USAWC STRATEGIC RESEARCH PROJECT

A HIGH-MOBILITY ARTILLERY ROCKET SYSTEM: PROJECTIONS FOR THE FIRE SUPPORT COMMUNITY

by

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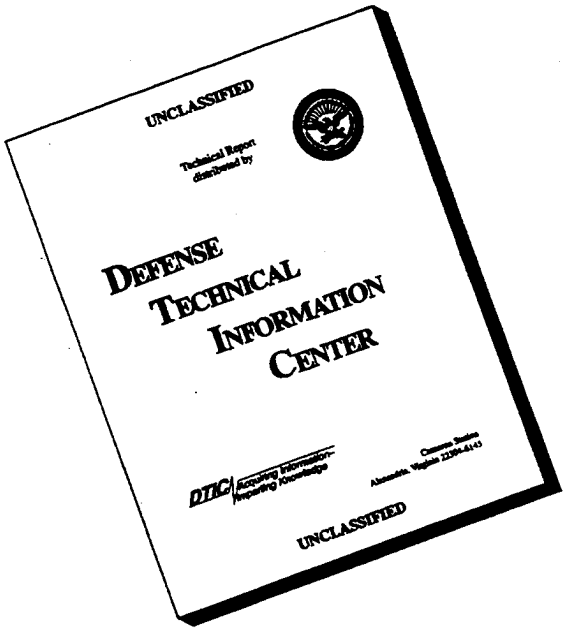

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ABSTRACT

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"The weapon systems we have in support of our light forces are aging-we need to update them" (Rigby 4). This project addresses the issue from the standpoint of fire support (i.e. indirect fire support systems) for tomorrow's early entry and light combat forces. Committed to a discussion of the Army's new High Mobility Artillery Rocket System (HIMARS), this research serves to address the historical perspective, specifications, tactical considerations and finally, overall assessment of HIMARS in the field artillery community. Recommendations for the utilization of the system for the Marine Corps, with more specific applicability to the reserve components of both the Army and Marines, conclude the work.

INTRODUCTION

The threats facing tomorrow's armed forces differ from those encountered before the breakdown of the Iron Curtain by yesterday's forces. The planning for massive encounters of armored divisions on the plains of Europe has given way to smaller skirmishes as demonstrated in Haiti, Somalia, and the Balkans. These types of small but potentially violent actions have created drastic change upon the armed services. The methods and equipment needed to be successful in these encounters are not necessarily met by traditional heavy armored forces, but rather lighter more deployable forces.

Force projection has also become increasingly important. The Army is now a force located within the United States. Therefore, for today's Army to be effective, it must be able to project itself to the theater of conflict in a most timely manner.

Light combat forces are tailored to meet the aforementioned criteria. However, the ability to be light and highly mobile must not be sacrificed in exchange for firepower necessary to both accomplish the mission and offer the American soldier his/her greatest survival protection.

HIMARS, a newly developed system, would appear to meet these needs while providing the overwhelming firepower on which soldiers have come to depend. Its place in the reserve component has yet to be determined. However, as downsizing continues and more of the combat services are placed in the reserves, this may well be the most important issue.

HISTORICAL PERSPECTIVE

As early as the 1980's the Army envisioned the need to not only increase the number of light divisions, but also expand the roles and missions of those light divisions. In 1982 in response to this requirement, the 9th Infantry Division submitted the request for a light-weight, easily transportable, indirect fire support system when it published its Quick Reaction Plan. By the end of the decade, as the Cold War threat diminished, interest in a deployable multiple rocket system to support light forces heightened. By the end of that decade, the M-270 Multiple Launch Rocket System (MLRS) system fielding was in full swing, yet the system, for a variety of reasons did not fulfill the needs of light forces.

In April 1990, the Field Artillery School in Fort Sill, Oklahoma formally documented the need for a light multiple rocket system reaffirming the aforementioned need. The system was designated High Mobility Artillery Rocket System (HIMARS), see Figure 1. In mid-September the Training and Doctrine Command (TRADOC) Commander wrote a letter to industry to alleviate their reluctance to commit research and development (R&D) resources, "TRADOC support for the HIMARS program has not waned. Indeed recent world events (the crisis in the Persian Gulf) serve to highlight the need for such a capability. The HIMARS program will continue to receive full TRADOC support... " (DoD 2).

