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Report to the Chairman, Committee on Armed Services, House of Representatives

October 1988

STRATEGIC BOMBERS

B-1B Maintenance Problems Impede Its Operations

GAO/NSIAD-89-15

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The Honorable Les Aspin
Chairman, Committee on Armed Services
House of Representatives

Dear Mr. Chairman:

This report, which was prepared at your request, addresses selected B-1B maintenance issues, including an update of maintenance information reported to you in June 1987. We are sending copies to interested congressional committees; the Secretaries of Defense and the Air Force; the Director, Office of Management and Budget; and other interested parties upon request.

Sincerely yours,

for Bill W. Thurman

Frank C. Conahan
Assistant Comptroller General

Executive Summary

Purpose

GAO reported in June 1987[1] that the Air Force was not supporting and maintaining the B-1B as expected but was working toward its goals for readiness and training. The Chairman of the House Committee on Armed Services requested that GAO continue reviewing the status of the B-1B's supportability, maintainability, and readiness.

This report, which follows GAO's report on parts support problems,[2] focuses on the status of the following selected aspects of B-1B maintenance:

- the test system on board the aircraft,
- the delivery of support equipment and repair instructions,
- the requirements for contractor engineering support and enhancements, and
- the effect of maintenance on aircraft availability.

Background

The Air Force plans for the B-1B to replace the B-52 as a penetrating bomber until a more advanced bomber is deployed. The B-1B might also be used as a cruise missile carrier and as a conventional bomber.

The Air Force expects to maintain the B-1B with its own resources. To minimize support personnel and equipment, the Air Force is developing a test system called the Central Integrated Test System. This system on board the aircraft measures the performance of B-1B parts and equipment in flight and identifies needed maintenance and repairs.

To maintain the B-1B with its own resources, the Air Force is obtaining support equipment and repair instructions from contractors. Until this equipment is delivered and related instructions are delivered and can be verified, the Air Force relies on contractors to perform numerous maintenance and repair tasks.

Contractor engineering support, called sustaining engineering, is also needed so the Air Force Logistics Command can improve the design and performance of B-1B systems and subsystems. In general, the more complicated the system, the more sustaining engineering support is required.

[1]Strategic Forces: Supportability, Maintainability, and Readiness of the B-1B Bomber (GAO/NSIAD-87-177BR, June 26, 1987).

[2]Strategic Bombers: B-1B Parts Problems Continue to Impede Operations (GAO/NSIAD-88-190, July 26, 1988).

The Air Force uses several measures to assess how well the B-1B is being maintained. The percent of time the aircraft is not mission capable because of maintenance is one measure that indicates the effect of maintenance on readiness.

Results in Brief

B-1B maintenance faces increased costs, extended reliance on contractor engineering support, and significant maintainability challenges. Problems with the on-board test system have limited the Air Force's ability to maintain the aircraft as planned. Also, the Air Force has not received, as planned, the support equipment and repair instructions needed to perform its own maintenance and repairs. As a result, interim contractor support costs have increased. Furthermore, estimated requirements and funding for sustaining engineering continue to increase, and needed reliability and maintainability enhancements are being identified. In addition to increased costs, the B-1B has not been mission capable because of maintenance a significant percentage of the time. This has affected aircraft availability and training.

GAO's Analysis

On-Board Test System Not Ready

The Air Force was working to have the B-1B on-board test system ready by the initial operational capability date of October 1, 1986. It sought a system that would provide no more than five false indications of part failures per flight. However, the system produced as many as 200 false indications of part failures per flight during early operations, and maintenance personnel could not rely on the system. The Air Force determined that contractor specifications needed to be changed to improve the system and has worked with contractors to reduce false indications. Continuing contractor support will be required to analyze systems data. In addition, to identify failed parts better and reduce false indications, the Air Force is replacing the test system's ground processor with one that has enhanced capability to analyze performance data. The total development and acquisition cost for the new capability is estimated to be about $34 million.

Support Equipment and Repair Instructions Delayed

The Air Force will not take over maintenance operations when planned because of delays in obtaining support equipment and repair instructions. GAO reported in June 1987 that the Air Force's projected dates for doing certain maintenance had slipped about 2 years. The continuing delays in receiving support equipment and repair instructions have caused about 2 years of additional slippage for depot-level maintenance.

Without its own maintenance capability, the Air Force must continue to rely on contractor support at increasing costs. In 1981 the Air Force estimate for interim contractor support was $250 million (1987 dollars). As of April 1988 the estimate for this support was $570 million, an increase of $320 million.

Sustaining Engineering and Enhancements Needed

In addition to increased interim contractor support costs, the Air Force has increased estimated costs and funding for B-1B sustaining engineering. The Air Force's January 1988 estimate for sustaining engineering funding for fiscal years 1988 through 1992 increased about 140 percent from its January 1987 estimate, from $101 million to $243 million. In addition, the Air Force B-1B program office has proposed over 50 reliability and maintainability enhancements totaling more than $586 million for fiscal years 1990 through 1997. Some enhancements are for problem parts, such as the windshields and the integrated drive generator, that the Air Force and contractors have been working on since production. Others provide for unknown contingencies.

Maintenance Problems Reduce Aircraft Availability

The portion of the hours each month from October 1987 through February 1988 that B-1Bs were not available because of maintenance at Dyess Air Force Base ranged from 47 to 66 percent. For mature systems, such as the B-52 and the FB-111 aircraft, the Air Force expects the total not mission capable rates because of maintenance to be no greater than 25 percent of the available hours. (These Air Force standards for mature bombers are provided as a basis for assessing the status of the B-1B maintenance support, not as a basis to determine what it should be.) The Dyess rates indicate that B-1B maintenance requirements are a challenge and that they have been limiting aircraft availability.

Limited availability of aircraft has (1) prevented crews from completing the training needed to be certified mission ready, (2) contributed to reducing the number of crews per aircraft to be trained, and (3) delayed the placing of additional aircraft on alert.

Recommendations

This report provides GAO's analysis of the status of selected aspects of B-1B maintenance; it contains no recommendations.

Agency Comments

The Department of Defense (DOD) generally agreed with GAO's findings. (See app. I.) DOD said the projections of future costs reflect planning by Air Force activities but may change significantly after the requirements are reviewed within DOD. GAO has revised its report, where appropriate, to note that these estimates are subject to changes.

DOD also pointed out that comparing B-1B maintainability factors to those of mature systems would have more validity after the B-1B reaches maturity. According to DOD, maturity is expected after the B-1B has flown 200,000 hours, estimated to occur in 1994. Data for mature systems are included in GAO's report to provide a basis to assess the status of the B-1B. DOD's current estimate of achieving aircraft maturity in 1994 represents a slippage of over 1 year, primarily due to limited aircraft availability.

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Abbreviations

AFB	Air Force Base
AFLC	Air Force Logistics Command
AFOTEC	Air Force Operational Test and Evaluation Center
ALC	Air Logistics Center
CITS	Central Integrated Test System
DOD	Department of Defense
GAO	General Accounting Office
ICS	interim contractor support
SAC	Strategic Air Command

Introduction

The Air Force plans for the B-1B to replace the B-52 as a penetrating bomber until a more advanced bomber is deployed. The B-1B can also be used as a cruise missile carrier and as a conventional bomber.

The decision to procure the B-1B was made in October 1981. At that time an initial operational capability date was set for October 1, 1986—when the 15th aircraft was to be delivered to the Strategic Air Command (SAC) with sufficient support resources to carry out its mission. The October 1986 date was considered achievable based on the experience gained in the earlier B-1A program. The Air Force recognized that achieving this date would require a high degree of concurrent development and production. Some development and production contracts were signed on the same day. The October 1986 date also compressed the test program. The Congress capped program costs, and the President certified that the program could be completed within the estimated time.

The Air Force contracted for the production of 100 B-1B aircraft, and it accepted the 100th B-1B on April 29, 1988. The planned deployment of the 80 primary aircraft in bombardment squadrons is as follows: 16 at Dyess Air Force Base (AFB), 32 at Ellsworth AFB, 16 at Grand Forks AFB, and 16 at McConnell AFB. Of the remaining aircraft, the Air Force assigned 10 to the training squadron at Dyess and 9 to backup inventory, and 1 was destroyed in a September 1987 crash. The Oklahoma City Air Logistics Center (ALC) is responsible for managing the maintenance and logistical support for the B-1B. SAC is responsible for B-1B operations.

Maintenance Operations

B-1B maintenance takes place at three levels: the organizational, intermediate, and depot levels.

- Organizational-level maintenance is usually performed on the flight line and includes such things as inspecting, servicing, lubricating, adjusting, and replacing parts, minor assemblies, and subassemblies.
- Intermediate-level maintenance usually takes place in shops at the main operating bases and includes such things as calibration, repair, or replacement of damaged or unserviceable parts, components, or assemblies; the emergency manufacture of nonavailable parts; and technical assistance to using organizations.
- Depot-level maintenance usually takes place at one of the ALCs or in contractors' plants, uses more extensive facilities for repair than are available at lower-level maintenance activities, and involves major overhaul or a complete rebuild of parts, assemblies, subassemblies, and end items,

including the manufacture of parts, modifications, testing, and reclamation as required. It also performs maintenance beyond the responsibility of lower levels of maintenance and provides technical assistance to these levels.

