

Can the USMC Support Bulk Liquids Requirements in a Ship to Objective Maneuver Environment?

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Title: Can the USMC Support Bulk Liquids Requirements in a Ship to Objective Maneuver Environment?

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Thesis: Supply, specifically bulk liquids, will be the lynch pin that cripples the STOM concept's ability to adequately address how logistics support will be rendered to the combat elements.

Discussion: Operational Maneuver from the Sea's implementing concept of Ship to Objective Maneuver is dependent on a sea based logistic concept to support it. Bulk liquids will be one of the major logistics requirements needed by the Ground Combat Element during operations ashore. Traditional methods of near shore off loading and logistics dumps ashore will no longer exist. Ship to Objective Maneuver scenarios will most likely be resupplied by air. New innovative ways to support the Ground Combat Element must be conceived, tested, procured and implemented, if this concept is going to work.

Not yet determined is the size and composition of the Ground Combat Element. Personnel and equipment will both require a minimum daily supply of bulk liquids. This day of supply will be directly competing for aircraft availability with other classes of supply that the Ground Combat Elements need for maneuver.

Currently, the USMC does not possess a credible fly in bulk liquids capability that will work within the Ship to Objective Maneuver scenario. Adding to this lack of capability is a requirements system that has yet to produce a requirement or revalidate an existing one to support Ship to Objective Maneuver. This void in new direction has required the Marine Corps procurement process to continue buying to the old standard. Some of the procurement programs currently underway, such as the Expanded Capability Vehicle, have the potential to be part of the Ship to Objective Maneuver logistics solution, but need a requirement to direct it.

Conclusion: As the concept refinement process is underway with Ship to Objective Maneuver, parallel efforts must be made to create or revalidate Operational Requirements Documents to drive the acquisition cycle. These requirements, implemented now, will allow the USMC to take advantage of advances in interdependent logistical areas such as containerization and transportation.

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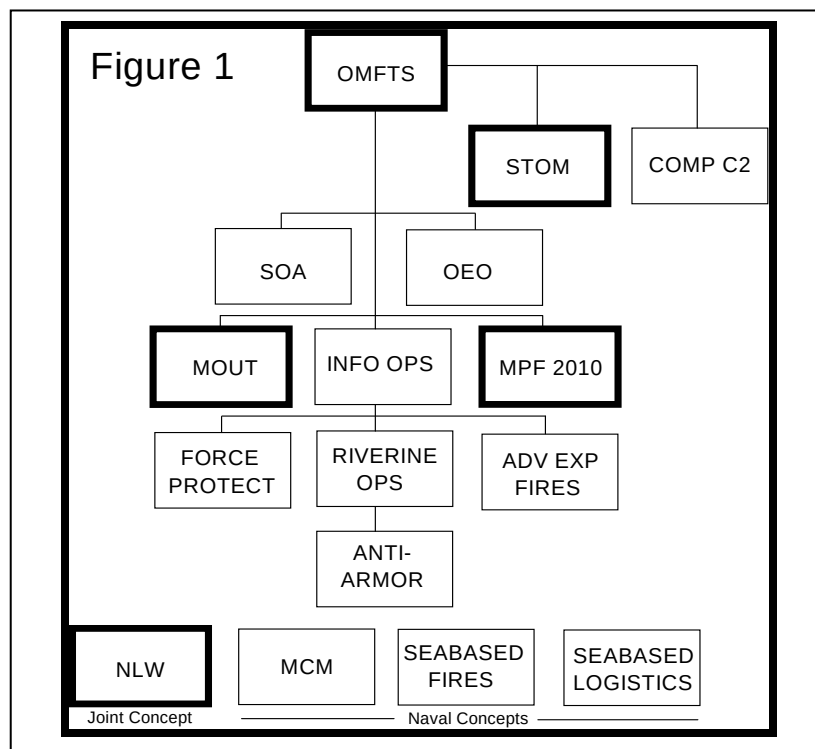
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BACKGROUND

The U. S. Marine Corps capstone concept, Operational Maneuver from the Sea (OMFTS), implements the Naval concepts of maneuver and projection of Naval forces into the littorals.¹ It guides the Marine Corps by focusing on the operational objective and uses the sea as a maneuver space to generate overwhelming tempo and momentum. It is designed to impose our will upon the enemy. To help implement this concept, figure 1 depicts key supporting concepts, based on OMFTS, that will shape the Marine Corps' vision about how it will fight in the future.²



Three concepts will shape how the Marine Corps will conduct logistics in the future. The first concept is Ship to Objective

¹U.S. Marine Corps Combat Development Command (MCCDC), *A Concept for Marine Air-Ground Task Force Logistics* (Quantico, Va: MCCDC, June 1997), 1.

²LTGEN John E Rhodes, USMC, "Every Marine an Innovator," *Marine Corps Gazette*, (January 1998): 40-41.

Maneuver (STOM). STOM depicts how the maneuver element will proceed directly from ships at sea to the objective area, without the operational pause caused by a build up of logistics ashore. The second concept is Maritime Prepositioning Force 2010 and beyond. The third, Naval Seabased Logistics, has yet to be approved. These concepts demonstrate how the Navy and Marine Corps team will sustain itself and provide a "sea" base of logistics for the maneuver force.

Current Marine Corps acquisition programs like the MV-22 Osprey Tilt Rotor Aircraft (CH-46 medium lift helicopter replacement) and the Advanced Amphibious Assault Vehicle (AAAV) (Amphibious Assault Vehicle replacement) are designed to provide the technology that will help implement these concepts. From a Marine Corps sustainment viewpoint, the delivery of many of the standard logistics staples such as ammo, fuel, water and rations are not well covered within the current scope of the Marine Corps acquisition programs. Discussion, experimentation and procurement of new hardware is still required.