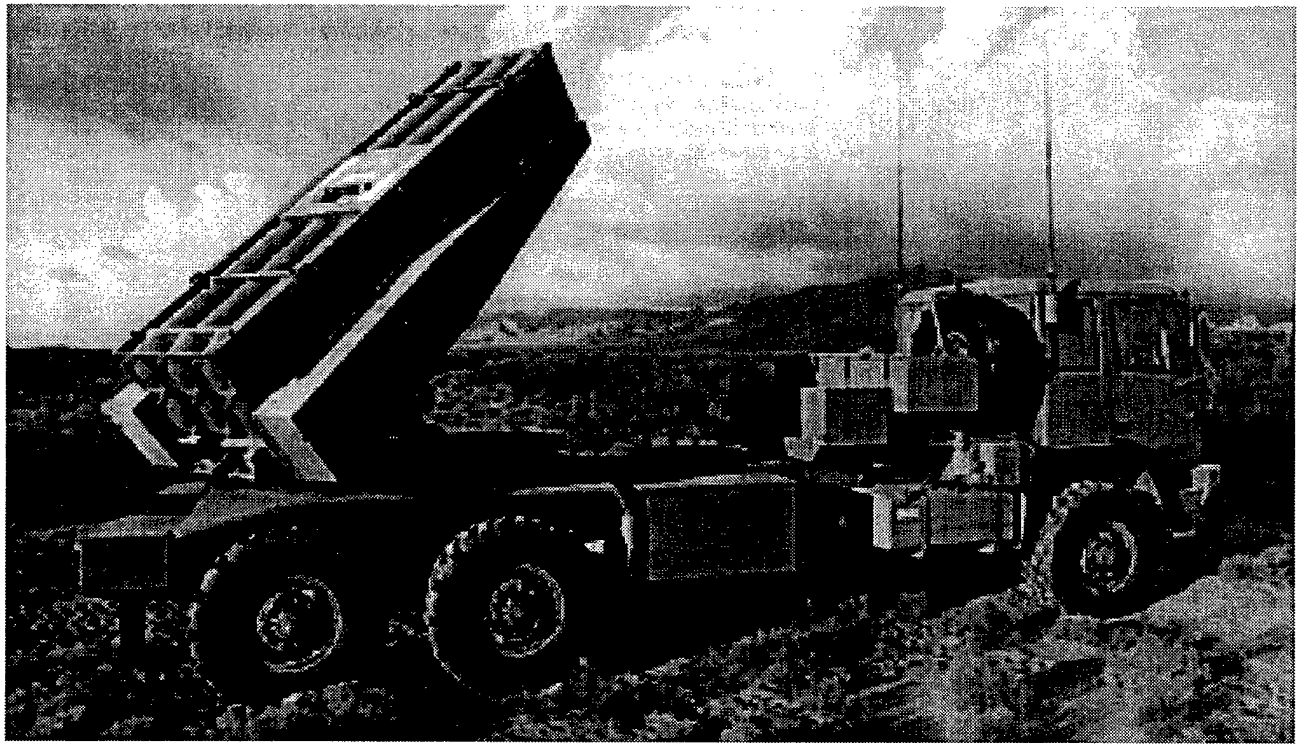

Figure 1. HIMARS

Initially, this HIMARS was developed as a private venture by Loral Vought Systems to meet a possible U. S. Army requirement for a lighter and more mobile version of the MLRS, one which might be assigned to corp field artillery brigades in support of light-divisions and contingency force operations while having the capability of being carried by the Lockheed C-130 Hercules aircraft.

The HIMARS system was first unveiled in the United States for the world to see in 1993 at the Fall Association of the U. S. Army (AUSA) convention in Washington D.C., and was shown for the first time in Europe in September 1994. HIMARS development continues at a rapid pace. Four prototypes are being built with three to be in support of the Rapid Force Projection Initiative (RFPI). Loral Vought has been granted the contract to build and deliver the prototypes in 1998-99. During FY 98, soldiers of XVIII Airborne Corps out of Fort Bragg, North Carolina, will field test the prototypes for twenty-four months, providing feedback to help expedite design changes (Rigby 4). These projects have been funded through 2002 with procurement beginning in 2005 (Dubia 4). The Army acquisition objective has tentatively been set at 160 systems by FY 2006. An effort to accelerate the program is ongoing, see Figure 2.