The Air Force plans for virtually all B-1B maintenance operations to be organic, that is, done within the Air Force by Air Force personnel. The Air Force used established procedures in deciding whether to use contractor or organic maintenance for its depot-level work. The major factors in the decision are military mission and cost. If the Air Force cites compelling military mission reasons to support the aircraft organically, as it did for the B-1B, then concern about costs is limited to ensuring that they are not exorbitant. An Air Force regulation provides that this can normally be done without a detailed cost study. Officials said that such studies were not done to determine differences between the Air Force's and contractors' cost or ability to perform B-1B maintenance. Nevertheless, the officials stated that the Air Force views interim contractor support for the B-1B as more costly and less timely than organic support. Longer repair cycles require more parts in the supply pipeline and could require more cannibalizations to keep some aircraft flying until repaired parts come back from the contractor.

Objectives, Scope, and Methodology

The Chairman of the House Committee on Armed Services requested that we continue reviewing the status of the B-1B's supportability, maintainability, and readiness.

The objectives of our review were to update the status of B-1B maintenance support issues identified in our June 1987 report and to examine other selected maintenance and related management issues. We reviewed Air Force policies and procedures at the B-1B System Program Office, the Aeronautical Systems Division, and the Air Force Logistics Command (AFLC), Wright-Patterson AFB, Ohio; SAC Headquarters, Offutt AFB, Nebraska; the Oklahoma City ALC, Oklahoma; Dyess AFB, Texas; and Grand Forks AFB, North Dakota. At each location we interviewed officials responsible for maintenance support. We obtained the following types of information:

- contract cost, schedule, and performance information for the B-1B's Central Integrated Test System (CITS);
- performance and operational evaluation reports on CITS and cost estimates for (1) an enhanced ground processor, (2) software maintenance aids, and (3) continuing contractor support;

- delivery schedules for maintenance support equipment and repair instructions, which we compared with Air Force plans to achieve organic maintenance;
- number and cost of contractor repairs under interim contractor support and estimated cost for continued interim contractor support until organic maintenance is achieved;
- lists of parts to be maintained organically and repaired, from which we identified frequently repaired parts and other parts that might warrant priority for organic maintenance;
- cost and budget information for sustaining engineering requirements and descriptive information on and examples of sustaining engineering efforts;
- cost and descriptive information on reliability and maintainability programs;
- maintenance reports including data on not mission capable rates, cannibalization rates, and maintenance time; and
- training reports on the numbers of qualified crews and on missed training due to aircraft maintenance.

We conducted our review from September 1987 to April 1988 in accordance with generally accepted government audit standards. DOD, Boeing Military Airplane Company, Eaton Corporation, and Rockwell International reviewed a draft of this report. Their responses are included in appendixes I through IV.

The B-1B On-Board Test System Is Not Ready

The B-1B maintenance concept depends on a properly working on-board diagnostic system, the Central Integrated Test System (CITS), to check out equipment performance and identify needed maintenance and repair. The Air Force developed CITS to minimize support personnel and equipment. In a 1983 report,[3] we said that failure of this system to perform as desired could result in increased costs for spares; additional test equipment; and a need for additional, more highly trained maintenance personnel. It also could result in reduced aircraft readiness.

The Air Force was working to have CITS ready by the B-1B's initial operational capability date of October 1, 1986. Developmental and operational problems with the system have prevented it from being used as planned. The Air Force has made progress in overcoming some of the problems, but Air Force maintenance personnel are not yet relying on CITS-generated work orders to maintain the B-1B's offensive or defensive avionics. In addition, the Air Force will continue to need contractor engineering support for several years to resolve system problems.

CITS is an electronic data processing test system on board the B-1B that monitors and measures performance of subsystems by indicators such as temperature, pressure, and voltage. The information obtained is translated by a computer program into maintenance codes that identify failures of parts or groups of parts and is recorded for later analysis during ground processing. Ground processing translates the flight information from the taped record into maintenance work orders.

Three B-1B associate contractors are developing various parts of the CITS system. Rockwell International is the contractor responsible for (1) collecting the flight data and maintenance codes to monitor aircraft equipment other than the offensive and defensive avionics subsystems and (2) recording and displaying all parameters, codes, and messages. Boeing Military Airplane Company is responsible for the offensive avionics subsystem, and Eaton Corporation is responsible for the defensive avionics subsystem.

To provide desired CITS capability, the Air Force is

- correcting unacceptable performance such as false indications of parts failures,
- identifying and obtaining contractor documentation needed to maintain software,

[3]The B-1 Bomber Program—A New Start (GAO/MASAD-83-21, April 13, 1983).

- replacing the ground processor with enhanced capability to analyze performance data, and
- providing for contractor support to complete development.

These are discussed in more detail below.

CITS Initial Performance Unacceptable; Improvements Underway

During initial B-1B operations in 1985, CITS was producing as many as 200 false indications of failures per flight. The Air Force determined that this was an unacceptably high number of false indications of aircraft systems and/or subsystems failures per flight. SAC concluded that CITS was operationally unacceptable in both maintenance cost and time wasted from responding to false failures. In a November 1985 meeting, the program office, SAC, and Rockwell determined that the contract specifications needed to be changed to improve CITS.

SAC wanted to limit false indications to a total of no more than five per flight for all three contractors. Boeing and Eaton agreed to a specification change that allowed each of them eight or less known but uncorrected false indications at the end of full-scale development testing. Rockwell stated that it was in compliance with the contract and would not agree to a specification change. However, it did agree, through an incentive award fee contract modification, to reduce its number of false indications to 10 or less per flight. Thus, under current agreements, CITS is to produce no more than 26 false indications per flight.

The Air Force authorized the Rockwell incentive modification in July 1986. The negotiated award fee was for a maximum of $1.2 million with three award fee periods, the last ending March 31, 1987. When the first period ended in December 1986, the Air Force recommended no award fee because of inadequate contractor performance. In a subsequent meeting with Rockwell, the Air Force agreed to (1) extend the maturation effort 8 months until November 1987, (2) revise the final two award fee periods, and (3) increase the total award fee by $400,000 to $1.6 million. On May 15, 1987, the second period ended. The Air Force awarded a fee of $165,838 because Rockwell had succeeded in reducing the number of false indications from an average of 93 per flight in December 1986 to an average of 29 per flight.

For the third period, the Air Force evaluated performance of the latest CITS software over 33 flights during October and November 1987 and reported that Rockwell's latest software greatly improved operations.

The initial Air Force count of false indications was about two false indications per flight. The program office concluded that Rockwell's portions of CITS had reached maturity. The Air Force awarded Rockwell the remainder of the $1.6 million fee for the final period.

Boeing was scheduled to complete its CITS maturation effort in April 1988. However, this was not achieved. The Air Force estimates that Boeing will complete its CITS maturation in December 1988. As of April 1988 Boeing was reporting an average of nine false indications per flight.

The Air Force was also concerned that Boeing's maintenance concept differs from the B-1B concept to perform required maintenance based on CITS work orders. Air Force procedures for offensive avionics maintenance indicate that ground readiness tests are to be used to verify the systems operation after replacing all faulty parts identified by the CITS-generated work order. Boeing's procedures are to use tests to verify whether a CITS-generated work order is valid. If the tests do not verify the problem, the technicians are to disregard the work order. If the tests verify the problem, Boeing uses additional engineering information to isolate faults.

SAC said in January 1988 that Boeing's portion of CITS is unusable without the additional engineering information. Furthermore, the Air Force Operational Test and Evaluation Center (AFOTEC) expressed concern that Boeing, under its contract, might not be required to provide the Air Force with this additional engineering information. SAC requested clarifications of contract requirements on the need for CITS ground readiness testing and additional trouble shooting before removal and replacement of offensive avionics parts.

According to the Air Force, Eaton will not have a mature CITS for defensive avionics until at least September 1989. This slippage is a result of continuing development of the defensive avionics system.

Additional Software Documentation Needed

The Air Force has concluded that software documentation, in addition to that which the contractor is required to provide, is needed to maintain the CITS software.

In February 1987 AFOTEC evaluators made their fifth maintainability evaluation of Rockwell's CITS software. They reported, as in the four previous evaluations, that the CITS documentation was unacceptable as a software maintenance tool. One major concern was that no concerted Air

Force effort existed to provide documentation needed for transferring a maintainable system to the Oklahoma City ALC, the responsible Air Force organization. The report concluded that the program office and the ALC must identify all software, hardware, and applicable Rockwell and vendor subsystem documentation required to support CITS.

The ALC subsequently prepared a list of CITS software documentation requirements. In May 1988 the program office negotiated a contract change for $12.7 million to transfer the avionics integration capability from Rockwell to the Oklahoma City ALC. DOD said that about $450,000 of this amount was for CITS documentation.

In its comments on our draft report, DOD provided cost data that differed from the information that was provided to us previously by the Air Force. We discussed DOD's information with Air Force officials and have changed our report to include DOD's data and to state that the Air Force negotiated a contract change rather than a contract.

Enhanced Ground Processing Capability Under Development

The Air Force has been developing a computer-based system, called the CITS expert parameter system, to improve B-1B diagnostics by better identifying failed parts and reducing false indications. The Air Force stated that the current CITS ground processor, an older model computer with limited capacity, is slow to generate reports and that current processing requires extensive interpretation by engineers. The primary goals for the parameter system are to (1) improve diagnostics on the B-1B and implement the technology required to improve existing and future diagnostics, (2) enhance CITS by reducing ambiguities, and (3) reduce maintenance costs and improve aircraft availability through the use of a maintenance advisory system.

In a briefing prepared for Air Force Headquarters officials, the program office reported that the parameter system could reduce the average organizational-level maintenance flow time—the time required for aircrew debriefing, fault isolation, repair, and repair verification—from 2 to less than 1-1/2 hours. It also reported that during preliminary operations, test time at the intermediate repair level was reduced from an average of 4 to less than 3 hours.

