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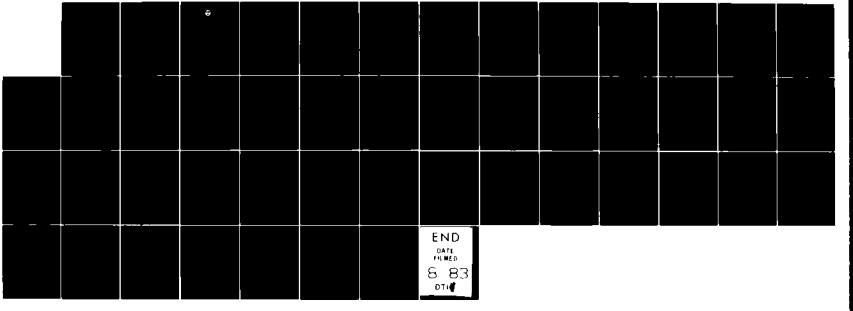

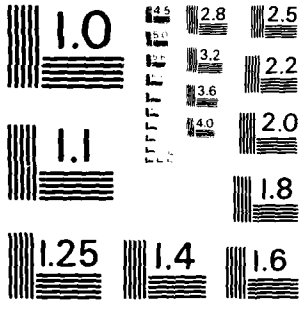

NOSC TD 602

Technical Document 602

MODULAR PERSONNEL ACCOMMODATIONS FOR TEMPORARY USE ABOARD SHIP

A Survey of Equipment for Current or Near-Term Use

SR Terwilliger
Code 5334

June 1983

NAVAL OCEAN SYSTEMS CENTER
San Diego, California 92152

NAVAL OCEAN SYSTEMS CENTER, SAN DIEGO, CA 92152

AN ACTIVITY OF THE NAVAL MATERIAL COMMAND

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Commander

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Technical Director

ADMINISTRATIVE INFORMATION

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A technology survey of state-of-the art personnel support equipment for application in the Merchant Ship Naval Augmentation Program (MSNAP) is presented. Also included are specifications and organizations related to MSNAP habitability module development.

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INTRODUCTION

MSNAP HABITABILITY OBJECTIVE

The objective of the Merchant Ship Naval Augmentation Program (MSNAP) is to develop the existing potential of commercial cargo ships to effectively augment naval auxiliaries during contingency and wartime situations. Established by the Naval Sea Systems Command in accordance with OPNAVINST 3030.1, the initial priority of the program is to develop an underway replenishment (UNREP) capability aboard general purpose dry cargo ships.

One issue facing Navy planners concerns providing personnel support facilities for the additional crew complement of 25-100 personnel needed to perform UNREP. Generally, merchant ships provide limited accommodations beyond those needed for a minimum crew sized to run the ship point-to-point without provisions for maintenance or cargo handling. Thus, on some ships, the available ship's power, fresh water, sanitation, messing, berthing, and other support facilities may have to be expanded for the ship to perform in augmentation roles.

A fundamental concept of MSNAP is that minimum modification be made to the merchant ship. Also, the modification hardware should be capable of rapid installation and removal. These two constraints require that a versatile yet standard modularity be built into any personnel support hardware. Further, a functionally modular support system would allow ready reconfiguration to varying sizes of augmentation crews, depending on the ship's role.

The development of modular transportable personnel support systems or subsystems is currently underway in both the private and public sector. Facilities for use in the oil industry, on construction sites, with hydrofoil squadron logistic support and with Marine Corps field support are just a few examples. Some of the systems are immediately available, others are still in the development phase, and still others are built on demand. Only a minimal number of the systems or subsystems, though, are suitable to the shipboard environment which MSNAP requires.

HABITABILITY SURVEY

This document presents information gathered during a technology survey conducted from January through May of 1982. The survey was conducted in direct support of the MSNAP personnel support issue and is therefore not comprehensive over the entire spectrum of personnel support facilities.

Special emphasis has been placed on functional modularity. Reference 1 indicates that modules fabricated within the envelope of an ISO standard container ensure uniformity of hard-points, tie-downs, and securing arrangements and strength. This makes the modules suitable for stacking and other predictable needs referred to in the previous section. Further, the survey focused primarily on defense-related activities, with only a brief review of private sector developments.

The survey covered three areas important to the development of personnel support facilities applicable to MSNAP: (a) modular personnel support systems and subsystems currently being developed; (b) Department of Defense organizations with corporate knowledge in certain support system technologies; and (c) requirements and specifications related to support facilities development. Specific contacts are listed in appendix A.

It is hoped that this survey will be a reference for individuals performing related work and a research aid to those seeking an expeditious answer to the MSNAP habitability issue.

SUMMARY

This survey documents both past and ongoing development efforts of modular, transportable, personnel support systems applicable to the MSNAP program. Four complete systems were encountered in the military community: MARAD-MSNAP, ARAPAHO, MCESS, PHM MLSGF. The first two were developed for shipboard use. The second two for shoreside or shipboard use. Only the ARAPAHO and PHM MLSGF systems are currently being funded to completion, the ARAPAHO as a proof-of-concept demonstration and the PHM MLSGF as an operational system.

Three Navy laboratories: NCSC, CEL, and NOSC are currently developing personnel support subsystems. These include sanitation units, shower units, berthing units, a containerized laundry, food service complexes, power generation and distribution units and combinations of these. All of the above systems and subsystems use the steel ISO shipping container as its fundamental building block and use shipboard compatible internal equipment.

Manufacturers who develop personnel support systems for various commercial needs were also contacted during the survey. Commercial systems were found to provide all functions necessary to support personnel under adverse or remote conditions. Commercial units use trailers, skids or integrated complexes as their structural building block (non ISO compatible). Construction materials usually consist of wood or aluminum and units are not always functionally modular. The manufacturers contacted also were not aware of the military's need for shipboard support systems.

The survey found that efforts to automate small personnel support systems have not been emphasized. Several efforts do exist, though, including CEL's efforts on a semi-automated conveyor-fed laundry and a zero-effluent head, and NATICK Laboratories' concept of a small food service system requiring zero support personnel. A major food service automation development effort was attempted at the Walter Reed Army Medical Center; however, existing technology was insufficient to support the concept. Other than current commercial vending machines and microwave technology, no other attempts at automation were found.

The survey also identified DOD organizations with expertise in certain areas of shipboard support system

technologies. These organizations are available for development work, consultation and/or review [illegible].

Although notable amounts of information are available regarding personnel support systems in general, present military, Coast Guard, and American Bureau of Shipping standards and requirements do not directly address modular personnel accommodations for temporary use aboard ships. Existing standards pertain to permanent habitability spaces aboard ship or mechanical standards for shipping containers but not an integration of the two. The Coast Guard indicated a willingness to waive peacetime regulations but not on a continuing basis. For this reason, care should be taken in the development of temporary shipboard habitability systems and the above mentioned expertise used where ever possible.

GOVERNMENT SPONSORED SYSTEMS

This section focuses on complete personnel support systems funded and developed by the federal government, primarily by the Navy or Marine Corps. Of the four systems presented, three are directly related to merchant ship conversion for military use. The other system, developed for pierside use, has good possibilities for adaptation to shipboard usage.

MARITIME ADMINISTRATION

Introduction

The initial research and development phase of the MSNAP program involved the Maritime Administration (MARAD). MARAD's efforts included the design of prefabricated accommodations modules to provide supplementary living quarters for the expanded auxiliary crew. M Rosenblatt and Sons, Inc, under contract from MARAD, began several studies in 1975, including manning, ship class selection and modular crew accommodations (reference 2). The studies were completed, but MARAD, lacking sufficient funding, has not constructed any of the modular accommodations to date.

Description

The accommodations complex consists of 21 ISO standard 8'x8'x40' containers plus one 8'x8'x40' container housing sewage tanks and pumps. The functional elements include berthing, messing, sanitation, medical, administration, store and recreation for 70 personnel. The facility is relatively self-contained, requiring only fresh water, salt water, and electric power. Storage is provided for 90-day endurance. Figure 1 depicts the module layouts.