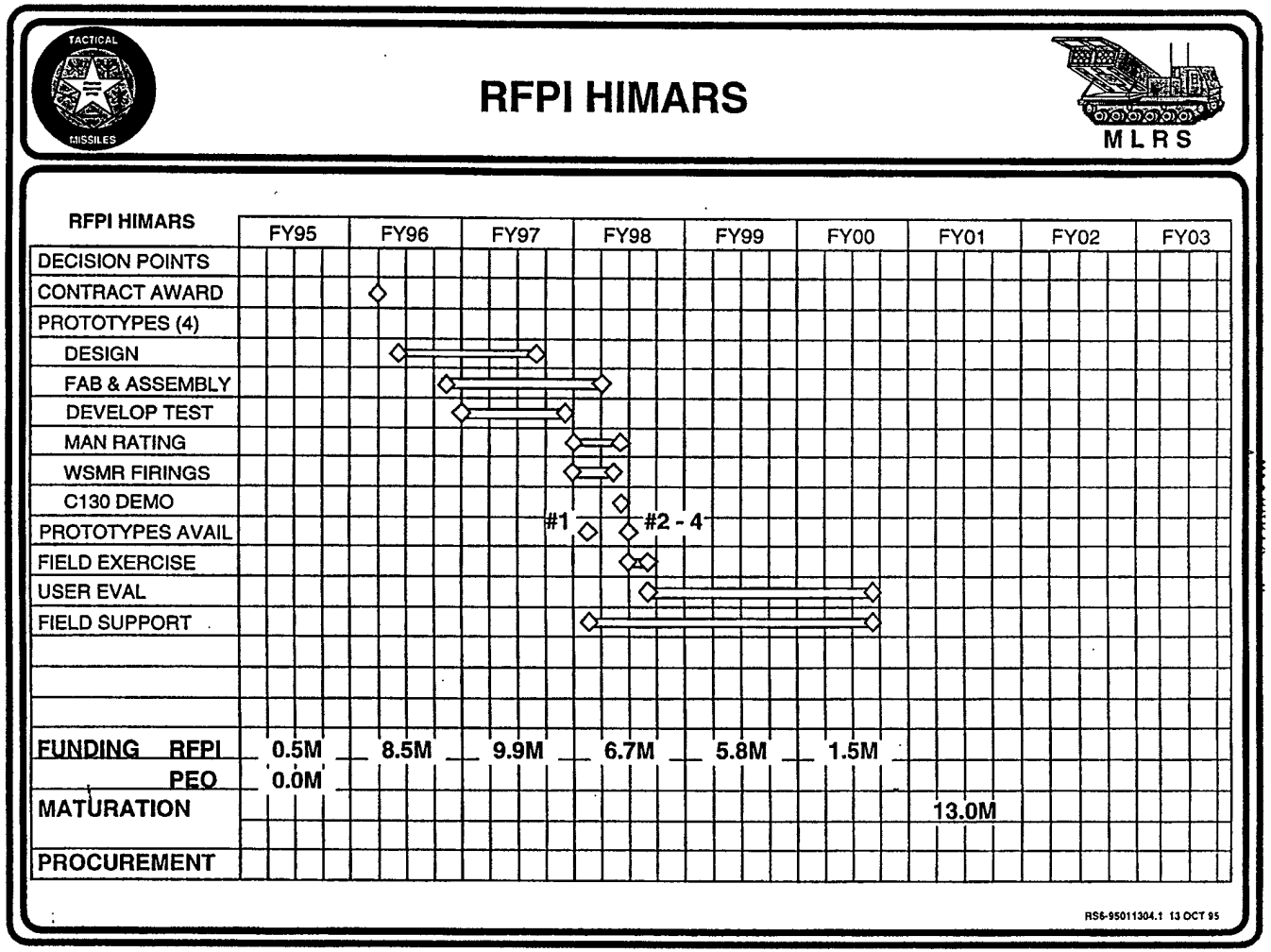

Figure 2. Rapid Force Projection Initiative.

Overview Of Systems Designed To Fulfill Light-Weight Division Needs

A complementary system of tube and rocket fires is being considered. Conventional artillery fires will utilize a new tube system known as Advanced Cannon Artillery System (ATCAS). The ATCAS will provide light forces a lighter weight, medium howitzer that can fire all current 155-MM munitions to a range of at least thirty kilometers with low and high angle fire in all directions. The rate of fire is between five and eight rounds per minute, as contrasted to four rounds of the present M-198 system. The chief advantage of ATCAS, however, would be its reduction in weight, making it more transportable—an important consideration for light divisions.

The HIMARS was dedicated as a system to provide rocket fires for the light divisions. This light-weight multiple rocket system had to satisfy a multitude of requirements such as: provide for interdiction, counterfire, engage deep targets and be C-130 transportable (the most difficult requirement). The HIMARS and ATCAS systems are expected to be employed as a light-heavy force mix. HIMARS is based on the need for a lighter weight, more deployable MLRS that can be sent anywhere in the world to quickly provide the maneuver commander lethal, close and long range fires (Froysland .02). With its "shoot-and-scoot" tactics, HIMARS units' survivability will be greatly enhanced (Waldeck 23). This ATCAS/HIMARS mix is well-suited for theaters which have narrow roads and limited maneuvering space such as Korea. The lighter weight of the HIMARS allows it to be transported by the C-130, which will give it rapid intra-theater mobility. This, coupled with the fact that it is wheeled and relatively light-weight, enables it to be rapidly and deeply entrenched in operational maneuver areas.

In initial operations, HIMARS and ATCAS will protect the force from threats ranging from harassment by mortars to ballistic missiles carrying weapons of mass destruction. These systems will allow commanders to shape the battlespace from the

beginning of the campaign. As the campaign progresses, the commander will use light forces to alter the tempo of the battle by employing air-mobile operations. HIMARS and ATCAS will protect his air bridgeheads. Together, these two systems will provide the optimal mix of cannon, rocket, and missile fires for light support, while requiring minimum strategic and intra-theater lift support (Rigby 4).

HIMARS Specifications/Modifications

The HIMARS is built on the chassis of the Army's new five-ton family of medium tactical vehicles. A major advantage of this wheeled platform will be a significantly greater capability to travel considerable distances required for future battles. Primarily utilizing the 6 x 6 version of the Family Medium Tactical Vehicles (FMTV), the HIMARS launcher can be fitted to other 6 x 6 tactical truck chassis types.

The HIMARS is able to fire the entire MLRS Family of Munitions (MFOM) (i.e. M-26 Basic Rocket, M-28 Practice Rocket, M-26A1 Extended Range Rocket), including the Army Tactical Missile System (ATACMS) (i.e. ATACMS Block 1 and ATACMS Block 1A) with the same effectiveness as when fired from the M-270. The ATACMS is a highly effective, very long range, deep attack missile (as attested to in Desert Storm), see Figure 3.

