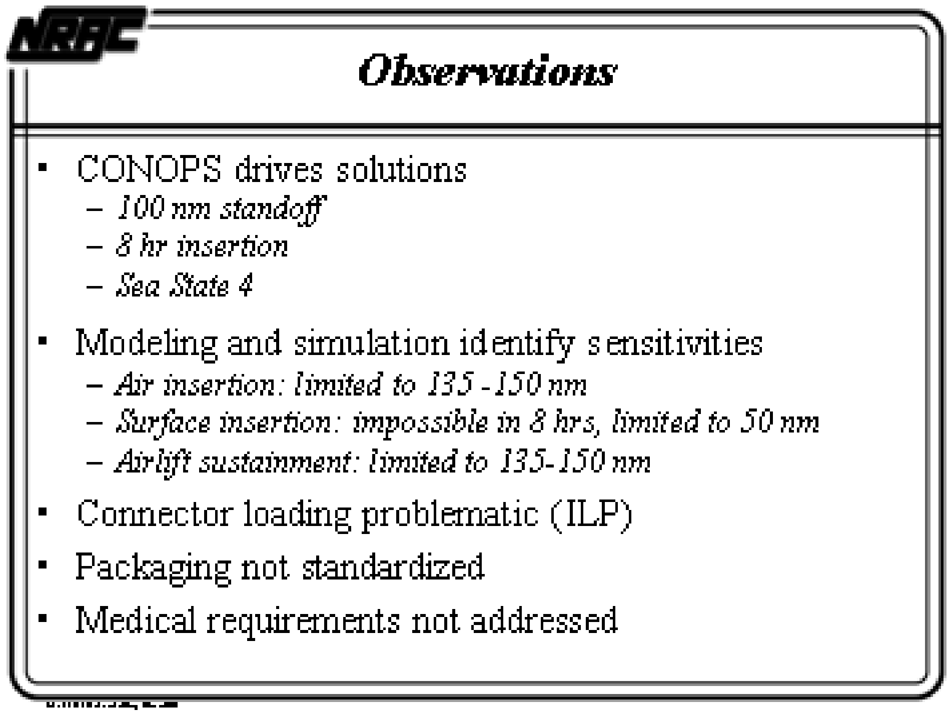


What Critical Function Drives Connector Requirements?

One of the primary purposes of the Sea Base is to provide facilities for a critical logistics distribution and management node to service the end-to-end transport and selective handling of materials from CONUS and Advance Bases through the Sea Base to the shore objectives. Similarly it serves as the critical node for reconstitution of materials when they are returned from the objective areas ashore. The Sea Base connectors form an essential link in this end-to-end material transport process and as such, their reliability and throughput capabilities, under all operational conditions, is essential to the success of the Sea Basing mission. In fact the MPF(F) ship configuration definition cannot really be completed until connector operating concepts and high throughput connector interface concepts for loading/unloading and on-board material handling are developed and demonstrated to be feasible.

One of the most important elements necessary to enable a high throughput material transport and handling process is the development of a standard container strategy. Such a strategy must include concepts which build upon the use of standard “first-level” containers which can be connected together to form larger units as may be required for larger material items. Multiple individual containers can then be assembled together into larger unit “frames” which are International Organization for Standardization (ISO) compliant so that they can be handled by normal commercial carriers such as container ships, and air freight carriers as well as the Air Force supply chain. At the lowest level, individual standard container units should be designed for handling by single individuals or by multi-man teams at the objective area. During the course of this study it was found that the JMIC Working Group has already developed initial specifications for a standard container strategy which appears to meet these requirements.

In addition to utilizing a standard container strategy, the MPF(F) ships involved in the Sea Base must include automated warehousing and selective load configuration capabilities in order to support the requirements for high throughput, end-to-end material handling. High throughput loading and unloading of connectors, both to and from the MPF(F) ships must also be achieved even in high sea state operating conditions. The Panel reviewed numerous concepts and technologies for transferring material from supply ships to the MPF(F) ships (i.e. big ship-to-big ship) as well as from the MPF(F) ship to tactical connectors (i.e. big ship-to-little ship). The latter of these is by far the tougher problem because of the relative ship motion particularly in high sea state conditions.



Observations

The Sea Basing CONOPS drives the selection of certain technology options over others. The Study Panel found the three most stressing aspects of the CONOPS to be:

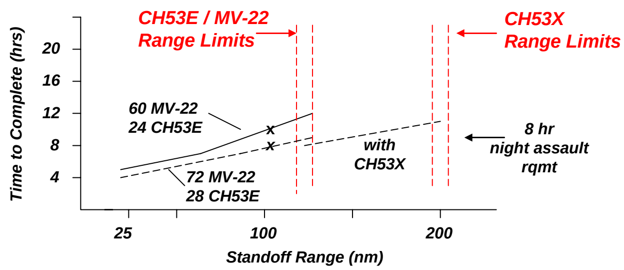
- The requirement for 100 nm stand-off from the Sea Base
- Sea Base operations through sea state 4 conditions (particularly for transfer of cargo between the Sea Base and the tactical surface connectors)
- The requirement from the 2015 MEB STOM for insertion of two Marine battalions in one period of darkness (8 hrs)

For example, the combination of 100 nm stand-off and sea state 4 operation is extremely stressing for the tactical surface connectors in that it limits the number of sorties per connector and therefore extends the time required to complete the transfer. Connector loading and unloading times as well as available facilities for loading surface connectors from the MPF(F) ships further aggravates this problem. Similarly, the planned STOM force insertions within eight hours limits airlift insertions to ranges considerably less than the desired 200 nm inland.

In order to understand the material flow rates which must be supported by the Sea Base connectors and to determine sensitivities which could limit those flow rates, the Panel relied heavily on the 2015 MEB STOM modeling results which were done by MCCDC using a Sea Base configuration made up of an ESG ship complement and a four ship MPF(F) complement based upon the MPF(F) AOA ship configurations including an (ILP) for interfacing with LCAC connectors.

In the modeling results, when airlift-only insertion of two Marine battalions was modeled using CH53E Service Life Extension Program (SLEP) and MV22s, the planned force insertion could be successfully completed within the 8 hour time allocation, however their radius of action from the Sea Base was limited to between 135 and 150 nm. The CH53's load carrying capability and range are also significantly affected by air temperature.

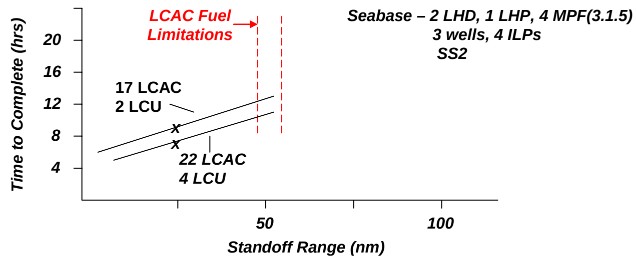
Air Assault - - Time to Complete



2015 MEB Air Assault can be Achieved in 8 Hr Goal
Analysis Assumes 15 C - - - Serious Degredation at 35 C
Serious Limitation in Range of Operation

Force insertions using surface connectors, primarily LCACs, required the Sea Base to approach within 25 nm of the shore and could not be completed within the 8 hour allocation. This was primarily because of the loading times and queuing delays involved for the the LCACs as well as the practical limitations on their range capability when loaded. The effective LCAC radius of operation was projected to be no more than 50 nm in sea state 4 conditions.

Surface Assault - - Time to Complete (day S+1)

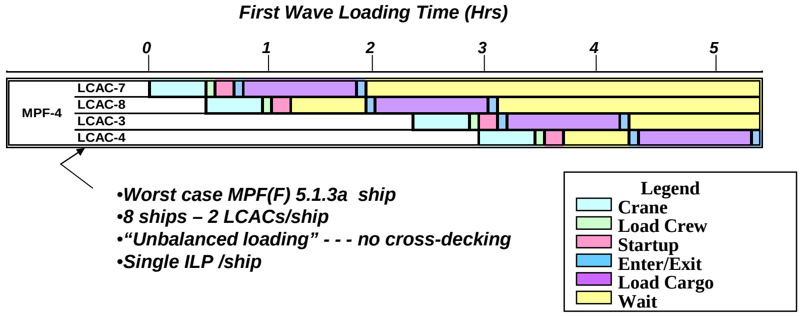


Standoff Range Seriously Limited by LCAC Fuel Consumption
Achieving 8 Hr Assault Goal is Problemmatic
LCAC Seakeeping is Limited to SS3

The modeling study also determined that the entire force ashore could be successfully sustained by the available airlift assets alone using CH53s and MV22s without exceeding pilot flight hour restrictions. However, other than some allocation of airlift assets for some medivac utilization, this did not leave much available time for airlift assets to be scheduled for any other operations ashore. Also, the sustainment airlift connector radius of operation was limited to 135 - 150 nm from the Sea Base, far short of desired operational capability.

The analysis showed that loading of either airlift or surface connectors formed a choke-point in the material throughput flow. For the flight deck spots modeled on both the ESG and MPF(F) ships, there was considerable loss of time while helicopters waited for deck spots to clear so they could be loaded. The lost time could be reduced but not eliminated, by careful distribution of cargo among the various Sea Base platforms and by “cross-decking” of personnel. Similarly, analysis showed that loading times for surface connectors from the ILP or from stern well decks on the ESG ships were major obstacles to overall material throughput.

Surface Assault - - Connector Loading Sensitivities



Faster Connector Loading with More Load Points is Necessary
Simultaneous ILP and Wet Well Operation is Problematic

The large variety of container types to be loaded and the relatively slow methods for loading, i.e. fork lifts, etc., contributed to the loading delays.

Finally, the Panel noted that medical support will inevitably prove to be a major function of the Sea Base, and the medical aspects of Sea Basing had generally received only limited attention in any Sea Base requirements analysis done to date. A validated concept of medical support of Sea Basing CONOPS is an obvious necessity. Current amphibious warfare doctrine assumes a limited medical presence ashore, and the ability to rapidly evacuate casualties to the Sea Base. The Marine Corps Modular EnRoute Care System (ERCS) has facilitated retrograde evacuation. The ERCS, which weighs 275 pounds, consists of a precise mix of medical equipment, treatment and communications protocols, and consumable supplies. It can support two critically injured casualties accompanied by two medical personnel.

Ideally, medivac should not rely on airlift transport alone, and should take advantage of emerging surface connector assets. For example, air cushion landing craft returning from over-the-beach delivery could be used to transport casualties. Large numbers of wounded may quickly overwhelm airlift transport capabilities given the limitation of space and configuration for litters. Currently the MH-60S is the only rotary aircraft with litter capability. It will require 30-35 MH-60 flights to evacuate 100 casualties 110 nm. It is clear that MV-22 (12 litters), CH-46E(15 litters), and CH53E(24 litters) aircraft would be required for medical transport of any sizable number of casualties.

The Sea Base itself must be able to flex up or down to meet combat casualty care requirements in a complex operational environment. The configuration of Sea Base ships must take into account medical support needs. For example, amphibious ships have a limited hospital bed capacity (22-40 beds) and are not designed to care for large numbers of seriously wounded. Given the multiple operational requirements of MPF(F) ships, Navy medical planners are considering the ability to flex from 22 intensive and step-down beds to a much more robust 120-bed configuration with greater Level III shock/trauma treatment capability, 4 major operating rooms, laboratory and radiology, patient decontamination, morgue, enhanced telemedicine, and C4I infrastructure.

