

# LIGHTWEIGHT 155mm HOWITZER



Report to the Senate and House  
Appropriations Subcommittees on  
Defense

Regarding a Plan for the  
Utilization  
of  
Rock Island Arsenal

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United States Marine Corps  
United States Army  
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Secretary of the Army (20310-0100)  
Secretary of the Navy (20350-1000)  
Washington, DC

17 FEB 1999

The Honorable Ted Stevens  
Chairman, Subcommittee on Defense  
Committee on Appropriations  
United States Senate  
Washington, DC 20510

Dear Mr. Chairman:

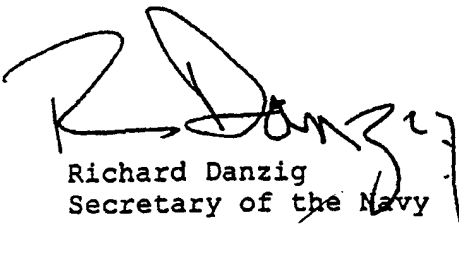
The Fiscal Year 2000 Defense Appropriations Conference Report 106-371 directed the Army and the Marine Corps to develop a plan to include Rock Island Arsenal (RIA) in producibility and manufacturing aspects of howitzer production, including recoil mechanisms and carriages for the Lightweight 155mm Towed Howitzer (LW155) Program, and other Army/Marine Corps future towed artillery programs.

We are pleased to submit the enclosed report, which provides some background on the LW155 program, as well as our plans to utilize RIA. The LW155 program office currently receives technical and logistical expertise from various Marine Corps and Army organizations. Personnel located at RIA have been providing expert logistical advice and will provide technical expertise on howitzer production to the program office.

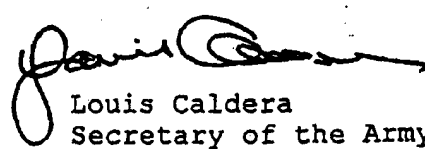
The prime contractor will be competitively seeking sources for approximately 70% of the production work for the LW155. RIA will be afforded every opportunity to bid on LW155 subcontracts, along with commercial industry. The expertise and experience that RIA possesses should allow them to submit a technically competitive bid for development and/or production of LW155 systems.

A similar letter has been sent to Chairman Lewis. As always, if we can be of any further assistance, please let us know.

Sincerely,



Richard Danzig  
Secretary of the Navy



Louis Caldera  
Secretary of the Army

Enclosure

Copy to:  
The Honorable Daniel K. Inouye  
Ranking Minority Member

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## EXECUTIVE SUMMARY

Congress expressed concern in the Fiscal Year 2000 Defense Appropriations Conference Report 106-371 to the 2000 Department of Defense Appropriations Act that the Marine Corps and Army are not utilizing the expertise of Army arsenals in the development and design of the Lightweight 155mm Howitzer (LW155). In particular, Congress requested a plan to include Rock Island Arsenal (RIA) in producibility and manufacturing aspects of LW155 and other Army/Marine Corps future towed artillery programs.

The LW155 program office is currently receiving significant technical and logistical expertise from various Marine Corps and Army organizations. Personnel located at RIA have been assisting the program in logistical areas and RIA producibility experience is planned to be utilized as the program completes development and enters production.

The LW155 is being developed by Vickers Shipbuilding & Engineering Ltd. (VSEL) of the United Kingdom whose design was selected as a result of an extensive nine month shoot-off and evaluation. As part of the development contract, the Marine Corps obtained option prices from VSEL for the first 190 production howitzers of the United States Marine Corps's planned acquisition objective of 450. VSEL is currently soliciting subcontractors in the US to provide materials, produce components and assemble the completed howitzer. The efforts being sought by VSEL in the US will account for approximately 70% of the completed LW155. VSEL has solicited US industrial sources as well as RIA to be subcontractors for the LW155.

The report concludes the best plan for the Marine Corps and Army is to use RIA experience and expertise during development in producibility and manufacturing planning. RIA has personnel with advanced metalworking skills who are on an equal footing with American industry when considering experience in working with titanium, lightweight high strength alloys, and composite materials. Therefore, for production RIA will be given the opportunity to compete with industry. For LW155 this means allowing the contractor to pursue a "best value" approach for selection of its subcontractor base. The "best value" approach will leverage the advantages of competition to deliver a quality

weapon at the lowest possible price. Similarly, RIA will be given the opportunity to compete with industry for all future towed howitzer work.

