United States General Accounting Office

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Report to Congressional Requesters

July 2000

DEFENSE ACQUISITIONS

Howitzer Program Experiencing Cost Increases and Schedule Delays

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DOD Department of Defense

United States General Accounting Office
Washington, D.C. 20548

National Security and
International Affairs Division

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July 28, 2000

The Honorable Richard J. Durbin
The Honorable Peter G. Fitzgerald
The Honorable Charles E. Grassley
The Honorable Tom Harkin
United States Senate

The Honorable Lane Evans
The Honorable James A. Leach
House of Representatives

This report responds to your January 31, 2000, request concerning the Marine Corps' development of the 155 mm lightweight howitzer. The lightweight howitzer, which will be procured for use by both the Marine Corps and the U.S. Army, is intended to provide greater mobility and improved operational characteristics while retaining the same range and accuracy as the current 155 mm howitzer, the M-198. The Marine Corps entered into a cost-plus-incentive-fee development contract for the howitzer in March 1997. The contract has a target price of $33.5 million and requires the development and manufacturing of eight howitzers. The program is currently in the engineering and manufacturing development phase,[1] and the Department of Defense currently plans to make a decision to go to full-rate production in March 2002.

[1]After a weapon concept is developed, the Department of Defense manages weapon acquisition programs in three stages: (1) program definition and risk reduction; (2) engineering and manufacturing development; and (3) production, fielding/deployment and operational support. During engineering and manufacturing development, the principal objectives are to translate the most promising design approach into a stable, interoperable, producible, supportable, and cost-effective design; validate the manufacturing process or production process; and demonstrate system capabilities through testing. In the production phase, operational and support systems are procured, items are manufactured, operational units are trained, and the systems are deployed.

A British company, BAE SYSTEMS,[2] is the lightweight howitzer prime contractor; the cannon barrels are being produced under a separate contract at the U.S. Army's Watervleit Arsenal and will be provided as government-furnished equipment. Although contract provisions do not require it to do so, BAE SYSTEMS plans to subcontract 70 percent of the howitzer's production to subcontractors in the United States. On April 14, 2000, we sent you our response to your concerns about compliance with the Arsenal Act[3] and congressional direction that the Department of Defense prepare a plan to include the Army's Rock Island Arsenal in the lightweight howitzer program. At that time, we also provided preliminary information on the howitzer's development cost, schedule, and performance. This report provides updated information in response to your request that we examine (1) whether the program is on schedule; (2) whether costs have increased and if there is sufficient funding; (3) what the extent of design changes is and how these changes have affected system testing; and (4) what effect the exclusive production of the howitzer by a foreign contractor could have on the Marine Corps' and Army's ability to maintain the weapon following its procurement, particularly during wartime.

Results in Brief

The lightweight howitzer program has experienced several schedule delays, and current schedules may not provide the Department of Defense sufficient information by March 2002 to make an informed decision to begin full-rate production. Following a change in prime contractors, the contract was restructured in 1998, and the production decision was delayed 21 months to September 2001. Manufacturing of the development howitzers has begun at the prime contractor's plant in Great Britain, but manufacturing problems have caused schedule delays in the delivery of the eight development models. These delays caused corresponding delays in the developmental test program, and in June 2000, the production decision was again delayed an additional 6 months (to March 2002). Further, the contractor was unsuccessful in selecting U.S. subcontractors by August 1999 as scheduled, and as of June 2000, selections still had not yet been made to produce the howitzer. Even with this latest production decision

[2]Created by the merger of British Aerospace and Marconi Electronic Systems.

[3]The Arsenal Act, 10 United States Code, Section 4532, requires that supplies needed for the Army shall be made in U.S. factories or arsenals if they can be made there on an economical basis.

delay, the program may not have sufficient time to move the howitzer's production from Great Britain to the United States and adequately demonstrate manufacturing processes and management controls in the United States before the decision date. Our reviews of commercial best practices have shown that the inability to validate the production processes and management controls before a production decision constitutes a cost and schedule risk that successful commercial firms consider unacceptable.

There has been significant cost growth in the lightweight howitzer prime development contract. This cost growth represents a significant part of the total $142.6 million development costs. In June 2000, the program office projected the cost of the lightweight howitzer prime development contract to be about $43.4 million—$9.9 million over the contract target cost. This estimate prompted BAE SYSTEMS to propose restructuring the development contract from a cost-plus-incentive-fee arrangement to a firm fixed-price arrangement, under which the company would be responsible for costs exceeding a new presumed higher fixed price, which would be negotiated. As of June 2000, the program office was discussing this proposal with Defense officials and negotiating specific contract provisions with the contractor. In addition, projected costs for producing the lightweight howitzer cannon barrels for the Marine Corps have increased. The Marine Corps is procuring the barrels from the Army's Watervliet Arsenal, which is required to include all costs, including overhead, in prices charged to non-Army customers. Because of increased Watervliet overhead rates, as of March 2000, unit cost estimates for the barrels for the Marine Corps had more than doubled—from $106,000 to over $260,000—since the original 1996 cost estimate. By May 2000, Department of Defense cost cutting measures had reduced these overhead estimates, but the Marine Corps still expects costs to exceed its original budget by $20.5 million.