The parameter system is being developed in three phases, two of which have been completed. Phase I was a feasibility study, Phase II was a prototype system with an operating demonstration, and Phase III will be

an operating system. Rockwell and Boeing completed their Phase II demonstrations in September 1987 and November 1987, respectively. Eaton is not developing a parameter system prototype because it will not have a workable CITS until about September 1989.

AFOTEC used preliminary information to report that Rockwell's demonstration was inconclusive concerning the effectiveness of its parameter system and that Boeing's demonstration showed potential. The users found that Boeing's parameter system reduced fault isolation time, was user friendly, and, if fully developed, would be an often-used troubleshooting aid. AFOTEC stated that the parameter system needs a fully mature CITS to be beneficial. In its comments, DOD noted that only Rockwell's system requires a fully mature CITS. It said Boeing's system uses parameter data and is not based on CITS maturity.

As of May 1988 the program office had not completed evaluating the contractors' reports to determine whether the parameter system would benefit the diagnostics capability for the B-1B. DOD commented that before the completion of the program office's assessment, the Air Force Weapons Aeronautical Laboratory provided an independent assessment of Boeing's system. The assessment concluded that it was a worthwhile effort and recommended proceeding with the program.

The program manager said that funds had been made available for one contractor to develop an operating system. A request for proposal for this has been sent to Boeing for the offensive avionics CITS expert parameter system. The program office has requested funds for fiscal year 1990 for the other two contractors to develop their portions of the system. This request will be reviewed by the Air Force and DOD to determine what amount of funds, if any, will be requested in the fiscal year 1990 budget. DOD's total estimated development and acquisition cost of the parameter system is about $34 million.

In its comments on this section of our report, DOD described the goals of the CITS expert parameter system and provided additional technical information on the system. We have revised this section to recognize its comments. Rockwell International also provided additional information concerning CITS development in its comments on the draft report. Rockwell's comments are included in appendix IV.

Continued Contractor Support Needed

In September 1987 SAC stated that the consensus of the Inter-Command CITS Working Group was that contractor engineering development support was required to maintain CITS and validate codes. As of April 1988 SAC reported that about 7,800 of the 10,500 CITS maintenance codes had not been validated, about 600 were being analyzed, and about 2,100 were working correctly. Air Force evaluators at Dyess AFB said that contractor engineering analysis was required for an average of about one new maintenance code per flight.

The program office had issued contracts totaling $17.6 million through fiscal year 1987 to provide engineering support at the operating bases as well as plant engineers for the CITS maturation effort. The program office intended to terminate engineering support in November 1987, but SAC requested a continuation. The program office proposed to fund engineering support at each operating base from November 1987 through December 1988 to assist SAC in (1) building the maintenance code database, (2) analyzing CITS data, and (3) identifying potential false alarms. However, after receiving Rockwell's proposal of $3 million for this support, the Air Force requested that Rockwell reduce the number of engineers at the operating bases. In January 1988 the program office issued an undefinitized contract change for CITS support for the period November 16, 1987, through August 15, 1988. The contract, with a not-to-exceed price of about $2 million, provides for fewer engineers than originally proposed. A $600,000 option covers the remaining period through December 15, 1988.

In February 1988 the program office issued Boeing a new contract for CITS engineering support with a not-to-exceed price of $1 million. Eaton has not completed its CITS development and will continue to develop its software under the current contract.

Delays Continue in Obtaining Support Equipment and Repair Instructions

The Air Force is not receiving on schedule the support equipment and repair instructions from contractors needed to achieve organic maintenance. Consequently, the Air Force continues to rely on contractors to repair B-1B parts, including critical parts in short supply. Contractor repair costs have been somewhat lower than contract amounts through fiscal year 1988 because the Air Force used data that overestimated the number of billed repairs. However, the total estimated interim contractor cost has increased by $320 million since the original estimate in 1981.

ALC officials said they are acquiring repair instructions and support equipment based on priorities for organic repair developed with such factors as high frequency of repair and criticality of parts. They believe this will reduce costs and improve aircraft availability.

Undelivered Support Equipment and Repair Instructions Delay Organic Maintenance

The lack of support equipment and repair instructions continues to delay the transition from contractor support to organic Air Force maintenance. Support equipment required to maintain and support the B-1B ranges from sophisticated test equipment to common hand tools. Air Force maintenance personnel use support equipment (1) on the flight line to repair aircraft systems and prepare these systems for their mission and (2) in base maintenance shops and depots to make repairs to and install modifications on aircraft. Repair instructions are needed so personnel will know how to use the equipment and make required repairs.

We reported in June 1987 that the Air Force's schedule for achieving organic intermediate- and depot-level maintenance capability had been revised from 1988 to 1990. The Air Force's revised schedules show that the transition is to be substantially complete by December 1989 for intermediate level, and by December 1990 for depot level. Although schedules have not been revised, ALC officials said in June 1988 that depot-level organic maintenance for non-avionics had slipped to 1992, avionics (except defensive avionics) to 1993, and defensive avionics to 1995.

Oklahoma City ALC officials identified 6,360 parts that they expect to maintain at the ALCs. In November 1986 the Air Force requested data from the contractors to establish dates for organic maintenance of these parts. The contractors provided some of these data. As of June 1988 the ALC had projected dates when organic maintenance could be achieved

for 1,712 of these parts but did not have the necessary contractor data to project dates for the remaining parts.

Similar situations were noted at the base level. For example, officials at Grand Forks AFB were preparing for organic maintenance of 43 parts as their first group. However, the base did not have all of the support equipment and repair instructions needed for Air Force technicians to repair 34 of the 43 parts. As of March 31, 1988, technicians at Dyess AFB were unable to maintain as planned (1) 26 parts because the contractors had not delivered the repair instructions and (2) 29 parts because of lack of support equipment.

Support Equipment

According to Air Force data, as of February 1988 about one-half of the support equipment identified as needed to maintain the B-1B has been delivered to maintenance facilities. As shown in table 3.1, the greatest shortage is at the depot level.

Table 3.1: Percent of Needed Support Equipment Delivered as of February 1988

Figures in percent

Level	Non-avionics	Avionics	Combined
Organizational	80	12	76
Intermediate	68	31	55
Depot	69	10	41
Overall	71	14	49

The depots are not scheduled to receive all the equipment needed to maintain non-avionics parts until 1991 or avionics parts until 1992. The delivery schedules also show that about one-half of the test program sets, such as computer software, will not be available by the end of 1992. Although the Air Force schedule showed the transition to organic depot support was expected to be completed in 1990, the Air Force cannot achieve this capability until the support equipment is operating at the depots. Table 3.2 shows the delivery schedule as of February 1988 for depot-level support and test equipment.

Table 3.2: Scheduled Availability of Depot-Level Support Equipment

(cumulative percent of requirements)

Year	Non-avionics equipment	Avionics	
		Equipment	Test program sets
1989	84	51	27
1990	92	76	28
1991	100	97	38
1992	100	100	49

A January 1988 Air Force audit report noted that factors such as extended testing, production problems, and late selection of support equipment contributed to the delay in support equipment deliveries. The report stated that support equipment nonavailability, in turn, contributed to delayed or canceled B-1B aircraft sorties, delayed repair instruction verification, and increased contractor support.

Repair Instructions

Air Force officials said that through February 1988 they had received about 33 percent of the repair instructions needed for organic maintenance. Table 3.3 shows that 2 percent had been delivered for the depot level. Contractors have not furnished availability dates for many of the repair instructions.

Table 3.3: Percent of Repair Instructions Delivered as of February 1988

Type	Required	Delivered	Percent delivered
Organizational level	417	411	99
Intermediate level	614	145	24
Depot level	775	17	2
Support equipment	499	179	36
Total	**2,305**	**752**	**33**

Once the Air Force receives repair instructions, it must verify their accuracy before they are used to guide repair of the aircraft. The Air Force's instruction verification is behind schedule. Its plan shows verification is expected to be completed by April 1990 for intermediate-level and March 1991 for depot-level repair instructions. However, by January 1988 the Air Force had completed verification of 63 of the 150 intermediate-level instructions it planned to verify by that date. Also, the Air Force had been scheduled to complete about 50 depot-level verifications by January 1988; however, ALC officials said that 27 had been completed.

In its comments on this report, DOD agreed with the information provided. It explained that earlier estimated delivery dates, which were used for planning verification and organic maintenance, were not binding until after contract negotiations were complete. It identified two documents that show delivery dates for technical orders on contract.

Interim Contractor Support: Costs Increasing, Repair Estimates Unrealistic

Most intermediate- and depot-level repairs for the B-1B continue to be performed under contracts called interim contractor support (ICS). ICS is a method whereby a contractor provides logistic support while requirements are being refined, technical problems are being resolved, design stability is being achieved, or lead time is provided for complex support resources. The Air Force provides organic maintenance for B-1B engines. Contractors provide most other intermediate- and depot-level maintenance. Table 3.4 shows the number of ICS repairs by contractor.

Table 3.4: Number of ICS Repairs From January 1, 1985, to December 31, 1987

Contractor	Number of Unique parts repaired	Total repairs	Unique parts with 5 or more repairs
Rockwell	925	5,158	238
Boeing	239	1,472	65
Eaton	341	934	50
Total	**1,505**	**7,564**	**353**

The ICS support contracts include a base year that ended September 30, 1985, and 4 option years. Fiscal year 1988 is the third option year.