The final link in the medical evacuation chain is transfer of stabilized combatants in need of continuing care to the Advanced Base or to CONUS. Sea Basing doctrine precludes predictable reliance upon large fixed-wing medivac aircraft. HSCs being planned as an essential part of Sea Basing CONOPS must be capable of supporting medical transport. Parallel planning of medical services in support of Sea Basing operations will be required to ensure that future wounded combatants have maximum potential for survival and quality of life.

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Critical Obstacles

- Air connectors
  - *Operational Range*
  - *Heavy lift to/from Sea Base*
- Surface connectors
  - *Sea State 4 transfers*
  - *LCAC fuel consumption*
  - *Unimproved shore*
- MPF(F) functions
  - *Fast load/unload*
  - *Material breakout*
  - *Automated warehousing*

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Critical Obstacles to Sea Basing

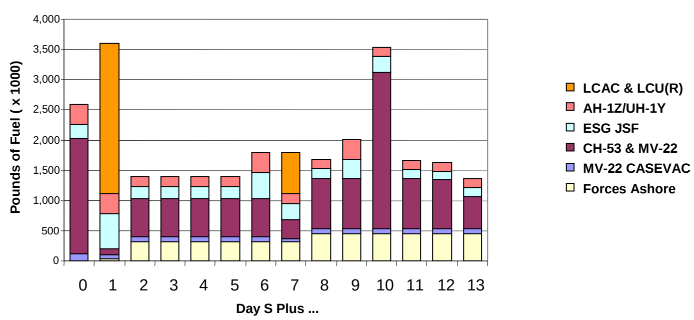
Based upon the fact-finding analysis and also upon the MCCDC modeling of connector performance sensitivities, the Panel identified three critical obstacle areas that will have major impact on connector performance in support of the Sea Basing CONOPS. The three primary problem areas are associated with airlift connectors, tactical surface connectors and with MPF(F) ship interface functions necessary to service the connectors.

Currently no program exists to provide heavy lift, long range air capability to- and from the Sea Base in the near- to mid-term. After careful review the Panel does not believe that operation of C-130 type aircraft from a large deck MPF(F) ship in all weather conditions is a realistic operational alternative although it has been discussed in some circles. The CH53-X program will provide realistic capability for airlift up to 13 tons with an operating radius up to 200 nm in the mid-term with improved performance over operational temperature ranges. This should definitely be pursued and probably represents the best capability that can be achieved in the next 10-15 years. The Joint Heavy Lift program proposes to extend airlift capability to 20 tons in the long term but this is still far short of capability required to air lift heavy armor units. With this background the Panel concluded that the Sea Base CONOPS and the MEB STOM should not attempt to structure operational requirements around heavy lift air connector capabilities in the near- to mid-term.. Rather the CONOPS should continue to focus on a combined role of air connectors and surface connectors where high speed surface connector strategies would have primary responsibility for heavy armor transport. The Panel also concluded that the need for extended operational range and speed capability for air connectors was more important than a very heavy lift capability.

As regards surface connectors, transfer of cargo from ship-to-ship in high sea states (SS 3-4) is extremely difficult because of the relative motion between platforms. This is a *lesser* problem in the case of transfers between large re-supply ships to the MPF(F) ships (i.e. large ship-to-large ship) because relative motion is *less*. *Commercial tanker operators routinely transfer oil by hose between large tankers sise-by-side in the ipen ocean in sea state 5 and even higher*. However, *transfers of ISO containers and vehicles presnt a more difficult problem*. The problem is particularly difficult for transfers from large (MPF(F) ships to smaller tactical surface connectors (i.e. LCACs and HSCs) because the difference in size aggravates the relative motion problem.

Connectors, both air and surface, were found to account for a major fraction of all fuel consumed by the entire Sea Base/MEB STOM force and supply structure. LCACs in particular, although unique among surface connectors in their ability to deliver cargo over-the-beach, are limited largely by fuel consumption to operational ranges of less than 50 nm in high sea state conditions (SS 3-4).

Fuel Usage Chart



- ***Connector Fuel Consumption is Significant***
- ***ESG fuel store is empty on day S+12 (1.5 M gal)***
- ***MPG fuel is 25% consumed on day S+16 (2.8 M gal)***
- ***Based Upon 2015 MEB STOM Modeling Simulation by MCCDC***

Connector Fuel Consumption is a Major Issue

Logistics operations over unimproved shores are the most stressing landing option the Panel examined. Although unimproved shores provide the most maneuver options, they also provide the greatest obstacles to most high speed connector concepts. When a high speed surface connector is designed to be beachable, other aspects of its performance are compromised, and even then it still might be unable to negotiate outer reefs or mud flats. The over-the-beach capability of the LCAC type connector is an extremely important advantage that this type of connector has over other alternatives. After reviewing inputs from Naval Expeditionary Force personnel and after assessing surface transport requirements in support of planned force projections, the Panel strongly felt that the capability for over-the-beach operation is extremely important for achieving overall force projection objectives as part of Sea Base operations.

Note: "over the beach" is a more demanding requirement than "beachable." A beachable HSC will off-load cargo at the water's edge in a wet environment with poor footing.

Several functional aspects of the MPF(F) AOA ship concepts presented serious obstacles to rapid and efficient throughput of material. The time required to unload commercial and MSC resupply ships from CONUS or the Advance Base, and to breakout and inventory material, and then to stow it can be unacceptably large. More importantly the selective retrieval of stored material, assembling it into tactical loads, and rapidly loading it onto surface and airlift connectors is even more problematic if on-board automation and warehousing technology is not effectively employed.

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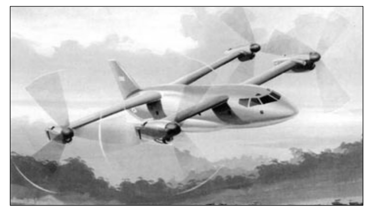
Overcoming Air Connector Obstacles

- Long-range heavy lift to/from Sea Base unavailable
  - *– CH-53X will help—deployment a problem*
  - *– Range/Speed enhancements are most important*
  - *– Other options are long-term - -i.e. Joint Heavy Lift*



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Overcoming Air Connector Obstacles

Strategic airlift aircraft—the C-5, C-17 and the commercial Civil Reserve Air Fleet (CRAF)—provide the connectors between the United States and an advance base today. Those aircraft, albeit modernized, will remain the prime airlift for the next twenty years. The Panel reviewed alternative concepts, including lighter-than-air (Walrus), wing-in-ground-effect (Pelican), and seaplanes. At this time, these concepts remain for the most part Power Point presentations. Their technical challenges remain formidable, their ultimate costs significant, and their operational feasibility suspect.

Few air connector concepts are viable for a lift from the United States to the Sea Base. Lighter-than-air must overcome those elements which were handicaps in the past (e.g. weather, ground operation, Sea Base interfaces, maintenance difficulty). The seaplanes' primary limitation would be cargo off load/on load adjacent to the Sea Base, particularly in moderate to heavy sea state conditions. The same difficulty is applicable to the wing-in-ground-effect vehicle.

Until the latter part of the next decade, the air connectors between Advance Base and Sea Base and Sea Base to Objective will be limited in payload (both weight and volume) and distance. Currently available connectors are the CH-53E with some augmentation by the CH-47D. Soon the MV-22 will become operational and become a significant lift addition. Payload and range remain a restrictor unless, in some situations, in-flight refueling or mid-range surface refueling is used. The payload and distance limitations apply to Sea Base to objective. No improvement to this capability is foreseen until about 2015 with the introduction of the CH-53X which will have a significant improvement to lift and range capability, achieving load capabilities on the order of 13 tons with round trip range in excess of 200 nm and reduced temperature degradation.

Just beginning is the Joint Heavy Lift (JHL) Task Force which will evaluate about ten concepts (helicopter, Canard Rotor, Coaxial, Quad Tilt Rotor, etc.) and then select 3 or 4 candidates for a concept exploration phase. The JHL will have a design point of 40,000 pounds at 250 nautical miles radius which will approximate that needed for the Sea Base concept of operations. These load capabilities still fall short of those required for transport of heavy armored vehicles. If the JHL proceeds with Navy, Marine Corps and Army participation and support, the vehicle would become operational about 2025. Naval support is essential to insure shipboard compatibility as well as need for the MPF(F) design to accommodate the projected weight of the JHL.

Based upon MCCDC's modeling results for the 2015 MEB STOM, the projected airlift capability provided by the CH53E(SLEP) and the MV22 aircraft can meet the operational requirements for those force insertion and force sustainment functions that were allocated to the airlift connectors. The most significant airlift performance issue that needs to be addressed is to extend the airlift range and speed capabilities. The CH53X program should provide an important enhancement in these areas.

Overcoming Surface Connector Obstacles

- Transfer rate in Sea State 4
  - *Eliminate relative motion*
  - *Load big—unload small*
  - *LCAC shuttle from MPF(F) to HSC*
- LCAC fuel consumption
  - *Use HSC as LCAC truck*
- Unimproved shore
  - *Deliver materiel over-the-beach*
  - *Use LCAC as pallet truck*

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Overcoming Surface Connector Obstacles

As noted above, the most challenging environmental obstacle to the implementation of surface connector solutions in support of Sea Base operations is the requirement to operate through sea state 4 weather conditions. This problem is primarily related to that of achieving high throughput material transfer rates when there are large differences in relative motion between the large MPF(F) ships and the smaller surface connector ships. This is most significant in the case of the tactical surface connectors used between the Sea Base and the shore. Resupply ships anticipated to be used between CONUS or advanced land bases and the Sea Base will have less of a connector interface problem because these ships will be of similar size to the MPF(F) ships. In fact commercial container ship carriers such as Maersk, Ltd., and others have already successfully demonstrated stabilized crane technology and open ocean fendering systems which will permit transfer of ISO containers and even larger loads in heavy sea state conditions. The problem of large ship to large ship transfers of heavy loads is manageable and should be solvable without a large and/or difficult development program.

The problem of high throughput transfer of material between a large MPF(F) ship and smaller tactical surface connector vessels such as the existing LCACs or new proposed HSCs through HIGH sea state conditions is a more difficult problem. Current wet wells used for loading/unloading LCACs on ESG ships effectively eliminate relative ship motion; however, the load rates and resulting queuing delays projected in the MCCDC flow rate modeling of the 2015 MEB STOM indicate that these solutions must be improved. Wet wells of this type are also a major driver in ship cost. The Panel also looked at the performance of the proposed ILP proposed for loading LCACs in the MPF(F) AOA report. The Panel felt that techniques for stabilizing such platforms in heavy seas using lee side weather shielding was very questionable since weather effects are not the only cause of the relative motion between the ships involved. Maintaining a lee side weather shielding situation could also interfere with desired wind conditions in support of airlift operations. The Panel believes that the loading rates for the ILP would be unacceptably slow in even moderate sea state conditions. This was borne out in the MCCDC flow rate modeling results.