The many related papers on OMFTS have expended countless pages on explanations and diagrams showing how the maneuver force will move from over-the-horizon to its objective area. however, there is little discussion on *how* this maneuver force will be supported from the sea. The OMFTS, STOM and Seabased Logistics concepts challenge the Marine Corps to provide adequate and timely logistics support for the Marine Air-Ground Task Force

(MAGTF).³ Even with full implementation of these concepts Marines will still require basic logistics support; However, they will not be hindered by a build-up phase that establishes large quantities of supplies ashore. Traditional combat service support functions will need to be provided from a seabase. One of the larger challenges and a potential show-stopper for the maneuver force is bulk liquids sustainment, this includes water and fuel. The Marine Corps has not addressed this issue adequately and faces significant shortcomings in its ability to provide bulk liquids support to future MAGTFs.

ASSUMPTIONS

This paper will assume the Marine Corps Warfighting Laboratory will be successful in conducting a series of warfighting experiments aimed at identifying the appropriate size of a STOM Ground Combat Element, along with doctrine, training, equipment and support requirements. The Marine Corps Warfighting Laboratory does not have a existing position on what the Ground Combat Element will look like in the future. This paper will assume that a STOM Ground Combat Element, in the 2015 time frame, will be a Battalion Landing Team.⁴ The paper also envisions the successful fielding of the MV-22, the AAV, and a suitable seabasing concept for the combat service support element.

³MCCDC, A Concept for Marine Air-Ground Task Force Logistics, 10.

⁴Maj Chris Yunkers, Project Officer at the Marine Corps Warfighting Laboratory, Electronic mail interview by author, 5 February 1998.

Technological advances such as total asset visibility will also have been achieved.

INTRODUCTION

It has been three years since the aforementioned concepts were introduced but we have still do not have a "workable" concept to support forces ashore from the sea. Supply, specifically bulk liquids, will be the lynch pin that cripples the STOM concept's ability to adequately address how logistics support will be rendered to the combat elements.

A standard combat unit configuration for STOM must be decided upon to allow logisticians to devise a support plan. Additionally, the refueling of aircraft during STOM can be accomplished at the shipboard embarkation point, but the need for fuel and water ashore becomes essential as the scenario unfolds. The simplest way to support a combat unit is with a predetermined day of supply for fuel and water. This day of supply can be prepackaged in collapsible and reusable containers, flown to the objective site and distributed. Containerization of materials is not a new concept to the Marine Corps. The current containers with their associated equipment, are meant for present day requirements and do not fit into STOM's vision. Developing a multifunctional container that is both compatible with the MV-22, the CH-53E and can be carried on a ground transport variant is critical for logistics sustainment in the future.

Adequately supplying the maneuver element, while allowing for its freedom of movement is critical. Supplies need to be tailored and packaged in such a way that their size is not a constraint. Limiting the amount of equipment with the maneuver element, coupled with increased fuel efficiency from new technologies, may decrease the need for fuel. However, the need for water will change as services such as laundry, hygiene, food preparation and medical are seabased. Only individual consumption demands will drive requirements needed ashore. Containerization of different liquids within the same container configuration, allows predictable ground force logistic plans.

Bulk liquids must be considered when developing supportability plans for maneuver elements in an over the horizon seabased environment. The scenarios will be based on notional units, i.e. Battalion Landing Teams, as the MAGTF's maneuver elements. This maneuver force delivered by the MV-22 and CH-53E, to an inland objective will be called the vertical force. This maneuver elements' mobility and firepower equipment capability will be limited by aircraft capability and sortie rates. The maneuver force delivered by a combination of the AAV and Landing Craft Air Cushion (LCAC), as well as the MV-22 and CH-53E will be called the surface force. This combined force has the ability to bring with it a greater complement of mobility, firepower and sustainment assets in support of the Ground Combat Element.

Both of these maneuver elements will require large quantities of bulk liquids to sustain both the personnel and equipment ashore. The large amount of bulk liquids required demand some type of logistic ground element to be present within the maneuver force to temporarily store, manage and dispense the bulk liquids. However, OMFTS, STOM and Seabased Logistics scenarios have eliminated the reliance on logistic support areas ashore.

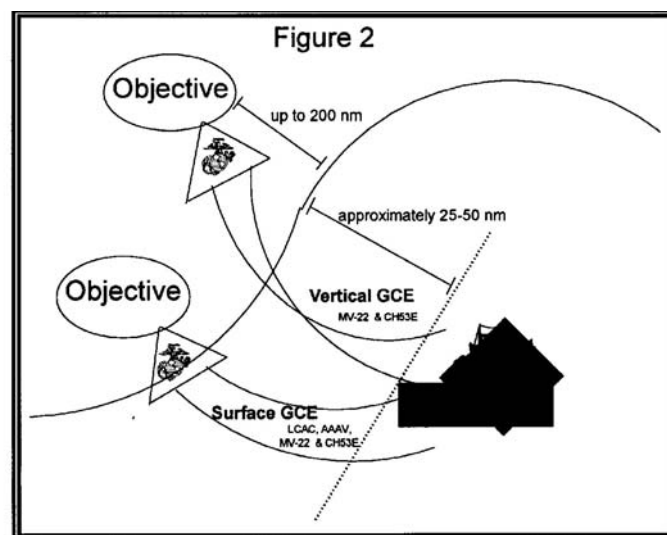
Lost in this new way of conducting operations is the separation of the landing force into the five traditional movement categories: scheduled waves, on-call waves, pre-positioned emergency supplies, remaining landing force supplies, and nonscheduled units. These traditional waves will not exist in STOM.⁵ Existing doctrine relies substantially on the near shore support shipping that provides supplies and support to personnel and equipment. This traditional approach will not be present until the transition to sustained operations ashore occurs. Recent Navy down-sizing has added to the difficulty of logistics support to the maneuver elements by the reduction and transition to the reserve fleet, of both the Landing Ship Tank (LST) and the Landing Cargo Assault (LKA). Both of these ships provided near shore water and fuel requirements during an amphibious landing and subsequent operations ashore. Loss of these bulk liquids platforms requires

⁵U.S. Marine Corps Combat Development Command (MCCDC), *A Concept for Ship to Objective Maneuver* (Quantico, Va: MCCDC, 25 July 1997), 10.

that both the Navy and Marine Corps find new ways to transfer bulk liquids ashore or develop tactical plans that require less liquids.