Since our June 1987 report, the Air Force has increased the total estimated cost of ICS because of continuing delays in establishing organic repair. Table 3.5 compares the original and updated estimates of ICS costs for fiscal years 1985 through 1994 and shows an increase of $116 million in total cost from the estimate in our June 1987 report. The 1988 estimate is as of April 1988.

Table 3.5: Estimated ICS Costs in Fiscal Year 1987 Dollars

Dollars in millions

	Year of estimate		
Fiscal year	**1981**	**1987**	**1988**
1985	$6	$11[a]	$6[b]
1986	12	52	38[b]
1987	62	77	72[b]
1988	144	107	104[b]
1989	26	100	107
1990	0	49	73[c]
1991	0	31	55[c]
1992	0	14	48[c]
1993	0	7	38[c]
1994	0	6	29[c]
Total	**$250**	**$454**	**$570**

[a]Our June 1987 report showed this as $42 million. Air Force officials said $31 million was more appropriately classified as preparation costs not included in ICS.

[b]The amount shown is the contractor's estimate at completion. Actual costs are lower than the amounts covered by contracts.

[c]Cost estimates may be substantially changed after internal DOD review.

As noted above, data from contractors show that the amount expended for repair of B-1B parts through 1987 was below the contract amounts. The contracts are based on an expected cost to repair items plus a fixed fee. Repair costs include a fixed level of effort to perform intermediate-level repairs both on and off base as well as payments to subcontractors for repair of individual parts. Total costs include repair costs, overhead, fixed fee, and firm-fixed-price portions of the contracts. The contractor receives the fee regardless of the amount of repairs performed.

Table 3.6 shows the total contract amounts and the contractors' estimates of total billings at completion of the contract for fiscal years 1985 through 1988.

Table 3.6: Amount Spent on ICS

Dollars in millions

	1985	**1986**	**1987**	**1988**	**Total[a]**
Contract amounts	$10.0	$54.6	$115.3	$116.7	$296.7
Less estimated billings[a]	5.6	38.3	72.0	103.8	218.9
Unexpended balance[b]	**$4.3**	**$16.3**	**$43.4**	**$12.9**	**$77.7**

[a]This includes amounts not yet billed to the government because some repairs are still in process. As of December 31, 1987, the contractors were repairing 1,454 parts.

[b]Totals may not add due to rounding.

Air Force officials stated that one reason repair costs were overestimated was that the Air Force was not able to fly the B-1B as many hours as estimated when the contracts were awarded. According to a Rockwell official, the flying hours were less than the Air Force expected in the early years and contributed to fewer-than-expected repairs, but in 1987 flying hours were about equal to expectations. The official said the main reason for the 1987 repair underrun was that many of the parts included under the contract were not failing at the rates estimated when the contracts were awarded.

Another major reason that repair costs were overestimated appears to be that Air Force analysts, in establishing contract amounts, included false failures and warranty repair in addition to failures that the contractor would be paid to repair. Including parts to be repaired under warranty and parts not requiring repair (false failures) overstated the number of repairs that would be billed to the government. The calculated number of repairs by one contractor for fiscal year 1989 would be reduced from 10,081 to 6,312 by excluding false failures and warranty repairs.

Air Force Efforts to Reduce ICS Costs and Improve Aircraft Availability

In June 1987 we reported that the Air Force had not set target dates for transferring maintenance from contractors to the Air Force, and the Air Force had not used such factors as repair rates or repair costs to help set priorities for organically maintaining parts. ALC officials said that in January 1988 they began placing the highest priority on transferring frequently repaired parts and problem parts (such as those in short supply and causing aircraft groundings) to organic maintenance to speed up the repair cycle and reduce ICS costs. The officials said they have not used the cost of repairs of individual parts to set priorities. The following examples are parts that were repaired five or more times by contractors, in short supply, and grounding aircraft. We noted that average costs of repairing individual parts can be determined and might be useful to the ALC in setting priorities.

- Turbo Compressor (NSN 1660-01-143-3521): A subcontractor repaired 21 of the compressors through 1987 at an average cost of $16,179, or a total repair cost of about $340,000. Monthly maintenance reports identify this item as causing high levels of not mission capable hours and high maintenance work loads. It was responsible for 10 high-priority parts requisitions from July 1987 to February 1988; aircraft were grounded until the part could be obtained. The Air Force has not established a target date for achieving organic maintenance for this item.

According to Air Force records, the repair instructions were expected to be available by June 27, 1988, but no date is shown for when the needed support equipment will be available.

- Constant Speed Drive (NSN 1650-01-148-2109): A contractor repaired 67 of these items through 1987 at an average cost of about $2,860, or a total repair cost of about $191,000. It was responsible for 49 high-priority requisitions from July 1987 through February 1988 because the lack of serviceable parts on hand was grounding aircraft. Air Force records show that organic repair of this item is scheduled for March 1990 and that the needed support equipment and repair instructions are scheduled to be available in November 1989.
- Radar Transmitter (NSN 5841-01-150-7528EK): A subcontractor repaired 61 of the transmitters through 1987 at an average cost of about $8,500, or a total repair cost of about $520,000. It was responsible for two high-priority requisitions from July 1987 to February 1988. The Air Force has not established a target date to achieve organic maintenance. Air Force records show that support equipment is scheduled to be available by August 1988, but no schedule has been established for repair instructions.

Sustaining Engineering and Enhancements Needed for Efficient and Effective Maintenance

The Air Force cites B-1B problems created by overlapping development and production and by the complexity and heavy use of computers as the primary reasons for extensive contractor engineering support, called sustaining engineering, and many reliability and maintainability enhancements. The Air Force states these programs are required to maintain a high state of readiness and mission success probability, minimize aircraft downtime, and reduce maintenance and spares costs. Because all specific requirements have not yet been identified, current cost estimates for sustaining engineering are uncertain. However, the Air Force is beginning to add specificity to some requirements.

B-1B Sustaining Engineering Program Growing

The Air Force uses sustaining engineering to ensure that needed engineering expertise is available to the AFLC so that design and performance improvements can be made on systems and subsystems. Most weapon systems managed by the AFLC require sustaining engineering in varying amounts. In general, the more complicated the system, the more sustaining engineering support is required.

Air Force regulations provide that sustaining engineering contractual services may be obtained when

- organic facilities cannot accomplish necessary testing and prototyping,
- engineering data are either not available or too costly to buy,
- organic engineering skills are not available, or
- the contractor has the only capability to respond to requirements that are critical because of time, scope, or complexity.

Sustaining engineering efforts appropriate for funding include investigative analysis, feasibility studies, engineering prototype development and testing, engineering for software/hardware deficiency corrections in support of weapon systems, and other efforts necessary to provide the engineering inputs preceding and supporting a formal modification.

The sustaining engineering plan for the B-1B, which includes details on activities and estimated costs, is used by the AFLC to develop the sustaining engineering budget. The requirements for B-1B sustaining engineering exceed initial estimated funding for fiscal years 1989 through 1994 by about $218 million (1987 dollars). Table 4.1 shows the requirements, funding estimates, and differences for that period.

Table 4.1: B-1B Sustaining Engineering Requirements and Funding Estimates[a]

Dollars in millions

Fiscal year	Requirements estimate	Funding estimates[b]	Difference
1988	$2	$2	$0
1989	81	20	61
1990	103	69	34
1991	109	75	34
1992	110	77	33
1993	105	76	29
1994	103	76	27
Total	**$613**	**$395**	**$218**

[a]Requirements and funding estimates beyond fiscal year 1989 might be substantially changed during internal DOD reviews.

[b]These are amounts based on data used for the fiscal year 1989 budget in 1987 dollars.

Tables 4.2 and 4.3 compare the January 1987 and January 1988 requirements and funding estimates, respectively, for B-1B sustaining engineering for fiscal years 1988 through 1992.

Table 4.2: Comparison of Sustaining Engineering Requirements Cost Estimates

Dollars in millions

Fiscal year	January 1987	January 1988	Difference
1988	$2	$2	$0
1989	73	81	8
1990	98	103	5
1991	105	109	4
1992	105	110	5
Total	**$383**	**$405**	**$22**

Table 4.3: Comparison of Sustaining Engineering Funding Estimates

Dollars in millions

Fiscal year	January 1987	January 1988	Difference
1988	$4	$2	$−2
1989	24	20	−4
1990	28	69	41
1991	18	75	57
1992	27	77	50
Total	**$101**	**$243**	**$142**

A comparison shows that in 1 year estimated requirements had increased $22 million, or about 6 percent, over the 5-year period, and the funding estimates over the same 5 years had increased $142 million, or about 140 percent.

In its sustaining engineering plan, the Air Force emphasizes the complexity of the B-1B and the rush to make the B-1B operational as causes for potential problems and premature failures. Officials pointed out that 1,540 B-1B service reports, which identify potential service problems, had material improvement programs in process as of March 16, 1988. Because the B-1B was still in development, officials expect reliability and maintainability problems to continue. They estimated that 2,000 service reports on problem parts would be submitted before January 1989 and that several years of intensive engineering support would be needed to correct problems and deficiencies adequately as aircraft systems, avionics, and associated software approached maturity between 1993 and 1995.

SAC officials state that the B-1B's full mission capability will be delayed and long-term costs will increase without adequate funding of sustaining engineering. The ALC has set priorities for the sustaining engineering requirements for fiscal years 1989 and 1990. Table 4.4 lists the 18 elements in the B-1B sustaining engineering plan in priority order and estimates of sustaining engineering requirements for fiscal years 1989 and 1990.