## INTRODUCTION

This report responds to the requirements established by the Conference Report of the Joint House-Senate Defense Appropriations Conference Committee for Fiscal Year 2000 (Page 214 of the Conference Report 106-371) which includes the following language:

"The conferees are concerned that the Lightweight 155mm Towed Howitzer program has been suffering from contractor and program deficiencies, which has led to a two-year delay in the program. The program has failed to fully utilize the expertise of Army arsenals in the development and design of the howitzer. Considering the long history of the arsenals in advancing howitzer producibility techniques, it is important that they be actively involved in the program, especially during the crucial EMD/prototype phase to ensure that efficient production techniques are designed at the earliest possible stage of the program. In addition, the arsenals constitute an important resource in providing spare parts and special development items for howitzer forces in time of war and national emergencies.

The conferees direct the Army and the Marine Corps to develop a plan to include Rock Island Arsenal in producibility and manufacturing aspects of howitzer production, including recoil mechanisms and carriages for the Lightweight 155mm Towed Howitzer Program and other Army/Marine Corps future towed artillery programs. The conferees expect the Army and the Marine Corps to issue a report to the Senate and House Appropriations Subcommittees on Defense no later than sixty days after the enactment of this Act outlining the plan."

## BACKGROUND

### **The LW155 System**

The Lightweight 155mm Howitzer Program (LW155) is a joint program between the Department of the Navy (Marine Corps) and the Department of the Army to develop and field the

next generation 155mm towed artillery system. The LW155 is a Marine Corps funded and led effort to replace the outdated M198 Howitzer. The M198 has demonstrated strategic, tactical, and physical shortcomings, and will meet the end of its 20 year service life in 2002. Table 1 is a comparison of some of the key requirements for the LW155 and the M198 system it is replacing.

	<b>M198</b>	<b>XM777</b>
<b>Weight</b>	16,000 lbs	9,000 lbs
<b>C-130 Capacity</b>	1 Howitzer	2 Howitzers
<b>Max Rate of Fire</b>	4 Rds/min	5-8 Rds/min
<b>Range</b>	30 Km (assisted)	30-40 Km (assisted)
<b>Emplacement Time</b>	8 Min	< 3 Min
<b>Displacement Time</b>	11 Min	< 2 Min
<b>Primer Mechanism</b>	Manual Single Round	Auto-primer Feed

**Table 1.0**

The LW155 will meet or exceed all M198 requirements while reducing weight from 16,000 pounds to 9,000 pounds. It will be compatible with all current 155mm munitions and be capable of being towed by the current and future family of 5 ton trucks, being secured aboard naval amphibious vehicles, and being transported by medium lift helicopters. In addition, a single C-130 aircraft will be able to transport two LW155's versus one for the M198. The reduced weight, emplacement/displacement times and improved mobility of the LW155 result in vastly improved survivability and lethality characteristics over the M198.

The LW155 howitzer has taken on an increasingly important role in recent months for the US Army. In recognition of the spectrum of conflicts in which the Army is likely to be involved in the future, there has been an increased emphasis on the need to respond rapidly and decisively to ensure success. The Army's transformation process will result in a force that is much more deployable, placing greater emphasis on mobility and the ability for precision strikes. With its 155mm fire power and reduced weight, the LW155 is particularly suited to address this change in Army doctrine.

The Engineering and Manufacturing Development (EMD) phase of LW155 development is scheduled for completion in September 2001, with production beginning immediately thereafter. Initial operational capability (IOC) is

scheduled for November 2003 for the United States Marine Corps and March 2005 for the Army with total required deliveries of 450 and 273 howitzers respectively. The United Kingdom Ministry of Defence and the Italian Ministry of Defence have both joined the LW155 development program under a Memorandum of Understanding with the Department of Defense and will procure approximately 70 weapons each for their armed forces.

The US Army is the lead service for the development of product improvements to the baseline LW155. The first improvement, called Towed Artillery Digitization (TAD), will eliminate the need for survey, aiming circles, aiming posts, collimators and communication wire to the Fire Direction Center. TAD will enable towed artillery units to compute ballistics on the gun, navigate while on-the-move, self-locate and generally provide greater accuracy, lethality and survivability. TAD development will begin in 2000 and continue through 2003, with production beginning in late 2003. TAD will be applied to the LW155 in the Army and Marine Corps, and offers potential application to other 155mm and 105mm towed howitzers in the US inventory. LW155 and TAD will provide unprecedented tactical and operational capabilities to our Marines and soldiers, ensuring we maintain superior fire support well into the next century.