The Marine Corps is developing concepts that embrace new ideas and depend almost exclusively on emerging technologies. Many of these technologies have the potential to solve the future logistics needs of the maneuver force, but without a programmed research and development schedule that parallels and complements the Marine Corps' premier warfighting maneuver items being fielded, these technologies are useless. Ensuring logistics supportability of the Ground Combat Element in STOM is paramount. It is essential that programs for research, acquisition and procurement be developed to provide the supporting capabilities required when these Marine Corps' concepts come to fruition.

Logistic Support for Ship to Objective Maneuver



STOM provides the tactical implementation of OMFTS by describing the application of Maneuver Warfare tenets to Amphibious Operations.⁶ The STOM concept is still being discussed and does not specify how logistics support will be provided to the maneuver force. Logistics support could be transported by either vertical or surface lift platforms beyond the horizon. When the concept was approved by the Commandant of the Marine Corps, it was intended to provoke thought on how to improve a variety of areas to include mobility and seabased logistics⁷.

The Marine Corps' desire to invoke thought has been the basis for a variety studies and articles in professional periodicals, analyzing how the maneuver element can or can not be logistically supported. The studies and articles each portray different size elements ranging from a squad to regiment. To

Table 1 Surface Assault Force Notional Size of Battalion Landing Team (BLT)		
Unit	People	Equipment
Command Element	25	2 HMMWV, 2 M900, 2 Trailers
Rifle Company	182	2 HMMWV MRC variants
Rifle Company	182	2 HMMWV "
Rifle Company	182	2 HMMWV "
Weapons Company	154	15 HMG/TOW HMMWV
AAAV Platoon	47	15 AAAV
LAV Platoon	24	6 LAV's
Artillery Battery	150	6 M198, 9 M900, 2 M105, 2 MRC
Source: Derived from Current T/O's and Practices		

⁶MCCDC, A Concept for Ship to Objective Maneuver, 3.

⁷MCCDC, A Concept for Ship to Objective Maneuver, 13.

properly assess the logistic challenges faced by the MAGTF, this paper will use the Notional Battalion Landing Team, depicted in Table 1, as a maneuver element.

This Battalion Landing Team is equipped with one Artillery battery, one AAV platoon, one Light Armored Vehicle platoon, three Infantry Companies, a Weapons company and the Battalion Command section. Each company brings with them their High Mobility Multi-Purpose Wheeled Vehicle variants.

To understand what is required to logistically support the maneuver force, the force must be looked at as two separate maneuver groups; the surface assault group, as depicted in Table 1, and the vertical assault group, as depicted in Table 2.

Table 2 Vertical Assault Force Notional Size of Battalion Landing Team (BLT)		
Unit	People	Equipment
Command Element	25	2 HMMWV, 2 M900, 2 Trailers
Rifle Company	182	2 HMMWV MRC variants
Rifle Company	182	2 HMMWV "
Rifle Company	182	2 HMMWV "
Weapons Company	154	15 HMG/TOW HMMWV
LAV Platoon	24	6 LAV's

The surface assault force will maneuver to the objective utilizing AAV, LCAC, MV-22 and CH-53E, bringing with it all its organic combat power. The vertical assault force will maneuver to the objective via the MV-22 and the CH-53E. This vertical force is envisioned to include only the Infantry, with its organic transport, and the Light Armored Vehicle platoon. After

movement ashore is complete, both maneuver units are envisioned to be logistically supported by air delivery.

With the myriad of support requirements for the maneuver elements being filled with limited assets, bulk liquids will be competing with other classes of supplies for transportation. One direct competitor for the limited sortie lift and ground transportation capability will be the variety of ammunition required to support the Battalion Landing Team. Daily ammunition requirements will directly compete with bulk liquids for transport assets. Based on the limited aircraft sorties available, the Battalion Landing Team must prioritize how it will allocate assets to supply the maneuver element.

Table 3 Daily Bulk Liquids Sustainment Requirement for a Notional BLT				
	People	Water (gal)	Fuel (gal)	Weight (Lbs) Water/Fuel
Infantry Bn	753	3,765	132	31,626 / 243
AAAV Platoon	47	235	498	1,974 / 3,785
LAV Platoon	22	110	144	924 / 1,094
Artillery	150	750	414	6,300 / 3,146
Totals	972	4,860	1,188	40,824 / 8,268
Source: FM 100-10-1/2 ⁸ Weight of water avg. 8.4lbs/gal Water usage 5 gallons per man per day in temperate climate Weight of diesel fuel ave 7.6lbs/gal Fuel usage based on average consumption per mile for all vehicles. Consumption rates are Based on planning factors produced by HQMC/LPO on 11 Mar 97. ⁹ Estimates for AAAV are based on information from the AAAV program office.				
FARP*	18	90		13,019
*Forward Arming and Refuel point requirement. Shown here to display the tremendous amount of fuel required. This capability will be handle by the CH53E and TBFDS.				

Table 3 depicts the requirements for this Notional Battalion's daily bulk liquids. The amount of fuel and water are

⁸Field Manual (FM) 100-10-1/2, *Staff Officers Field Manual, Organizational, Technical, and Logistical Data Planning Factors, Vol 2* (Washington, DC: Department of the Army, 7 October 1987), 2-8, 2-9.