Table 4.4: Sustaining Engineering Elements in Priority Order

Dollars in millions

Priority	Engineering element	Fiscal year 1989	1990
1	Systems engineering	$7.0[a]	$9.4[a]
2	Offensive system	13.2[a]	17.6[a]
3	Avionics	9.7	12.9[a]
4	Software only (Oklahoma City ALC)	6.8	9.1[a]
5	Software support (Oklahoma City ALC)	4.2	5.6[a]
6	Mechanical systems	3.7	4.9[a]
7	Electrical systems	2.5	3.4[a]
8	Structural integrity	3.1	4.1[a]
9	Software only (Warner Robins ALC)	4.9	6.5
10	Software support (Warner Robins ALC)	3.7	5.0
11	Electronic warfare	4.8	6.4
12	Training devices software	9.1	9.1
13	Support equipment	2.0	2.7
14	Software support	1.8	1.3
15	Automatic test equipment	1.0	1.0
16	Reliability/maintainability assessment	1.6	2.2
17	Stores compatibility	0.8	1.0
18	Survivability/vulnerability	0.6	0.8
Total		**$80.5**	**$103.0**

[a]These are the engineering elements and amounts that estimated funding levels can support.

Because funds requested are less than requirements, the Air Force could choose to distribute available funds by using other priorities or by funding a portion of each of the 18 sustaining engineering elements.

The engineering tasks planned under these 18 elements can generally be categorized as problem analysis and solution, technical and configuration database maintenance, deficiency correction, engineering support for testing, or data collection. For example, the Air Force says that under the systems engineering element, contractors' engineers will analyze aircraft subsystem deficiencies and their impact on the whole system to identify causes and recommend solutions. Engineering expertise for aircraft and avionics subsystems is needed along with a contractor computer analysis center to perform the complex computations necessary to analyze the whole weapon system. The Air Force position is that without this contractor engineering effort, system expertise needed to evaluate problems and recommend solutions will not be available, and problems will remain unsolved.

In its comments on a draft of this report, Rockwell International provided additional information concerning sustaining engineering. It said that transfers of program management responsibility from the program office to the Air Logistics Command usually occurs about one-third to one-half the way through production. For the B-1B, responsibility will transfer in January 1989, 8 months after the production of the last aircraft. Rockwell said that because production support activities and personnel are no longer assigned to the B-1B program, the cost of sustaining engineering for the B-1B compared to other programs might be greater.

Reliability and Maintainability Enhancements Beginning

Sustaining engineering efforts are a major factor in defining the reliability and maintainability enhancements needed for the B-1B. Accordingly, the Air Force has begun to define enhancements that might be required. Some of these are for problem parts such as windshields and the integrated drive generator that the Air Force and contractors have been working on since production. The B-1B program office has proposed over 50 reliability and maintainability enhancement programs totaling $586.4 million for fiscal years 1990 through 1997. DOD noted that enhancements proposed for fiscal years 1990 through 1997 are for planning purposes and might be substantially revised in subsequent internal DOD reviews.

Four of these enhancement programs are described below.

Windshields

The current B-1B windshield has distortion and delamination problems caused by the manufacturing process. AFLC officials said the B-1B windshield differs from B-1A windshields—the windshields were enlarged, the outer glass ply processing was changed, and the frames were altered. According to program officials, this windshield represented the latest technology when the B-1B program started and the program funding cap prevented research and development to improve this technology. Air Force officials claim current technology is better, and the enhancement program, which is estimated to cost $15.2 million, would provide for the testing and acquisition of new technology windshields.

Video Recorder

The B-1B uses a video system to record data for training offensive avionics system operators. SAC plans a new video recording system because the current system does not provide adequate training data. This nhancement is estimated to cost $38.5 million.

Electrical Power

The Air Force identified no specific enhancements for electrical power when the fiscal year 1990 Program Objective Memorandum was prepared; however, $37.5 million was included as a contingency to fund changes and enhancements as required. Three potential uses identified for these funds since the memorandum are to (1) correct deficiencies in the integrated drive generator, (2) correct problems caused by two parts on the same electrical data bus, and (3) change the power control assemblies from on-aircraft to off-aircraft maintenance. For the first two potential uses, the enhancement funds would probably pay the government share under the correction of deficiency clause in the contracts. This clause requires the government to pay from 50 to 80 percent of the costs to correct a deficiency. Costs to correct these deficiencies are unknown because solutions have not been identified.

Reliability Enhancements

The Air Force estimates that it needs $39.4 million to fund reliability enhancements for unknown contingencies beyond current program direction and contractual requirements.

Maintenance Problems Reduce Aircraft Availability

The Air Force has had difficulty with B-1B aircraft availability. As discussed in our July 1988 report, limited aircraft availability has prevented crews from completing the training needed to be certified mission ready, contributed to reducing the number of crews per aircraft to be trained, and delayed the placing of additional aircraft on alert. The time that aircraft are not available because of maintenance is a contributor to the overall availability problem of the B-1B.

Maintenance Operations: A Factor in Aircraft Availability

The Air Force uses several measures to assess a maintenance unit's ability to provide aircraft for training or wartime missions. One such measure is the percent of time aircraft are not mission capable because of maintenance. This percentage rate is the sum of the percent of time the aircraft is not available to perform its mission because of maintenance alone plus the percent of time it is not available to perform its mission because of both supply and maintenance.

The Air Force has not established B-1B goals for not mission capable maintenance and cannibalizations per flying hour because it considers the system to be too immature. Maturity for the B-1B is not expected to be achieved until the aircraft have completed 200,000 flying hours; this is expected to occur in 1994, a slippage of more than 1 year. In the absence of interim goals for the B-1B, we present goals for mature systems as a basis to assess the status of the B-1B, not as a basis to determine what it should be.

The Air Force's goals for the B-52 and FB-111 are that total not mission capable rates because of maintenance not exceed 25 percent. The B-1B total not mission capable because of maintenance rates ranged from a high of 66 percent in November and December 1987 at Dyess AFB to a low of 12 percent in November 1988 at Grand Forks AFB, as shown in table 5.1. The Dyess rates indicate that B-1B maintenance requirements are a challenge and that they have been limiting aircraft availability. According to the Air Force, as reliability grows and maintainability improves through experience, goals similar to those for the B-52 and FB-111 will be established.

Table 5.1: Percent of Time Aircraft Were Not Mission Capable Because of Maintenance

	AFB		
Month and year	Dyess	Grand Forks	Ellsworth
October 1987	50	35	17
November 1987	66	12	26
December 1987	66	13	31
January 1988	55	27	27
February 1988	47	33	31

Cannibalization

Cannibalization refers to the removal of a needed part from one aircraft to put on another. High levels of cannibalization have contributed to an increased work load for B-1B maintenance crews. For example, at Grand Forks AFB, maintenance personnel performed 35 generator cannibalizations during December 1987 and January and February 1988. Removing generators from one aircraft and placing them on another accounted for 13 percent of the non- or partially mission capable hours during this period.

The extent of the additional work load caused by cannibalizations of B-1B aircraft is evidenced by comparing the overall Air Force rate to the rate at the B-1B main operating bases. The rate for all Air Force aircraft has been about 3 to 4 cannibalizations per 100 flying hours. Table 5.2 shows the rate for the B-1B at Dyess, Grand Forks, and Ellsworth AFBs.

Table 5.2: B-1B Cannibalizations Per 100 Flying Hours

	AFB		
Month and year	Dyess	Grand Forks	Ellsworth
October 1987	31	59	25
November 1987	35	32	34
December 1987	35	33	21
January 1988	19	56	36
February 1988	26	62	37

Maintenance personnel attempt to lessen the impact of cannibalization on the flying schedule by concentrating the cannibalization actions on as few aircraft as possible. Personnel use these aircraft as a source for parts. As more parts are removed, the time needed to return the aircraft to a flyable condition lengthens. For example, as of April 5, 1988, maintenance crews at Grand Forks AFB had cannibalized parts from 3 of the 16 assigned aircraft: 1 aircraft for 29 grounding parts, 1 for 13, and 1

for 3. Maintenance personnel estimated that, if parts were available, repair of these aircraft would take 96, 72, and 7 hours, respectively.

Even more maintenance hours are required when one cannibalized aircraft is made flyable by cannibalizing parts from a different aircraft under a rotation policy. According to base maintenance officials, if aircraft are not flown for long periods of time, additional maintenance problems arise, such as seals drying out and moisture in instruments. A SAC regulation defines an aircraft grounded in a not mission capable status for 30 days as a "hangar queen." SAC requires reports on such aircraft, and the aircraft are not to be cannibalized further without approval from SAC. SAC has waived the approval requirement for B-1B aircraft only. For the B-1Bs, SAC's approval will not be required until they have been grounded for 90 days. SAC states that it is unlikely that B-1Bs will remain in the hangar queen status longer than 120 days from the last flight. At Grand Forks AFB, officials use a locally imposed 60-day limit.

Other Maintenance Problems

Not mission capable because of maintenance hours are further increased by the additional work load resulting from troubleshooting CITS false failure problems and from the relatively frequent failures of certain parts, such as tires and windshields. If CITS is not reliable and it identifies a part as failing, additional testing is done to determine if the part did actually fail. Without additional testing, the part is removed and sent to the contractor for repair, at which time it might be found to be operational.