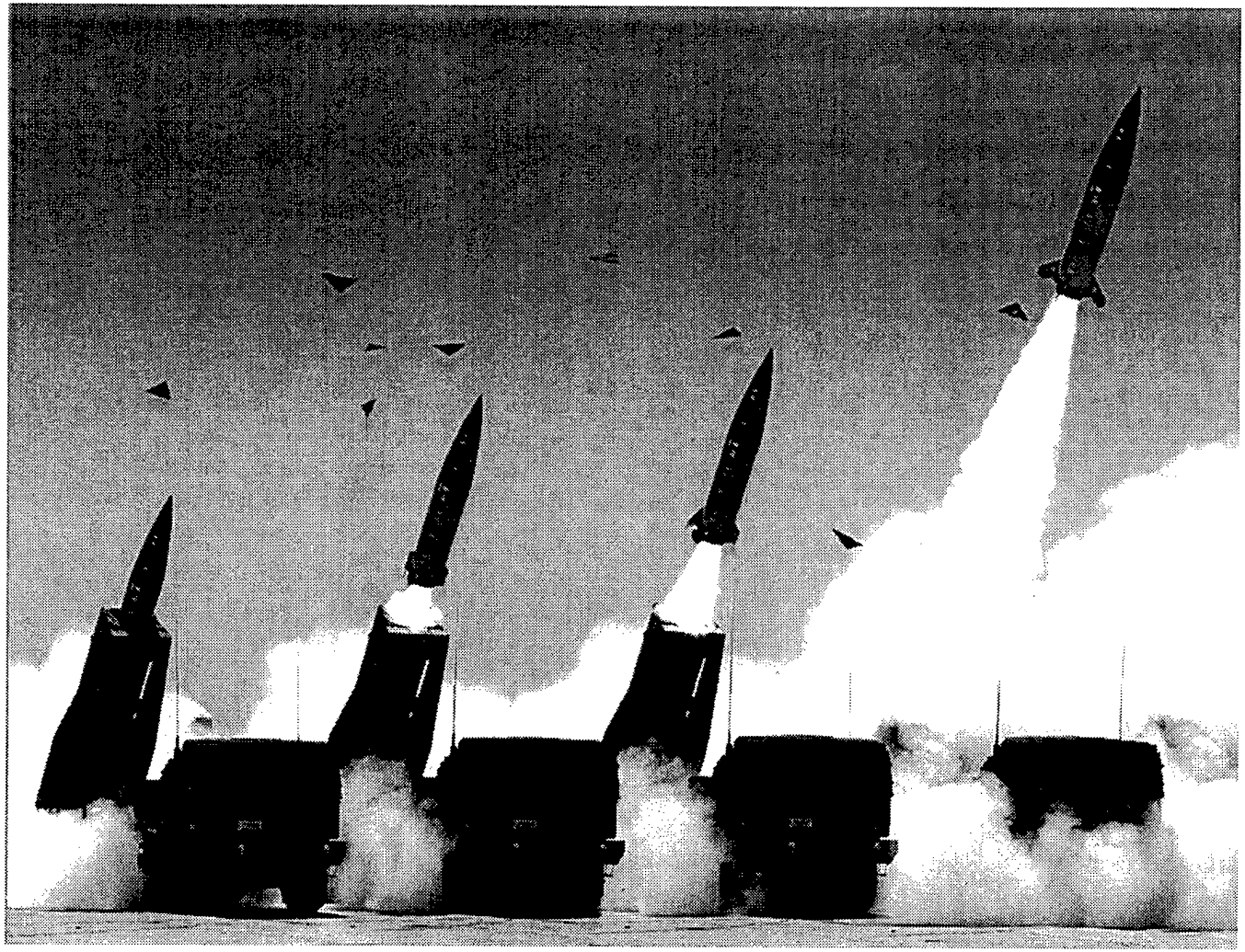

Figure 3. ATACMS being fired from HIMARS.

Weighing in at only fifteen tons (about thirteen tons lighter than the M-270), HIMARS will also be C-130 transportable, allowing it to be moved into areas in overseas theaters that were previously inaccessible to the larger C-141 and C-5 aircraft required to move the M-270. Light rapid-reaction forces would thus be able to deliver the system's heavyweight artillery punch. Resupply will be provided by a Heavy Expanded Mobility Tactical Truck (HEMTT) which carries four fully loaded rocket pods, and its Heavy Expanded Mobility Ammunition Trailer (HEMAT), also capable of carrying four additional fully loaded rocket pods.

This development of HIMARS will seek to include efforts to maximize component commonality with the M-270 launcher while minimizing the number of unique supply parts requirements. The HIMARS system has the same operating procedures as the current MLRS system, including fire-control, electronics, and communication sub-units. It also retains the proven-successful self-loading and autonomous features. Although it has a three-man crew, it can be operated by just one man. To date, the HIMARS has fired the standard Phase 1 rocket, the Reduced Range Practice Rocket, and the Army Tactical Missile. Hopefully, this wheeled launcher will take advantage of lower operation, maintenance, and support costs.

Specifications include:

Crew:	1 + 2
Configuration:	6 x 6
Weight:	(complete system) 13,696.36 kg (carrier vehicle) 8,272.73 kg (launcher/loader) 2,914.55 kg (rocket pod) 2,281.81 kg (crew) 227.27 kg
Length:	6.94 m
Width:	2.4 m
Height:	3.18 m
Ground Clearance:	0.564 m
Wheelbase:	4.1 m
Angle Approach/Departure:	40°/63°
Max speed:	89 km/h
Range:	(loaded) 480 km
Max gradient:	60%
Fording:	(with kit) 1.538 m (without kit) 0.923 m
Engine:	Caterpillar 3116 ATAAC 6.6 1 6-cylinder turbo charged and after-cooled diesel developing 290 hp at 2600 rpm
Transmission:	Allison MD-D7 automatic, 7-speed
Transfer Case:	Allison single-speed
Steering:	Power-assisted
Suspension:	Parabolic leaf springs
Tires:	395R 20XML
Electrical System:	12/24 V
Alternator:	100 A
Status:	Development

Source: Jean-Claude Leon, *Interavia/AeroSpace World,* (1993), 698-99.

Robert H. Neighbors, the MLRS/HIMARS Technology Demonstration Manager at Redstone Arsenal, Alabama, issued the priorities as recognized for HIMARS to be the following:

1. a system safety which minimizes crew hazards and maximizes survivability
2. C-130 transportability

3. maximization of initial capabilities

4. a maturing performance and capability which translates into the ability to fire the entire MLRS Family of Munitions (MFOM)

5. adaptations to changing tactics and doctrine

He further specifies that the modifications of FMTV to accommodate HIMARS should include:

1. structural strengthening of the cab to withstand rocket plume loads

2. provision to provide protection from particle impacts from foreign objects

3. the addition of a launcher drive system for controls, azimuth drive, and crane power

4. the addition of base, cage, and turret structure for weapon platform to include self reloading capability (Neighbors 6).