The modules are positioned seven containers abreast by three containers high. The assembled structure is to be located on the aft section of the ship, behind the deck house (see figure 2), and can be oriented the same on each of the four ship classes. All soil and waste are gravity drained into a collecting and holding tank in the container located in the hold below the complex. Sewage is pumped overboard while at sea and is held in the holding tanks while in port and pumped at convenience to a shore connection.

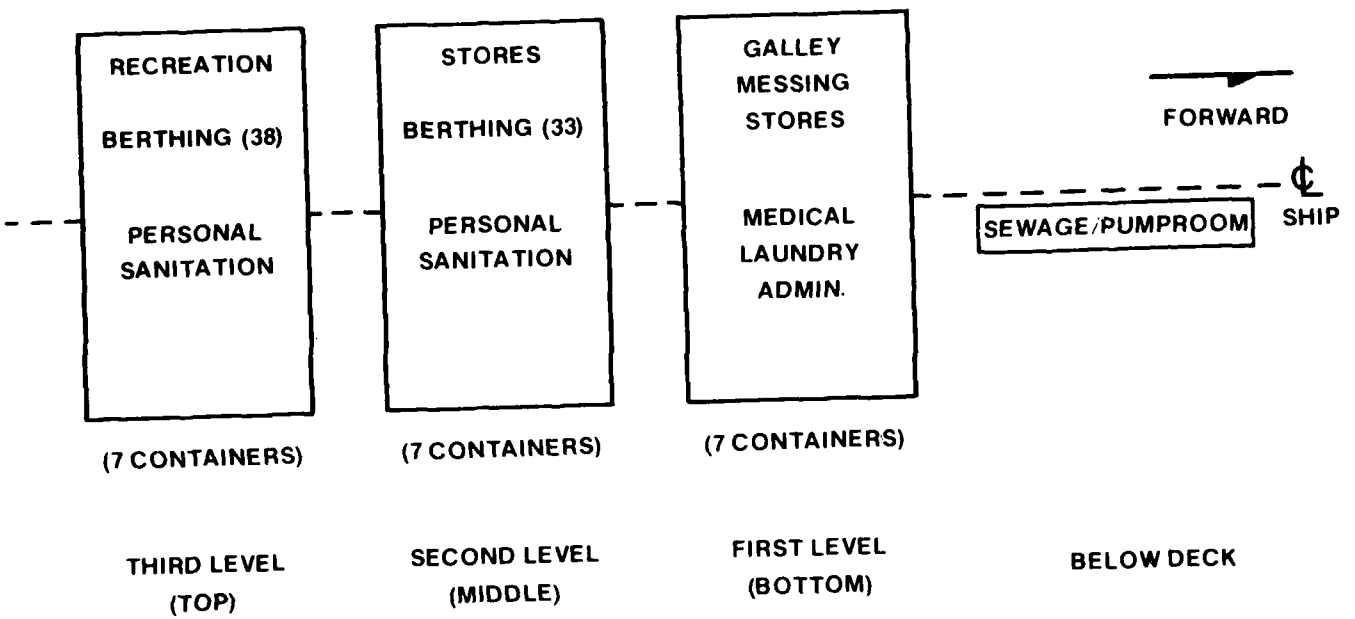


Figure 1. MARAD crew accommodations complex (ref 3).

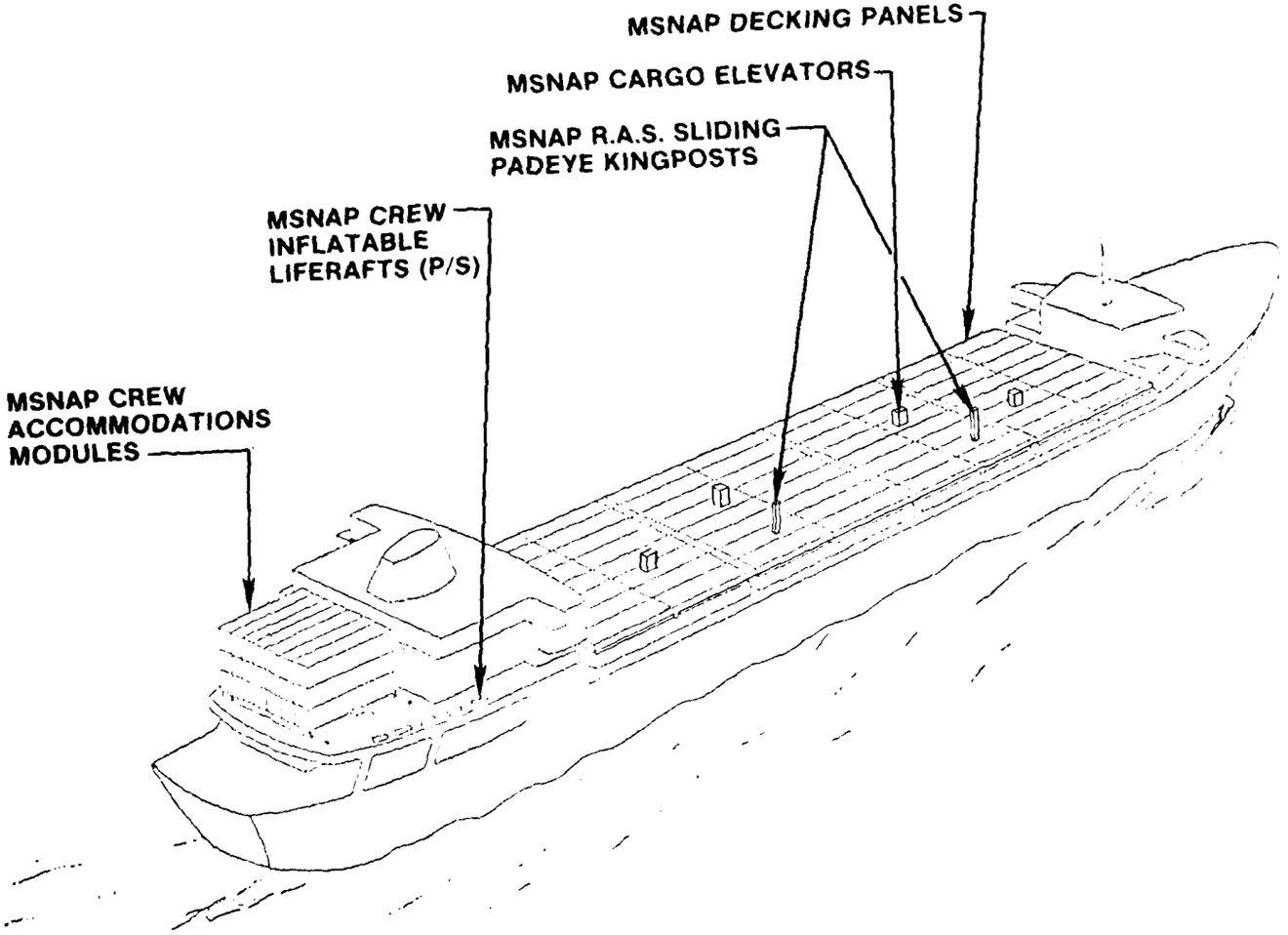


Figure 2. MSNAP containership - basic crew accommodations location and arrangement (ref 3).

The standards applied to this accommodations plan were not specifically identified, but the contractor referenced previous work (reference 3) related to the the ARAPAHO project described below. This project did not enter the certification process due to lack of funding.

Synopsis

Title: MSNAP Crew Accommodations

Contact: Maritime Administration
C Cherix (202)426-5836

Concept: Relocatable accommodation facilities for use on merchant ships to augment Naval auxiliaries.