⁹Installations and Logistics Branch (Code LPO), Headquarters Marine Corps memorandum, subject: "Revised Bulk Fuel Planning Factors," 11 March 1997.

based on sustained combat in a temperate climate. Consumption factors include projections for the AAV and otherwise reflect usage rates within the Fleet Marine Forces for the last twenty years.¹⁰ Five or six sorties would be required to support the vertical delivered forces daily equipment requirement for bulk liquids and approximately six to nine sorties for the surface delivered forces because of the additional fuel burning assets that it brings ashore. These sortie rates are dependant on the aircraft availability, as depicted in Table 4, as well as susceptibility to weather conditions.

Table 4 MV-22 Sorties Required for Daily Bulk Liquids Sustainment			
Unit	Water (800gal containers)	Fuel (800gal containers)	Total Sorties
BLT	5	1	6
AAAV Plt	1	1	2
LAV Plt	1	1	2
Artillery Battery	1	1	2

To determine the bulk liquids sustainment sorties depicted in table 4, the Ground Combat Element in a STOM scenario is assumed to have only limited fire power assets at its disposal, ensuring a smaller footprint and ease of maneuverability. Firepower superiority comes from Naval Gunfire and seabased Close Air Support, driving down the need to have aircraft fueling assets ashore.

¹⁰MSgt John Ehlenburger, Bulk Fuel Project Officer at the Marine Corps Systems Command, Telephone interview by author, 5 February 1998.

The less equipment taken by the vertical maneuver element, the more likely it is to meet its stated conceptual objective of, "attack from over the horizon and strike rapidly at deep objectives, reembark, and strike other objectives before the enemy can react."¹¹ The vertical assault mission can easily allow the maneuver element to remain inland, attacking objectives in support of the overall mission and maneuvering either on the ground or vertically. The addition of artillery assets has the potential to severely overtask the ability of the aircraft to vertically move this element to different objectives, as well as, logistically support it. Given this type of scenario, aerial resupply becomes critical to mission success.

Surface delivered maneuver elements, utilizing the LCAC, AAV, MV-22 and CH-53E have the ability to take whatever firepower they deem necessary to successfully complete the assigned mission. Table 1 has assumed that the surface delivered force will maneuver ashore with its battery of artillery with associated mobility and support equipment. When the Ground Combat Force maneuvers inland, logistical resupply via surface routes does not support the basic tenets of STOM. In theory all resupply must be air delivered. Yet, this firepower and support equipment requires a substantial amount of daily resupply as illustrated in Table 3 and is susceptible to weather and small handheld surface to air missiles in the 200 mile air bridge needed to bring fuel from a seabase to the inland forces.

¹¹U.S. Marine Corps Combat Development Command (MCCDC), Ship to Objective Maneuver (Quantico, VA: MCCDC, 25 July 1997), 7.

Along with the shift to STOM as a means to achieve success with limited assets ashore, the Marine Corps must have confidence that technological advances in areas such as communications, total asset visibility, and fire support will provide the means necessary to support maneuver forces. These technology advances should provide the alternate means in which the maneuver element will receive support, such as fires. The removal of the artillery battery alone has the potential to lower the overall bulk liquids requirement by 15 to 20 percent as depicted in Table 3. This reduced requirement for bulk liquid sustainment is derived from two factors: First, and most obvious, is the reduced amount of fuel consumed on the ground. Second, is the substantial reduction in the amount of fuel consumed by the equipment used today and the potential for even better fuel efficiencies in the future. Bulk fuel planning factors have been completely revised, dropping the average hourly usage and fuel consumption rates for large end items between 30 and 50 percent.¹² Within the STOM scenario, less equipment and people directly correlates to a drop in bulk liquids requirements of approximately 900 gallons of fuel per day and 4000 gallons of water per day as shown in Table 3.

The bulk liquids sustainment problem needs to be focused on the most efficient way to keep the maneuver force constantly supplied, rather than on how to supply the total daily amount at one time. However, planners must plan for the worst case

¹²Revised Bulk Fuel Planning Factors, 1.

scenario to ensure the container assets and transport means will be present if and when required. Once assets are in place to receive, hold and transport fuel with the maneuver unit, usage rates can be predicted based on equipment within the unit and the bulk liquids support assets available for it. This method allows seabased planners to fit resupply sorties, through special instructions, into the Air Tasking Order ensuring a constant supply. Table 4 depicts how the sortie rate could be managed using an 800 gallon multi-purpose container.

Seabased Logistics

"Seabased logistics is the operational and tactical sustainment of forces operating on and from the sea. It is a Naval concept to support forces that are Naval in character but can quickly transition to an integral part of a larger Joint Task Force effort. The concept describes a means for projecting Naval power in littoral regions, from over the horizon, and at the time and place of their choosing."¹³

This concept's primary focus is the reduction of the logistical footprint ashore by exploiting existing and emerging technologies and practices for holding, maintaining, and providing supplies and support requirements to the maneuver force. In short, no longer will every item of needed supply be pushed ashore to logistics dumps and then doled out to the maneuver elements. Technology will track what is being consumed and allow resupply to be pulled, in most cases electronically, in

¹³Naval Doctrine Command (NDC), Sea Based Logistics A Naval Concept, Draft Copy (Norfolk, VA: NDC, 19 August 1997), 1.

a timely and accurate fashion by the requesting unit. Within this concept, the Navy has pointed out that,

"the plan for bulk fuel, water, and ordnance must have the highest visibility... and supplying them will absorb a large portion (if not the majority) of available transportation... other classes of supply may acquire critical import if not satisfied, but they will not impact operations as readily as water, fuel, and ordnance."¹⁴

Obviously, the authors of this concept realized the importance of bulk liquids to the success of the maneuver force. It is vitally important that the Marine Corps ensures parallel tracks for logistics support requirements and the development of logistics support equipment. As these two events occur in parallel, doctrine can be developed to mutually support both concepts. Ensuring that each of the processes occur simultaneously will ensure that the force of the future is sustainable, from the sea.