#### **LW155 Acquisition**

A primary tenet of the LW155 program from its inception was to encourage maximum competition. As such, an extensive market survey was performed in December 1994. At the outset of the market survey, two prototype systems were known to exist - a system developed by Royal Ordnance of the United Kingdom and a system developed by Vickers Shipbuilding & Engineering, Ltd., also of the United Kingdom. In response to the market survey, Lockheed Martin Defense Systems of Pittsfield, Massachusetts indicated that they were in the process of developing a prototype LW155 system. No indication of interest was received from any government activity.

A request for proposal was released, dated April 10, 1996, soliciting offerors for an LW155. The intent of the acquisition strategy was to leverage the development of existing competitive prototypes. The solicitation required that, to be considered for award of a contract for the

shoot-off phase, an offeror had to present a howitzer at Yuma Proving Ground by April 25, 1996 which met specific criteria stated in the solicitation - including weight limitations, transportability requirements, traverse and elevation requirements, and safety documentation. Those offerors receiving shoot-off contracts would remain in the competition for the Engineering, Manufacturing and Development (EMD) contract award. The EMD contract was to be awarded based on an evaluation of technical merit, a past performance risk assessment, and an assessment of the immediate and long-term costs, with the final selection being made to the proposal representing the best overall value to the Government.

Three industrial firms competed in the nine month shoot-off - United Defense Limited Partnership of Minneapolis, Minnesota teamed with Royal Ordnance, Textron Marine and Land Systems of New Orleans, Louisiana teamed with Vickers Shipbuilding and Engineering, Ltd. (VSEL), and Lockheed Martin Defense System of Pittsfield, Massachusetts. A fourth firm, Lewis Machine and Tool Company of Moline, Illinois initially responded to the solicitation, but was disqualified. Rock Island Arsenal (RIA) was a major subcontractor to Lewis. The determination to disqualify Lewis was challenged to the Comptroller General, the District Court and ultimately the US Court of Appeals with the DoD position being upheld at all levels.

In a related legal matter, the American Federation of Government Employees (AFGE) union representing RIA employees filed a lawsuit claiming numerous statutory violations by the Army. Recently, the 7<sup>th</sup> Circuit Court of Appeals remanded this case back to the District Court for a trial on the merits. The issue involves whether the Army complied with the Arsenal Act (10 USC 4532) in conducting the LW155 acquisition as well as an acquisition involving mounts for the Abrams tank. The Army believes there is no merit to this suit and feels strongly that its position will prevail.

In March 1997, following the results of the shoot-off and the evaluation of all information by a formal source selection process, the LW155 EMD award was made to the team consisting of Textron and VSEL. In December 1998, after experiencing internal management difficulties at the New Orleans facility, Textron novated the contract to VSEL who was already performing virtually all of the technical

development activities. Upon novation of the contract, VSEL announced its intent to have approximately 70% of all LW155 manufacturing and assembly work performed in the United States under subcontract. To this end, VSEL has been working to establish this US subcontractor base. Approximately 35% of this effort consists of the supply of raw materials with VSEL close to a selection of US sources at this date. The remaining approximate 35% of work consists of manufacturing and assembly activities. To perform this effort, VSEL has been in contact with various US defense contractors, as well as RIA.

#### **CURRENT LW155 PROGRAM STATUS UNDER VSEL**

Since the novation in December 1998, VSEL has made significant inroads to return the program to its intended course. The largest challenges for VSEL have been to adapt to the systems engineering process as it is performed in the United States, and to become familiar with and implement an Earned Value Management System within their company. Despite an initial delay prompted by restructuring their efforts to accomplish the necessary pre-production systems engineering tasks, VSEL is now recovering lost schedule and is on target for delivery of the first EMD gun in June 2000, with all eight EMD howitzers being delivered by November 2000. VSEL has over 100 years experience in the design and manufacturer of medium and large caliber artillery systems. Recently, they have manufactured the FH70 (more than 1,000 are in service with six armies worldwide) and the AS90 (having delivered 178 systems to the British Army and just having been selected to co-produce for Poland). DoD engineers have been satisfied with VSEL's production background and capabilities.