Number of people supported: 70

Endurance: 90 days

Requirements: electric power
potable water
seawater

System Elements:

- 22 ISO containers (8'x8'x40')

Functional Elements:

- Berthing (10 men/container)
- Messing
- Head/shower/lavatory
- Medical
- Administration
- Recreation
- Stores
- Sanitation/pumping

Compatable ship classes:

"Lancer" C7-S-68e
"Pacesetter" C6-S-85b
"Seamaster" C6-S-69c
"Bath" C5-S-73b

Availability: Designs only

NAVAL AIR SYSTEMS COMMAND

Introduction

ARAPAHO is a NAVAIR research and development project. Its purpose is to explore the feasibility of operating ASW helicopters from merchant ships during contingency situations. The project is being directed through NAVAIR's Advanced Systems Directorate. Construction of the prototype is underway at the Naval Air Engineering Center (NAEC), Lakehurst, New Jersey (reference 4).

The concept of ARAPAHO uses ISO standard-size modules to form a large hanger, two-spot flight deck, aviation fuel system, Navy personnel accommodations and basic aviation logistics support aboard modern container ships. It is envisioned that such mobile facilities, like MSNAP facilities, could be activated in a matter of hours, transported, and installed topside aboard the merchant ship. The ship would still carry 70 - 75% of its normal cargo.

Description

The personnel accommodation complex was designed utilizing 8'x8'x40' standard ISO shipping containers. Currently, the complex consists of eight such containers, some having been configured for several functions, eg, mess room, adjacent stateroom; galley, adjacent head. The basic configuration is shown in figure 3.

The ARAPAHO plan is to locate the complex on the aft section of a typical container ship, but its standard modular design allows it to be readily adaptable or relocatable to several different classes of container ships.

The original design for the complex was accomplished by a private contractor and has since been reconfigured by engineers at NAEC. Habitability standards are comparable to other modularized facilities and certification is unnecessary at present due to the project's intended purpose as demonstrating proof of concept.

Synopsis

System Name: ARAPAHO

Contact: NAVAIR 03 JJ Mulquinn (202)692-7394

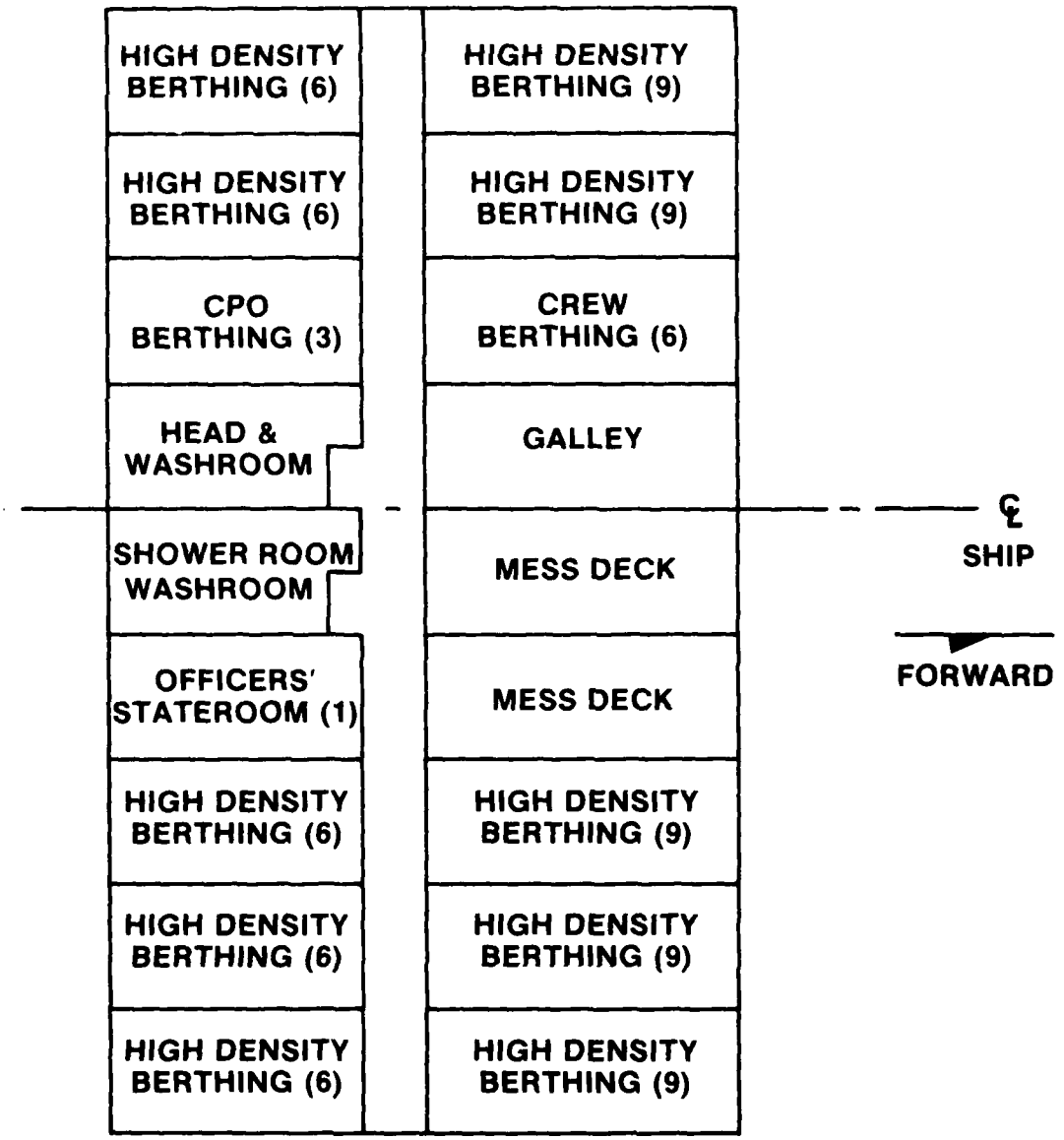


Figure 3. ARAPAHO accommodations configuration.

Concept: Prototype relocatable facility for ASW support aboard commercial container ship.

Number of people supported: 80

Endurance before resupply: Not applicable to current effort.

Requirements:

- Potable water
- Sewage disposal; trash and garbage
- Saltwater for fire mains

System elements - personnel accommodations only

8 ISO containers (8'x8'x40')
2 diesel generators (in Aviation Support Complex)

Functional elements:

Berthing (15/container)
Head/shower/lavatory
Galley/scullery

Compatable ship classes:

Preliminary tests: MA Design C5-S-736

Availability: Currently being fabricated at Naval Air Engineering Center, Lakehurst, NJ.