Several design changes have been made to the lightweight howitzer; however, testing of the modified weapon will be delayed by the late delivery of the howitzers to the test program. Based on the results of tests conducted on the lightweight howitzer prototype since 1996, design modifications have been made to strengthen the assembly that holds the cannon barrel and to enlarge the spades used to anchor the weapon securely against recoil. However, testing of the intended production configuration that incorporates these changes will not be possible until the third of eight development units is manufactured and delivered. The third unit, originally scheduled for delivery in June 2000, is now scheduled for delivery in November 2000. The program office is adjusting its test plans to

complete the testing needed to verify system performance and initial operational capabilities before the production decision.

The effect of production by a foreign contractor on the Marine Corps' and Army's ability to support the howitzer cannot be assessed until the contractor determines where production models will be built. There is no contract requirement to produce the howitzer in the United States; however, if subcontractor costs can be held within the production contract's ceiling price, BAE SYSTEMS said that it plans to subcontract 70 percent of the howitzers' production in the United States. To provide assurances that the howitzer can be supported in wartime, program officials are requiring the company to provide a plan to manufacture 100 percent of the howitzer's parts in the United States.

The Department of Defense had no comments on the report, but provided technical clarifications and comments, which we incorporated as appropriate.

Background

The Department of Defense (DOD) is acquiring the lightweight 155 mm howitzer to replace its M-198 towed howitzer. The new howitzer will be a lighter, more transportable, and mobile weapon for strategic and tactical movements. Weapon performance requirements include a maximum weight of 9,000 pounds, reduced time to place the weapon in a firing position, and increased rate of fire compared with current weapons. The program is currently scheduled to complete development in March 2002 and begin production under an option in the development contract. Current plans call for the procurement of 450 lightweight howitzers for the Marine Corps and 273 for the Army. However, Army quantities could rise to 387 under new force structure plans now being finalized. Great Britain and Italy intend to procure about 70 lightweight howitzers each.

The original engineering and manufacturing development contract was signed with Cadillac Gage Textron, Inc., in March 1997. Textron, however, had extensive management problems, and in December 1998, Vickers Shipbuilding and Engineering Limited—which had been responsible for design of the howitzer under Textron—took over responsibilities as the prime contractor. Renegotiating the development contract required establishing a new program baseline schedule and increased overall program costs by about $43 million, to a total of $1,129.9 million.

BAE SYSTEMS acquired Vickers Shipbuilding in November 1999 and took over as the prime development contractor. BAE SYSTEMS is developing the lightweight howitzer under a cost-plus-incentive-fee contract with a current target price of $33.5 million. This contract requires the development and manufacturing of eight howitzers and established ceiling prices for the first two production options. Under the contract, BAE SYSTEMS receives a 6-percent fee if it meets the target cost and up to $900,000 in additional fees if the final cost is below the target. If the target cost is exceeded, the contractor pays 30 percent of the increased cost. Initially, the 30-percent share is deducted from the contractor's fee until the fee is gone, at which point the contractor is liable for up to $5 million of the final cost. The contract also provides for annual award fees based on performance in specific technical areas designated by program management.

The development contract also includes long lead procurement and production options for the first (70 units) and second (120 units) production lots. Each option has a unit target price and a unit ceiling price,[4] with a unit price reduction of about 12 percent for the second lot. If BAE SYSTEMS exceeds the ceiling price for these lots, the company bears full responsibility for the additional cost.

The lightweight howitzer cannon barrel is to be produced under separate contract at the U.S. Army Watervliet Arsenal and will be provided to BAE SYSTEMS as government-furnished equipment. The development program is funded and led by the Marine Corps through the lightweight howitzer program office, which manages both the BAE SYSTEMS and Watervliet contracts for the government. The lightweight howitzer will also incorporate the towed artillery digitization upgrade, which is a precise location and targeting system being developed by the Army. The Army will provide this upgrade as government-furnished equipment and assume program management responsibilities for the lightweight howitzer program upon completion of deliveries to the Marine Corps.

The Army's two manufacturing arsenals, Watervliet, New York, and Rock Island, Illinois, were established in the 1800s to provide a primary manufacturing source for the military's guns and other war-fighting equipment. In 1920, the Congress enacted the Arsenal Act (10 U.S.C. 4532), which requires the Army to have its supplies made in U.S. factories or

[4]All prices are subject to an escalation provision.

arsenals provided they can produce the supplies on an economical basis. Use of the arsenals has declined significantly since World War II because the private sector has assumed an increasingly larger share of this work. In November 1998, we reported that since the end of the Cold War, workloads and employment at these two remaining Army arsenals had declined substantially, and operating costs had escalated as fixed costs were spread among increasingly smaller amounts of workload.[5]

Program Schedule Has Slipped, and Challenges Remain

When Vickers assumed prime contractor responsibility for the program in December 1998, the program office established a new baseline schedule for the program. Under this schedule, the decision to begin the production phase of the program (Milestone III) was delayed 21 months, from December 1999 to September 2001. Also, the initial operational capability—the availability of the first Marine Corps unit that is equipped and trained to operate the howitzer—was delayed 20 months, from March 2002 to November 2003. The December 1998 schedule delays for major program events are shown in table 1.