#### **LW155 USE OF GOVERNMENT EXPERTISE**

Army arsenals and organizations, as well as the Marine Corps Systems Command and Marine Corps Logistics Bases have played an important role in the LW155 program from its outset. The world's leading experts in field artillery have been actively engaged, working with VSEL, to ensure that the final LW155 design will provide an optimal level of performance at an affordable price for our Marines and soldiers. Likewise, DoD expertise has been at work from

the beginning in the planning of logistics, including the future supplying of spare parts. Some of the most significant contributions received to date are set forth below.

### **Picatinny Arsenal**

In 1977, the Army consolidated the major components of large caliber gun and cannon design (e.g. weapon, fire control and ammunition) at Picatinny Arsenal in an organization now known as the Armament Research Development and Engineering Center (ARDEC). This included the transfer of the mission for design of large caliber weapons from Rock Island's Rodman Laboratory to Picatinny. Although the LW155 development effort is entirely funded by the Marine Corps, it was decided from the outset to locate the LW155 program office at Picatinny Arsenal to capitalize on the wealth of resident knowledge. The LW155 program is currently utilizing Picatinny to provide expertise in all phases of gun and fire control design and development including modeling, analysis, computer aided design, reliability and maintainability, quality assurance, configuration management, logistics management, safety, environmental, production planning, and testing.

### **Barstow Marine Corps Logistics Base**

Personnel from the Barstow Marine Corps Logistics Base are currently conducting a rebuild of the Marine Corps' existing M198 towed howitzers which gives them extensive experience and insight into contemporary towed howitzer issues. Information from Barstow is being utilized to support the LW155 engineering effort, to ensure that problems and deficiencies associated with the M198 are not carried over to the LW155 design. In support of this, Barstow personnel have been involved in the LW155 program and their input, especially in the areas of manufacturing and producibility has been most useful.

### **Rock Island Arsenal**

Currently, the LW155 program is utilizing the expertise of personnel located at Rock Island in planning for the fielding and support of the LW155 in logistics management. The program plans to continue to utilize these personnel throughout the EMD phase and fielding of the LW155.

### LW155 INTELLECTUAL PROPERTY RESTRICTIONS

Since the acquisition strategy for the LW155 was to leverage technology from existing designs and prototypes, all of the system research and development was accomplished by private industrial concerns at their own expense. In order to protect their initial investments, the teams who competed in the LW155 source selection competition understandably placed restrictions upon the use of their background intellectual property. In the case of the VSEL design, the United States Government received the right to compete the LW155 design after placement of an order for the first 190 howitzers (which were priced as an option to the EMD contract). At that time, VSEL would be due a royalty for any howitzer not manufactured by VSEL or a team in which they are a part. As such, DoD has neither the right to compete the LW155 EMD design, nor to direct its manufacture at RIA. Any action to move or direct production efforts from VSEL contrary to the contractual terms would require VSEL's prior approval.

### MATERIAL AND MANUFACTURING ISSUES

The manufacturing skills required to produce the LW155 are significantly different from any howitzer previously built. This is due to the extensive use of titanium which, although affording high strength at a relatively low weight is more difficult to manufacture and weld. Therefore, prior producers of howitzers made from conventional materials would not necessarily be equally qualified to produce a LW155. This country's foremost expert in titanium welding is the Edison Welding Institute (EWI). EWI is currently assisting the LW155 program by providing extensive support in the development of specifications and standards for welding titanium alloys.

The current contract with VSEL requires the delivery of 8 prototype weapons. The contract also has options for the first two years of production for another 70 and 120 systems. Although 144 per year is currently the maximum scheduled production rate, as previously mentioned, ongoing studies for accelerating the Army's procurement of the LW155 could push the demand up to more than 200 systems/year

## ROCK ISLAND ARSENAL

### **Expertise**

RIA has more than 100 years of history in providing weaponry of all sorts to America's armed forces. RIA produced, or supported the production of over 2,000 M198 155mm towed howitzers between 1975 and 1995. In addition, approximately 65% of the Army's 425 M119, 105mm towed howitzers, were produced by RIA between 1991 and 1997. The specific skills and capabilities available at RIA include welding, casting, machining, plating, inspections, assembly, testing, and hydraulic simulation of recoil systems. While no production of towed howitzers has occurred at RIA since 1997, RIA has continued manufacturing spare parts for the M198 and M119. In recognition of the manufacturing and producibility expertise available at RIA, the LW155 program will work to incorporate that knowledge into its EMD program to ensure logical and economical transition to production regardless of where production takes place.