NAVAL SEA SYSTEMS COMMAND

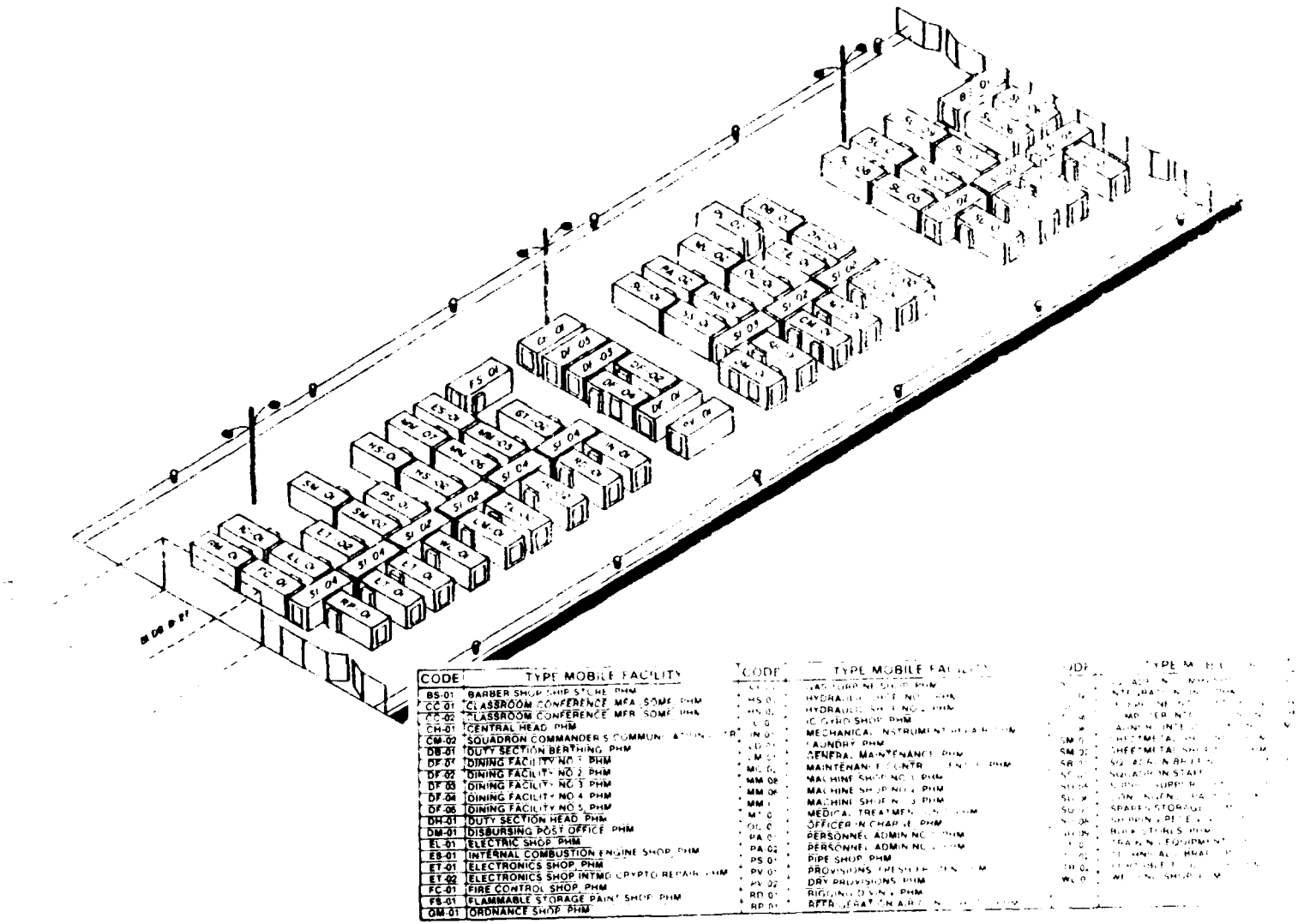
NAVSEA is sponsoring the development of the Mobile Logistic Support Group. "The Mobile Logistic Support Group (MLSG) has the mission of providing logistic support for a squadron of Guided Missile Patrol Combatant (hydrofoil) (PHM) ships" (reference 5). The program is being directed through the NAVSEA PHM Ship Acquisition Project Office (PMS 303.21).

The basic missions of the PHM Squadron are to: operate offensively against major surface combatants; conduct limited surface surveillance, patrol and blockade in coastal areas, inland waters and inland seas; provide limited anti-air warfare defense; augment screening of coastal convoys against surface attack; and special operations. Because this force is to be highly mobile and only minimal organizational level maintenance can be performed while the ship is underway, the MLSG is a necessary and vital requirement. The logistic support provided by the MLSG includes: necessary repair facilities (organizational and intermediate); administrative support; supply support (consumables, spare parts, food service, laundry service); test equipment; technical and maintenance documentation; and special training support (reference 6).

Description

To provide the required mobility and logistics support, the MLSG Facility (MLSGF) was designed around 8'x8'x20' ISO standard containers, each outfitted and configured to serve a specific function. Currently, the MLSGF consists of 61 Mobile Facilities (MF's) and 12 Integration Units (INU's). These facilities are configured into four major complexes, as shown in figure 4. The arrangement satisfies maintenance, supply, food service, and administrative/operations/ medical requirements.

A basic assumption in the design of this facility was to locate it as a tenant activity of an existing naval station or facility. Due to this basing concept, certain limitations are presented when trying to locate the facility aboard ship. The major limitation is the amount of deck space required due to the modules being connected in "L" and "T" shapes rather than a side-by-side configuration.



CODE	TYPE MOBILE FACILITY
BS-01	BARBER SHOP SHIPSTORE PHM
CC-01	CLASSROOM CONFERENCE MFR SOME PHM
CC-02	CLASSROOM CONFERENCE MFR SOME PHM
CH-01	CENTRAL HEAD PHM
CM-02	SQUADRON COMMANDER'S COMMUNICATION
DB-01	DUTY SECTION BERTHING PHM
DF-01	DINING FACILITY NO 1 PHM
DF-02	DINING FACILITY NO 2 PHM
DF-03	DINING FACILITY NO 3 PHM
DF-04	DINING FACILITY NO 4 PHM
DF-05	DINING FACILITY NO 5 PHM
DH-01	DUTY SECTION HEAD PHM
DM-01	DISBURSING POST OFFICE PHM
EL-01	ELECTRIC SHOP PHM
ES-01	INTERNAL COMBUSTION ENGINE SHOP PHM
ET-01	ELECTRONICS SHOP PHM
ET-02	ELECTRONICS SHOP INTMD CRYPTO REPAIR PHM
FC-01	FIRE CONTROL SHOP PHM
FS-01	FLAMMABLE STORAGE PAINT SHOP PHM
GM-01	ORDNANCE SHOP PHM

CODE	TYPE MOBILE FACILITY
HS-01	HYDRAULIC SHOP NO 1 PHM
HS-02	HYDRAULIC SHOP NO 2 PHM
IG-01	IC GYRO SHOP PHM
IN-01	MECHANICAL INSTRUMENT REPAIR PHM
LD-01	LAUNDRY PHM
MA-01	GENERAL MAINTENANCE PHM
MC-01	MAINTENANCE CONTROL PHM
MM-01	MACHINE SHOP NO 1 PHM
MM-02	MACHINE SHOP NO 2 PHM
MM-03	MACHINE SHOP NO 3 PHM
MT-01	MEDICAL TREATMENT ROOM
OC-01	OFFICER IN CHARGE PHM
PA-01	PERSONNEL ADMIN NO 1 PHM
PA-02	PERSONNEL ADMIN NO 2 PHM
PS-01	PIPE SHOP PHM
PV-01	PROVISIONS ISSUE SECTION PHM
PV-02	DRY PROVISIONS PHM
RD-01	RIGGING LOFT PHM
RP-01	REFRIGERATION REPAIR PHM

CODE	TYPE MOBILE FACILITY
SM-01	SHEETMETAL SHOP NO 1 PHM
SM-02	SHEETMETAL SHOP NO 2 PHM
SR-01	SQUADRON BERTH
SS-01	SQUADRON STAFF
SU-01	SUPPLY SUPPORT
SU-02	SUPPLY SUPPORT
SU-03	SUPPLY SUPPORT
SU-04	SPARES STORAGE
SU-05	SUPPLY PETTY OFFICER
SU-06	BULK STORES PHM
TE-01	TRAINING EQUIPMENT
TR-01	TECHNICAL TRAINING
TR-02	TECHNICAL TRAINING
WL-01	WELDING SHOP PHM

Figure 1. Mobile Logistic Support Group Facility (MLSGF) configuration [illegible]

However, three ship classes were reviewed for partial basing, with an LST being considered the most suitable.

The design approach used in the MLSGF development was one of sequential review and input by participating managers. Navy expertise was used throughout the design phase, ie, Navy Food Service Systems Office, Bureau of Medicine and Surgery, etc, with the Naval Sea Systems Command reviewing and approving the final design.

Synopsis

System name: PHM MLSGF

Contact: NAVSEA PHM Ship Acquisition Project Office
B Steele (202)692-0605

Concept: Prototype relocatable shore facility for patrol hydrofoil squadron.