The LCAC connector itself, despite its serious disadvantages in terms of high fuel consumption and limited operational range in heavy sea states (SS3-4), has one major advantage. That advantage is the capability for "over-the-beach" operation with very heavy load capability. In studying the tactical surface connector problem, the Panel feels strongly that this "over-the-beach" operational requirement must be maintained in developing surface connector strategies in support of Sea Base operations. Cargo discharge at the water's edge is not sufficient in terms of providing the war-fighter with the widest possible range of options in terms of support force insertions. Attempting to load palletized cargo aboard trucks at the water's edge for relatively unimproved beach is inherently slow and uncertain. The local conditions at the shoreline are likely to include beach slopes, tidal excursions and, worst of all, wet sand or mud with poor load bearing capability. Shallow reefs could further complicate operations. For all of these reasons the Panel looked toward a surface connector solutions which would combine the best features of existing LCAC capabilities with those of the newly emerging HSC technologies.

With this background the Panel focused on the development of surface connector strategies which would utilize LCACs as material and equipment shuttles from MPF(F) ships to nearby HSCs which, in one of its operating modes, would serve as large "flatbed trucks" for carrying LCACs to the shore area. The HSCs would each be capable of carrying three loaded LCACs at high speed from the Sea Base to the area of shore disembarkment. The LCACs would then transfer under their own power from the HSCs to the shore and then over-the-beach to unloading areas as required. Empty LCACs, or LCACs with wounded or with material to be returned would then transit back to the HSC, reload themselves and be returned to the Sea Base. This concept for exploiting the synergies between LCACs and HSCs could greatly extend the effective range of combined surface connectors thereby enabling greater Sea Base stand-off ranges from the shore. It could also reduce total fuel consumption since the HSC is much more economical as a cargo mover over long range than is the LCAC.

Finally, the Panel believes that to support high throughput loading/unloading of LCAC connectors at the MPF(F) interface, relative motion between the platforms must be eliminated. Such loading interfaces should also be compliant with high speed, automated loading techniques which would permit an LCAC to be quickly loaded with a few large pallets of assembled sub-containers (i.e. "load big"). These sub-containers could then be individually broken out and unloaded at the shore objective (i.e. "unload small"). To accomplish this the Panel suggests that the following MPF(F) connector interface concepts should be explored:

- internal “transverse tunnel” drywells for loading/unloading LCACs using heavy lift internal overhead gantry cranes,
- stern mounted elevator loading platforms similar to those used on SEABEE ships,
- Intermediate Transfer Platform.

These concepts will be discussed further later in the report.

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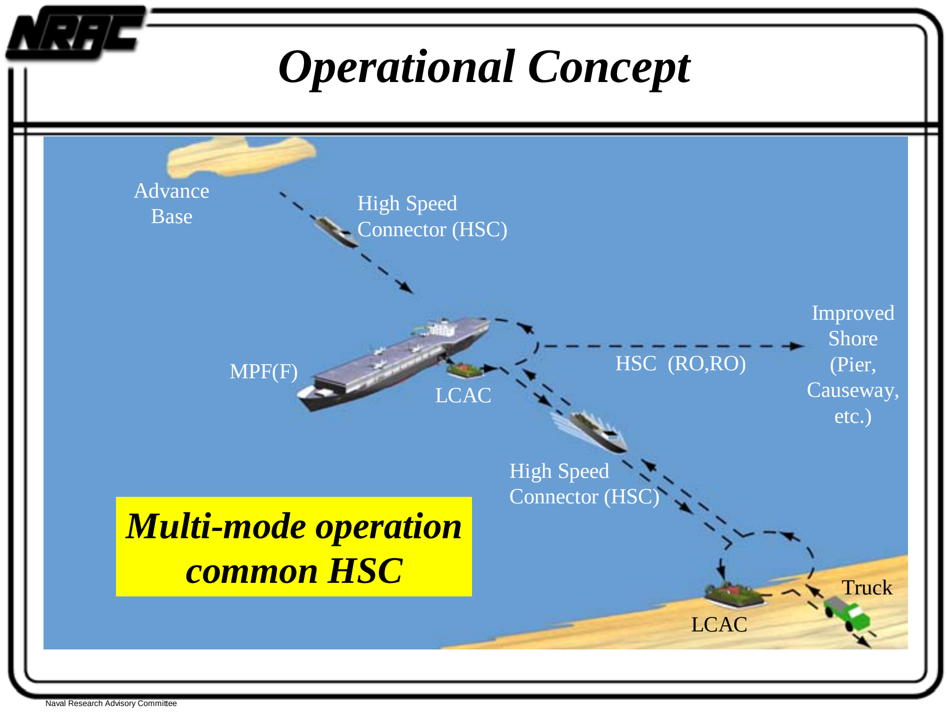


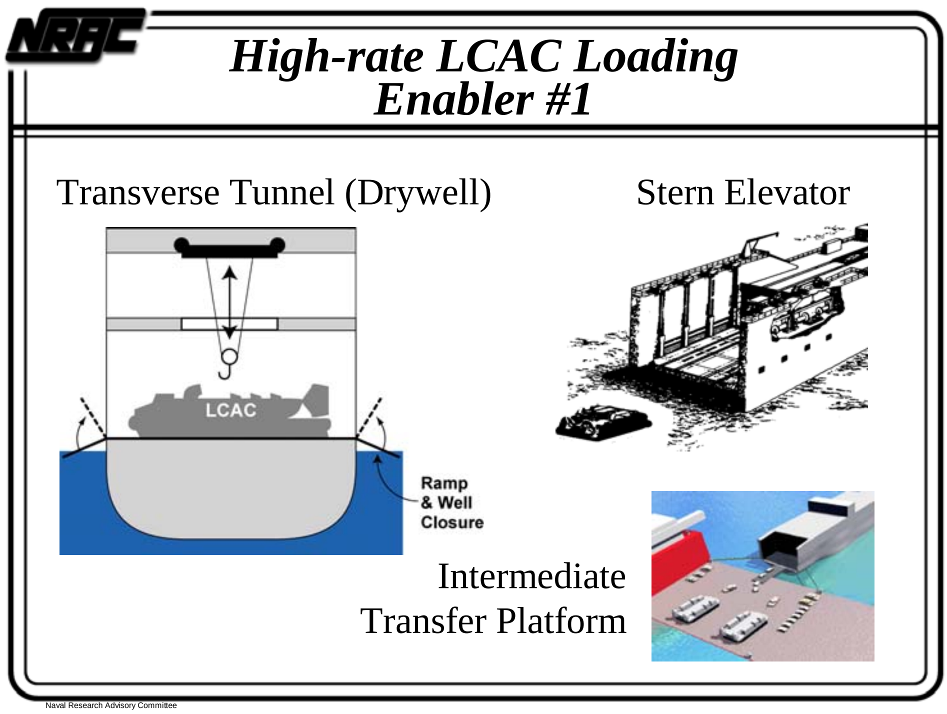
Operational Concept

In the proposed operational concept, there are three roles for a high-speed surface connector (HSC). These are to operate between an advanced base and the sea base, between the sea base and an unimproved beach, and between the sea base and an improved beach (or harbor). It is proposed that a common HSC be designed to fill all three roles.

The most demanding role for the HSC is to operate from the sea base to an unimproved beach in seas up to the top of sea state 4. To do this successfully and with acceptable cargo transfer rates, LCACs are utilized to deliver cargo to shore high and dry, well away from the water's edge. The HSC is employed as an "LCAC truck" carrying LCACs from the sea base to near shore. The LCACs are loaded aboard the MPF(F) ships, either in a dry well (lowering loaded pallets onto the LCAC by overhead gantry crane) or on a raised stern elevator (loading by crane or ro/ro). Another option would be to fly the LCACs onto an Intermediate Transfer Platform and load them there by crane or RO/RO. The LCACs leave the MPF (F) ship under their own power and proceed to the nearby HSC where they are quickly taken aboard. The HSC is designed to carry several LCACs and additional cargo as well. The HSC carries the loaded LCACs to a point close to the beach and the LCACs are off-loaded. The LCACs proceed to the beach under their own power, mount the beach and off-load their cargo well above the high water mark. The LCACs return to the HSC, are quickly taken aboard, loaded with additional cargo, discharged and the cycle repeated. Each LCAC makes several round trips between the HSC and the beach. When the HSC cargo has all been off-loaded, the empty LCACs are brought aboard and the HSC returns to the sea base well off-shore. There the LCACs are off-loaded and the process repeated.

If the beach is improved by a pier or causeway, or if there is a sheltered harbor in the vicinity, the HSC could dispense with the LCACs, take on additional cargo from the MPF (F) ship, and transit directly to the beach or harbor. The HSC cargo would be off-loaded by a crane ashore or by RO/RO. If a harbor is available, this could be done through sea state 4. For successful off-loading from the HSC directly to pier or causeway on an oceanfront beach, the sea state would likely have to be more moderate. The HSC could be loaded in any one of three ways to increase its flexibility: LCACs could be brought aboard, vehicles loaded by RO/RO, or dry cargo loaded from above using a crane mounted on the sending ship.

It is proposed that the same HSC be used with relatively minor reconfiguration for transporting personnel and high value cargo from an advance base to the sea base and vice versa. Loading at either end would be by crane (ashore or on the MPF(F)ship) and by RO/RO.



High-rate LCAC Loading Enabler #1

High rate LCAC loading is a critical enabler. This can be accomplished by eliminating or reducing the relative motion between the MPF(F) and the LCAC and by rapidly loading large assembled units of cargo ("load big"). Three approaches for accomplishing this are shown. Two approaches, the stern elevator and the "transverse tunnel" dry well, would eliminate all relative motion by accomplishing transfers <u>aboard</u> the MPF(F). Multiple "transverse tunnels" could also be used. Should both approaches prove feasible, the MPF(F) could adopt both. Incorporating both features would increase the transfer rate, provide redundancy and eliminate the chance that a single point failure would destroy all ability to transfer cargo to surface connectors bound for the shore. It would also likely increase the sea state capability of the transfer system since, depending on the environmental conditions, ship heading, etc., one method is likely to be more capable than the other. In lower sea state conditions, a third concept, the use of an ITP would reduce relative motion between the MPF(F) and LCAC by serving as a stable LCAC landing platform and decoupling the two vehicles.

The transverse tunnel is a relatively short, shell-to-shell dry well in which a LCAC can be loaded directly from above. The freeboard of the tunnel deck above the water line will vary with the ship's loading condition but will nominally be about two to three feet. Groups of JMIC boxes or vehicles are pre-assembled and secured to large pallets/rafts on the deck above the tunnel. The large pallets are then moved to a hatch opening, lowered onto the LCAC cargo deck under positive control, and quickly secured using integrated pallet lock-down techniques similar to that already used by FEDEX in aircraft environments. The number of large pallets per LCAC is likely to be on the order of 4 to 8. The ramps shown in the figure could be swung up when not in use to form the lower portions of the necessary closures for the ends of the tunnel. If quick-acting, they could also be closed to provide shelter for the LCAC while it was being loaded. One way movement of the LCAC through the tunnel is preferred. However, in higher sea states, it would be possible to keep the weather side ramp up for additional protection and back the loaded LCAC out of the tunnel on the lee side, the side it entered on. The sides of the tunnel will likely incorporate a set-back for a catwalk to facilitate line handling and personnel access to the LCAC, as well as additional clearance for the LCAC's ducted propulsors.