### **Cost**

The Army recently requested Department of Defense clarification on the application of the Arsenal Act to weapons systems that have been contracted out to private commercial firms. According to the clarification, the Act does not mandate breaking out component parts so they can be evaluated for arsenal production. In addition to being legally correct, this interpretation avoids compromising the ability to hold systems contractors responsible for production and integration of weapons systems.

While RIA could ultimately be facilitized and hire sufficient numbers of skilled personnel to produce the LW155 in specified quantities, the cost of RIA production is the fundamental problem. Currently, RIA has an underutilization rate of 83% which contributes to their hourly rate being about double that of several firms in the private sector which have essentially the same manufacturing capability. For the LW155, using RIA as the producer would increase the cost of the system by about \$135 million for the Marine Corps and about \$100 million for the Army. For this reason RIA is currently pursuing a host of initiatives to decrease its manufacturing costs.

Additionally, the Army is looking at ways to make not only RIA, but all of its arsenals more competitive with industry. In the Army's ongoing assessment, it is evaluating arsenal capabilities, Army requirements, and the challenge of increasing workload at the arsenals when there is little work to go around. One possible solution is to encourage contractors to take over these government owned arsenals and bring other work in that can lower the hourly rates.

#### **PLAN TO INCLUDE RIA IN PRODUCIBILITY AND MANUFACTURING**

##### **Completion of EMD Phase**

Production has already commenced for the eight EMD howitzers and RIA is currently contributing support for logistical planning. Producibility techniques to ensure proper planning for efficient full scale production are a part of the EMD contract and Government experts continue to work with VSEL. Recognizing RIA manufacturing and producibility experience, the LW155 program will utilize RIA expertise as part of this review.

##### **Production Phase**

It is our plan to ensure that RIA has every opportunity to team with VSEL and produce substantial parts of the LW155. However, we will not mandate an RIA role. VSEL has interest in teaming with RIA so long as they receive a competitive market price for the work being performed. VSEL is obligated to ceiling option prices for the first 190 howitzers. These option prices were based upon the cost of having the LW155 components manufactured and assembled in the United Kingdom. Estimates received by VSEL for subcontract work in the United States show that there are United States firms capable of performing the work for similar prices, as was quoted in the United Kingdom. However, these option prices are not achievable utilizing RIA as a subcontractor since RIA's hourly labor rate with overhead is more than twice that of VSEL. A significant cost problem will similarly exist if DoD were to reach agreement with VSEL to segregate part of the manufacturing effort for RIA and furnish it to VSEL as government furnished material. Under RIA's best case scenario, this would result in an additional expense of some \$135 million in Fiscal Year 2000 dollars over the

course of the Marine Corps' 450 howitzers and an approximately \$100M additional for the Army's 273 LW155s.

### CONCLUSION

Army arsenals and internal DoD expertise have played, and will continue to play, an important role in the LW155 and future Army artillery programs. Within the last twenty years, much of the work historically performed by RIA has migrated toward the private sector. Specifically in the area of self-propelled howitzers, industrial concerns have manufactured over 2,500 M109 self-propelled howitzers. Currently, industry is producing the Paladin upgrade to the Army's M109 self-propelled howitzer (950 produced) and the Navy's MK45 gun systems, as well as functioning as the principal developer for Crusader, the Army's next generation self-propelled howitzer, and the Navy's new 155mm gun system. While RIA certainly has personnel with advanced metalworking skills, they are on an equal footing with American industry when considering experience in working with titanium, lightweight high strength alloys, and composite materials.

The Marine Corps and Army have concluded that the best plan for the LW155 program is to utilize RIA experience and expertise in producibility and manufacturing planning while allowing RIA to compete for manufacturing work. The eight prototype howitzers required to complete development and testing have already commenced fabrication. DoD experts (including RIA) will be involved in working with VSEL on producibility techniques to ensure proper planning for efficient full scale production. For production, RIA will be given the opportunity to compete with American industry. The Marine Corps and Army, however, are compelled to allow the prime LW155 contractor to pursue a "best value" approach for selection of its subcontractor base. The "best value" approach will leverage the advantages of competition to deliver a quality weapon at the lowest possible price.

Similarly, RIA will be given the opportunity to compete with industry for all future towed howitzer work. However, mandating the use of RIA for such future programs would be imprudent and would arbitrarily eliminate the possibility of competition, thereby denying the Services the benefits of industrial innovation and price competition.