Number of people supported: 250 maximum

Endurance before resupply:

Basic provisions support - 14 days (food, water, etc)
Repair and resupply support - 90 days (spare parts, POL, etc)

Requirements:

- Pierside real estate
- Sewage treatment; trash and garbage disposal
- POL, ammunition, provision sources
- Fire mains
- Communication facilities

System elements:

- 61 ISO containers (8'x8'x20') with doors (76"x48") at both ends
- 12 integration units with three additional (76"x48") openings in the sides
- 16 hydraulic jacks for MFs
- 8 200-kW 60-Hz diesel generators (with capability to use JP-5 fuel)
- 6 "CONFLEX" 3400-gallon liquid storage containers
- 6 air compressors

- 6 saltwater pumps

Functional elements:

Administration/Training:

- Maintenance Control Center
- Technical Library
- Office of Officer-in-Charge MLSG
- Squadron Staff Office
- Squadron Commander's Office
- Squadron Briefing/Operations Center
- Personnel/Administrative Office
- Duty Section Berthing (12/container)
- Duty Section Head (head, shower, lavatory)
- Squadron Commander's Communications Center (MF shell only)
- Classroom/Conference Room
- Training Equipment

Personnel Service:

- Dining Facility
- Central Head (head, lavatory)
- Dry Provisions
- Fresh/Frozen Provisions
- Medical Treatment Unit
- Disbursing Office/Post Office
- Laundry
- Barber Shop/Ship's Store

Supply Support:

- Supply Support Center
- Shipping/Receiving
- Bulk Stores
- Spares Storage
- Contingency Pack-Up

Shop:

- Gas Turbine
- Rigging and Diving
- Electric
- Electronics
- Electronics/Intermediate Crypto Repair
- Ordnance

- Fire Control
- Hydraulic
- Machine
- Sheet Metal
- Welding
- Refrigeration, Air Conditioning and Photo
- Portable Tool Issue
- Mechanical Instrument Repair
- Flammable Stowage/Paint
- Pipe Shop
- Internal Combustion Engine Repair

Availability: Currently being fabricated at Navy Public Works Center, Norfolk.

MARINE CORPS

Introduction

The Marine Corps Expeditionary Shelter System (MCESS) is currently being developed as part of the Field Logistic System for the Marine Corps. These MCESS modules are designed using 8'x8'x20' ISO shipping container standards and provide shoreside living accommodations for troops. Due to the lack of ships in the merchant fleet which are readily convertible to troop transport ships, the Marine Corps, in cooperation with the Naval Sea Systems Command, conducted a study (reference 7) to assess the feasibility of modular outfitting of containerships for troop transport. Completed in 1979, the study concluded that:

> "Employment of selected Field Logistic System (FLS) modules in U.S. flag merchant ships is feasible, practicable, and productive, and that modular installations can be made rapidly, effectively, and without permanent modification to the merchant ship. In this way, the program offers a solution to a logistical problem of growing severity created by the shift away from breakbulk, cargo and passenger ships and toward containerships in the U.S. flag merchant fleet." (reference 7)

Description

After a review of candidate ship classes (see synopsis), the study found the most flexible and easily-effected design to be a single hatch complex; ie, that each hold would become a self-sufficient accommodation complex. The general module arrangement for each hold is given in figure 5. The MCESS modules needed to effect the majority of this design are currently in different stages of development under the Marine Corps effort. However, due to lack of funds, further development of essential access and utility trunk modules and implementation of the concept have been prioritized to a very low level of effort. Detailed module descriptions, configuration plans and ship class studies can be found in references 8 - 10.

The berthing, head, and shower modules were developed using the habitability standards of OPNAV Instruction 9330.5A of 30 August 1965. The design of the MCESS aboard-ship arrangement incorporates the suggestions and comments of the US Coast Guard to the maximum possible extent without rendering the whole concept impracticable. However, peacetime full-scale testing would require a Coast Guard waiver.

Synopsis

Title: MCESS Troop Ship Complex

Contact: HQ Marine Corps, R Riggs, (202)697-6959

Concept: The use of the Marine Corps Expeditionary Shelter System to effect the conversion of a modern containership to a troop ship.

Number of people supported: 150+

Endurance: 30 days

Requirements: Self-sustaining assuming all utility modules are developed.

System elements:

- Modules 8'x8'x20' ISO compatible

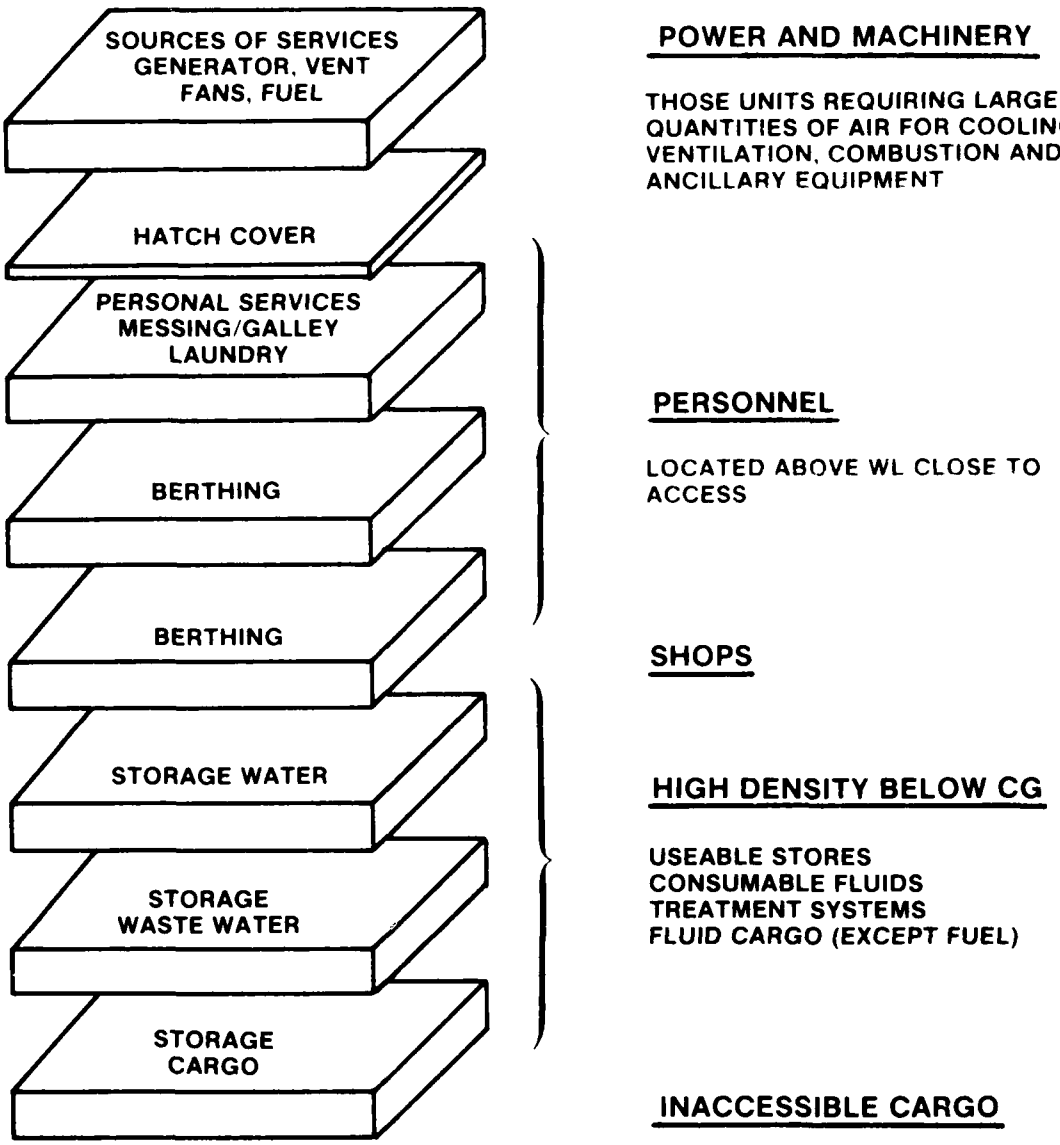


Figure 5. General module arrangement for single hatch complex (ref 7).