Current Concepts

As the Marine Corps moves rapidly toward the 21st century, the job of innovative thinking, concept discovery, and joint inter-operability is the assignment of the Concepts Division of the Marine Corps Combat Development Command. Of the five approved concepts in Figure 1, four require some level of bulk liquids support to ensure their success. The capstone concept, OMFTS,

"offers the promise of extraordinary leaps in operational flexibility by introducing the

¹⁴Naval Doctrine Command, 6.

notion of enhanced capability from Seabased logistics... Seabasing facilitates maneuver style operations by eliminating the requirement for an operational pause."¹⁵

It is this vision of OMFTS that creates the biggest challenge for the logistics planner. How is the bulk liquids product going to be packaged for rapid movement ashore when and where it is needed?

The STOM concept embraces new technologies and seeks to exploit the MV-22, LCAC and AAV for rapid power projection of the combined arms team ashore. It emphasizes sea based logistics as its sustainment platform for the future, citing better information connectivity to determine when and where combat units will need to be re-supplied.

From a logistics perspective, the obvious question is how are these units going to receive deliveries of ammo, chow, water, fuel and the myriad other staples required by a combat unit engaged in its mission. The "how to" has not been fully explored by the Marine Corps. The tendency is to believe that Navy's sea based logistics concept will provide all the requirements the maneuver units need without problems. It is one thing to understand what is needed and when, but quite a different problem arises when it comes to providing that need without the use of the ship-to-shore logistics capability currently provided by the LCAC and Landing Craft Utility (LCU).

¹⁵U.S. Marine Corps Combat Development Command (MCCDC), "A Concept for Projecting Naval Power Ashore: Operational Maneuver from the Sea," *Proceedings*, (June 1996): 10.

Use of MV-22 and other technologies, such as the possible application of Unmanned Aerial Vehicles and Para-foils, to fly in bulk liquid logistics, requires dedicated assets and containers that are designed to accomplish this mission.

As logistics support concepts are discussed and possibly refined into approved requirements, combat developers must keep in mind that the Marine Corps' initial operational capability for the amphibious triad will not be operational until between 2008-2015. This time frame is very short when one considers that the normal time span for a new logistic support item to be fielded is approximately 8-12 years from requirement approval to initial operational application.

In an effort to address the bulk liquids problems that have been foreseen within the OMFTS concept, working groups among the services have begun to meet on a regular basis. To centralize the working group process, the Marine Corps Combat Development Command in conjunction with the Marine Corps Systems Command, Naval Expeditionary Warfare Division and Naval Strategic Sea lift have established a joint working group comprised of military and civilian bulk fuel support experts. This group, called the "D-Day Mobile Fuel working group"¹⁶ has been charged with defining the variety of bulk fuel problems associated with OMFTS and its supporting concepts. Once defined, the group is chartered to propose possible solutions on how to supply ground

¹⁶Buck Thomas, member D-Day bulk fuel working group, Electronic mail interview by author, 12 September 1997.

forces from a sea based environment. However, this project has yet to,

“conduct any doctrinal analysis for fuel support of Operational Maneuver from the Sea, even though the concept is being refined and seems destined to be Naval Doctrine with Maritime Prepositioning Force 2010 and Seabased logistics as the way to provide logistics support.”¹⁷

This means that without the analysis of Naval and Marine Corps current bulk liquids systems, procurement programs and requirements, updated documents can't be produced. Without these new requirement documents, the Marine Corps and Naval Systems Commands have nothing to base OMFTS bulk liquids acquisition programs on. Unfortunately, without a new direction to apply efforts to, the emphasis and funding is being placed on replenishment and product improvements of bulk liquid equipment currently fielded.¹⁸

Current Bulk Liquids Capabilities

US Marine Corps

The equipment inventory for bulk liquids support currently contains the Amphibious Assault Fuel System, Helicopter Expedient Refueling System, SIXCON Container System and Reverse Osmosis

¹⁷Thomas.

¹⁸Programmed Objective Memorandum for Fiscal Year 2000 (POM-00), *Bulk Liquids Input Data*: Program Manager for Combat Support and Logistics Equipment (Quantico, VA: Marine Corps Systems Command, December 1997), 1-15.

Water Purification Unit for storage, movement and distribution support. These systems with the exception of the Helicopter Expedient Refueling System are designed for large scale, fixed, logistics operations. The Amphibious Assault Fuel Systems 600k based modular system has an extremely large footprint and is both manpower and equipment intensive. The Current Marine Corps Warfighting Publication 4-25, *Bulk Liquids Operations* is geared toward sustained operations ashore with a tremendous amount of manpower and equipment dedicated to operate the systems. Bulk Fuel alone requires the ships to come in close to shore and off load. The current inventory of Marine Corps transportation systems, trailers, SIXCON's and bladders are not well suited for employment in a STOM environment because of the tremendous logistics tail required to employ them.

Bulk water is provided either by offshore shipping or a land based Reverse Osmosis Water Purification Unit; both require their bulk liquids to be transported by some type of container. Adding to the footprint ashore the Reverse Osmosis Water Purification Unit requires a source of power, water and fixed containers. The SIXCON and Helicopter Expedient Refueling systems are capable of supplying bulk liquids from over the horizon, but fall short of simplicity because of their requirements to have support systems to move, pump, and maintain them once employed.

The only currently viable storage containers that provide ease of movement in the STOM scenario are the five gallon fuel and water cans. It can be argued that the M149 water bull and SIXCONs have larger capacities and can be air transported.