Table 1: Key Program Events

Program event	Original baseline	December 1998 baseline	Months delayed
First test howitzer delivery	June 1998	May 2000	22
Production approval (Milestone III review)	Dec. 1999	Sept. 2001	21
Production contract award	Dec. 1999	Oct. 2001	22
First production howitzer	Mar. 2001	Jan. 2003	22
Marine Corps initial operational capability	Mar. 2002	Nov. 2003	20
Army initial operational capability	Mar. 2005	Mar. 2005	0

Source: Lightweight howitzer program office.

In August 1999, BAE SYSTEMS prepared a plan to make up for delays that had occurred at that time, but the company was unable to keep up the pace needed to maintain the schedules, and delays continued. Fabrication of

[5] *Army Industrial Facilities: Workforce Requirements and Related Issued Affecting Depots and Arsenals* (GAO/NSIAD-99-31, Nov. 30, 1998).

eight development howitzers is underway in Great Britain, but due to manufacturing difficulties, scheduled deliveries of development howitzers will be delayed up to 7 months.

In February 2000, an inspection revealed manufacturing quality problems with the first developmental howitzer. The primary source of the problems was in welding and fabricating critical titanium components. To reduce the howitzer's weight, the basic structural elements are made of titanium. As a result, extensive use of precision, high-technology titanium welding techniques will be required in the manufacturing process. Following engineering review, BAE SYSTEMS revised its manufacturing procedures and tooling to incorporate necessary changes, and delivery schedules were revised. Fixing these problems will require reworking the welding process and will delay other manufacturing activities. Program officials said that they are learning important lessons regarding welding techniques, heat treatment, and the use of fixtures in the howitzer's production. In May 2000, the contractor and program office agreed to revise the schedule for delivering eight developmental howitzers. (See table 2.)

Table 2: Changes in Schedule for Delivery of Eight Developmental Lightweight Howitzers (as of May 2000)

Developmental howitzer (unit number)	Original delivery date	Revised delivery date	Calendar months delayed
1	05/00	06/00	1
2	05/00	10/00	5
3	06/00	11/00	5
4	06/00	01/01	7
5	10/00	02/01	4
6	10/00	02/01	4
7	10/00	02/01	4
8	10/00	02/01	4

Source: Lightweight howitzer program office.

The revised schedule shows the last four lightweight howitzers–50 percent of the development effort—are to be delivered on the same date. Program officials said the delivery date shown represents the last day that these four howitzers can be made available to the government to support preparations for operational testing. Program officials told us that they anticipate that final assembly and integration of the four howitzers will actually be

staggered by a few weeks. They expect initial test firings of each weapon by the contractor to occur in January and February 2001, prior to delivery to the government.

The delays in deliveries of developmental lightweight howitzers necessitated a delay in the production decision to accommodate completion of developmental and operational testing. The production decision was initially delayed 3 months, but the requirements for cold weather testing required an additional 3-month delay to March 2002. First production delivery is currently scheduled for January 2003. Other program milestones remain the same.

Selection of U.S. Production Subcontractors Has Been Delayed

BAE SYSTEMS plans to subcontract up to 70 percent of its lightweight howitzer production work at U.S. facilities. In 1999, the contractor solicited bids from U.S. contractors with the intention of selecting U.S. participants by August 1999. Bids were received from the U.S. Army Rock Island Arsenal and a private contractor, but both were rejected because the proposed costs were too high for BAE SYSTEMS to meet the production contract ceiling price. BAE SYSTEMS has restructured the content of the subcontractor packages and has again solicited bids from U.S. contractors.

On April 25, 2000, BAE SYSTEMS asked U.S. companies to indicate their interest in the lightweight howitzer production program by May 10, 2000. The company sought statements of interest for the manufacture of subassemblies and for final assembly and testing of the completed howitzer for delivery to the government. A total of 51 contractors, including Rock Island Arsenal, indicated interest in some or all of the lightweight howitzer subcontracting packages, and BAE SYSTEMS identified 19 of these as competent to meet the requirements. BAE SYSTEMS intends to select the subcontractors and complete negotiations by November 2000.

BAE SYSTEMS' decision to select U.S. subcontractors for lightweight howitzer production is contingent on holding costs to the production ceiling contained in the development contract options. If U.S. manufacturers' prices do not meet these constraints, BAE SYSTEMS may retain all of the manufacturing and assembly effort in Great Britain. Program officials stated that on the basis of the costs of U.S. suppliers during the 1999 solicitation (prior to the addition of contractor overhead rates), BAE SYSTEMS is confident that production contracts can be obtained in the United States.