Functional elements:

- Officer Berth (6/container)
- Enlisted Berth (9/container)
- Messing/Recreation
- Galley
- Scullery
- Head
- Shower/Lavatory
- Laundry
- Elevator
- Stairway/Utility
- Dry Waste Storage
- Fresh Water Storage
- Fuel Oil
- Generator
- Dispensary
- Ward
- Office and Radio
- Ship's Store
- Ship's Store Storeroom
- Dry Provisions Storage
- Reefer
- Maintenance Shop
- Water Purification
- Weapons/Baggage
- Waste Water
- Fan
- Cargo

Ship Classes Studied:

1. MA Design C5-S-73b
2. MA Design C6-S-1x
3. MA Design C6-S-69c
4. MA Design C6-S-85a
5. MA Design C7-S-68c
6. MA Design C7-S-68d
7. MA Design C7-S-68e
8. MA Design C8-S-85c
9. Hull #4650 Bethlehem Steel
10. Hull #4651 Bethlehem Steel

Availability: Various stages of development and fabrication.

GOVERNMENT OR NCR RET SUBSYSTEMS

The following section describes subsystems being developed at several Navy laboratories which could be incorporated into a complete support system.

NAVAL COASTAL SYSTEMS CENTER

The Naval Coastal Systems Center (NCSC) presently is involved in accommodation module development for immediate use in the MSNAP concept. Developments to date include a berthing module and a head/shower sanitation program. Procurement specifications are written for both units and are described in reference [illegible]. Current efforts are directed toward galley development and candidate ship class analysis. [illegible] berthing and sanitation modules [illegible].

Berthing Module

The berthing module is an ISO standard 8'x8'x20' container. It is outfitted with appropriate wall and floor coverings, interior lighting, personnel access door and environmental control systems. Furnishings include berths for five personnel, lockers, a folding desk and chair, a refrigerator and fire extinguishers.

Sanitation System

The sanitation system consists of a head/shower module and a mechanical skid. The head/shower module is a standard ISO 8'x8'x20' container with a personnel access door and is equipped with two vacuum heads, two showers, four lavatories, three urinals, a portable air conditioner, and appropriate floor and wall coverings and conveniences. The mechanical skid has the 8'x8'x20' standard dimensions but is not enclosed. It consists of a vacuum collection and power tank, a sewage holding tank, a fresh water tank, two hot water heaters, vacuum and pumping systems and appropriate controls. The unit uses 1/2 pint water per flush and will support 20 men for 7 days. The unit is all electric and has Coast Guard approval for use.

CIVIL ENGINEERING LABORATORY

The Civil Engineering Laboratory (CEL) is currently developing subsystems and analyzing water recycling alternatives for the Marine Corps. The effort includes development of head, shower and laundry systems intended for use in the MCESS shelter system. Because of the MCESS troop ship concept, the designs allow ready integration to portable shipboard use. A brief description and current status of each system follows. More detailed descriptions and test results of the above systems can be found in references 13 - 15.

Head Module

The objective of the head module hardware development was to replace the standard burn-out head with a zero-effluent facility which could be installed and maintained easily. The concept involves incinerating sewage solids in a conveyor-fed combustion chamber and evaporating the liquids. By placing the screened conveyor belt directly beneath the commode, immediate separation of solids and liquids occurs, eliminating holding tanks, pumps, and controls. Inherently simple and efficient, the unit is totally electric-powered, contains minimal moving parts, occupies two pallets and will accommodate between 25 and 50 men per day. An advanced prototype design is currently being fabricated and tested, and procurement specifications should follow directly.

Shower Module

The shower module was designed as a replacement for existing portable units. Designed as a knock-down unit to operate as a stand-alone unit or within a shelter, the system consists of a pallet-size unit with four shower sections per pallet and a support module. Each shower module includes a base pan with built-in drain, supporting framework, shower nozzles and side curtains. The support module contains a water pump, in-line, instantaneous hot water heater, mixing valve and wastewater pump. The modules can be connected together and, because the power is all-electric, they can readily be used aboard ship. Procurement specifications currently are being written.

Laundry Module

The objective of the laundry module hardware development was to replace batch-style conventional washing and drying machines with a more time- and manpower-efficient system. The concept employs a continuous-cycle system with a conveyor to transport the clothes automatically through the washer and dryer processes. The process is as follows

1. The clothes are sandwiched between a double layer of teflon coated fiberglass mesh conveyor belt.

2. The clothes then move through two low-frequency vibrating rollers which cause intense agitation at the surface of the casing.

3. After washing, the clothes are spray rinsed using high velocity water jets and passed through a set of high efficiency water extraction rollers which remove 80% of the moisture.

4. The clothes are then passed through a continuous process, hot air convection dryer.

Cycle time is approximately five minutes and the laundry will handle the clothes at the rate of 300 pounds/hour. The prototype is all electric, fills a standard 8'x8'x20' ISO container, and requires two to three men to operate. Further development of the laundry unit has been suspended due to lack of funding.

NAVAL OCEAN SYSTEMS CENTER

The Mobile Systems branch (Code 7112) of the Naval Ocean Systems Center (NOSC) designs and builds custom support facilities for shipboard use. The group typically builds modularized repair facilities, special equipment modules, instrumentation modules and combined berthing, head, shower and lounge modules. The group has integrated entire ship systems for in-house towed array programs using oil field resupply ships. A description of two modules of particular interest to MSNAP follows.

Habitability Module

The habitability module is a standard 8'x8'x40' container which has been reinforced. The module includes berthing, head, shower and lounge accommodations for eight men and has provisions to be stacked.

Power Module

The 20-foot power module contains two 125-kW diesel generators and bus transfer distribution panels. Both modules have a projected at-sea life of 10 years.

AUTOMATED SYSTEMS

In an attempt to keep the scale of a temporary, modular, shipboard habitability system to a minimum, it would seem that a reduction in support personnel through vending machine technology, microwave technology, or other means of automation should be investigated. Attempts at automation were found at several DOD facilities. Those accomplishments at CEL were described in a previous section.

An effort to automate a transportable food service system was found at the Army Research and Development Laboratories, Natick, Mass. NATICK was involved in planning for a food service system for the Ground Launched Cruise Missile (GLCM) project. The concept involved Tray-pack dry food stores developed at NATICK. This new food packaging container (ie, flatcan) acts as a non-refrigerated storage container, heating pan and serving tray that can be heated in conventional food service equipment. The concept uses all throw-away utensils and requires one duty person to heat the Tray-packs, thus eliminating many traditional food service personnel. The GLCM project is currently unfunded,; however, development and testing of the Tray-pack containers is continuing.

A major attempt to automate a large-scale food service facility was conducted at Walter Reed Army Medical Center (WRAMC). The concept of an integrated, computer-dependent system utilizing factory production techniques and technically advanced equipment was to be the ultimate in food service facilities. This "ready foods" concept involved a centrally automated food processing facility utilizing cryogenic (quick freeze) technology, semi-automated patient tray preparation, computer-controlled rethermalization carts, fully automated dish and ware-washing facilities and monorail cart delivery systems. However, WRAMC experienced virtually total systems failure when the facility was opened. This was due to a number of factors, including:

1. Certain technologies incapable of supporting the concept (eg, cryogenic freezers, computer-controlled rethermalization carts, etc).

2. Key personnel changes at critical times.

3. Prototype R&D facility trying to perform a full-time patient care function.

A major renovation of the facility currently is in progress. Reference 16 is a videotaped brief describing this project and the renovation taking place. Certainly, pieces of the concept and the technology will be utilized in this renovation. The system, though not designed for shipboard use, may exhibit methods or technology which would be applicable to a small, transportable food service system. However, further development and testing of the technology would be required.

COMMERCIAL SECTOR

The commercial sector has been producing modular personnel support systems for over two decades. Applications vary from use on construction, drill, well and geophysical testing sites to more hostile conditions such as offshore platforms, drill barges and in the arctic environment. Due to the wide variety of equipments and systems available, the discussion herein is limited to a general review with regard to the MSNAP problem.