However, each of these respective systems require the large M900 or LVS series trucks, forklift and associated pumps to accomplish the transportation. This type of bulk liquid support package is not in keeping with the desire to reduced logistics footprint ashore. It requires a tremendous lift capability to deliver the equipment to the objective. Once on the objective, this equipment requires large vehicle support to move it around, adding to usage rates and footprint. 500 gallon bladders are common items with both the Tactical Bulk Fuel Dispensing System and Helicopter Expedient Refueling System. These bladders can be air lifted to the objective and with a little bit of innovation placed in some elevated area (a hill) so as to provide a head pressure to pump the liquid. The downside to this method is the inability to move the bladder once it begins to deflate. One option, since these bladders are relatively cheap, might be to abandon it once it has been deflated.

US NAVY

The ability of the Amphibious Ready Group to store fuel and water for a landing force is spread loaded throughout the many amphibious landing ships, as depicted by Table 5. The delivery of these bulk liquids, particularly fuel, can be accomplished through use of the Off Shore Petroleum Distribution System. The shortfall with this system is the requirement for the ship to be

no more than three miles off shore, and the requirement for some type of large scale containers to support the fuel when delivered ashore. Water is delivered using large containers that can be either air or surface delivered. Both the distance and the footprint required does not fit into the OMFTS or STOM scenarios.

Table 5								
Characteristics of assault ships for seabased logistics ¹⁹								
Ship type	Troop	Vehicle (sq ft)	Cargo (cu ft)	Helicopter (CH-46 eq.)		Landing craft	Water cap/dis (000) (gal)	POL cap (000) (bbls)
				Stow	Ops			
LPH	1,489	3,400	40,500	26	7	--	122/100	6.9
LPD-7	788	11,300	18,600	4	2	4 M-8	92/60	6.6
LHA	1,713	25,400	105,900	42	9	or		
						1 LCU		
LSD-41	454	13,100	5,100	--	1	7 M-8	178/140	0.7
						or	4	
LHD	1,892	20,100	125,000	45	9	LCU		
						3 LCU	61/60	0.7
LSD-49	454	15,500	50,700	--	1	8 M-8	178/140	9.5 ¹
						or		
LHD	700	25,500	25,500	4	1	4 LCU		
						6 M-8	61/60a	0.7 ¹
LHD	700	25,500	25,500	4	1	or		
						2 LCU		
						1 LCAC	unk	unk
1. Estimated water and POL Characteristics								

As stated before, the difficulty is not bringing the bulk liquids into the theater of operations, but getting the logistics support to where it is needed most. The backbone of the OMFTS and STOM concepts relies heavily on the Amphibious Triad of the MV-22, AAV and LCAC to assault and then support the assault from over the horizon. The only portion of the Triad in service today is the LCAC, and this asset is only partially fielded. The LCAC

¹⁹Center for Naval Analysis (CNA) Research Memorandum 91-6, *Supporting Amphibious Assault from a Sea Base* (Alexandria, VA: Center for Naval Analysis, April 1991), 5-12.

provides the only capability for large, non-air transportable equipment to accompany the surface assault force from over the horizon.

The current LCAC fielding plan is spread out over the future years' defense plan to ease the overall procurement cost of purchasing these items. This strategy is uniquely flawed. When the last LCAC is delivered, a percentage of those originally fielded will no longer be in service, lowering the availability of landing craft to provide logistics sortie support. Use of the LCAC to support the assault with floating fuel and water platforms has been discussed and experimented with, within the Fleet Marine Force. One shortfall of designating LCACs for bulk liquid support is the loss of these scarce assets for transporting the maneuver forces to support other various logistics requirements. Each platform would also require some type of logistics preparation for set up, load and off load of bulk liquids to some type of container. While all of this is feasible, the loss of these lift assets to logistics fuel dumps would strain a limited supply of LCACs. This limited supply of assets, and the need to solve the problem is frequently discussed within the D-Day Mobile Fuel working group, but it is assumed that if the assault momentum is being stalled for lack of bulk liquids support assets, the lift resources required would be made available.²⁰

²⁰Thomas.

Future Capabilities

Advanced Amphibious Assault Vehicle

As currently planned, the AAV will provide the over the horizon and land based troop transport for the Marines' assault capability of the future. The AAV program office's current procurement schedule shows that this maneuver capability will meet its initial operational capability in 2008. The surface maneuver element will most likely employ the AAV as a troop carrier and direct fire support weapon during combat operations ashore.

The fuel consumption of the AAV is 1.3 gallons per mile on land and five gallons per nautical mile. The AAV has a fuel capacity of 420 gallons.²¹ The employment of the AAV is envisioned to start about 25 nautical miles off shore, using the sea as a maneuver space. When it comes ashore it is expected to have approximately 295 gallons of fuel left or 250 miles remaining for maneuver. Depending on the distance to the objective, the AAV will most likely need refueling 24 to 48 hours after it reaches land. Refueling the AAV to achieve a full tank is not always a requirement to accomplish the mission. Common sense and mission requirements can allow for the spread loading of additional fuel throughout the AAV platoon. This will ensure availability and maximum distribution of fuel without burdening the logistics system with requests for additional fuel to fill gas tanks to their capacity.

²¹LTCOL Clayton Nans, USMC, "The AAV Program" lecture presented at the Marine Corps Research Center, Quantico, VA, 24 February 1998.