Other stipulations for HIMARS advised by the MLRS Project Office include the ability to operate in basic and hot environments without additional equipment. The system should be fully operable under battlefield conditions that include obscurants, electromagnetic environmental effects, electronic counter measures, electronic counter-counter measures, rain, fog, haze, snow, freezing precipitation, thunderstorms, salt water, sand and dust.

The Office further specifies that suspension lock-out and stabilization jacks must be "cab operable." Even though a test firing was accomplished successfully without a suspension lock out (i.e. only a parking brake was set), this feature is considered necessary. This did, however, conclusively demonstrate that a wheeled platform was stable enough to be successful.

Crew protection was also addressed: "The crew shall be able to complete

fire missions from the cab. Protection from rocket motor exhaust gasses, exhaust-blown debris (tube covers, gravel, etc.), noise, heat, overpressure, and chemical contamination shall be provided for the crew. It is desired that the crew cab provide ballistic protection from small arms fire, fragmentation effects to include the effects of scatterable mines and fragments from rocket motor rupture" (The MLRS Project Office 8).

In addition to the MLRS basic software, HIMARS will feature meteorological data and improved positive navigation. Additional modifications will include launcher interface software, fire control panel software and other common application software (Neighbors 8).

The maintenance aspects of the HIMARS system are also simplified due to the commonality of existing systems. HIMARS has no repair parts that are HIMARS-specific. With its "ease of maintenance" design, HIMARS has a recommended mean time to repair of not more than one hour for unit-level maintenance and four hours for direct support-level maintenance, with maximum time allowable being three hours at unit levels and twelve at the direct-support level (The MLRS Project Office 9).

Tactical Considerations

With tactical forces sparsely arranged over nonlinear fronts but required to mass rapidly for decisive operations, HIMARS will be able to use roads or trail networks and travel reliably at high speeds over extremely long, operational distances to deliver its fires. A tracked vehicle simply does not have this operational mobility without a similarly sized fleet of heavy equipment transporters (HETs) (Waldeck 24).

But the greatest advantage of HIMARS is that it can be transported, combat-loaded, by a C-130, see Figure 4. HIMARS has the ability of being as deployable as the units it supports. When the 82d Airborne Division arrived in Saudi Arabia on August 8, 1990, it was expecting a fight to be imminent. Assuming that the Iraqis had continued across the Kuwaiti border to attack the 82d, there would have been nothing to stop their armored forces, less a number of tactical air assets (TACAIR), until they moved in range of the division's tube-launched, optically-tracked, wire-guided (TOW) missiles. The U.S. attack helicopters and M-270's were either still in strategic aircraft flow or being reassembled at the port in Dhahran.

The advantage of C-130 transportability for HIMARS in this instance is obvious. It would have translated to a twenty-five percent savings in strategic airlift. In addition to being available much earlier, HIMARS could also have been transported by C-141s, which during Desert Storm had been restricted to a maximum cabin load lighter than the weight of a M-270. Having HIMARS units in force would have meant operational and tactical fires on the ground the same day the maneuver forces arrived in Saudi Arabia (Waldeck 23).