A stern elevator, as depicted here, is installed on the SEABEE Class barge carriers and could be adapted for MPF(F). Both sides of the elevator are protected by extensions of the hull side. The elevator would lift the LCAC to align with any cargo deck and permit direct ro/ro transfer of vehicles or JMIC boxes pre-assembled on large pallets/rafts. When loaded, the LCAC would be lowered to the water, power up and debark from MPF(F). Ship heading could be controlled to minimize wave action in way of the elevator. A loaded LCAC on-cushion will easily fit onto the current SEABEE elevator. The current SEABEE elevator is designed to lift two fully loaded lighters at 1000 tons each. Thus its capacity is much greater than the capacity required to lift a single loaded LCAC at about 170 tons. The stern elevator could be used to lift LCACs to the weather deck of MPF(F). They could then be moved forward to stowage positions for transit to/from the sea base operating area.

The ITP is a large, self-propelled element of the sea base similar to modern heavy lift ships. It can be positioned beam to the seas and held there using dynamic positioning. It is ballasted down with some list so that the lee side deck edge is at the water surface and the weather side freeboard is increased for greater protection. Preliminary model tests at Naval Surface Warfare Center Carderock Division (NSWCCD) have shown that a very effective lee is created; wave heights are reduced 40 to 50% in the midship region of the platform. Several LCACs could fly onto the lee side of this very large, stable platform and large, pre-loaded pallets or vehicles could be loaded aboard by roll on/roll off (RO/RO). With this option, the MPF(F) ship could Med moor to the weather side of the platform, head to the wind and seas. Cargo and vehicles could be moved from the MPF(F) to the platform using the stern elevator and a ramp.

The ITP would also serve a key role in transferring cargo and vehicles from the supply connectors to the MPF(F) or from the MPF(F) directly to HSCs. It would greatly facilitate RO/RO vehicle transfers between RO/RO supply ships and MPF(F). The MPF(F) and a RO/RO supply ship could both Med moor stern to the ITP and vehicles could be rolled directly from the supply ship to the MPF(F) via the ITP. MPF(F) will require a stern ramp capability to enable this but a stern ramp would likely be compatible with a stern elevator.

High Speed Connector Enabler #2

Threshold capabilities:

- *> 30 kts, 2000 nm loaded*
- *3 loaded LCACs + additional cargo/troops*
- *Rapid LCAC launch and recovery*
- *Three loading modes*
  - –LCAC
  - –Vertical
  - –RO/RO

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High Speed Connector Enabler #2

One of the principal recommendations of this study is to develop surface connector strategies which can exploit the strong advantages of existing LCAC connector capabilities and at the same time capitalize on the new capabilities offered by the emerging HSC technologies. With this in mind the Panel believes that the design and CONOPS for the HSC is critical to the success of Sea Base operations and as such, the HSC represents one of the most important "enabling" capabilities for Sea Basing.

After looking at the issues of surface connector solutions and connector/MPF(F) interface options in light of Sea Base operational requirements, the Panel has recommended that one of the tactical intra-theater roles for the HSC would be that of a transporter of loaded LCAC vehicles between the Sea Base and the shore area (i.e. a fast "flatbed truck"). A second role for the same HSC vehicle design would also be to serve as a high speed inter-theater connector between the Advance Base and the Sea Base. This would utilize the same HSC vehicle design, continuing the fast "flatbed truck" concept with minor configuration changes, but would likely be carrying different cargo formats, i.e. assembled JMIC containers in ISO container formats, assembled CH53 aircraft, personnel, etc.

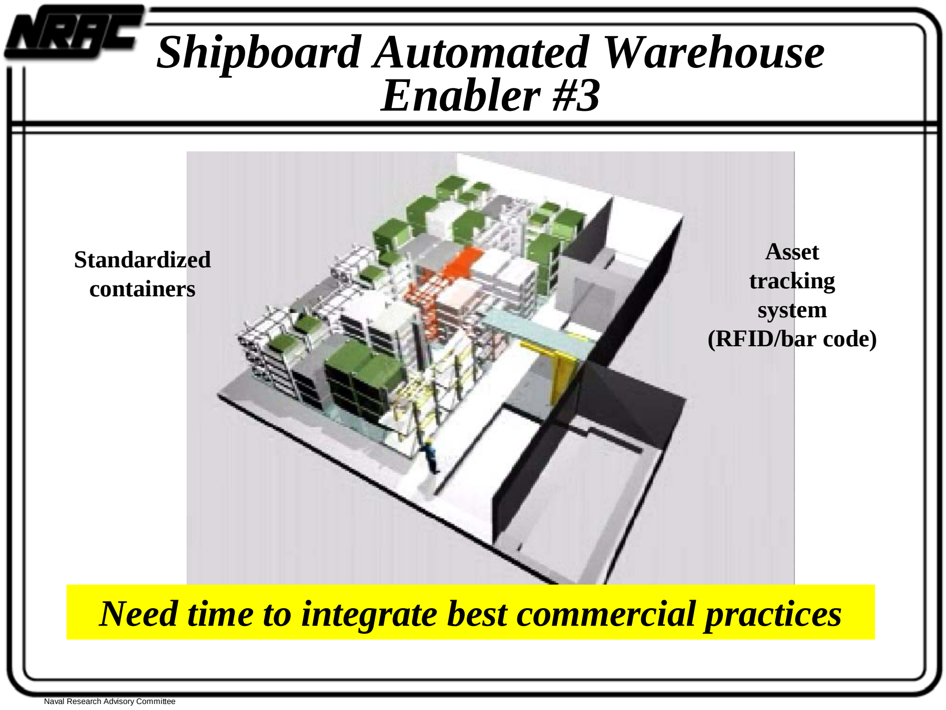
The essential threshold HSC capabilities required to support the proposed operational concept are listed in the figure above. They will be the principal drivers of any HSC design concept. The stated speed, range and payload requirements are conservative minimums that the Panel is quite certain can be achieved in a slender monohull design or other hull formats with low risk. They can probably be exceeded with increased risk by adopting innovative HSC hull forms, features and techniques. The "hump speed" of some of the new innovative hull designs occurs in the region of

32 knots and represents a speed above which efficiency and sea-keeping capability is significantly improved. Even greater speed capability would be very desirable, such as a sustained speed in calm water of more than 50 knots. Trade studies are required to investigate the penalties associated with increasing the sustained speed, as well as increasing range and payload. The specified range is at the sustained speed and has been included here to support the inter-theater role of the HSC. Much greater ranges should be achievable at reduced speeds for long transits.

The requirement to carry three or more fully loaded LCACs is a major driver due more to the footprint of the craft than to its weight. In addition to loaded LCACs, the HSC must carry additional JMIC boxes on pallets/rafts, vehicles, and troops. The HSC must be able to independently load its "extra" JMIC cargo and vehicles onto empty LCACs that return to the HSC after their first trip to the shore. The quantity of additional JMIC cargo/vehicles carried by the HSC must be determined in the course of exploratory ship concept studies. It would be desirable to carry at least two additional LCAC loads for each loaded LCAC carried by the HSC. Troops could be transported in comfortable "airline business class"-type seats for trips from the Advanced Base to the Sea Base (2000 nm at 32 knots requires 62 hours or 2.6 days-the maximum trip length envisioned). The troop seats can readily be modularized, i.e., secured in rows on rafts, so that they can be placed in JMIC cargo/vehicle stowage areas as an alternative payload option.

Rapid LCAC launch and recovery is possible with a dry well permitting "fly-on/fly-off." Such a dry well can be incorporated into a slender monohull. Many surface HSC concepts utilizing multi-hulls (Small Waterplane Area Twin Hull (SWATH), catamarans, trimarans, pentamarans, Surface Effect Ship (SES), etc.) do not lend themselves to near-surface drywells enabling LCAC fly-on/off. This is due to the required cross-structure clearance above the water surface, as well as the required depth of the cross structure itself. Whether a practical, rapid LCAC launch/recovery method could be incorporated into such HSC concepts remains to be seen. Ramps or lifting devices might require too much cycle time to be effective.

The HSC must be capable of being loaded by three techniques, as noted in the figure. The HSC is envisioned to operate in any one of three modes: (1) carrying loaded LCACs from the sea base to just off the beach and bringing empty LCACs back to the sea base, (2) linking the Advanced Base to the Sea Base carrying JMIC cargo and vehicles loaded by crane or RO/RO, and (3) linking the Sea Base to an improved beach (piers, causeways, etc.), also carrying cargo and vehicles loaded by crane or RO/RO. In addition to rapid LCAC launch/recovery and direct RO/RO loading, the HSC must be capable of vertical load/unload by crane.



Shipboard Automated Warehouse Enabler #3

Commercial material handling systems (standard packaging, automated warehousing, asset tracking) existing and available today, when marinized, will provide an integrated material handling system from CONUS and the Advance Base to the Sea Base and the objective. The system, when demonstrated, will be a critical enabler for the design of the MPF(F). The system elements consist of:

- Standard packaging (JMIC-like) scalable and connectable up to the size of an existing container/20 ft ISO container provides for flexibility and manageable handling (most importantly at the objective on the beach) and also is designed to be within the capability of any existing air connectors.

- An automated warehouse on the Sea Base (Advance Base, etc.) integrated and designed to handle the standard scalable package and container/TEU will provide for optimum flexibility (container reconfiguration) and reliability.

- Asset management and tracking system (radio frequency identification (RFID) and bar code).

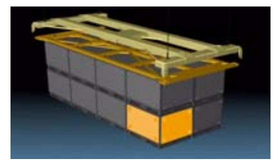
All of these elements when coupled with the high-rate surface connector loading enabler and air connector assets will comprise an Integrated Sea Basing Material Handling & Transfer System. This system will be compatible with a mandated Joint Integrated Material System which will allow for flexibility, reconstitution and asset visibility anywhere in the end-to-end material system. The system is the most effective, reliable and least manpower intensive enabler.

The Naval Research Advisory Committee (NRAC) has visited and reviewed in detail the Federal Express operation for which this type of standardized container and material handling strategy is utilized. At the Memphis site alone Federal Express transfers three million packages and another 600K cubic feet of cargo in a four-hour periods with less than a 1% error rate. Wal-Mart utilizes a similar operation and has seamless interfaces with commercial producers and shippers using barcoding and RFID tracking which now represent reliable industry/commercial standard technologies.

