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EMBEDDED COMPUTERS

B-1B Computers Must Be Upgraded To Support Conventional Requirements

GAO

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

Accounting and Information
Management Division

B-270699

February 27, 1996

The Honorable William J. Perry
The Secretary of Defense

Dear Mr. Secretary:

At the request of the Subcommittee on Military Research and
Development, House Committee on National Security, we have reviewed
the Air Force's efforts to upgrade the computers and software for the B-1B
Bomber Conventional Mission Upgrade Program (CMUP). Our National
Security and International Affairs Division is studying other aspects of the
B-1B and the role of bombers for specific missions.[1] This letter discusses
recent decisions the Air Force has made in upgrading the B-1B's
embedded computer systems in view of concerns we raised during our
review. Details on our scope and methodology are in appendix I.

As you know, the $2.7 billion CMUP program is intended to convert the B-1B
from a primarily nuclear weapons carrier to a conventional weapons
carrier. If the B-1B is to be the "backbone" of the bomber fleet, as Defense
envisions it, then upgrading the computers and software is critical to
achieving the new conventional capabilities for the B-1B. As with other
older weapons systems, the 1970s vintage computer systems embedded in
the B-1B are operating at near capacity and, without upgrades, cannot
support additional weapons and capabilities, which are to include cluster
bombs, a global positioning system for improved navigation and guidance,
and more accurate and increased-range weapons. In addition, because the
software used in the B-1B is complex, poorly documented, and has been
extensively modified over the years, it is difficult and expensive to
maintain.

The Air Force recognized that in order to support the additional B-1B
capabilities, the computer systems must be modernized. Last year, it
identified several preliminary computer upgrade options, ranging from a
simple memory upgrade, to installing all new computer processors and
Ada software—a more modern computer language which offers
advantages in design, coding, and documentation, and cost-effective
software maintenance and support. However, because of its desire to
maximize resources available to weapons and capability upgrades, it
allocated $2.3 billion for this purpose leaving $412 million for the

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[1]GAO's survey of the B-1B CMUP is discussed in its letter to the Secretary of the Air Force, dated
December 4, 1995 (GAO/NSIAD-96-52R). GAO's other ongoing review addresses the cost to keep
bombers in the force and to modify them to use precision-guided munitions.

computer upgrade. As a result, the only affordable option was a simple memory upgrade.

On numerous occasions from June through November of 1995, we met with Air Force officials—including the B-1B's deputy program executive officer, deputy program manager, chief engineer, software acquisition and maintenance engineers, project managers, and the program element monitor at the Air Combat Command—and we expressed concerns that the memory upgrade option would not support the conventional weapons and related capabilities the Air Force wanted to add to the B-1B and could, therefore, jeopardize the entire CMUP effort. We concluded that the simple memory upgrade, which only doubled the memory of the existing processors and did not increase the throughput capacity,[2] was clearly inadequate because it would not do the following.

- Support conventional weapons and capabilities currently included in the CMUP effort, such as the Joint Standoff Weapon and the Wind Corrected Munitions Dispenser.
- Allow the B-1B to carry and deploy three different types of weapons per mission as required by the Air Force's Operational Requirements Document, which defines specific weapons the B-1B must carry. The simple memory upgrade would only accommodate one type of weapon per mission.
- Provide the spare memory and throughput capacity specified in the System Requirements Document to accommodate future weapons and capabilities that are not part of the current CMUP effort. The Air Force envisions adding new and more sophisticated weapons requiring unknown additional amounts of memory and throughput capacity. Potential candidates for future capabilities include digital terrain maps, improved targeting systems, various on-board mission planning functions, and more sophisticated precision-guided munitions.
- Facilitate cost-effective software modification and maintenance over the upgraded B-1B's expected 20-plus year life. Under this option the Air Force would retain the existing software and the difficult and costly maintenance associated with it.

The Air Force subsequently increased funding to about $510 million to upgrade the B-1B's embedded computer systems by replacing the existing computers with new 32-bit technology processors and converting the outdated software to Ada. Rockwell International, the prime B-1B

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[2]Memory capacity is a measure of the amount of information a computer system can store. Throughput capacity is a measure of the data processing rate or "speed" of a computer system usually expressed in millions of instructions per second.

contractor, will be assisting in putting together a Request for Proposals to use to solicit bids for the upgrade. The Air Force expects to award a contract for the computer upgrade design in April 1996 and expects work to be completed in January 1997.

Our work directly supports the decision to replace the processors and convert the software to Ada. This is clearly preferable to the simple memory upgrade originally planned because it will not only increase the memory and throughput capacity of the computers, but could potentially save over $800 million in software maintenance and support costs over the expected 20-plus year life of the upgraded aircraft.[3] We believe that it is extremely important that the Air Force not revert to a computer upgrade approach for the B-1B based on cost alone but ensures that sufficient resources are allocated so that the computers can support the conventional weapons and capability requirements planned for the B-1B.

Recommendation

When bids are being considered for the B-1B's embedded computer system upgrade, we recommend that you ensure that the upgrade will:

- accommodate all currently planned B-1B weapons and capability enhancements,[4]
- meet the B-1B weapons interoperability requirement (three types of weapons per mission),
- reduce the risks of additional costly computer upgrades in the future,
- allow for the necessary spare memory and throughput capacity to accommodate future growth, and
- reduce software maintenance costs.