Achieving Production Readiness as Scheduled Will Be a Challenge

If BAE SYSTEMS completes selection of U.S. subcontractors for production of the lightweight howitzer in November 2000, there will be less than 18 months to meet the numerous challenges involved in moving and establishing manufacturing processes for the production units in the United States. Although manufacturing the development prototypes is underway in Great Britain, different facilities, personnel, and tooling are planned for the production units. Manufacturing processes established in a single location during development may have to be divided and dispersed to multiple facilities prior to the start of production. Manufacturing drawings and specifications will have to be converted to U.S. measurements and producibility standards. Finally, the howitzers manufactured at new facilities must demonstrate that they meet the same performance standards as the prototypes used in the development and initial operational testing to verify system performance.

If U.S. subcontractors are selected, the lightweight howitzer program office must avoid the manufacturing and schedule problems experienced in an earlier attempt to produce a British-designed howitzer in the United States. In 1984, DOD selected a 105 mm lightweight howitzer designed by Royal Ordnance, a British contractor, to be built for the Army by the Watervliet and Rock Island Arsenals. Although the howitzer, designated the M-119, was being produced in Great Britain, converting the British design, metric measurements, and manufacturing approach to U.S. measurements and DOD's rigorous producibility standards cost about $30 million and caused a 2-year delay in the original production schedule.

M-119 manufacturing problems were caused principally by the British technical data package[6] supplied to the arsenals because it did not meet DOD producibility standards. Specific problems included inadequate design drawings and conversion of metric measurements, as well as problems with the British approach of tailoring (hand fitting) parts to each weapon during production, rather than the U.S. approach of having standard parts produced for all weapons. These problems required time-consuming reengineering to meet U.S. requirements. Program officials stated that to prevent these problems on the 155 mm lightweight howitzer, they have required BAE SYSTEMS to provide an "Americanized" technical data package (including drawings to U.S. non-metric standards) as part of

[6]A technical data package includes the engineering drawings, technical specifications, and production processes stated in terms suitable for producing an item with the specified operational characteristics.

the development contract. They are also using private U.S. contractors and Rock Island Arsenal officials to review technical data for producibility.

While some U.S. subcontractor tasks sought by BAE SYSTEMS may require little preparation, others may require extensive production preparation. For example, titanium welding is a precision, high-technology procedure that is critical to the lightweight howitzer manufacturing process. During development, BAE SYSTEMS is doing this welding by hand, without the mechanical guides and controls that experts say will be needed for higher rate production manufacturing. Expert consultants from the Edison Welding Institute estimate that establishing the processes, tooling, and expertise required for production rate capability in a U.S. plant will take 18 to 24 months before work on the first production article can be started if the contractor has no previous titanium welding experience. Program officials stated that BAE SYSTEMS is considering only firms with titanium welding experience for this portion of the manufacturing effort; this should reduce the preparation time needed.

Government funds to finance production preparations required for the new U.S. subcontractors will not be made available to the prime contractor until the production contract is awarded; this is not scheduled until March 2002. BAE SYSTEMS said that it intends to provide up to $10 million of its own money in advance of award of the production contract to finance production start-up activities by the selected subcontractors to ensure that production manufacturing capability is available on schedule. BAE SYSTEMS has proposed to use this money to fund the manufacture of three to five production-configured lightweight howitzers as a means of initiating and qualifying subcontractor operations. Once completed and tested to ensure compliance with performance standards and contractual requirements, these weapons could be delivered to the government as production items. Contractual provisions for this arrangement would be negotiated and incorporated in the development contract or formalized through a Memorandum of Understanding between the program office and BAE SYSTEMS, according to program officials.

Program officials stated that the agreement currently being negotiated with BAE SYSTEMS involves funding of three advanced production weapons. Transfer of manufacturing would begin upon completion of subcontractor selection in November of 2000 and would continue until July 2001, when fabrication of the first advanced production (AP-1) howitzer is begun. The three advanced production weapons will be completed in December 2001,

April 2002, and June 2002 (see fig. 1). Following their completion, these weapons would be used for contractor testing.

Validating the manufacturing processes and management controls needed to manufacture hardware items that conform consistently is a critical objective of the development phase. A successful production readiness review[7] to document completion of this activity is a primary criterion for approval of the lightweight howitzer's production. To ensure that all key manufacturing processes are under control so that quality, volume, and cost of the output is proven and acceptable, the best commercial firms accumulate the necessary knowledge of actual processes and eliminate unknowns well ahead of production. Defense guidance states that it is important that physical facilities, personnel, and manufacturing documentation be evaluated during this review.

As shown in figure 1, the extent of U.S. manufacturing start-up prior to the production decision is highly dependent on BAE SYSTEMS advanced funding. The production readiness review will start in April 2001, 2 months after the scheduled completion of development manufacturing. The review will be completed in January 2002, 2 months before the scheduled production decision. The only manufacturing activity that will be ongoing during the production readiness review would be the advanced production, if funded by BAE SYSTEMS. If BAE SYSTEMS funds advanced production and completes it as the program office currently expects, the first advanced production lightweight howitzer would be completed and tested by the contractor, but not by the government, by March 2002, the production decision date.