Benefits of Candidate Solution

- Standoff range increased
- LCAC advantages retained
- HSC serves multiple purposes
- Rapid loading
  - *LCAC on MPF(F)*
  - *HSC via LCACs*
- Modular container breakout
  - *Large for loading efficiency*
  - *Small for beach movement*
  - *No TEUs on shore*

LCAC offers over-the-beach capability



16 JMIC containers equal 1 TEU

No technical breakthroughs needed

Naval Research Advisory Committee

Benefits of the Candidate Solution

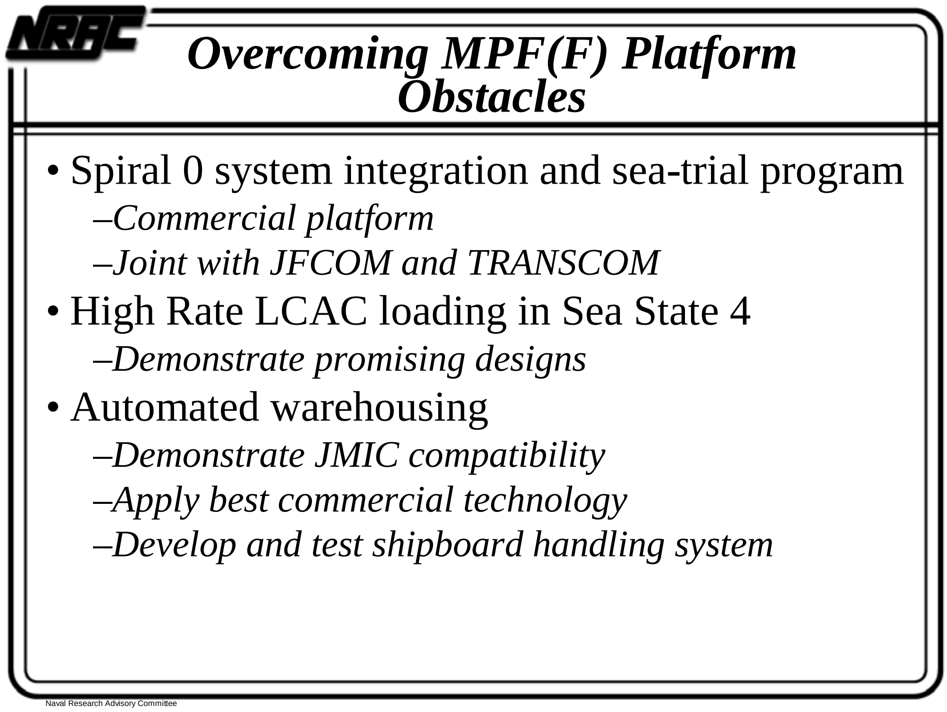
One overarching benefit of our candidate solution is that it demonstrates that Sea Basing is a viable concept—we can close the logistics chain for MEB, delivering what is needed in volume and heavy elements, in the near term, affordably, and without a worrisome level of technical risk. Thus, we have put a reference point in place against which other candidate solutions should be measured in terms of IOC, cost, and prerequisites.

Our candidate solution makes use of the Navy's existing inventory of LCACs, ensuring that heavy equipment can be delivered not just in the sand at water's edge, but beyond any otherwise encumbering marshes or mud flats, over boulders and other impediments, at slopes up to 10%. The proposed concepts for using LCACs also breaks through traditional obstacles to rapid movement of material from the Sea Base to the user in the field: long load time at the Sea Base end and unloading problems on the shore. Rapid loading is ensured because large pallets, bearing vehicles or large containers, are loaded on the LCAC from above while it rests in the transverse tunnel of a Sea Base ship, isolated from weather conditions.

On shore, cargo is carried "over-the-beach" to stable unloading areas. Vehicles can roll off LCACs on their own. LCACs rapidly discharge containers onto trucks using roller plate techniques and scissor lifts similar to those now used by Federal Express. Alternatively, LCACs could unload JMIC-based container cargo on the ground for later break-up and loading, with fork lifts, onto trucks. In extreme cases, dumped container cargo could be broken up into individual JMICs containers and carried short distances or lifted by small numbers of Marines, assisted by handles or poles like those used to carry a litter. Thus, material break up occurs just-when-necessary, preserving the throughput-enhancing benefit of large containers as long as possible. Also, because the JMIC containers clip together and can be disassembled, there are no large steel containers left on shore thereby simplifying retrograde motion. While the benefits of LCACs are retained, this concept significantly reduces their principal problem which is limited range---on the order of 50 nm radius in bad weather---driven by high fuel consumption.

By piggybacking LCACs onto an HSC, the HSC handles most of the transit between the Sea Base ship and the shore, using the LCACs high fuel consuming capabilities only where and when they are needed. Because the LCACs and HSCs work synergistically, the LCACs no longer limit standoff ranges for the Sea Base itself. A 100nm standoff, outside of cruise missile range, becomes realistic. Beyond its tactical intra-theater role as a transporter of LCACs, the HSC could also be used in an inter-theater role for ferrying troops, personnel, vehicles, and containers between an Advance Base and the Sea Base. Multiple functional roles for a common HSC vehicle should improve its overall cost effectiveness and affordability.

The surface connector concepts proposed in this study have a further advantage in that technological risk is minimized. LCACs represent an existing operational capability although their fuel efficiency should be improved. Considerable technology development and operational evaluation has already been conducted on a variety of innovative new hull designs which could be candidates for the suggested HSC ship design. Also, for the initial “Spiral O” test version of a proposed MPF(F) ship configuration, existing high efficiency container ships such as Maersk’s S-Class ship are already operational and could be available as an MPF(F) demonstration candidate at very reasonable cost. For evaluation purposes, modifications to these ships to accommodate extensive flight deck capabilities and the “transverse tunnel” dry well implementation could be done at very reasonable cost in US shipyards.



Overcoming MPF(F) Platform Obstacles

Connector operations will place demands on the connector interface concepts and capabilities of the MPF(F) ships themselves. The MPF(F) ship will require large flight deck and hangar facilities to provide a large number of aircraft loading spots for simultaneous loading of CH53X and MV22 aircraft as well as to provide launching and landing area for Joint Strike Fighter (JSF) aircraft. In addition, to support rapid loading of surface connectors the MPF(F) ship will need to provide physical interface structures such as the suggested “transverse tunnel” drywells and/or stern elevator/ramp structures. In terms of onboard facilities required to service connector operations, the MPF(F) ship will need to also provide the following integrated capabilities - - - -

- reliable fast loading/unloading of both air and surface connectors
- material breakout and selective load configuration
- automated warehousing and material tracking.

Achieving these capabilities will require an effective, timely systems integration approach that is structured around multiple feasibility demonstration steps. A spiral development integration and demonstration approach using a commercially available, state-of-the-art modified container ship as an integration test platform is recommended. A proposal for such a platform has already been developed by Maersk, Ltd., under contract to Military Sealift Command/United States Transportation Command (MSC/USTRANSCOM), utilizing a modified version of their S-Class container ship. The Panel further recommends that a “Spiral 0” system integration and demonstration phase of the MPF(F) spiral development using such a ship should be a coordinated joint program activity with USTRANCOM and Joint

Forces Command. In this way near-term feasibility demonstration of the critical Sea Base connector enabling capabilities, including automated warehousing and material handling, asset management, and high speed connector loading in high sea state conditions could be done in order to optimize solutions in a realistic integrated systems environment.

MPF(F) Vision Unclear

- All-purpose ship versus family of ships
- Command and control
- Manning (civilian, Navy, Marine)
- Maintenance/repair capability
- Troop accommodations
- Medical facilities
- Reconstitution requirements
  - *–Retrograde*
  - *–Personnel*
  - *–Equipment/supplies/vehicles*
- Connector deployment

Too many unknowns; not ready to build

Naval Research Advisory Committee

MPF(F) Vision Unclear

In addition to the platform obstacles already discussed related to ship transfer systems, LCAC loading and automated warehousing and handling, many other concerns loom that bring into question the Navy's readiness to design and build an MPF(F) ship (or family of ships). Not only has no approved concept of operation been finalized, but the need for the Sea Base to include one kind of ship (that carries and does everything) or several specialty ships (with specific capabilities, such as air handling or cargo carrying) has not been determined either. The Panel saw no evidence that the required cargo transfer rates to and from each individual MPF(F) ship in the sea base had been determined based upon a systems engineering analysis at the end-to-end material transport requirements from CONUS to the Expeditionary Force end-users ashore. Furthermore, the command and control architecture has not been addressed, nor have manning requirements, maintenance and repair capabilities, troop accommodations, medical facilities, or means of reconstituting assault forces in the Sea Base in 30 days. Connector employment and deployment remain to be addressed, along with an articulation of Joint requirements—particularly Army requirements—and the inherent interoperability issues these pose.

In short, there remain too many unknowns that must be resolved before the Navy moves forward with a shipbuilding program. For these reasons the Panel recommends that a "Spiral 0" MPF(F) systems integration, development and demonstration program be initially undertaken as a joint program activity with USTRANSCOM and Joint Forces Command in order to refine MPF(F) system requirements and CONOPS.

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MPF(F) Spiral Development— New Initiatives

- Near term (12 to 18 months)
  - *S-Class container ship conversion*
    - LCAC transverse tunnel interface
    - Flight deck and hangar
    - Automated warehousing
  - *SeaBee stern elevator/LCAC interface demo*
  - *Intermediate transfer platform demo*
- Mid-Term (18 to 36 months)
  - *Initiate MPF(F) shipbuilding program*

Cost effective and timely investment

Naval Research Advisory Committee

MPF(F) Sprial Development - - New Initiatives

In the near term, tests and trials should be performed in order to evaluate critical MPF(F) systems and features and refine the MPF(F) CONOPS before initiating the MPF(F) shipbuilding program and its first step: definition of major requirements and ship concept design. The Panel proposes the Navy quickly convert a Maersk S-Class containership to a MPF(F) Spiral 0 configuration and use the modified S-Class ship for specific tests and evaluations. The S-Class ships are modern, state-of-the-art containerships which are in operational use. Twenty one ships are in service and six are currently being built. The preliminary design for the proposed S-Class conversion has been completed under MSC/USTRANSCOM contract. The converted ship would be an aviation capable, operational platform with other near-term sea base capabilities. The principal characteristics of the Mod. S-Class ships are listed below:

- Length 1140 ft, Beam 140 ft, Depth to Main Deck 78 ft, Draft FL 35 ft, and Freeboard FL 43 ft
- Sustained speed 24.6 knots
- Single screw, diesel propulsion
- Range 15,000 nm at 25 knots
- 2-compartment damage stability
- Flight Deck: Supports AV-8B and JSF STOVL aircraft; operational spots: (15) CH-53 or (12) V-22 or (15) CH-46; (2) inboard aircraft elevators

- Hangar Deck: Length 660 ft, width 122 ft, height 24.5 ft); environmentally controlled and protected; hangar capacity (72) CH-46 helos stowed for transit

- Modular berthing and support for up to 6000 troops

- Crew size: 40 persons plus 42 persons per 1000 troops for support (cooking, cleaning, laundry, etc.)

- Modular living, service, mission and office spaces

- Ammo magazine plus ordnance handling system forward

- Aviation fuel capacity: one million gallons

- Capable of skin-to-skin cargo transfers in up to sea state 4 using a 20 ton Safe Working Load (SWL) motion compensated cargo crane

- Automated in-hold cargo stowage and retrieval system with selective container recovery and discharge system for up to (180) 20 FT ISO containers

- One container elevator

- Underway replenishment (UNREP) system for receiving fuel, dry cargo and ammo

- One fueling at sea (FAS) sending station for refueling smaller craft

- Transverse tunnel (dry well) for LCAC loading, launch and recovery

Using the converted S-Class ship, near term testing is proposed, focusing on three aspects: LCAC loading, launch and recovery operations using the transverse tunnel, aircraft operations on the flight and hangar decks, and the on-board automated warehousing system.

The system tests of high throughput LCAC loading will require that the deck above the "transverse tunnel" be fitted with the critical elements of the system developed to pre-stow JMIC containers and vehicles on rafts, move the rafts to the open hatch, and lower them to their stowed position on the LCAC cargo deck. The transverse tunnel must be fitted with automated closures that, when open, will also serve as ramps to the tunnel deck. The LCAC/tunnel interface testing must address LCAC loading rates, sea state limitations, exhaust gas issues, LCAC mooring, ramp/tunnel closure operations, and recommended operational procedures for the entire LCAC recovery, load and launch sequence.