Because of the Subcommittee's continuing interest in this area, we would like the Air Force to provide us with the results of its Request for Proposals and documentation of subsequent decisions on the upgrade approach once a contract is awarded in April 1996. We plan to evaluate that response and share any additional concerns that we may have at that time.

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[3]The Air Force estimated that Ada will cost $42 million a year less to maintain and support than the current software, Jovial.

[4]This does not include computer upgrades needed for the defensive system or the central integrated test system. The Air Force plans to address computer upgrades needed for these systems at a later date.

The head of a federal agency is required by 31 U.S.C. 720 to submit a written statement on actions taken on this recommendation to the Senate Committee on Governmental Affairs and the House Committee on Government Reform and Oversight within 60 days after the date of this report. A written statement also must be sent to the House and Senate Committees on Appropriations with the agency's first request for appropriations made more than 60 days after the date of this report.
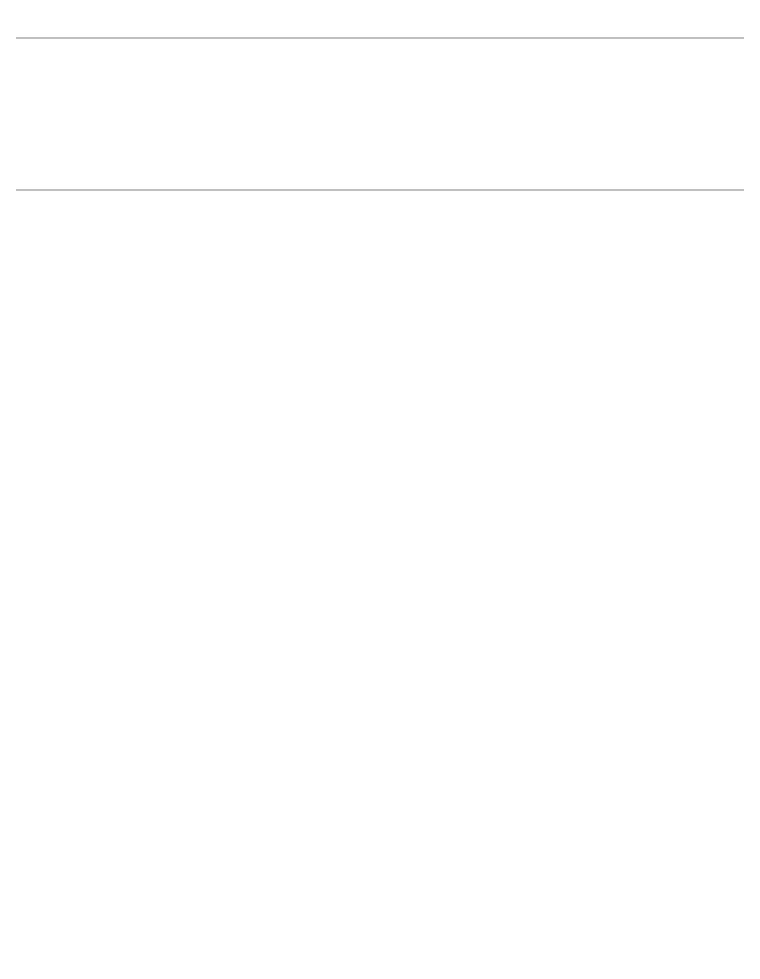
In commenting on a draft of our report, officials representing the Office of the Secretary of Defense and the Air Force concurred with our findings and recommendations and agreed to ensure that the B-1B Bomber computer upgrade will support conventional weapons requirements.

We are sending copies of this report to the Chairmen and Ranking Minority Members of the Subcommittee on Military Research and Development, House Committee on National Security; the House and Senate Committees on Appropriations; the Senate Committee on Armed Services; the Secretary of the Air Force; and to other interested parties upon request. If you have questions or wish to discuss the issues in this letter, please contact me at (202) 512-6240. Major contributors to this report are listed in appendix II.

Sincerely yours,

Jack L. Brock, Jr.
Director, Defense Information and
    Financial Management Systems

Scope and Methodology

To assess the Air Force's approach to upgrading the B-1B's computers and software, we reviewed (1) Defense and Air Force instructions and guidance governing the development, testing, and management oversight of embedded computer systems, (2) B-1B program documents, including software requirements documents, software development and test plans, technical risk assessments and program status reports, and (3) contractor documents and assessments by system users and independent agencies. We discussed B-1B issues and concerns with officials at Air Force Headquarters and Office of the Secretary of Defense offices, Arlington, Virginia; Air Combat Command Headquarters, Langley Air Force Base, Virginia; the B-1B System Program Office and Aeronautical Systems Center, Wright Patterson Air Force Base, Ohio; and the Oklahoma City Air Logistics Center, Tinker Air Force Base, Oklahoma, which is primarily responsible for maintaining the B-1B.

In conducting our review, we analyzed assumptions in Defense cost estimating models for the B-1B and evaluated independent assessments of the various computer upgrade options. We conducted our review from June 1995 through November 1995, in accordance with generally accepted government auditing standards. We requested comments from the Secretary of Defense and the Air Force. On January 30, 1996, representatives from the Office of the Under Secretary of Defense for Acquisition and Technology, the B-1B Program Executive Office, the B-1B System Program Office, and the Joint Chiefs of Staff provided us with oral comments on a draft of this report. These comments are discussed at the end of this report.

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