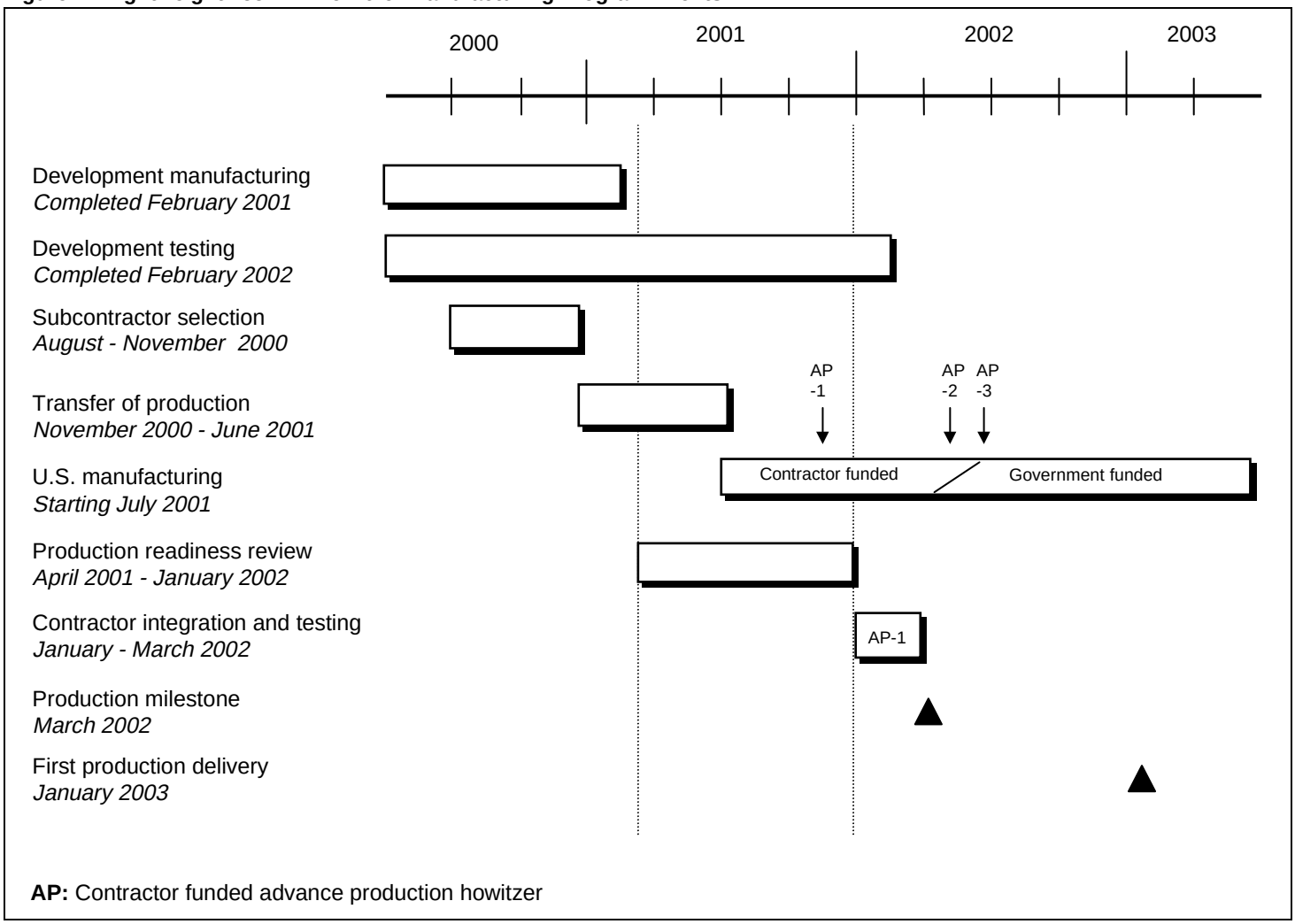
It is uncertain, however, to what extent the production readiness review will be able to validate lightweight howitzer production processes and controls before the production decision is made. To date, subcontractor selection has not been completed, renegotiation of the development contract is still in process, and specifics of the advanced production program are unknown. Until manufacturing arrangements are known, subcontractor processes are defined and integrated, and management and quality controls are in place, the program office cannot demonstrate lightweight howitzer production readiness.

[7]Production readiness review is a formal examination of a program to determine whether the design is ready for production, production engineering problems have been resolved, and the producer has adequately planned for the production phase.

For example, contractor management controls, subcontractor manufacturing processes, and quality control systems will be important to the lightweight howitzer production effort, particularly in the early stages, when BAE SYSTEMS integrates the multiple U.S. production efforts. Development manufacturing was conducted in one location in Great Britain, but must be split up to multiple locations for U.S. participation and then reintegrated to provide a single production effort. Defining the individual processes, setting up and proving multiple U.S. manufacturing efforts, and integrating the individual management control systems to provide a reliable information and control system prior to the production decision will be a major challenge.

Major events in the lightweight howitzer manufacturing program plans are shown in figure 1.

Figure 1: Lightweight 155 mm Howitzer Manufacturing Program Events



Source: Lightweight howitzer program office.