MV-22

As currently planned, the MV-22 will provide the vertical mobility required for the assault maneuver forces in the STOM concept. These aircraft have an internal load capacity of 20,000 pounds or an external load capacity of 15,000 pounds. Initial operational fielding for this asset is 2002. It is envisioned that the resupply logistics fuel container can be carried internally. This will give the aircraft maximum speed and maneuverability as it flies over hostile territory delivering its cargo. While the MV-22 has a substantial external lift capability, its use comes at the expense of speed. The MV-22 cruises at 240 knots with an internal load, but 150 knots or less with an external one. The external load configuration has the potential to slow the aircraft down by 30%, making it very

susceptible to surface-to-air missile fire.²²

Day of Supply Requirement

The average day of supply requirement in sustained combat operations for an air delivered assault unit is approximately 1200 gallons of fuel and approximately 5000 gallons of water, as previously shown in Table 3. The day of supply can easily be packaged in 800 gallon containers and delivered to the objective area. Consumption rates of fuel and water need to be monitored through advanced technologies that provide both the maneuver

²² LT Mark W Beddo, USN, "Logistical Implications of Operational Maneuver From the Sea" *Naval War College Review*, (Autumn 1997): 37.

force and the seabased logistics systems with real time and exact usage rates. Pre-planned minimums should be monitored and resupply needs to be electronically pulled to ensure ample quantities of bulk liquids are on hand. Dedicated logistic support vehicles, to be brought in with the maneuver force, with self loading and unloading capabilities must be developed.

Supportability Shortfalls

Supporting the STOM elements creates a unique supply support requirement for the commander. Even though resupply by air is not a new issue to the Marine Corps, daily resupply from a sea based logistics platform, with the potential to travel up to 200 nautical miles, is new. Critically lacking for bulk liquids support is the means to package, transport and dispense fuel and water while maintaining a reduced footprint ashore with lightweight maneuver forces. The Marine Corps must be able to place the right amount of logistics at the right place and time without creating an operational pause for buildup of combat service support ashore. "As the Marine Corps gets closer to implementing this concept, logisticians must come forward and lay the problems on the table for all to see and discuss."²³

Bulk liquids will be the main logistics challenge to the force in the future. As the Marine Corps continues to flesh out the various implementing concepts of OMFTS, it must ensure the requirements and acquisition process are given the necessary

²³LTCOL Les Stein, USMC, "OMFTS/STOM Logistics" lecture presented at Ellis Hall, Quantico, VA, 25 February 1998.

tools and funding to keep pace with the emerging changes. The tools to accomplish this requirement come in the form of revalidated or new Mission Needs Statements describing a specific need that is lacking in the Fleet Marine Force. This need is then turned into an Operational Requirements Document by fully integrating it within the scope of current operational doctrine by scrutinizing them through the doctrine, operational, training, education and supportability process. These documents, coupled with a high funding priority, are the main catalyst in obtaining material solutions through the acquisition process.

Current Bulk Liquids Acquisition Process

The ongoing programs within the bulk liquids community do not reflect the changing nature of the Marine Corps warfighting concepts. The most recent Mission Needs Statement²⁴ for bulk liquids systems is dated 1992. Our current bulk liquid systems are geared toward expeditionary operations ashore and are well suited for large scale, logistically intensive missions. The changing requirement for bulk liquids has been a hot topic for quite some time among Marine Corps logisticians. However, other priorities have continually disrupted the writing process to modernize the requirement for both technology and concept supportability.

The Marine Corps needs an acquisition program for new bulk liquid equipment. Many of our current Operational Requirement

²⁴Mission Needs Statement (MNS) No. LOG 216.3.10, Bulk Fuel Delivery Subsystem, CH-53E (Quantico, VA: Marine Corps Combat Development Command, 12 September 1992)

Documents are over 20 years old. The lack of new and revalidated documents have forced Project Officers to purchase replenishment stocks and equipment based on 1970's and 1980's tactics. This process will ensure that the Marine Corps will have a substantial amount of bulk fuel and water systems to meet the logistics support needs in the future, however it is all be based on the old doctrine. To fully embrace the new concept of OMFTS and STOM, these old style, land based, systems simply do not fit in. A combined bulk liquids acquisition program that requires the Marine Corps to research, develop and procure systems that fit into a seabased logistics and STOM environment must be written and adopted. Ignoring this requirement until OMFTS platforms are fielded only exacerbates the problem. Given the current initial operational capabilities of the OMFTS platforms, if supporting programs are not begun in parallel, then it will be 2020 before we can truly say we are STOM capable and supportable.

The Programmed Objective Memorandum submission for Fiscal Year 2000 (POM-00) reflects the large scale bulk liquids logistics programs and is shown in Table 6.

Table 6 CURRENT BULK LIQUIDS ACQUISITION PROGRAMS IN POM-00²⁵			
Tactical Fuel Systems (TFS)	Highly versatile fuel systems designed to receive, store, transfer and dispense fuel in support of MAGTF operations ashore	Programs within this program are the: -Amphibious Assault Fuel System (AAFS) -Helicopter Expedient Refueling System (HERS) -SIXCON Fuel and Water Distribution System	\$\$ over FYDP in Millions 23245
Hose Reel System (HRS)	Stand alone system that provides a linear	HRS provides a 5 mile reach with 11 reels each containing 2400'	

²⁵POM-00, 1-15.

	fuel transfer between TFS	of lightweight hose. Requires Motor Transport augmentation to employ	16505
Water Supply Support Equipment (WSSE)	Provides all aspects of land based water support to include water analysis, pumping, storage and distribution	WSSE is a roll up line for 24 different items associated with storage and distribution of potable water.	13201
Enhanced Reverse Osmosis Water Purification Unit (EROWPU)	Provides the MAGTF with an enhanced capability to produce 1200-1500 GPH of potable water.	EROWPU produces potable water from salt, brackish, and fresh water sources. 70% of current family of ROWPUs exceed current repair criteria and don't meet the need for the MAGTF.	87668

The Tactical Fuel system, which in reality is a system of bulk fuel assets, contains the Amphibious Assault Fuel System, Helicopter Refueling Systems and the SIXCON fuel and Water Distribution System. Except for the SIXCON, which can provide limited support, they are not suited for the STOM environment. The Hose Reel System is currently being developed to simplify sustained operations ashore. This system is a large truck mounted reel that allows 600 foot sections of a six inch lightweight discharge hose to be reeled both out and in, with the capability of being coupled together for any desired length. It is a vast improvement over the manual system, but not practical for the STOM environment.