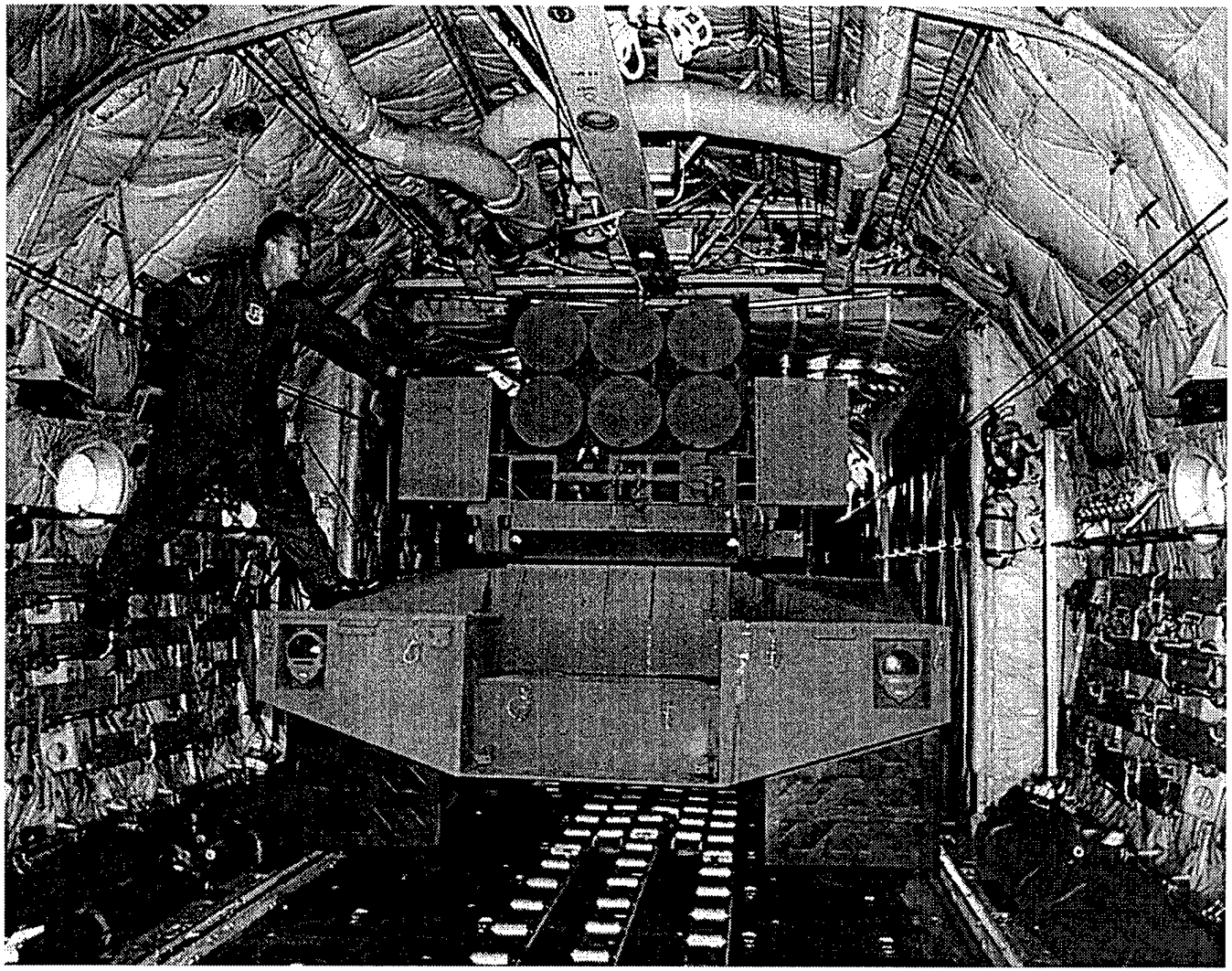

Figure 4. HIMARS being airlifted by an Oklahoma Air Guard C-130.

Cross-Service Commonality

The Desert Storm experience also generated much interest by the Marine Corps. At present the Marines have identified a need for what they call "Expeditionary Rockets." The HIMARS would fulfill their requirements, which are essentially the same as Army light forces. The Marines, at present, are severely lacking in fire support in the General Support mode. Currently, they have overcome this difficulty by a cooperative agreement with the Army to provide them with MLRS support. The following analysis portion of a Marine Draft White Paper Report addresses this:

1. The method of deployment/entry will largely depend upon the Mission Enemy Troop Time (METT-T) considerations corresponding to the specific contingency operation. It is a function of the size of the force, the deployment timeline, availability of secure airfields and post facilities, and whether or not an amphibious landing is to a benign beach or point (2).

2. The most appropriate force alignment is an MLRS battery supporting a Marine Expeditionary Brigade (MEB) and an MLRS battalion supporting a Marine Expeditionary Force (MEF). This is commensurate with the U.S. force structure and the Field Artillery (FA) doctrine. Corps MLRS battalions and possible MLRS heavy FA brigades will normally be attached to heavy divisions (2).

3. Deployment timelines will most certainly vary in accordance with (IAW) the mission. Shorter timelines will preclude reserve units from deploying based on mobilization requirements. MLRS contingency deployment packages (15-30 days) have been developed by III Corps Artillery. Rapid deployment contingency packages (24-36 hours) have been developed by XVIII Corps Artillery (Airborne). Each details the lift assets required. These may, however, need to be supplemented with additional packages due to the lack of Army support available and the likelihood that the

unit would be entering an immature theater. The MLRS battery has neither a liaison section nor a robust enough staff to interface with a United States Marine Corps (USMC) controlling headquarters on operational or logistical matters effectively. Therefore, a deployed MLRS battery would necessarily include a battalion headquarters to perform needed planning, coordination, control, and liaison functions (2).

4. The primary means of entry into theater should be airlift and sea-lift based on the priorities of the Marine Air-Ground Task Force (MAGTF) commander. MLRS unit equipment is not "through-surf" capable and should not be considered capable of amphibious assault. Preferred ship-to-shore amphibious transit for MLRS is Landing Craft, Air Cushion (LCAC); Landing Craft, Utility (LCU) and Landing Craft, Mechanized (LCM-8) are not recommended due to the effects of corrosive salt water on sensitive launcher electronic components (3).

Final recommendations, in part, include:

1. An MLRS battalion headquarters slice should deploy regardless of the size of MLRS unit to deploy in order to perform needed planning, coordination, control, and liaison functions. This may occur in stages built upon deployment timelines, resulting ultimately in a complete MLRS battalion contingency package (to include dedicated logistic assets) deployed to the theater.

2. If amphibious landing is required, the M-270 launchers and other MLRS unit tracked vehicles should be a high priority for use of the LCAC's. This is the best amphibious method of ship-to-shore transit for the MLRS unit because the launchers disembark on dry land, and thus have a much greater probability of providing the force an operational firing platform at the completion of the ship-to-shore transit.

3. The preferred joint command relationship for Army MLRS support of USMC operations is Tactical Control (TACON).

4. Two Army TPQ-37 radar sections should be attached to the MLRS battalion upon deployment to provide adequate target acquisition capability.

5. The controlling USMC FA headquarters must provide a reciprocal liaison to the MLRS unit headquarters.

6. The force FA headquarters should be augmented with multiple Army TPQ-37 radar sections. These should be attached to the MLRS battalion (from the Corps Artillery TAD or Heavy Divisional TAB) for deploying the placed OPCON to the controlling USMC FA headquarters (3).