Commercial Best Practices Ensure Production Readiness Before the Production Decision

Under DOD's acquisition process, the production decision represents final permission to produce, deploy, and support a weapon system and provides approval for award of a production contract. In our past work on the application of commercial best practices to DOD weapon acquisitions, we have pointed out the need for the Department to obtain better knowledge of the producibility of new products and better control of manufacturing processes before initiating production.[8] The Department traditionally has not had the same level of knowledge commercial firms generally require before starting production and, as a result, has experienced turbulence in outcomes as it moves to production. We have also pointed out that successful commercial programs consider that, without this knowledge, they face an unacceptable risk of delays and increased costs.

A production review is a critical part of assessing readiness for production. However, production approval and award of a production contract based on review of plans and in-process manufacturing preparations, as in the case of the lightweight howitzer, represents a substantially higher risk than actions based on established performance. Our work on commercial best practices has shown that successful commercial firms consider not having knowledge of the producibility of a new product and control of manufacturing processes prior to initiating production an unacceptable risk.

Program Has Experienced Cost Overruns and Funding Shortfalls

The lightweight howitzer program office is currently engaged in efforts to manage significant cost growth in both the development contract and the production of the government-furnished cannon barrels. The program office projects that the BAE SYSTEMS development contract will overrun its current $33.5-million target price by about $10 million, or 30 percent, and is considering a contractor proposal to renegotiate the contract. At the same time, projected increases in the cost of cannon barrels for the Marine Corps' production program has resulted in a $20.5-million deficit in Marine Corps funding.

[8] *Best Practices: Successful Application to Weapon Acquisitions Requires Changes in DOD's Environment* (GAO/NSIAD-98-56, Feb. 24, 1998).

As of June 2000, the lightweight howitzer program office projected that the development contract will cost $43.4 million, $9.9 million over the target price. Under contract provisions, 30 percent of this cost growth, or $3 million, is the responsibility of BAE SYSTEMS ($1.8 million loss-of-fee plus $1.2 million in increased costs = $3 million).[9] The contractor's May 2000 proposal to renegotiate this contract would increase the cost to the government, but BAE SYSTEMS would be responsible for 100 percent of any costs that exceed the new contract price. The program office is currently discussing renegotiation of the development contract with Defense procurement officials and is negotiating specific contract modifications with BAE SYSTEMS officials. There would be no change in the price of the howitzer's production options.

DOD has also reduced a projected shortfall in the Marine Corps funds budgeted for the lightweight howitzer production. The shortfall was caused by an increase in cost for the government-furnished cannon barrels. The cannon barrels are being produced under a separate contract with the U.S. Army Watervliet Arsenal. Under Army Working Capital Fund provisions, overhead rates at Watervliet Arsenal must be included in the price of cannon barrels manufactured for the Marine Corps.[10] As a result of increased overhead costs, Watervliet Arsenal's estimated cost to the Marine Corps for cannon barrels more than doubled, from $106,000 to more than $260,000, since the original program estimate.

Increased cannon barrel costs threatened to increase the cost of the Marine Corps lightweight howitzer production program to $70 million beyond the amount budgeted by the Marine Corps. To reduce these costs, in March 2000, the lightweight howitzer program office explored alternative cannon barrel procurement approaches. The program office requested cost information and manufacturing data on cannon production from Watervliet Arsenal and two commercial contractors.

[9]The government is responsible for 70 percent of any additional cost growth, up to a total contract cost of $56.2 million. Beyond that, the government is responsible for all costs.

[10]Under Army Arsenal pricing policy, arsenals are required to include all costs, including indirect overhead costs and prior year losses, in calculating labor rates to be charged to their non-Army customers. As a result, these overhead costs are included in the price of the cannon barrels for the Marine Corps but are not directly charged for the cannon barrels to be produced for the Army.

In its proposal, Watervliet Arsenal outlined a program to reduce personnel, decrease excess facilities, and control costs. In addition, Watervliet has received new contracts that have increased its projected business base and will further reduce overhead charges to the lightweight howitzer program. Reduced overhead projections lowered the estimated cost to about $183,600 per cannon barrel. This cost, while still significantly higher than the original estimate, would lower the Marine Corps' budget deficit by about 70 percent to $20.5 million. Army officials stated that other factors could further reduce the projected Marine Corps funding deficit. These include additional efforts currently being considered to reduce facility, personnel, and other operating costs at Watervliet; future increases in business at the arsenal; and an acceleration of the Army's lightweight howitzer production.

Defense cost experts and lightweight howitzer program office personnel analyzed the three proposals to determine the validity of the cost data and the potential program risk involved in each proposal. In early May 2000, Navy acquisition officials responsible for the Marine Corps procurement budget decided to maintain howitzer production at the Watervliet Arsenal. At the same time, the Marine Corps has proposed slowing its scheduled production delivery rate from that shown in the fiscal year 2001 budget. On the basis of this delivery schedule, the Army and the Navy finalized an agreement on lightweight howitzer cannon barrel costs on June 14, 2000. Under this agreement, the Army committed to an average fixed price of $183,600 per barrel to the Marine Corps. The Army would fund any higher cost or retain any savings, depending on the actual cost of cannon barrels when delivered.