Frequent failures of tires and windshields have contributed to additional B-1B maintenance hours. Dyess AFB lists the main landing gear tire among the top failure items in its monthly maintenance reports. Dyess officials said that maintenance crews had replaced 630 main landing gear tires and 29 nose wheel tires through March 1988. According to Dyess officials, the tires are only lasting about 60 landings instead of an expected 120; thus the maintenance work load to remove and replace the tires is twice the anticipated level.

The Air Force is not currently recapping the failed tires but is in the process of qualifying companies to recap tires in the future. Grand Forks has been selected as the first base to remove tires for possible recapping. The tires from the first aircraft were being removed for possible recapping after only 24 landings. The other operating bases are

leaving the tires on until they wear into the tire carcass, at which time the tire is worn beyond recapping limits.

Windshields have also caused unexpected maintenance work loads at Dyess AFB. Dyess officials said that 45 windshields were removed and replaced during the period of April 1987 through March 1988 mainly for delamination. They said it takes Air Force maintenance crews about 3 days to remove and replace a windshield.

Maintenance Cancellations and Air Aborts

The B-1B has experienced a higher level of flight cancellations due to maintenance and air aborts than the cancellation goals SAC has established for other mature bombers. One measure of the impact of maintenance and logistics problems on the flying schedule is the maintenance cancellation rate. SAC's goal for mature aircraft is that B-52 aircraft experience a cancellation rate of no more than 5 percent and that FB-111 aircraft experience a rate of no more than 8 percent. SAC has not established a goal for the B-1B. During the period of October 1987 through February 1988, the B-1B maintenance cancellations averaged 19 percent at Grand Forks AFB, 15 percent at Dyess AFB, and 16 percent at Ellsworth AFB. According to Grand Forks officials, 21 of the 58 maintenance cancellations occurring at their base during the period of October 1987 through March 1988 were caused by generators.

Air aborts are defined as situations in which the condition of the aircraft requires that the sortie be terminated before mission completion. When this occurs, crews do not complete training, which will need to be rescheduled. SAC's goal is that no more than 2 percent of all B-52 and FB-111 airborne sorties be aborted. SAC has not yet set a goal for the B-1B aircraft. B-1B air aborts averaged about 5 percent at both Grand Forks and Dyess AFBs during the period of October 1987 through February 1988. The aborts are caused by a variety of maintenance problems. For example, the Dyess maintenance report discussed failures in the hydraulic system, which were responsible for three of the base's nine air aborts in February. The report said that excessive vibrations in flight cause the hydraulic lines to rupture.

In its comments, DOD noted that the "growing pains" inherent in the B-1B continue to be a troublesome, but a manageable part of its development.

Training Limitations

Because of the shortage of flyable aircraft and operational restrictions on these aircraft, SAC has not trained all of its aircrews to fly the low-level bomber mission as planned.

As of March 31, 1988, none of the 17 B-1B crews at Grand Forks AFB had been trained to perform the low-level missions of the B-1B because of safety restrictions placed on the aircraft following the crash of a B-1B caused by a bird strike. Until the Air Force completes a modification on each aircraft to strengthen the aircraft against bird strikes, no low-level flight activity is permitted and crews will not be mission ready. Of the 17 B-1B crews assigned to Grand Forks, 10 were considered mission ready except for the low-level events, and the other 7 crews were being trained in other than low-level events. According to Grand Forks officials, parts shortages have prevented the wing from flying the sorties needed to train these seven crews to the mission-ready level. Other problems, such as icing on engines and generator problems, have also slowed training.

At Dyess AFB, many of the pilots assigned to the B-1B bombardment squadron were unable to complete all of SAC's flight training required for the training periods ending June 30, 1987, and December 31, 1987. SAC evaluates crewmember training status twice a year on January 1 and July 1. As shown in table 5.3, at the end of the first period, 11 of 13 aircraft commanders (pilots) were not able to complete all of SAC's flying training requirements. For 7 of the 11, the deficiencies resulted in pilots being classified as not mission ready at the end of the training period; thus, they could not be placed on alert status. At the end of the second period, five aircraft commanders were not able to complete all requirements, and three were classified as not mission ready.

Table 5.3: Dyess AFB B-1B Crewmember Training Status

	Pilots	Copilots	Offensive system officers	Defensive system officers
July 1, 1987				
Total assigned	13	13	13	13
Some requirements incomplete	11	10	2	5
Not mission ready	7	1	1	4
January 1, 1988				
Total assigned	8	12	7	8
Some requirements incomplete	5	12	6	4
Not mission ready	3	8	3	4

The Dyess training report states that lack of available aircraft due to maintenance was the reason that individuals could not complete required training. The training squadron commander described the flying schedule as dynamic and turbulent and noted that a firm flying schedule was the item most needed to improve training.

An additional limitation on training is the delay in bringing the weapons system trainers on line at the combat crew training squadron at Dyess. Until weapon system trainers are on line, crews accomplish ground training with cockpit procedures trainers, which are considerably less effective. The June 1987 training report stated that the weapons system trainers were to be available for training by September 30, 1987. However, Air Force officials said this schedule was not met because the contractor experienced problems in software development. The estimate in the December 1987 training report was that the first trainer would be ready in December 1988 and that the second trainer would be ready in March 1989. The delays were caused by computer software problems with the offensive and defensive system officer training stations.

In its comments on a draft of our report, DOD said that training was not inhibited by limitations on the performance capabilities of those aircraft able to fly. We have clarified our point that in addition to shortages of flyable aircraft, other operational limitations imposed on aircraft able to fly have affected training. An example of this is the restriction on high-speed, low-level training cited in DOD's comments.

Comments From the Assistant Secretary of Defense for Production and Logistics

ASSISTANT SECRETARY OF DEFENSE
WASHINGTON, D C 20301-8000

PRODUCTION AND
LOGISTICS
(L/MD)

SEP 13 1988

Mr. Frank C. Conahan
Assistant Comptroller General
National Security and
International Affairs Division
U.S. General Accounting Office
Washington, DC 20548

Dear Mr. Conahan:

This is the Department of Defense (DoD) response to the General Accounting Office (GAO) Draft Report, "STRATEGIC BOMBERS: B-1B Maintainability Dependent on Contractors and Increased Funds," dated July 20, 1988 (GAO Code 392366), OSD Case 7718. The DoD generally agrees with the GAO draft report.

In several instances, the GAO report contains projections of costs expected to be incurred in future years. While these projections may correctly reflect current planning by Air Force activities, the amounts involved may be changed significantly after these requirements are subjected to internal reviews within the DoD. The tentative nature of these planning estimates needs to be clearly indicated when costs beyond FY 1989 are included.

While there have been many improvements in the maintainability of the B-1B, much remains to be done. The full maturity of the system is currently defined as occurring after 200,000 flying hours, which will be about 1994. After that time, the use of factors by the GAO to compare B-1B maintainability with other weapon systems would have more validity.

The detailed DoD comments on the report findings are provided in the enclosure. The DoD appreciates the opportunity to comment on this draft report.

Sincerely,

Jack Katzen

Enclosure

GAO DRAFT REPORT - DATED JULY 20, 1988
(GAO CODE 392366) - OSD CASE 7718

"STRATEGIC BOMBERS: B-1B MAINTAINABILITY DEPENDENT ON CONTRACTORS AND INCREASED FUNDS"

DEPARTMENT OF DEFENSE COMMENTS

* * * * *

FINDINGS

- FINDING A: Maintenance Operations. The GAO reported that B-1B maintenance takes place at the organizational, intermediate, and depot levels. The GAO described the levels of B-1B maintenance, as follows:

  - organizational-level maintenance, which is usually performed on the flight line, includes inspecting, servicing, lubricating, adjusting, and replacing parts, minor assemblies, and subassemblies;

  - intermediate-level maintenance, which usually takes place in shops at the main operating bases, includes calibration, repair, or replacement of damaged or unserviceable parts, components, or assemblies, the emergency manufacture of nonavailable parts, and technical assistance to using organizations; and

  - depot-level maintenance, which usually takes place at one of the Air Logistics Centers (ALCs) or in contractor plants, involves major overhaul or a complete rebuild and requires more extensive facilities for repair than are available at lower-level maintenance activities.

  According to the GAO, it is the Air Force plan that virtually all B-1B maintenance operations be done within the Air Force by Air Force personnel. The GAO explained that the major factors in the decision to use contractors vs organic (in house) maintenance are military mission and cost. (The GAO noted that Air Force regulation provides that this can normally be done without a detailed cost study.) The GAO reported that, according to Air Force officials, the Air Force views interim contractor support for the B-1B as more costly and less timely than organic support. The GAO observed that the longer repair cycles require more parts in the supply pipeline and could require more cannibalizations to keep some aircraft flying until repaired parts come back from the contractor. (pp. 15-16/ GAO Draft Report)

  DoD RESPONSE: Concur.

Now on pp. 8-9.

Enclosure

- FINDING B: Central Integrated Test System Initial Performance Unacceptable; Improvements Underway. The GAO reported that, during early B-1B operations, the Central Integrated Test System (CITS) identified as many as 200 false indications of parts and equipment failures per flight. The GAO further reported that the Air Force (1) determined this was an unacceptably high number of false indications of aircraft systems and/or subsystems failures per flight and (2) concluded that the CITS was operationally unacceptable in both maintenance cost and time wasted from responding to false failures. According to the GAO, in a November 1985 meeting, the B-1B Program Office, the Strategic Air Command (SAC), and Rockwell determined that the Contract specifications needed to be changed to improve the CITS. The GAO explained that the Strategic Air Command (SAC) wanted to limit false indications to a total of no more than five per flight for all three contractors (Boeing, Eaton, and Rockwell). The GAO found that Boeing and Eaton agreed to a specification change, which allowed each contractor eight or less known, but uncorrected, false indications at the end of full-scale development testing. The GAO further found, however, that Rockwell claimed it was in compliance with the contract and would not agree to a specification change, although it did subsequently agree, through an incentive award fee contract modification, to reduce its number of false indications to ten or less per flight. (pp. 1-5, pp. 21-24/GAO Draft Report)

Now on pp. 3, 12-13.