Interviews with Colonel Gido, commander of the 14th Marine Reserve Regiment, Artillery, and Lieutenant Colonel Lain of the MLRS Project Office, Fort Sill, indicated that the Marines have an interest in their own indigenous rocket support. Therefore, the Marines foresee a much more promising future in the HIMARS than the tracked M-270 version. The HIMARS' transportability, high volume of fire, ease of maintenance, mobility, and lighter weight have made it the weapon system of choice. In short, the HIMARS fulfills the Marines' need to an extent not possible with Army supplied, heavy M-270 launchers. It is also interesting to note that the Marine plan would be to place the HIMARS primarily in its reserves.

Reserve Component Applicability

A very successful fire support experiment during Focused Dispatch (August 1995, Mounted Battlespace Battle Lab, Fort Knox, Kentucky) concluded that: 1) "no matter how we configure the force or how good our situational awareness is, we must still clear and coordinate fires," and 2) "we must still plan fires to support the combined arms teams in ground combat situations" (Rigby 3). The study also concluded that each division must have two Field Artillery brigades in support. "At least one of

those additional Field Artillery brigades will come from the Army National Guard (ARNG)."

By FY 99, ARNG battalions will comprise 62 percent of the Field Artillery. One of the two Field Artillery brigades assigned to support every division will be an ARNG brigade—a major conflict will not be won without ARNG support.

It has never been more important to maintain a trained and ready reserve component (RC) force. Training relationships between Active and ARNG units must work to foster one another.

As current doctrine increases the amount of fire support per committed division, it becomes mandatory that much of that fire power will need to be in the reserve component. With the conversion of the U. S. Army Reserve to Combat Service Support (CSS), this places the additional artillery assets needed in the National Guard (NG).

So the question may become what is an ideal weapon system that meets the requirements of the mission (General Support to the Corp Artillery) and the parameters of being located in the NG.

To what types of missions does the National Guard artillery lend itself most ideally, and also for what missions is the HIMARS most capable? A preferred tactical mission is that of General Support (GS). This doctrinal mission provides for the most centralized control. The HIMARS system is particularly well-suited for this mission because of the weapon's range, lethal shock effect, and large submunition dispersion pattern. In combined arms operation this mission could also augment Marine divisions which have no organic GS assets.

A General Support Reinforcing (GSR) mission assignment would allow the unit to provide fire to both the reinforced unit and the force Field Artillery Headquarters (FA HQ). In this regard GSR is somewhat less centralized in control as it allows requests for fire to come directly from the reinforced unit and not through force

FA HQ. The GSR role might, however, be a way in which the unit could respond to the counterfire role for the reinforced unit.

A HIMARS unit with a reinforcing mission would respond directly to the reinforced artillery unit. This mission is useful for the engagement of counterbattery and area fire missions, but not for reinforcement of direct support artillery units due to its standard "Danger Close" of 2000 meters. For this reason the HIMARS is not considered in a direct support role. However, most NG artillery units are structured for the GS, GSR, or R missions.

From the standpoint of efficiency of rocket systems, MLRS and HIMARS will definitely supercede. One M-270 rocket contains 644 submunitions, a 155 Howitzer projectile only 88, see Figure 5. The arithmetic demonstrates that one pod (six rockets) yields the same number of submunitions as 44 rounds of 155. The following illustrates this disparity of fire power even more conclusively. A battalion of HIMARS (27 launchers) firing one pod (six rockets) each would yield a total of 104,328 submunitions being delivered within approximately 90 seconds. A 3 x 8 (a battalion of three firing batteries with eight howitzers per battery) 155 Bn firing all guns at a rate of one volley every twenty seconds could deliver only about 8,448 submunitions in the same time span, a ratio of about 12:1.