Details of the fiscal year 2001 lightweight howitzer congressional budget request and the proposed revised Marine Corps delivery schedule are in appendix I.

Testing Design Changes Await Howitzer Deliveries

Delays in lightweight howitzer deliveries to the test program will reduce the time available to test design changes made to the prototype design. The impact of these delays will not be known until the program office realigns its test program. Testing prior to the production decision must successfully demonstrate that the lightweight howitzer design to be built in the production program will comply with performance specifications and meet mission needs. Recent delivery schedule changes caused the Marine Corps to extend the test program by 6 months to accommodate performance testing in a cold-weather environment. This extension required a

corresponding delay in the Milestone III production decision to March 2002. The program office is now adjusting its test plans to complete the testing needed to verify system performance and initial operational capabilities before the production decision.

Production Models Will Incorporate Design Changes

Primary among the modifications made to the lightweight howitzer prototype are enhancements to improve the howitzer's accuracy and stability by strengthening the saddle component that holds the cannon barrel and to better anchor the weapon against recoil. These changes have been incorporated in the development design. However, because the modified saddle will not be available in time for incorporation on the first two development models, it will have to be retrofitted to the weapons after delivery of the final development howitzer (scheduled for February 2001). Modifications, however, have increased the howitzer's weight, and current projections are that the actual weight of development models will be very close to the limit of 9,000 pounds. At the same time, no existing prototype incorporates all the development design changes, and no testing of full production design will be possible until the third development unit is manufactured and delivered to the test program in November 2000.

Program officials are confident the production design will meet performance requirements. They said that lengthy testing of the prototypes greatly facilitated the design and improvement process, and because Vickers has been the primary design contractor from the beginning of the development program, this effort was not significantly affected by program management changes.

Delivery Delays Increase Challenge to Test Program

The lightweight howitzer development test program calls for the first four howitzers to be used primarily to verify over 300 specific system performance requirements contained in the development contract. The final four development howitzers will be used primarily to conduct the initial testing of the systems' capabilities in an operational environment; this testing is required before the production decision is made. The initial priority in the test program will be given to safety testing and the testing needed to begin operational testing. In June 2000, program officials told us that because of climate conditions required for cold-weather testing, the late deliveries of production-configured test howitzers required a 6-month delay in the test program to provide for winter testing in Alaska in 2002.

The extension of the lightweight howitzer test program will provide more time for testing than was available under the original test program. The program office is currently working on the test program revisions needed to ensure that all 300-plus performance requirements are tested within the time provided under the new delivery schedule. Although the first development model was delivered to the Marine Corps in late June 2000, the new test schedule is dependent on developmental units 5 through 8 being delivered in February 2001. As discussed above, this delivery date is based on when the weapons are needed for operational testing preparations. Any delay in these deliveries could compress the testing schedule.

Manufacturing Decisions Needed to Clarify Supportability Concerns

Until manufacturing plans are finalized, it is difficult to assess the ability of the Army and the Marine Corps to support the lightweight howitzer, particularly if the howitzers are produced and assembled in Great Britain. Program officials said that if 70 percent of the howitzers are produced in the United States, as BAE SYSTEMS plans, the weapon could be supported in wartime. In addition, BAE SYSTEMS will conduct an analysis to ensure that all howitzer parts (including those produced in Great Britain) can be produced in the United States, should the need arise.

Although BAE SYSTEMS plans to produce 70 percent of the lightweight howitzers in the United States, the contractor is not required to do so under the terms of the production options contained in the development contract. The production options contain fixed ceiling prices and U.S. production is contingent on U.S. subcontractor proposals that allow BAE SYSTEMS to ensure that the ceiling cost is not exceeded. As discussed previously, BAE SYSTEMS is confident that it will obtain bids from U.S. subcontractors that will keep development and production costs within the ceiling prices.

It is unclear what the support implications for U.S. forces would be if all lightweight howitzer production occurs in Great Britain. DOD's prior experience with the M-119 howitzer showed that even after production problems were resolved at U.S. facilities, differences between American and British maintenance philosophy and organization of maintenance support caused logistics planning and supportability problems throughout the life of the M-119.

Agency Comments and Our Evaluation

DOD had no comments on a draft of this report. DOD's letter is reprinted in appendix II. DOD officials provided technical clarifications and comments on the report that we incorporated as appropriate.

Scope and Methodology

To determine the program schedule, cost and funding, and system performance of the lightweight howitzer program, we reviewed program documents and the fiscal year 2001 Defense budget. We also interviewed program management personnel and representatives of the prime contractor at the lightweight howitzer program office, Picatinny Arsenal, Picatinny, New Jersey; and resource management personnel at Headquarters, Department of the Army, Pentagon, and Army Materiel Command, Alexandria, Virginia. To understand manufacturing requirements for titanium welding, we discussed the issues with expert personnel from the Edison Welding Institute, Columbus, Ohio, who are consultants to the program office and Rock Island Arsenal on the program. To determine the status of issues relating to Army arsenals and arsenal policy, we interviewed officials at Army Material Command's Industrial Operations Command, Rock Island, Illinois. We also visited the Army's Rock Island Arsenal and discussed issues related to the lightweight howitzer program and the status and manufacturing capability of the arsenal with key management personnel. To address what effect howitzer production by a foreign contractor could have on the Marine Corps' and the Army's ability to support the weapon, we reviewed contract requirements, discussed issues with program officials, and examined DOD's prior experiences with a British-designed howitzer.