DoD RESPONSE: Concur.

- FINDING C: Additional Software Documentation Needed. The GAO reported that, in five separate reviews of Rockwell's CITS software, Air Force evaluators concluded the information Rockwell is to provide is not adequate for Air Force personnel to maintain the software developed so far. According to the GAO, the major Air Force concern was that no concerted effort existed to provide documentation needed for transferring a maintainable system to the Oklahoma City ALC, the responsible Air Force organization. The GAO added that the ALC subsequently prepared a list of CITS software documentation requirements and, in May 1988, the program office negotiated a $14 million contract amendment for additional B-1B software documentation, of which about $2 million of this amount was for CITS documentation. (p. 5, pp. 24-25/GAO Draft Report)

Now on pp. 13-14.

DoD RESPONSE: Partially concur. The System Program Office (SPO) did not negotiate a contract of $14 million for additional software documentation. The SPO negotiated Contract Change Proposal Number 600 for $12.7 million to transfer the Software Avionics Integration Laboratory capability from Rockwell to Oklahoma City Air Logistics

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Center. The Contract Change Proposal included all necessary support documentation for all Rockwell software associated with the laboratory. Additional documentation was included for the CITS in the proposal at the time of fact finding for a cost increase of $450,000, which is well below the $2 million total reported by the GAO.

- FINDING D: Enhanced Ground Processing Capability Development. The GAO reported that the Air Force has been developing the CITS expert parameter system, a computer-based system to improve B-1B diagnostics. The GAO described the goals for the parameter system as (1) improving diagnostics by reducing those shortfalls that made the CITS unacceptable and (2) providing a supplement to existing manual diagnostics and thereby reduce the hours spent on and the cost of maintaining the B-1B aircraft. The GAO explained that the parameter system could reduce the average organization-level maintenance flow time--i.e., the time required for aircrew debriefing, fault isolation, repair, and repair verification--from 2 hours to less than 1-1/2 hours, as well as reducing test time at the intermediate repair level from an average of 4 hours to less than 3 hours. The GAO observed that the parameter system is being developed in three phases, two of which have been completed, as follows:

  - Phase I was a feasibility study;
  - Phase II was a prototype system with an operating demonstration; and
  - Phase III will be an operating system.

  According to the GAO, Rockwell and Boeing completed Phase II demonstrations in September 1987 and November 1987, respectively, but Eaton is not developing a parameter system prototype because it will not have a workable CITS until about September 1989. The GAO observed that the Rockwell demonstration was inconclusive as to effectiveness, while the Boeing demonstration showed potential. According to the GAO, the users found that the Boeing parameter system reduced fault isolation time, was user friendly and, if fully developed, would be an often-used troubleshooting aid. The GAO noted, however, that the Air Force Operational Test and Evaluation Center stated the parameter system needs a fully mature CITS to be beneficial. The GAO further noted that, as of May 1988, the B-1B Program Office had not completed its evaluation of the contractor reports to determine whether the parameter system would or would not benefit the diagnostics capability for the B-1B. The GAO observed that funds had been made available for one contractor to develop an operating system, and a request for proposal had been sent

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Now on pp. 3, 14-15.

to Boeing for the offensive avionics parameter system. The GAO learned that the Air Force plans to request funds in the FY 1990 budget for the other two contractors to develop their portions of the system. Total development and acquisition cost is expected to be about $30 million. (pp. 5-6, pp. 25-27/GAO Draft Report)

DoD RESPONSE: Partially concur. The primary goals of the CITS expert parameter system (CEPS) are more appropriately stated as (1) improving diagnostics on the B-1B aircraft and to implement the technology required to improve existing and future diagnostics; (2) enhancing CITS by reducing ambiguities (e.g., Cannot Duplicate and Retest OKs); and (3) ultimately, reducing the maintenance costs and improving aircraft availability through the use of a maintenance advisory system. These goals will be achieved by applying artificial intelligence (AI) to the recorded B-1B CITS parameters.

The details referenced on the three phases of the CEPS are inaccurate. The GAO noted that "the Air Force Operational Test and Evaluation Center stated the parameter system needs a fully mature CITS to be beneficial." The Rockwell CEPS prototype design was based on the CITS fault isolation outputs and required a mature CITS. The Boeing prototype design, however, uses the raw parameter data and is not based on CITS maturity.

On May 27, 1988, the Air Force Weapons Aeronautical Laboratory provided an independent assessment of the B-1B CEPS Phase IIIA program. This assessment indicated that CEPS Phase IIIA was a worthwhile effort and recommended proceeding with the program.

The CEPS Phase IIIA will involve Boeing, as the lead contractor, who will develop the maintenance advisory system using AI expert system technology, and Rockwell, who will provide an Interface Control Document (ICD) and the external interface system. Phase IIIB will include further enhancements to the CEPS program.

The GAO is also incorrect when it stated "...the Air Force plans to request funds in the FY 1990 budget..." The Program Office plans to submit a request for the remaining funds in FY 1990. The $3 million CEPS I and $7.7 million CEPS II research and development funds were provided by Air Force agencies to transition research and development into the field. The CEPS I and II funds were obligated in FY 1985-1987. The Reliability and Maintainability Technology Insert Program (RAMTIP), the Generic Maintenance Diagnostic Aids (GIMADS), and the Weapon System Support Development (WSSD) program all contributed to CEPS

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development to bring the advances of commercial computer technology into the Air Force inventory.

Cost projections beyond FY 1989 appropriations are for planning purposes only and are subject to substantial change after internal DoD review.

The CEPS IIIA effort implements the CEPS concept of Phase I and II. The cost for the CEPS IIIA effort is $5.5 million and these funds will be obligated in FY 1988. The CEPS IIIB effort is estimated at $18 million.

- FINDING E: Continued Contractor Support Needed. The GAO reported that, after the contractors develop and/or change the CITS program, the CITS maintenance codes must be validated through flight operations. The GAO found that, as of April 1988, about 2,100 CITS maintenance codes had been validated as working correctly, 600 were in the process of being analyzed, and the remaining 7,800 had not begun validation. The GAO concluded, therefore, that contractor support apparently will be required for some time. The GAO observed that, although the B-1B Program Office had intended to terminate contractor engineering support in November 1987, the SAC requested a continuation. The GAO noted that, as a result, the Program Office proposed to fund engineering support at each operating base, from November 1987 through December 1988, to assist the SAC in (1) building the maintenance code data base, (2) analyzing CITS data, and (3) identifying potential false alarms. The GAO further found, however, after receiving the Rockwell proposal of $3 million for this support, the Air Force requested that Rockwell reduce the number of engineers at the operating bases and, in January 1988, issued an undefinitized contract change for CITS support for the period November 16, 1987, through August 15, 1988. The GAO reported that the contract, with a not-to-exceed price of about $2 million, provides for fewer engineers than originally proposed and has a $600,000 option to cover the remaining period through December 15, 1988. The GAO further reported that, in February 1988, the Program Office issued Boeing a new contract for CITS engineering support with a not-to-exceed price of $1 million. The GAO also noted that, since Eaton has not completed its CITS development, it will continue to develop its software under the current contract. (p. 6, pp. 27-28/GAO Draft Report)

Now on pp. 3, 16.

DoD RESPONSE: Concur.

- FINDING F: Undelivered Support Equipment and Repair Instruction Delay Organic Maintenance. The GAO found that the lack of support equipment and repair instructions continues to delay the transition from contractor support to organic Air Force maintenance.

The GAO noted that Air Force schedules show the transition is to be substantially complete by December 1989 for intermediate level, and by December 1990 for depot level. While schedules have not been revised, the GAO reported that, in June 1988, ALC officials advised depot level organic maintenance for non-avionics had slipped to 1992, avionics (except defensive avionics) to 1993, and defensive avionics to after 1995. The GAO concluded that, based on Air Force reports, as of February 1988, only about one-half of the support equipment (identified as needed to maintain the B-1B) has been delivered to maintenance facilities, with the greatest shortages at the depot level. The GAO found that the depots are not scheduled to receive all the equipment needed to maintain non-avionics parts until 1991; avionics parts until 1992. The GAO further found that delivery schedules also show about one-half of the test program sets, such as computer software, will not be available by the end of 1992. The GAO concluded that, although the Air Force schedule shows the transition to organic depot support to be completed in 1990, the Air Force cannot achieve this capability until the support equipment is operating at the depots.

The GAO also found that, through February 1988, the Air Force had received only about 33 percent of the repair instructions needed for organic Air Force maintenance. Furthermore, the GAO found that contractors had not furnished availability dates for many of the repair instructions. The GAO observed that, once the Air Force receives the repair instructions, their accuracy must be verified before being used to guide repair of the aircraft. Although the Air Force plan shows verification to be completed by April 1990 for intermediate-level and March 1991 for depot-level repair instructions, as of January 1988, the Air Force had only completed verification of 63 of the 150 intermediate-level instructions it had planned to verify by that date. The GAO also found that, although the Air Force had been scheduled to complete about 50 depot-level verifications by January 1988, ALC officials told the GAO that only 27 had been completed at that time. The GAO concluded that the Air Force instruction verification is behind schedule. The GAO further concluded that, without organic capability, the Air Force must continue to rely on contractor support for most maintenance, which as of January 1988, the Air Force estimates will cost $570 million. (pp. 6-8, pp. 29-34/GAO Draft Report)

Now on pp. 4, 17-20.