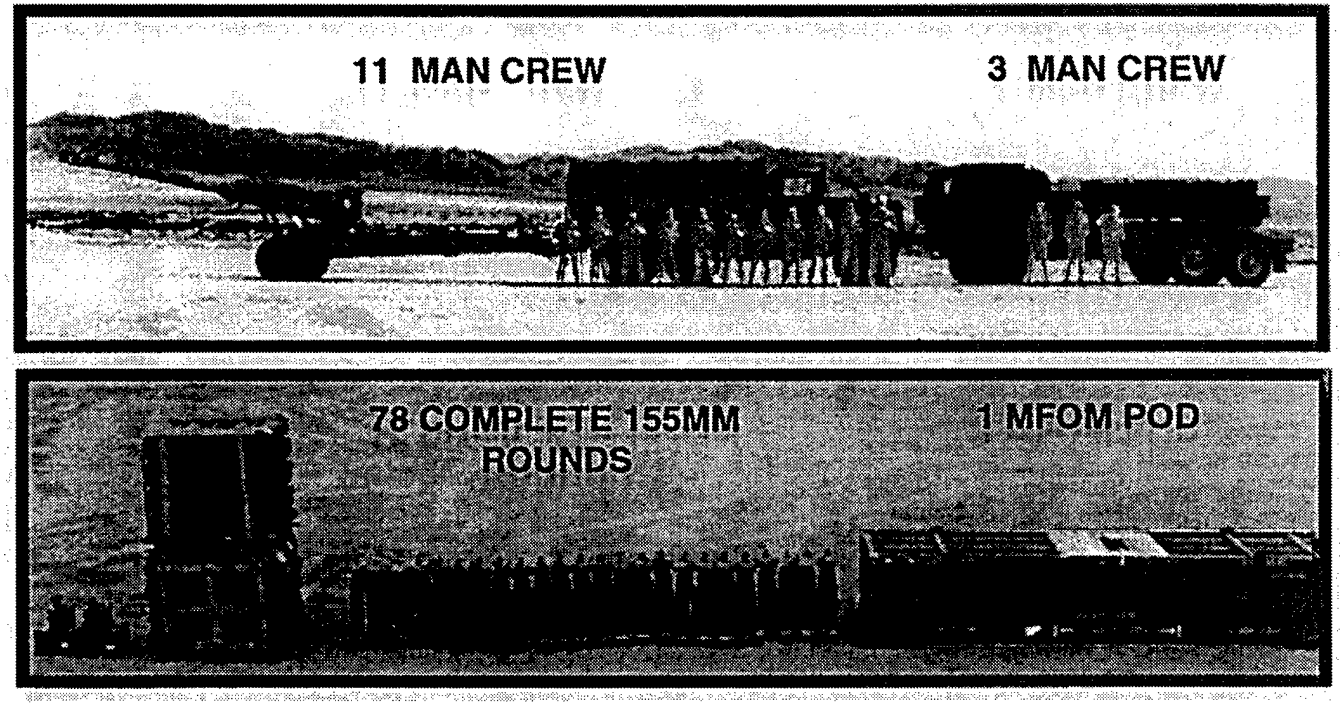

Figure 5. Manpower and ammunition comparisons between HIMARS and the M-198.

Numbers like these are certainly not the whole story, however. Looking also at survivability, the HIMARS system with its "shoot and scoot" tactics makes it an impossible target for counterbattery fires. Another advantage of the HIMARS system over the tracked version is the reduction of maintenance costs. As budget constraints increase, this in turn becomes more and more important.

One of the biggest advantages the HIMARS has over the tracked MLRS is that of reduction of weight, along with the fact that it is wheeled, allowing NG units to use close-in training areas near their armories, which are not accessible to tracked vehicles. This advantage was illustrated when some NG units transitioned from the M-110 8" howitzer to the M-198 155mm howitzer.

The tremendous decrease in the amount of time needed for maintenance support, along with that fact that all guns can now be located at home stations, greatly increases the amount of usable training time and, hence, combat readiness on the whole.

It must be remembered that heavy tracked vehicles, M-110 or M-270s, cannot be driven on civilian highways. Thus, these weapons are necessarily kept at some centralized holding facility, usually at a training post (i.e. UTES or MATES). Crew members are availed with this actual equipment only a few times per year. Wheeled vehicles face none of the aforementioned problems. Locating them at armory locations enables crew members access during all drill assemblies. This argument has illustrated two things: 1) the much-multiplied fire power the rocket system has over the tube systems (albeit there are missions that necessitate tubes) and 2) the economy of wheels over tracks.

HIMARS is also C-130 transportable. Most of the Air Forces's C-130 lift capability is in the Air National Guard. Coordination within the states between the airlift wings and HIMARS battalions would assure their rapid deployment as needed. The HIMARS systems (the entire battalion) could drive to Airpoints of Debarkation

(APODS) and no rail movement would be unnecessary. This is not an unimportant consideration when the units are located in the more remote rural areas of the country.

Brigadier General Randall L. Rigby states in his 1995 article "Fires for Division XXI: State of the Branch 1995" that "the ARNG is an essential element of our force today, but its role will increase dramatically in the future. In FY 90, ARNG and Army Reserve (USAR) Field Artillery battalions comprised 53 percent of the Field Artillery force. Our RC Field Artillery battalions will experience 92 major changes between 1995 and 1999 with USAR inactivations and ARNG battalion and brigade activations, conversions to new weapon systems and upgunning to 3 x 8 configurations. By the end of FY 96, all USAR FA units will be inactivated" (2).

Dr. Felix Fenter offers his perspective, "As a nation, we have to do a better job of using the reserve components of our armed forces. The current downsizing is a time of friction for the defense establishment, and it tends to cut back on the nation's reserve activities in proportion with the cuts it makes on our active forces. From a strategic point of view, this is not a realistic move for the nation to make" (30).

With the requirement to deploy a complete contingency force package with little notice, one of the most important assets is fire power. The force efficiency of weapon systems such as MLRS and HIMARS is tremendous. It only takes three men to do the job better than an entire 8-inch battalion, see Figure 5. The hidden value many persons do not realize is that training is very benign—a soldier can go to the armory and through training simulators and keep a very high degree of proficiency and state of readiness (Fenter 31).

The first Guard unit to get MLRS was the 1st Battalion, 158th FA of Oklahoma. This unit took the weapon to Desert Storm, and was also the first Guard unit to fire the ATACMS, and prove themselves they did.

In his concluding remarks Dr. Fenter states, "The national cost-cutting is astronomical with the number of citizen-soldiers that man such a battalion. It is the weapon of the future that is ideally suited for the Guard. It also erases a lot of the argument that many people have that our reserve soldiers aren't ready upon mobilization" (32).

In conclusion, Captain James J. Waldeck, Assistant Training and Doctrine Command Systems Manager for Rockets and Missiles at the Field Artillery School in Fort Sill, Oklahoma, sums it up best when he states, "The multi-polar nature of the world today requires we tailor our forces to respond with short notice to contingencies in any number of regions. The rapid deployment of US combat forces into a crisis area can forestall or upset the plans and preparations of an enemy" (25).

"HIMARS will fill a combat power gap that exists in these forces by adding significantly to our close support, counterfire and interdiction capabilities at both the tactical and operational realms of combat. Highly lethal, deployable and mobile—HIMARS not only will give us critical capabilities, but it also will add power to the word "*deterrence*" (25).

Today's winning Army features world-class excellence despite technological overmatch, downsizing, and an austere resource environment. Tomorrow's Army will need to be smaller with new technologies, a global reach, and force projection, while possessing more lethal weapon systems. The HIMARS definitely accommodates this lethal technology category and will provide the timely firepower required by the total force.

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