We conducted our work from February through July 2000 in accordance with generally accepted government auditing standards and generally relied upon Defense-provided data.

We are sending copies of this report to the Honorable William S. Cohen, Secretary of Defense; the Honorable Richard Danzig, Secretary of the Navy; General James L. Jones, Commandant of the Marine Corps; the Honorable Louis Caldera, Secretary of the Army; the Honorable Jacob J. Lew, Director, Office of Management and Budget; and other interested congressional committees. Copies will be available to others upon request.

Please contact me at (202) 512-4841 if you or your staff have any questions concerning this report. Key contributors to this report were Robert P. Kissel, Jr., Richard J. Price, and Mary K. Quinlan.

James F. Wiggins, Associate Director
Defense Acquisitions Issues

Lightweight Howitzer Fiscal Year 2001 Budget Request

The lightweight howitzer will eventually incorporate the Army's towed artillery digitization upgrade, which is budgeted separately. The towed artillery digitization upgrade, a precise location and targeting system, is being developed by the Army and will be provided as government-furnished equipment. The upgrade will be included on the howitzer units produced for the Army; however, it will not be incorporated on the howitzers delivered to the Marine Corps but will be added at a later date.

The Fiscal Year 2001 U.S. Army and U.S. Marine Corps Defense Budget Requests for the 155 mm lightweight howitzer program and the towed artillery digitization program are summarized in table 3. The table also shows production quantities and the Marine Corps' May 2000 revised procurement schedule for production quantities. Changes to the Marine Corps' budget needed to implement this schedule will be included in the fiscal year 2002 Defense budget.

Table 3: Lightweight Howitzer Fiscal Year 2001 Defense Budget Request, Schedule for Production Quantities, and Revised Marine Corps Procurement Schedule

(dollars in millions)

	Fiscal Year 2001 Defense budget request					Production procurement quantity/schedule		Revised procurement quantity/schedule
Fiscal year	Marine Corps howitzer RDT&E[a]	Marine Corps howitzer production	Marine Corps towed artillery digitization[b] production	Army towed artillery digitization[b] RDT&E	Army howitzer and towed artillery digitization production	Marine Corps	Army	Marine Corps
1995	$6.3							
1996	14.4							
1997	13.5							
1998	36.2							
1999	31.9			$1.0				
2000	27.1			4.8				
2001	13.2	$11.1		17.4				
2002		90.1		10.7	$0.1	70		70
2003		197.1		9.9	7.4	185	5	120
2004		142.4			26.5	195	20	130
2005		0.2			42.0		31	130
2006			$33.0		103.1		64	
2007			18.7		133.3		80	
2008					81.6		51	
2009					56.9		22	
Subtotal	$142.6	$440.9	$51.7	$43.8	$450.9			
Total					**$1,129.9**	**450**	**273**	**450**

[a]RDT&E = research, development, test, and evaluation.

[b]Towed artillery digitization (TAD) program.

Source: Fiscal Year 2001 Department of Defense Budget, February 2000.

In addition to the lightweight howitzer budget request, the Army's fiscal year 2001 budget request for Army arsenals includes a request for an

increase of $25 million.[1] If provided, $20 million of this money would be allocated to the Watervliet arsenal (responsible for producing the howitzer cannon barrels) to offset costs of maintaining excess capacity. This would reduce overhead charges at Watervliet in fiscal year 2001. However, because major production activity for the lightweight howitzer program will not start until fiscal year 2002, this reduction would not affect the Marine Corps' current $20.5 million estimated funding shortfall for cannon barrels unless annual subsidies continue through the completion of the Marine Corps' production program in fiscal year 2005. Army budget projections, included in the fiscal year 2001 budget submission, do not include continuation of this subsidy.

[1]The Army requires arsenals to maintain capacity that might be needed in the future. To compensate the arsenals for this, the Army budget includes an account for "underutilized capacity"; however, Army Industrial Operations Command officials said that in recent years annual funding of this account has provided less than 40 percent of the budget needed to cover these costs.

Comments From the Department of Defense

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ACQUISITION AND TECHNOLOGY

21 JUL 2000

Mr. James F. Wiggins
Associate Director
Defense Acquisition Issues
National Security and International Affairs Division
U.S. General Accounting Office
Washington, D.C. 20548

Dear Mr. Wiggins:

This is the Department of Defense (DoD) response to GAO Draft Report, "DEFENSE ACQUISITIONS: Howitzer Program Experiencing Cost Increases and Schedule Delays," dated June 19, 2000 (GAO Code 707508/OSD Case 2036).

The DoD has no comments on the draft report. Thank you for the opportunity to review it.

George R. Schneiter
Director
Strategic and Tactical Systems

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