Commercial systems can provide all of the functional elements necessary for a shipboard personnel support system. The basic elements such as berthing, sanitation, messing, medical, and repair facilities are currently in use. Also, the supporting elements like desalination units for potable water, waste disposal units fuel and water storage and power generation units exist. Although the functional elements exist and are in use, there are major obstacles for the direct incorporation of commercial systems into the MSNAP operational environment.

Assuming MSNAP units are based on an ISO standard shipping container, one of the major obstacles preventing direct incorporation of commercial modules is their physical disparity from ISO shipping container standards. Most commercial modules are in either skid form or trailer form and have odd dimensions; ie, 8'x24', 10'x36', 12'x52'. These characteristics do not allow easy tie-down to ISO standard connections aboard modern container ships; ie, 8'x20, 8'x40'. Another obstacle is the disparate structural materials used in commercial systems, generally wood, reinforced fiberglass or aluminum. Although strong, it is questionable whether these modules would endure topside blue water conditions. Also, very few of the offshore modules encountered have Coast Guard approval.

Another obstacle to Navy use is the module layouts. Designed for civilian use, the accommodations are sometimes lavish with respect to Navy habitability standards. Also, some of the equipment in the modules is not suited for shipboard environments.

These obstacles and others were discussed with the manufacturers. Replies indicated the ability existed to quickly redesign and build to the Navy's specifications. With their assembly line environments and their accumulated

knowledge of available subsystems, this may be a very viable route to provide MSNAP support modules. Table 1 contains a list of manufacturers of personnel accommodations systems contacted during the course of the survey.

Firm	Address	Telephone
Aluminum Body Corp	Montebello,CA	(213)728-7611
Elder International	Houston, TX	(713)466-4353
GeoSource	Humble, TX	(713)540-2030
GIC Industries, Ltd	Edmonton, Alberta, Canada	(403)454-8626
Levingston-Armadillo, Inc	Tyler, TX	(214)877-3131
Porta-Kamp Manufacturing Co	Houston, TX	(713)869-3294
Teton Homes	Casper, WY	(307)235-1525

Table 1. List of Manufacturers of Modular Transportable Personnel Systems.

COGNIZANT DOD ORGANIZATIONS

The following DOD organizations are given as a reference. The corporate knowledge which these organizations retain should be used by designers of modular shipboard accommodations. They can provide technical assistance as well as design reviews.

NAVAL SEA SYSTEMS COMMAND

Within NAVSEA lies the Ship Arrangements Design Branch (Code 3211) Habitability Section. This section conceives new ship habitability designs, provides fleet support for existing ship alterations, and administers a self-help program to those ships effecting their own alterations. Involved with all areas of design for personnel spaces aboard ships, the section maintains habitability specifications and standards, updates manuals, and has a thorough working knowledge of Navy and MSC habitability requirements.

BUREAU OF MEDICINE AND SURGERY

The Navy's Bureau of Medicine and Surgery has within it a Surface and Sealift Medicine Section (Code 3C3). This section has the responsibility for design of all medical and dental spaces aboard ship. They maintain specifications of equipment and can review designs for technical guidance. This section maintains liaison with the NAVSEA Ship Arrangements Branch.

NAVY FOOD SERVICE SYSTEM OFFICE

The Food Service System Office administers the Navy Food Service Program. This involves technical and financial direction for all Navy enlisted food service facilities. The office also gives administrative and technical guidance for CPOs' and officers' quarters. The work includes design of ship galleys and the modular galley for the PHM mobile logistic support group.

NAVY RESALE AND SERVICES SUPPORT OFFICE

The Resale and Services Support office has the responsibility for design and specification of all afloat laundries. As such, it maintains specifications on current equipment available and the habitability and productivity requirements needed to make up-to-date designs. It is the Navy resource for laundry design and textile cleaning, and is available for technical guidance and review.

ARMY NATICK RESEARCH AND DEVELOPMENT LABORATORY

The primary mission of the NATICK Laboratories is to sustain effective military personnel under all conditions. As such, their research and development efforts include: food and food service, textiles, clothing, containers, and field support and air delivery equipment. Four laboratories are organic to this scientific community. They are:

1. Aero-Mechanical Engineering Laboratory
2. Clothing, Equipment, Materials Laboratory
3. Food Engineering Laboratory
4. Science and Advanced Technology Laboratory

The laboratories provide engineering support and operational assistance to DOD, the Armed Services and other government agencies. Developments to date are too numerous to list, but include the Marine Corps ISO galley (reference 17) for use in the MCESS system and the Tray-Pack foods packaging concept. Also,, they are providing support to other efforts which require mobile food service.

ARMY CONSTRUCTION ENGINEERING RESEARCH LABORATORY

The Facility Systems Division at the Construction Engineering Research Laboratory is involved with improving the habitability of existing facilities. The research covers conventional construction as well as shipboard systems. The staff includes environmental psychologists who do basic research in ergonomics, including the areas of social interaction, aggresivenesss, confined spaces and high density habitation. This group can answer basic

habitability questions and is available for research or design of new systems.

SPECIFICATIONS, REQUIREMENTS AND CERTIFICATION

A review of systems and equipment developed or being developed for use in temporary modular personnel accommodations aboard ships requires a discussion of applicable regulations and specifications. For a commercial, seagoing system, various government and non-government standards are followed during design, in addition to obtaining Coast Guard approval before use. In contrast, a military system is primarily based on military specifications and instructions. However, when military systems are operated aboard commercial ships, both military and federal specifications may apply. The discussion herein is based on a general review of requirements for certification for use.

Most regulations, military or otherwise, do not specifically cover temporary accommodation modules for shipboard use. If one assumes that modules used in an MSNAP application must meet all existing safety and habitability standards for commercial ship design, the whole concept may be impractical. Even the application of some military regulations would restrict development. Knowing that during a real emergency, all regulations could be waived, the obstacles to certification for use apply only to the peacetime environment.

Coast Guard regulations are the principal governing authority for commercial vessels. They allow for waivers for the testing of experimental installations. However, frequent need for waivers involving systems which do not meet safety regulations may not be granted. Therefore, when developing systems for MSNAP or other military applications being placed aboard commercial ships or involving commercial seamen, Coast Guard regulations should be followed in every way possible.

Two major areas concerning development and certification for use of a system are the mechanical requirements and the habitability requirements. Mechanical refers to elements such as structural integrity, electrical wiring or fire safety, whereas habitability refers to elements such as environmental control, personnel spaces and sanitation. Tables 2 and 3 list regulations and requirements pertaining to these areas. No implication is made that any or all of the listed requirements must be met, but they should be used as a guide to the designer of temporary modular accommodations.

Classification	Type	Authority	Document
Government	Regulations	Coast Guard	Code of Federal Regulations (CFR) Title 33; Title 46
	Specifications	Military	DOD-P-15328 - Primer (Wash), Pretreatment (Formula No 117 for Metals) (Metric)
			DOD-P-17545 - Primer Coating, Alkyd-Red Lead Type, Formula No 116 and Formula No 116D (Metric)
			MIL-I-45208 - Inspection System Requirements
		Federal	TT-E-490 - Enamel, Silicone Alkyd Copolymer, Semigloss (for exterior and interior non-residential use)
	Standards	Military	MIL-STD-129 - Marking for Shipment and Storage
			MIL-STD-130 - Identification Marking of US Military Property

Table 2. Guidelines for mechanical requirements.

Classification	Type	Authority	Document
	Standards		MIL-STD-210 - Climatic Extremes for Military Equipment
			MIL-STD-480 - Configuration Control - Engineering Changes, Deviations and Waivers
			MIL-STD-889 - Dissimilar Metals
	Standards	Federal	FS-595 - Colors
Private	Standards	American Bureau of Shipping	Rules of the American Bureau of Shipping
	Classification	National Motor Freight Traffic Assoc Inc	National Motor Freight Classification Classes and Rules
	Recommendation	IEEE	IEEE No 45, "Recommended Practice for Electric Installation on Shipboard"

Table 2 (cont).