The Water Supply Support Equipment is a system of water purifiers and containers that contain little useful application in the STOM environment. Lastly, the Enhanced Reverse Osmosis Water Purification System, requires a myriad of support equipment and a semi-permanent location with a constant water source.

These programs represent over \$140 million dollars earmarked for sustained bulk liquids support ashore and nothing towards the STOM equipment solutions.

POM Cycle

Fielding new equipment takes approximately 8-12 years depending on the technology involved and the availability of projected funding. The next POM cycle will occur for 2002. This means that if material solution requirements are generated, which usually takes anywhere from one to two years, and programs are initiated, the Marine Corps could see this new equipment between the years 2010-2014. This time frame is approximately two years after the initial operational capability for the AAV and eight years after the initial operational capability of the MV-22. Commercial-off-the-shelf technologies may shorten the time sequence, but as stated previously the Marine Corps needs an approved bulk liquids Mission Needs Statement or Requirements Document before they begin their search for a solution.

As a concept based requirement system, Marine Corps requirement developers and acquisition personnel must be fully immersed in the new warfighting philosophy and understand what the concepts are meant to accomplish. This involvement will drive the thought process and clarify the needs involved in obtaining a solution for the material requirements.

POSSIBLE SUPPORT DIRECTIONS **Containers**

The amount of bulk liquids consumed can be supported by aerial resupply if the vertical assault force is reduced to its organic infantry companies and equipment plus the Light Armored Vehicle section. The surface delivered force, with the addition of the artillery, increases the requirements for bulk liquids by 15 to 20 percent as depicted on Table 3.

To meet the intent of STOM a container that can overcome all of the operational employment constraints must be developed. This, of course, assumes the aircraft availability for both logistics and Close Air Support to achieve this resupply. The Marine Corps' current bulk liquids delivery systems do not meet this challenge. Development of a new container must meet these basic requirements; collapsible, light weight, easily stored, filled and discharged, internally and externally liftable with the MV-22, include a removable bladder and is both self-loadable and transportable by the logistics vehicle system. This container must meet the challenges (cube, footprint and weight limitations of ground transport assets) of the future.

Current technologies, such as the Palletized Loading System being used by the United States and British Armies, have shown that this type of loading, unloading and transporting can be accomplished in a quick and simple manner. Discharging the contents can be achieved through two simple methods, gravity and over pressure. Both these methods alleviate the need for pumping assets. Multiple outlets and fittings can be arranged to support any combination of vehicle or personnel requirements.

Support is only as good as the weakest link. In this case, the amount of bulk liquids the container should and can hold must not exceed the payload capability of the smallest transport platform within the chain of movement. The ground transport platform is envisioned to have the least amount of payload weight capacity.

Designing these containers with removable bladders allows the flexibility needed to use them for supplying ammo, chow and other requirements. These platform based containers can be dropped anywhere by the CH-53E and MV-22, dragged if needed or abandoned if required.

Heavy High Mobility Multi-purpose Wheeled Vehicle

The High Mobility Multi-purpose Wheeled Vehicle Program Office which controls a series of tactical wheeled vehicle variants is currently in the process of creating a number of new variants. One of these variants is called the Expanded Capacity Vehicle. This Expanded Capacity Vehicle is being designed to have a payload capacity of 5,300 pounds with the standard bed and side wall features common among the High Mobility Multi-purpose Wheeled Vehicle series of vehicles.²⁶ Using the Expanded Capacity Vehicle design, but removing the cargo bed and replacing it with rails and technology that emulates that of the palletized loading and DROPS systems is feasible. This variant would have the potential to provide the means to maneuver the bulk liquids

²⁶MAJ Rob Chappell, USMC, Light Weight Fleet Project Officer at the Marine Corps Systems Command, interview by author, 6 January 1998.

with the ground element. As mentioned previously, parallel efforts need to be undertaken between both Marine Corps Combat Development Command and Marine Corps Systems Command to ensure that material solutions, such as the Expanded Capacity Vehicle, are incorporated into the concept-to-requirement process. The designs need to be influenced to provide a material solution that fully implements the STOM requirements in the future.

Personnel Support for Bulk Liquids in STOM

Forward Logistics Element

Typically, the logistics support units come from the Combat Service Support Element in the MAGTF. STOM envisions that these elements will be seabased along with a majority of their capabilities. However, to best support the Ground Combat Element, specialized members of the Combat Service Support Element need to be task organized and embarked with the Ground Combat Element in a direct support mode. This forward logistics element would notionally consist of military occupational specialties of 1391 bulk fuel men and 1171 water equipment specialists, as well as other experts that the Ground Combat Element would require for direct logistics accountability and support. These forward logistics elements would be attached directly to the ground element's S-4, operate the bulk liquids support vehicles, and account and distribute the fuel and water.

CONCLUSION

The Marine Corps is in the midst of a doctrinal revolution which will make it the premier littoral fighting force for the 21st century. The key drawback with this revolution is the fiscal constraints placed on the developers and innovators who must compete for dollars with real-time operational requirements.

The question remains, is bulk liquids supportability in a STOM feasible? Yes, the MV-22 has the potential to provide bulk liquids support to the maneuver elements. However, without the Operational Requirements Documents to drive the acquisition cycle, advances in interdependent logistical areas such as asset visibility, containerization, fuel efficiencies and transportation will not be fielded, thus failing to provide the Ground Combat Element with the necessary tools to implement this concept. The Marine Corps cannot afford to continue to procure assets, with limited available funding, that support 1980's requirements. The loss of this precious funding in the procurement, fielding and support of equipment that will not meet the challenges of the littoral battlefields of the future, will push the time frame for supporting OMFTS well into 2020 and beyond.

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