The tests of the automated warehousing system must include all the critical elements of the MPF(F) cargo handling system, including load, strike-down, strike-up, breakout, assembly of tailored JMIC boxes, and transfer to the LCAC loading system. System reliability and sea state limitations must be assessed as part of operational demonstration testing.

A SEABEE Class Barge Carrier should also be activated from the Ready Reserve Fleet (RRF) to evaluate the stern elevator and the weather deck barge handling system. The ship should be used for tests of the LCAC/stern elevator interface. The aspects to be evaluated include:

- LCAC stowage on the weather deck
- JMIC cargo and vehicle loading into the LCAC on the elevator at several deck levels (vertical positions of the elevator)
- Operational limitations on ship speed, heading relative to the seas, and sea state

In addition to the above tests, a study should be performed to evaluate ways to improve the elevator reliability and reduce maintenance requirements using modern technology.

A large heavy lift ship should be chartered from a commercial operator to demonstrate the capabilities of the ITP. The tests should include:

- Evaluate effectiveness of the lee created by the platform when lying beam to the seas
- Med moor large RO/RO and SEABEE ships to the platform (stern to with bows into the encountered seas); perform RO/RO operations between two adjacent ships via the platform
- Med moor High Speed Vehicle (HSV) and other HSC candidates to the lee side of the platform and performing RO/RO operations to/from the platform
- Ballast the platform to bring the lee side to the water surface and conduct LCAC recovery, loading by RO/RO, and launching operations using the platform (fly-on/fly-off).

Only after the tests and trials outlined above have been performed and the results digested should the MPF(F) CONOPS be defined and the shipbuilding program initiated.

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Maersk S-Class Conversion Concept

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Maersk S-Class Coversion Concept

Maersk is a $25 billion company with more than 250 container ships worldwide, and is the third largest terminal operator in the world. Wal-Mart is their client for warehousing and distribution. Maersk operates, among other vessels, S-class container ships. These are the largest in the world (1145 feet long). There are twenty one such ships in service with six more under construction.

Conversion of an S-Class would provide a commercial off the shelf (COTS) platform with flexible modular capabilities that would be available in less than a year. ROM cost estimate from Maersk for purchase and conversion is $300M. Conversion design was completed for DoD after the Chief of Naval Operations (CNO) directed MSC to assess an Afloat Forward Staging Base concept as an alternative to using USS Kitty Hawk as a Special Operations Forces (SOF) support platform during operations in Afghanistan. The design included: two flight deck elevators, deck spots for 15 V-22 equivalents, and an environmentally controlled hangar with stowage space for 72 H-46 equivalents. A "transverse tunnel" dry well concept for LCAC loading has been reviewed and analyzed by Maersk engineers and is feasible. An S-Class conversion would provide near- term operational Sea Basing capability.

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Why an S-Class Conversion?

- Commercially operational
- Preliminary conversion design done for DoD
- Sea test in 12 to 18 months
- Provides deck spots and hangar
- Demonstrates critical MPF(F) enablers
  - *–Automated warehousing*
  - *–Rapid LCAC loading*
- Affordable

Deployable for near-term strategic missions

Naval Research Advisory Committee

Why an S-Class Conversion?

In reviewing the Sea Basing concept, the Panel saw early on that there are more questions than answers in the effort to determine what ship transfer and handling capabilities and connector interfaces would be required to sustain MPF(F) and Sea Base operations. As a result, the Panel asked for a briefing from the Maersk Line, Ltd. The Department of Defense had asked Maersk, through a Military Sealift Command contract, to provide a proposal for converting its present S-class containership to an MPF(F) ship. From that presentation, and from their previously submitted solicited proposal to MSC, it became quickly apparent that for approximately $300M, the Navy could buy and convert an available S-class ship in a U.S. shipyard. In 12 to 18 months the Navy would have a platform ready to test out the necessary warehousing and connector loading/unloading technologies, refine MPF(F) conops, and gain an MPF(F)-like asset available at any time to deploy for an emergent strategic mission.

In view of the current unknowns in MPF(F) requirements and the anticipated $2-3B cost in developing and constructing a new MPF(F) ship, the Panel felt that a "Spiral 0" system integration test and demonstration program using a modified S-Class ship would be a very cost-effective and timely investment.

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NRAC

Summary of Conclusions

- Material Handling
  - *–JMIC essential for throughput*
  - *–Automated warehousing*
  - *–LCACs as pallet-trucks/lighters*
- Connectors
  - *–HSC efforts lack system focus*
  - *–HSC and LCAC synergy possible*
  - *–HSC needs multiple loading options*
  - *–Fuel consumption limits operations*
  - *–Heavy cargo is a problem*
  - *–Airlift options limited*

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Summary of Conclusions

The following summarizes key conclusions developed in the Sea Basing Study. These are grouped into three areas - - -

- Material Handling Strategies
- Surface Connector Strategies
- MPF(F) Ship Interface Strategies

Material Handling Strategies

It is essential that throughout the Sea Base system—from CONUS to the battlefield—a standardized means be used for packaging and handling material, from bombs and bullets to beans and bottled water. The Joint Modular Intermodal Container (JMIC) design concepts offer the potential for such packaging, which will facilitate handling at all transit points, shipboard stowage, and transport by various air and surface connectors. Thus, JMIC is an essential component of the Sea Base concept.

Within the MPF(F) ships it will be critical that JMIC packages, containers, and other material be readily located and, when possible, automatically transferred/moved to enable the rapid "marriage" of troops and equipment, the delivery of critical spare parts, and the flow of ordnance and supplies to troops in the field. Accordingly, the Sea Base must embrace the concept of automated warehousing, including systems to immediately locate any package that comes aboard the Sea Base and, to the extent possible, have that package automatically delivered to a specific location on the MPF(F) ship.

LCACs have unique advantages for transit of materials and personnel "over-the-beach" and these should be retained. When LCACs are combined with high speed surface connectors (HSC) as suggested in this report, the combined advantages of both technologies can be enhanced while eliminating many of the disadvantages of each as a stand-alone. In this combined connector concept the LCACs must be considered as "pallet trucks/lighters" and thus be interfaced to the MPF(F) ship with appropriate interfaces to the automated warehousing and related subsystems to enable the high throughput movement of material onto the LCACs. This will include pallet-like platforms that can be preloaded aboard ship, lowered directly onto the LCAC, and rapidly secured for transit to an HSC or directly to the beach.

Surface Connector Strategies

The effort to develop a high speed surface connector requires an integrated system focus which must include consideration of the loading/unloading interfaces required. The HSC must be fully compatible and integrated with both the Sea Base (e.g., MPF(F) ships, amphibious ships, cargo ships) and with the final off-loading and delivery systems for bringing cargo and troops ashore. A number of HSC evaluation and demonstration programs have been undertaken but most of these have addressed the performance of the HSC as a stand-alone system.

As has been stated earlier, there is the potential for considerable synergy between the HSC and the LCAC connector technologies. The LCAC offers the best near-term capabilities as an effective surface connector with "over-the-beach" delivery capabilities. However, the LCAC suffers from a high rate of fuel consumption and operational range limitations which could be mitigated or overcome by an effective, LCAC-carrying HSC platform. Fuel consumption has been identified in the MCCDC modeling of the 2015 MEB STOM operations as being a major concern for connector operations.

The HSC, while viewed in large part as primarily an LCAC transporter, must have multiple loading options to insure flexibility in cargo carrying and loading/unloading. Accordingly, the HSC must also be capable of being loaded by ramp (i.e., RO/RO features) and by overhead crane and heavy-lift helicopter (i.e., open deck and accessible cargo spaces).

Heavy cargo is a problem for Sea Base connectors, especially outsize cargo such as M1A1 Abrams tanks and engineering vehicles. Such items cannot be air lifted by helicopters and are beyond the capacity of many shipboard ramps and cranes. Again, special planning and handling arrangements are required, while future connectors—air and surface—should be capable of handing heavy cargo.

Major enhancements in airlift connector options for Sea Base operations are not going to be realistically available in the near- to mid-term. For this reason airlift connector operational requirements for the next 15 years must be planned to make use of existing capabilities with moderate improvements. Expanding the operational ranges possible with the existing CH53e and MV22 airlift vehicles is perhaps the most important performance enhancement to be addressed. Achieving extremely heavy lift capability above 20-40 tons is not going to be operationally feasible for many years. Today the CH-53E is the largest-capacity helicopter in the West with a maximum lift capacity of 16,000 pounds; the planned CH-53X follow-on helicopter will have a lift capacity of approximately 27,000 pounds. (These are maximum capacities; they degrade with increases in range and higher temperatures.) Further, the CH-53 is not self-deploying and must be carried to the forward area by ship or heavy-lift aircraft. If the latter, they must be partially disassembled, with two days required for both disassembly and assembly. The proposed quad-tilt-rotor could partially alleviate this problem, being self-deploying and having the lift capacity of a C-130 Hercules.

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NRAC

Summary of Conclusions (continued)

- MPF(F) Ships
  - *Current interface concepts inadequate*
  - *Automated warehousing critical*
  - *Need:*
    - Total Sea Base systems engineering
    - Refined CONOPs and requirements
    - Connector interface system
    - Logistics C2 system
    - At-sea demonstrations

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Summary of Conclusions (continued)

MPF(F) Ship Interface Strategies

The current interface concepts for the MPF(F) ship as discussed in the MPF(F) AOA including the Integrated Landing Platform (ILP) and conventional wet well concepts are inadequate for achieving the high throughput material transfer rates that we believe are required under high sea state conditions as predicted in the MCCDC flow rate modeling. Effort must be expended in this area to insure the safe and efficient transfer of troops and cargo to and from the Sea Base. Because of the efficiency of the LCAC as a surface connector, the "traverse tunnel" (drywell) and SEABEE-type stern elevator offer the promise of effective handling schemes for the LCAC and their feasibility in high sea state conditions should be evaluated.

Automated warehousing is critical to the effectiveness of the Sea Base and must be a major consideration in the design of the MPF(F) ships. The proposed Maersk S-class conversion provides an excellent platform for the development and evaluation of automated shipboard warehousing for the MPF(F) ships.

For the effective design and construction of MPF(F) ships the Navy should (1) develop a refined CONOPS and define requirements for the MPF(F) ships; (2) address the Sea Base in the context of total systems engineering and allocation of functions; (3) develop an effective and comprehensive connector interface system; (4) develop an effective logistics communications system for the Sea Base; and (5) undertake appropriate at-sea demonstrations for connector concepts and technologies.

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Recommendations

- Mandate standardized JMIC container program
- Develop HSC prototype to exploit synergies with LCAC
- Pursue S-class conversion as MPF(F) Spiral 0 capability
- Conduct MPF(F) defining demonstrations
  - *–Automated material handling system*
  - *–Transverse LCAC loading tunnel*
  - *–SeaBee-type stern elevator LCAC loading*
  - *–FLO/FLO LCAC loading/cargo transfer*
- Maintain CH-53X funding
- Support the Joint Heavy Lift Task Force

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Recommendations

A standardized container concept and strategy are essential to end-to-end material handling if the Sea Base is to achieve the high volume throughput required to support a MEB. The JMIC container design concept is sized to be compatible with all airlift connectors including the C-130, and with all surface connectors including commercial container ships. The JMIC specifications have been developed to meet joint service requirements by the Joint Working Group and should now be adopted and implemented as an active program by Naval logistics.