Classification	Type	Authority	Document
Private	Test Methods	American Society for Testing Materials (ASTM)	ASTM E84 - Standard Test Methods for Surface Burning Characteristics of Building Materials
			ASTM E119 - Standard Test Methods for Testing of Building and Construction Materials
			ASTM E152 - Standard Methods of Fire Tests of Door Assemblies
			ASTM D2859 - Standard Test Method for Flammability of Finished Textiles Floor Covering Materials
International			International Rules of the Road

Table 2 (cont'd.

Classification	Type	Authority	Document
Government	Standards	Military	MIL-STD-1472B - Human Engineering Design Criteria for Military Systems, Equipment and Facilities, December 1973
			MIL-STD-1472B - Notice 2, May 1978
	Specification	Military	MIL-STD-46855B - Human Engineering Requirements for Military Systems, Equipment and Facilities, January 1979
	Handbook	Military	MIL-HDBK-759 - Human Factors Engineering Design for Army Material, March 1975
			MIL-HDBK-759 - Notice 1, June 1979
			Dept of Defense, Joint Services Committee - Human Engineering Guide to Equipment Design, McGraw-Hill, revised 1972

Table 3. Guidelines for habitability requirements.

Classification	Type	Authority	Document
Government	Instruction	Military	OPNAV INST 9640.1 - Shipboard Habitability Program, October 1979
			COMSCINST 9330.6C - Accommodations Standards for Nucleus Fleet Ships of the Military Sealift Command
	Manual	Military	NAVSEA 0964-000-2000 - Lighting on Naval Ships
			NAVSEA 0929-002-7010 - US Navy Shipboard Color Coordination Guidance Manual
	Manual	Military	NAVSHIPS 0933-005-3010 - Habitability Manual
	Regulations	Federal	US Department of Labor, "Safety and Health Regulations for Longshoring", and the "Occupational Safety and Health Act"

Table 3 (cont).

Classification	Type	Authority	Document
Government	Handbook	Federal	United States Public Health Service including Publication No 393, "Handbook on Sanitation of Vessel Construction", and USPHS and Administration's Joint Publication No PB 161019, "Ratproofing of Ships"
Private	Recommendations		Illuminating Engineering Society, "Recommended Practice for Marine Lighting"
			IEEE No 45, "Recommended Practice for Electric Installation on Shipboard"
International			Merchant Shipping Crew Accommodations, Regulations 1978, Dept of Trade, #795, Her Majesty's Stationery Office, London, 1978.
			Survey of Crew Accommodations in Merchant Ships, Dept of Trade, Her Majesty's Stationery Office, London, 1979.

Table 3 (cont).

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4. Mulquin, JJ, The Navy ARAPAHO Project, Naval Reserve Association News, Vol 29 No 2, p 5-7, February 1982.

5. NAVSEA, PHM Squadron MLSG Facilities Acquisition Plan, Revision B, September 1981.

6. NAVSEA, General Information for Guided Missile Patrol Combatant (Hydrofoil) (PHM) and Mobile Logistic Support Group (MLSG), Revision B, December 1981.

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9. EG&G Washington Analytical Services Center Modular Suiting of Merchant Ships to Troop Ships Using the Marine Corps Expeditionary Shelter System (MCESS): Final Report, Unclassified, March 1980.

10. Marine Corps Field Logistic System Quarterly Engineering Progress Report, Fourth Qtr FY 1980.

11. Naval Coastal Systems Center, Manufacture and Acceptance Specification NCSC SPEC 5382-002, Relocatable Personnel Berthing Module for the Merchant Ship Naval Augmentation Program (MSNAP), January 1982.

12. Naval Coastal Systems Center, Manufacture and Acceptance Specification NCSC SPEC 5382-001, Relocatable Personnel Sanitation System for the Merchant Ship Naval Augmentation Program (MSNAP), January 1982.

13. Civil Engineering Laboratory, Unclassified Technical Memorandum, TM-54-79-22, Marine Corps Field Head Module, TA Kuepper, November 1979.

14. Civil Engineering Laboratory, Unclassified Technical Memorandum, TM-54-81-09, Portable Laundry and Shower Facilities Development and Test Program, K Adams, August 1981.

15. Civil Engineering Laboratory, Unclassified Technical Memorandum, TM-54-79-23, Cost Analysis of Water Recycling Alternative for MARCORPS Laundry and Shower Modules, KD Adams and TA Kuepper, November 1979.

16. Walter Reed Army Medical Center WR#A1710-82-0465, Food Service Renovation Briefing, MAJ Mouritsen, August 82, videotape.

17. US Army NATICK R&D Laboratories, NATICK/TR/80/033, Marine Corps Shelterized Expeditionary Food Service System, ND Roberts, AL Murphy, Jr, RJ Buffone, Unclassified, August 1980.

APPENDIX A: CONTACTS

The following is a list of the people contacted during the survey stage of this report. They are grouped according to the appearance of subject material within this report.

SYSTEMS

ARAPAHO

NAVAIR 03
472-JP1
Washington, DC 20360
J Mulquinn
(202)692-7394

Naval Air Engineering Center
Lakehurst, NJ
CDR M Saraniero
(201)323-2394

PHM MLSGF

NAVSEA PHM Ship Acquisition Project Office
PMS 303.21
NC-3
Washington, DC
W Steele
(202)692-0605

MSNAP ACCOMMODATIONS

Maritime Administration
Washington, DC
C Cherix
(202)426-5836

MCESS TROOP SHIP COMPLEX

Commandant of the Marine Corps (LME)
HQ Marine Corps
Washington, DC 20380
R Riggs
(202)697-6959

SUBSYSTEMS

Naval Coastal Systems Center
Code 722
Panama City, FL 32407
(904)234-4180
R Bailey
B Nolte

Civil Engineering Laboratory
Code L03AB
Port Heuneme, CA 93043
D Lambiot
(805)982-4191

Naval Ocean Systems Center
Code 7112
San Diego, CA 92152
C Hansen
714-225-2164

OTHER DOD ORGANIZATIONS

NAVSEA Ship Arrangement Design Branch
Habitability Section
Code 3211
NC-3
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J Castle
(202)692-1591

Bureau of Medicine and Surgery
Surface and Sealift Medicine
Code 3C3
NAVSEA Liaison Office
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LCDR Shockley
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Navy Food Service System Office
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Army Construction Engineering Research Laboratory
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Army NATICK Research & Development Laboratories
Natick, MA 01760
LCDR Bianco Navy Liaison Office
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Walter Reed Army Medical Center
Food Service Directorate
6825 16th St NW
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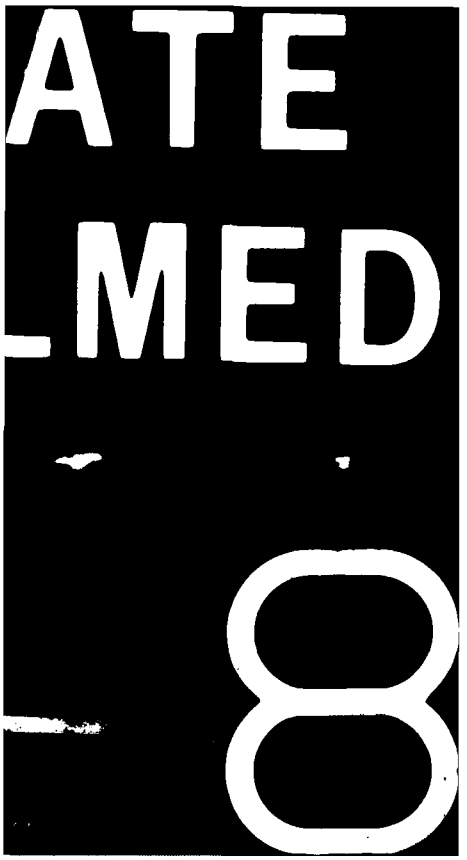
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