Various high performance hull designs should be considered in the development of HSC concepts and designs which are sized and configured to carry multiple fully loaded LCACs and additional cargo or troops at high speed (>32 knots).

The Navy should undertake a “Spiral 0” MPF(F) requirements development and demonstration program. This should be done as a joint initiative with Joint Forces Command and USTRANSCOM. The Panel further recommends that a modified S-Class container ship be used as the demonstration test platform in the “Spiral 0” program. Feasibility evaluations and demonstrations of high throughput LCAC loading techniques and integrated automated warehousing and selective material handling should be conducted. The S-Class conversion and related defining demonstrations are required as a prerequisite to the MPF(F) design and construction to refine requirements and also to provide a near- term deployable afloat forward staging base.

Limited remaining operating life of the current CH-53E fleet dictates that the CH-53X program remain on track and that full funding be maintained in order to meet near-term and mid-term Sea Base operational requirements.

The results of this study have indicated that achieving airlift connector capability for heavy lift (> 20 tons) is of secondary importance to achieving longer loaded operating range (> 250-300nm) with existing systems. However it is felt that the Navy should continue its participation in the Joint Heavy Lift Task Force to ensure that Naval operational requirements are addressed as part of the long range airlift solutions developed.

Recommendations (continued)

- S&T Investment
  - *Pursue aggressive EXLOG FNC Program*
  - *Develop innovative HSC hull and propulsion technology*
  - *Invest in advanced air-cushion technology*
  - *Focus ONR Innovative Naval Prototyping on MPF(F)/HSC Spiral 0 initiative*

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Recommendations (continued)

S&T Investments

After reviewing ONR's Expeditionary Logistics Future Naval Capability (EXLOG FNC) program, the Panel believes that the program is properly directed in addressing application of technologies in automated warehousing, selective material handling, and connector interfacing (i.e. stabilized craning). The Panel recommends that S&T funding be provided so that the EXLOG program can be more aggressive in the integration and demonstration of "marinized" automated warehousing and material handling solutions as part of a "Spiral 0" MPF(F) development and demonstration program. The Panel also recommends that the EXLOG program also address high throughput LCAC loading solutions in conjunction with the "transverse tunnel" drywell and stern elevator connector interface concepts.

The Panel further recommends that ongoing S&T program funding in the development of innovative HSC hybrid hull and propulsion technologies should be continued and specifically focused on the requirements for a high speed surface connector which can perform efficiently as an LCAC transport system as described in this report. S&T funding should also be allocated for investments in advancements in air-cushion vehicle technology which could enhance performance, improve fuel efficiency and extend the life of the LCAC connector systems. Suggested areas for investment might include propulsion systems and "skirt" sealing technologies.

Finally, the Panel recommends that the Chief of Naval Research initiate a new ONR Innovative Naval Prototyping program specifically focused in support of the MPF(F)/HSC "Spiral 0" integration and demonstration initiative which has been recommended in this report.

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Appendix A

Acronyms

AFSB	Afloat Forward Staging Base
AOA	Assessment of Alternatives
CNO	Chief of Naval Operations
CONOPS	Concept of Operations
COTS	Commercial-off-the-shelf
DoD	Department of Defense
DSB	Defense Science Board
ERCS	En-Route Care System
ESG	Expeditionary Strike Group
EXLOG FNC	Expeditionary Logistics Future Naval Capabilities
FAS	Fueling at Sea
HSC	High-Speed Surface Connector
HSV	High Speed Vessel
ILP	Integrated Landing Platform
IOC	Initial Operational Capability
ISO	International Organization for Standardization
ITP	Intermediate Transfer Platform
ITS	Intermediate Transfer Station
JHL	Joint Heavy Lift
JMIC	Joint Modular Inter-Modal Container
JSF	Joint Strike Fighter
LCAC	Landing Craft Air Cushion
MCCDC	Marine Corps Combat Development Center
MEB	Marine Expeditionary Brigade
MOB	Mobile Offshore Base
MPF(F)	Maritime Prepositioning Force (Future)
MSC	Military Sealift Command
NAVSEA	Naval Sea Systems Command
NRAC	Naval Research Advisory Committee

NSWCCD	Naval Surface Warfare Center Carderock Division
ONR	Office of Naval Research
OPNAV	Office of the Chief of Naval Operations
RFID	Radio Frequency Identification
RO/RO	Roll on / Roll off
ROM	Rough Order of Magnitude
RRF	Ready Reserve Forces
SES	Surface Effect Ship
SLEP	Service Life Extension Program
SOF	Special Operations Forces
STOM	Ship to Objective Maneuver
SWATH	Small Waterplane Area Twin Hull
TEU	Twenty-Foot Equivalent Units
TSV	Theater Support Vessel
UNREP	Underway Replenishment
USTRANSCOM	United States Transportation Command

Appendix B

Terms of Reference

Objective. Identify and analyze cost effective and technically feasible high speed, high capacity connectors (to include hybrid technology) to close a Marine Expeditionary Brigade from the continental United States to a sea base and operate forces from the sea base to objectives ashore.

Background. *Naval Power 21* is the Department of the Navy vision statement that includes both *Marine Corps Strategy 21* (implemented through *Expeditionary Maneuver Warfare*) and *Naval Power 21*, the individual service strategies. Each strategy contains as one of its core elements a concept of Sea Basing. A Defense Science Board report states "a sea base represents a sovereign, maneuverable capability for rapidly projecting U. S. offensive and defensive power, as well as assembling, equipping, supporting, and sustaining scalable forcible entry operations without the need for land bases in the joint area of operations."

The sea base concept includes many capabilities and is certainly a concept that will develop from the legacy amphibious capabilities of today to the fully integrated, joint capabilities of the future. Various sea basing scenarios project the sea base as the confluence of multiple platforms in an area of operation, maneuvering independently but operating synergistically in contrast to a single large platform typified by a Mobile Offshore Base (MOB). Notwithstanding the actual composition or the many operational capabilities of a sea base, in its most fundamental state, a sea base is a trans-shipment point. Personnel, equipment and supplies are moved from rear areas to the sea base in order to provide the appropriate assault forces and subsequent logistics support for the ashore force. The major difference between the sea base and traditional amphibious logistical footprint of today is that it is not ashore. The political and strategic advantages of not having a large logistical position ashore are many but new challenges arise with such a change in tactics. A primary challenge to be met in developing the sea basing concept is the ability to transport all of the personnel, equipment and supplies to the sea base and then more importantly into the objective area as required by the forces ashore.

Heretofore, most amphibious assaults utilizing forcible entry have been supported by relatively nearby land bases and once entry has been made a logistic land base is established to support further operations. The concept for sea basing recognizes that there may be no nearby land base to support the operations. All personnel, equipment and supplies may come directly from the U. S. or other friendly but distant countries. Additionally, in today's ever advancing technologically based warfare there will not be the time to establish a land based logistic site at a beachhead before inland objectives can be attacked. Today's current amphibious capability cannot support the logistic requirements of tomorrow's warfare challenges. There are two distinct problems to be overcome. The first is the ability to rapidly move large amounts of personnel and materiel, no matter how heavy, to the sea base. The second is getting that same materiel and personnel, but now combat loaded, to the proper place ashore in a timely manner. Not only does the varying distance of the sea base from the shore complicate this problem, but also the actual delivery location may be up to 200 miles inland. These problems can be grouped under the rubric of "connectors" to the sea base.

Specific Tasking. Specifically, this NRAC study will:

- Identify and analyze cost effective and technically feasible high speed, high capacity connectors (to include hybrid technology) to close a Marine Expeditionary Brigade to a sea base from the continental United States and from advanced bases closer to the sea base.

- Identify and analyze cost effective and technically feasible high speed, high capacity connectors for operational forces from the sea base to objectives ashore.

- Consider technically feasible connector-to-platform interfaces required for these connectors, both from and to the sea base, capable of operating in various sea states up to and including sea state 4.

- In addition to mobile connectors, consider (but do not necessarily require) ancillary equipment like causeways, piers or landing strips that facilitate, not bottleneck, the throughput of personnel and materiel.

Make recommendations for near and far term technologies or equipment to be developed to provide the connector capabilities.

Appendix C

Glossary

Advance Base. An ashore base established between CONUS and the area of operations.

Connector. A ship, craft, aircraft, or other vehicle that connects the Sea Base with the advance base or area of operations debarkation point.

Joint Modular Intermodal Container. A standardized container under development for the Department of Defense. Abbreviated JMIC.

Marine Expeditionary Brigade. A Marine air-ground task force that is constructed around a reinforced infantry regiment, a composite Marine aircraft group, and a brigade service support group. The Marine expeditionary brigade (MEB), commanded by a general officer, is task-organized to meet the requirements of a specific situation. It can function as part of a joint task force, as the lead echelon of the Marine expeditionary force (MEF), or alone. It varies in size and composition, and is larger than a Marine expeditionary unit but smaller than a MEF. The MEB is capable of conducting missions across the full range of military operations.

Med Moor. A ship moored stern-to the pier or quay, a common practice in the Mediterranean Sea.

Military Sealift Command. A major command of the U.S. Navy, and the U.S. Transportation Command's component command responsible for designated common-user sealift transportation services to deploy, employ, sustain, and redeploy U.S. forces on a global basis. Also called MSC.

S-class container ship. A large commercial container ship, 1140 feet long, with a speed of 26 knots.

Sea Basing. In amphibious operations, a technique of basing certain landing force support functions aboard ship which decreases shore-based presence. The term is evolving as one of the key elements of *Naval Power 21* to cover the establishment of a sovereign, self-contained system of platforms and connectors capable of supporting an expeditionary force without the need to establish or rely on shore bases within the theater of operations.

Transportation Command. United States Transportation Command's mission is to provide air, land and sea transportation for the Department of Defense, both in time of peace and time of war.

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Appendix D

Briefings and Visits

- Sea Basing Conops: Major General Battaglini, USMC Director, Expeditionary Warfare N75
- MPF(F) Analysis of Alternatives: Center for Naval Analysis
- Sea Basing Video (CD): Marine Corps Combat Development Command
- Enabling Capabilities for the Sea Base: Expeditionary Logistics Future Naval Capability
- MEB Sea Basing Mission Area Analysis: Marine Corps Combat Development Command Modeling and Simulations
- MPF(F) Logistics: Chief of Naval Operations Staff Department (N421)
- Sea Basing and USMC Logistics: Headquarters, U.S Marine Corps
- Terms of Reference Guidance: Expeditionary Warfare (N75V Special Assistant Sea Basing)
- Quad Tilt Rotor and Heavy Lift Air Connectors: Bell/Textron
- HSC Conops: Headquarters,U.S. Marine Corps
- Sea Basing Roadmap Development: Naval Sea Systems Command
- Joint Vertical Aircraft Task Force: Naval Air Systems Command
- Army Theater Support Vessel (TSV): US Army Program Manager for TSV
- WALRUS and Heavy Lift Aircraft: DARPA/TTO
- MPF(F) and Sea Basing: NAVSEA PMS-325
- CH-53X and Heavy Lift Air Alternatives: Sikorsky - Bell/Textron
- Sea Basing Ideas: Chief of Naval Research
- Ship Alternatives for the MPF(F) and Mobile Offshore Base (MOB): Maersk Shipping
- Tour of High Speed Vessel (HSV): Commanding Officer, USS Swift
- Tour of USS Iwo Jima (LHD-7): Executive Officer, USS Iwo Jima
- Fleet Forces and Sea Basing: Commander, Fleet Forces Command (Director, N8)
- Sea Basing Modeling for Marine Expeditionary Brigade Movement: MCCDC Modeling and Simulations

- Sea Basing Roadmap Progress: Expeditionary Warfare, N75 Science and Technology
- Joint Modular Intermodal Container (JMIC): Headquarters U.S.Marine Corps
- T-AKE Dry Cargo/Ammunition Ship: Naval Sea Systems Command PMS-325
- LCS and possible HSC Variants: Lockheed Martin
- Sea Basing and Aviation: Headquarters U.S.Marine Corps (Deputy Commandant for Aviation)
- Sea Basing Connectors: Naval Sea Systems Command O5D
- Composite Hulls and Surface Effects Ships: UMOE
- Multi-Agency Craft Conference: MACC
- Federal Express

Appendix E

Interim Operational Sea Basing Capability

Summary: NRAC has evaluated converting an existing, modern, all diesel, containership into an Afloat Forward Staging Base (AFSB) as a part of its recently completed integrated review of Sea Basing. The intent is driven by the need to have a demonstrator platform for Sea Basing, while at the same time provide a fully operational interim sea basing capability. This will provide for a cost effective and vitally needed spiral development platform to be used for development and refinement of Sea Basing concepts and operational plans, as well as a fully functional interim sea base asset for use in real world contingencies. The information needed by planners to develop and refine the Sea Basing concept is best achieved through experimentation, which provides real time information. Experimentation requires an affordable platform that closely mimics the range of possible final capabilities in a relevant time frame. The AFSB solution is a near term capability, with the converted vessel available 12 to 18 months from the start of work, depending on requirements. The conversion AFSB therefore provides an ideal platform for experimentation plus an operational sea basing capability immediately that otherwise would not be available for a decade. There has been concern raised that a program such as an AFSB conversion may be harmful to the industrial base since a potential hull for this class containership (S-Class vessel, 1140 feet) would have been previously built in a foreign shipyard. More specifically, the program is narrowly viewed as a potential threat to U.S. shipyard employment. In fact, all proposed modifications to the existing containership in order to satisfy platform requirements for SeaBase evaluations can and will be easily accomplished in U.S. shipyards and would therefore contribute to U.S. shipyard employment. Another misconception is that a deepdraft vessel can not be dry docked in the U.S., requiring such work to be done overseas. In fact, both the East Coast and West Coast each have a yard that can dock such a vessel. The AFSB program will *not* harm the industrial base, but instead will lead to *at least steady* (vice declining) levels of employment, protect the most critical aspect of the industrial base (labor), and will likely result in increased top tier shipyard work. In addition, this program brings to the US advanced commercial ship design and technology, which does not currently exist in this country.

Need for a Demonstrator Platform: Funding requests for Sea Basing initiatives receive close scrutiny because there is no clear answer to questions such as “how will the Sea Base be used?” The vision set forth by the CNO in Naval Power 21 is quite clear: to project power from the sea through sea basing. The problems surface when attempting to translate that vision into concepts of operations, then to hard steel assets. Even a simple question such as “what is the Sea Base?” elicit 10 different answers from 5 different people. Consequently, funding for MPF(F) and other Sea Base assets is in jeopardy. The chances of getting funding for major Sea Base acquisitions are much higher if a clear, lucid, and convincing argument for how the Sea Base will be used to further national interests can be advanced. Funding approval results in major construction projects (such as MPF(F)) in top tier shipyards, leading to increased levels of employment. When clear, lucid answers to Congressional questions are not advanced, funding is withheld, new construction programs such as MPF(F) do not happen, and top tier yards lose jobs. That chain of causality is clear.

The AFSB offers an additional benefit as an experimentation platform in that a range of Sea Basing capabilities is put to sea at the same time, vice developing the various capabilities in stovepipes and attempting to integrate them on a platform at the tail end of the development. The solution to the Sea Basing capabilities is a system solution. It is not only developing the individual capabilities, but also how they will be used together. The best alternative for a system development problem is to develop the solution set concurrently and test them together. In this way, operational requirements drive capabilities development vice operational plans having to adjust to capabilities developed in isolation. A spiral development platform which allows putting a full set of potential sea base capabilities to sea to test as a system solution will lead to faster development of operationally effective sea base capabilities at reduced cost.

A demonstrator platform is a necessary element in developing the answers to conceptual questions for transformational efforts such as sea basing. For demonstrator programs to work they must be cost effective and fast. Cost effectiveness lessens the impact on budgets for other programs placing demonstrator platforms within the realm of possibility given existing capital allocation constraints. Quick development time is essential to ensure that these platforms are in the water and in use to provide the needed information in a time frame relevant to the debate. New construction is neither cost effective nor fast. In stark contrast, a well-managed conversion program is both cost effective and fast. Therefore a conversion program that produces a demonstrator platform used for spiral development will provide clarity as to the role of the Sea Base and its concept of operations. It will also allow refinement of the critical design and operational features of future Sea Basing assets such as MPF(F). Conversion of a state of the art commercial vessel also affords Navy designers the opportunity to evaluate advanced commercial design in terms of operational capability versus cost (initial construction and total cost of ownership). Future vessel designs then have the opportunity to take advantage of world class technology whatever the source. This will ensure that when the Navy funds MPF(F) at over $1B per ship, the vision articulated in Naval Power 21 is met at a price the country can afford to pay. In addition, experimentation allows difficult questions from funding sources to be answered clearly and convincingly. This dramatically improves the likelihood of funding for new construction programs, leading to increased tier one shipyard work and increased, long-term levels of employment.

<u>AFSB Conversion leads to jobs in the Near Term</u>: As noted above, for a demonstrator platform to be effective, it must be available in a time frame relevant to the debate. An AFSB conversion shrinks the acquisition time line considerably. The procurement process for new construction programs take years to work through, and given the price tag, funding is consistently in doubt. A conversion is available in the near term, and given the comparatively low cost, not subject to the same level of funding uncertainty. New construction programs generate uncertain potential for job creation at some unspecified number of years in the future. Conversion programs create real, value adding, jobs today. For the AFSB program, two-thirds of the

delivered value of the final vessel is created in U.S. shipyards. A critical element in the speed and cost control aspects of a conversion project is that these programs typically can be done at tier two yards. Somehow, this use of tier two yards has been construed to also be a threat to the industrial base. The single most important aspect of the shipyard industrial base is the skill of its workers. These workers will be employed in a conversion project; they do not simply fade away if not employed by a top tier yard. Instead they go to where the work is. Therefore, a conversion project not only provides real jobs, right now; these are jobs that protect the industrial base because labor that would otherwise be idled, and perhaps lost to the country forever during the long procurement process for new construction, remains employed. There may be a period of underutilization for top tier yard equipment, but equipment can always be mothballed, then reactivated when needed. This mothball/reactivation cycle will not work for the labor community, however, who must work to provide for their families and keep their skills sharp. The critical element of the industrial base, the labor, remains active in a conversion program, honing their skills and learning from advanced commercial design and technology. This can also provide a direct benefit to new construction programs in that highly skilled labor remains active in the industry and is available immediately with little or no training necessary. A protracted new construction process, with no filler work such as a conversion, may lead to an exodus of labor from the industry in the near term. Training and learning curve costs then are increased significantly when new construction programs are eventually started. A conversion program such as the AFSB actually protects the true critical assets in the industrial base, the highly skilled men and women who work in the industry, ensuring they remain employed, skills current, and ready to serve the country in what ever facility needs them.

Capital Allocation Constraints Are a Fact: Money for shipbuilding is not unlimited. In fact, there are constraints on shipbuilding funds today that have not been seen for some time. Every MPF(F) that the Navy builds translates into $1B + plus that will not get spent on an alternate shipbuilding program. The country must make tradeoffs. There is a fixed level of shipbuilding that will occur, the question being which programs will get funded and which will not. The amount of money needed for a conversion program will not affect the overall level of funding for major new construction programs. Therefore, spiral development programs such as AFSB will not detract from new construction activity. The extent of decline in new construction relates to reductions in major systems acquisition, not the small investment in a one-off conversion. Furthermore, since a fixed level of construction will occur, AFSB can be seen as additive to overall shipyard employment. Remembering that new construction acquisition is a long process, the level of new construction activity that will take place in the next year or two is essentially fixed, and an AFSB conversion will not change this. Instead, AFSB provides work for the industrial base above and beyond that of new construction. This additional work will keep labor and critical skills in the U.S. shipbuilding industry that would otherwise leave in a period of reduced new construction.

Vessel Characteristics are Not an Impediment to Work in the US: There appears to be a misconception that potential conversion vessels and particularly the S-class vessel (the vessel the AFSB is based on) can not be drydocked in the U.S., thus requiring dry-dock work to be done overseas to the detriment of U.S. yards. This is simply not true. The vessel requires a dock approximately 1150 ft in length. On the East Coast, Newport News Shipbuilding and Drydock (NNSD) is capable of docking the vessel. Operational draft of the vessel is 35 ft, however this is with a full load of fuel and ballast. For docking purposes, the vessel can be lightened up to a 28 foot draft, so NNSD graving dock #12 (max draft 31.6 ft) can handle the vessel. On theWest Coast, Puget Sound Naval Shipyard, and DD # 6 is large enough to accommodate the vessel. Thus, there is in fact drydocking capacity on both coasts of the U.S. to allow for docking of the S-class vessel. The operational draft of the converted AFSB of 35 foot ensures access to virtually all significant U.S. Navy and commercial ports in the U.S. for non-drydock repair, routine outfitting, and re-supply. In addition, with a draft of 35 ft, the vessel will have access to a wide range of ports around the world for routine operations.

Conclusion: A conversion program provides clear industrial base benefits that should be evaluated in their proper light. First, a near term, cost effective demonstrator platform provides planners with the detailed information needed to develop the functionality and capabilities required of the Sea Base. In transformational paradigm shifts such as Sea Basing, this information needs to be developed through experimentation. Experimentation requires affordable and time relevant assets that closely mimic the capabilities needed in the final requirement. A conversion project provides real time information useful for decision making. This increases the likelihood of funding for Sea Base new construction programs. In addition, a fully capable, operational asset is available to respond to contingencies, filling the long gap until MPF(F) is available. The vessel has no operational restrictions or characteristics that prevent her from being drydocked in the U.S., or husbanded at a wide range of ports, both in the U.S. and abroad. Second, new construction programs have very long gestation periods. During these periods, the industrial base, and most importantly the labor that makes it up, is likely to see reduced levels of employment. A conversion program creates near term employment: real jobs, right now. Thus labor that might otherwise leave the industry will be available when new construction programs ultimately occur. Third, the small cost associated with a conversion program will not impact large system new construction programs, they stand or fall on other factors not the least of which is capital allocation issues. Increases in MPF(F) funding will lead to decreases in other new construction programs. Conversely, conversions do not compete for capital on that scale, and remain out of that funding fray. Unlike new construction programs, they can be work “in addition to” rather than “instead of”.

A conversion program provides an essential element in the development of the Sea Basing concept while at the same time, protecting and advancing the industrial base that will be needed to turn that concept into reality in the future. In addition, a fully operational Sea Base asset with a large array of capabilities is available to warfighter very quickly. This provides robust interim capability to bridge the gap that currently exists between current capability and future vision.