DoD RESPONSE: Concur. The GAO stated that contractors had not furnished availability dates for many of the repair instructions (technical orders). The associated contractors each provide a Technical Order Status and

Schedule and a Depot Maintenance Planning Data Document, both of which show delivery dates of technical orders on contract. Earlier estimated delivery dates, upon which verification and organic planning were based, were not contractually binding until after negotiations were complete.

Schedules and costs extending beyond FY 1989 are for planning purposes only and are subject to substantial revision.

- FINDING G: Interim Contractor Support: Costs Increasing--Repair Estimates Unrealistic. The GAO reported that most intermediate- and depot-level repairs for the B-1B continue to be performed through interim contractor support (ICS) contracts, under which the contractor provides logistics support while requirements are being refined, technical problems are being resolved, design stability is being achieved, and/or lead time is provided for complex support resources. The GAO explained that the Air Force provides organic maintenance for B-1B engine, but contractors provide most other intermediate- and depot-level maintenance. The GAO reported that, since its June 1987 report[1/] because of continuing delays in establishing organic repair, the Air Force has increased the total estimated cost of the ICS. According to the GAO, the ICS costs for FY 1985 through FY 1994 show an increase of $116 million in total cost, to $570 million, as compared to the $454 million estimate in the June 1987 report. The GAO observed that contractor data also show the amount expended for repair of B-1B parts through 1987 was below the contract amounts, which are based on an expected cost to repair items plus a fixed fee. The GAO noted that repair costs include a fixed level of effort to perform intermediate-level repairs both on and off base, as well as payments to subcontractors for repair of individual parts; while total costs include repair costs, overhead, fixed fee, and firm fixed price portions of the contracts. The GAO noted that the contractor receives the fee regardless of the amount of repairs performed. The GAO reported that, according to Air Force officials, repair costs were overestimated because:

  - the Air Force was not able to fly the B-1B as many hours as estimated when the contracts were awarded (the GAO noted, however, that according to a Rockwell official, while the flying hours were less than

1/ GAO/NSIAD-87-117BR, "STRATEGIC FORCES: Supportability, Maintainability, and Readiness of the B-1B Bombers," June 16, 1987 (OSD Case 7343).

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expected in the early years and contributed to fewer than expected repairs, in 1987, the flying hours were about equal to expectations because many of the parts included under the contract were not failing at the rates estimated when the contracts were awarded); and

- Air Force analysts, in establishing contract amounts, included false failures and warranty repair, in addition to failures that the contractor would be paid to repair--hence the number of repairs that would be billed to the Government was overstated. (p. 8, pp. 34-37/GAO Draft Report)

Now on pp. 4, 20-22.

DoD RESPONSE: Concur. However, the cost estimates extending beyond FY 1989 are planning numbers which may be substantially changed after internal DoD review.

- FINDING H: Air Force Efforts to Reduce ICS Costs and Improve Aircraft Availability. The GAO found that, in January 1988, the ALC began placing the highest priority on transferring frequently repaired parts and problem parts (such as those in short supply and causing aircraft groundings) to organic maintenance to speed up the repair cycle and to reduce ICS costs. The GAO noted that the ALC advised it had not used the cost of repairs of individual parts to set priorities. The GAO provided three examples of parts that were repaired fewer or more times by contractors, in short supply, and grounding aircraft (i.e., the Turbo Compressor, the Constant Speed Drive, and the Radar Transmitter). The GAO concluded that average costs of repairing individual parts is available and might be useful to the ALC in setting priorities. (pp. 37-39/GAO Draft Report)

Now on pp. 22-23.

DoD RESPONSE: Concur. Average cost of repair for any item is not currently available contractually, but has been added to FY 1990 and later contracts.

- FINDING I: B-1B Sustaining Engineering Program Growing. The GAO reported that the Air Force uses sustaining engineering to ensure that needed engineering expertise is available to the AFLC so design and performance improvements can be made on systems and subsystems. The GAO reported Air Force regulations provide that sustaining engineering contractual services may be obtained, as follows:

  - when organic facilities cannot accomplish necessary testing and prototyping;
  - when engineering data are higher, not available or too costly to buy;
  - when organic engineering skills are not available; or

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- when the contractor has the only capability to respond to requirements that are critical because of time, scope, or complexity.

The GAO reported that the sustaining engineering plan for the B-1B, which includes details on activities and estimated costs, is used by the AFLC to develop the sustaining engineering budget. The GAO found that the requirements for B-1B sustaining engineering exceed initial estimated funding for FY 1989 through FY 1994 by about $218 million. The GAO observed that, in its sustaining engineering plan, the Air Force emphasizes (1) the complexity of the B-1B and (2) the rush to make the B-1B operational, as causes for potential problems and premature failures. The GAO further observed that, because the B-1B is still in development, Air Force officials expect reliability and maintainability problems to continue. The GAO also noted that, according to Air Force officials, 2,000 service reports on problem parts are estimated will be submitted before January 1989, and that several years of intensive engineering support will be needed to adequately correct problems and deficiencies as aircraft systems, avionics, and associated software approached maturity between 1993 and 1995. The GAO also noted that SAC officials assert the B-1B full mission capability will be delayed and long-term costs will increase without adequate funding for sustaining engineering. According to the GAO, the ALC has set priorities for the sustaining engineering requirements for FY 1989 and FY 1990. The GAO pointed out that the engineering tasks planned under the 18 priority elements can generally be categorized as (1) problem analysis and solution, (2) technical and configuration data base maintenance, (3) deficiency correction, (4) engineering support for testing, and (5) data collection. The GAO observed that, because requested funds are less than requirements, the Air Force could choose to distribute available funds using other priorities or by funding a portion of each of the 18 priority sustaining engineering elements. (pp. 8-9, pp. 40-46/GAO Draft Report)

Now on pp. 4, 24-28.

DoD RESPONSE: Concur. Requirements beyond FY 1989 are for planning purposes only and may be substantially changed during internal DoD reviews.

- FINDING J: Reliability and Maintainability Enhancements Beginning. The GAO reported that sustaining engineering efforts are a major factor in defining the reliability and maintainability enhancements needed for the B-1B; accordingly, the Air Force has begun to define enhancements that might be required. The GAO found that, for FY 1990 through FY 1997,

the B-1B program office currently has proposed over 50 reliability and maintainability enhancements totaling $586.4 million. The GAO discussed four such enhancement programs, as follows:

- Windshields. The GAO noted that the current B-1B windshield has distortion and delamination problems caused by the manufacturing process. The GAO reported that, according to program officials, this windshield represented the latest technology when the B-1B program started; however, the program funding cap prevented research and development to improve this technology. The GAO noted that contractors claim current technology is better and the enhancement program, which is estimated to cost $15.2 million, would provide for the testing and acquisition of new technology windshields.

- Video Recorder: The GAO reported that the B-1B now uses a video system to record data for training offensive system operators. Because the current system does not provide adequate training data, however, the GAO learned that the SAC plans a new video recording system at an estimated cost of $38.5 million.

- Electrical Power. The GAO reported that, when the FY 1990 Program Objective Memorandum (POM) was prepared, the Air Force did not identify specific enhancements for electrical power; however, $37.5 million was included as a contingency to fund changes and enhancements as required. According to the GAO, since the POM, the Air Force has three potential uses for these funds--(1) to correct deficiencies in the integrated drive generator, (2) to correct problems caused by two parts on the same electrical data bus, and (3) to change the power control assemblies from on-aircraft to off-aircraft maintenance.

- Reliability Program: The GAO reported that the Air Force estimates it needs an additional $39.4 million to fund reliability enhancements for unknown contingencies, beyond current program direction and contractual requirements. (pp. 9-10, pp. 46-49/GAO Draft Report)

Now on pp. 4, 28-29.

DoD RESPONSE: Concur. Enhancements proposed for FY 1990 through 1997 are for planning purposes and may be substantially revised in subsequent internal DoD reviews.

- FINDING K: Maintenance Operations: A Factor in Aircraft Availability. The GAO reported that the Air Force uses several measures to assess a maintenance unit ability to provide aircraft for training or wartime missions, including the percentage of time

aircraft are not mission capable because of maintenance. The GAO explained that the not-mission-capable because-of-maintenance percentage rate is the sum of the percent of time the aircraft is not available to perform its mission because of maintenance alone, plus the percent of time it is not available to perform its mission because of both supply and maintenance. The GAO noted that the Air Force goals for total-not-mission-capable-rates-because-of-maintenance for the B-52 and FB-111 are 25 percent. The GAO reported, however, that the Air Force has not yet established a maintenance goal for the B-1B because it considers the system to be too immature. The GAO also noted that, as reliability grows and maintainability improves through experience, goals similar to the B-52 and FB-111 will be established. The GAO found that the B-1B total not-mission-capable-because-of-maintenance rates ranged from a high of 66 percent in November and December 1987 at Dyess AFB to a low of 12 percent in November 1987 at Grand Forks AFB as follows:

PERCENT OF TIME AIRCRAFT WERE NOT MISSION CAPABLE BECAUSE OF MAINTENANCE

	AFB		
Month and Year	Dyess	Grand Forks	Ellsworth
October 1987	50%	35%	17%
November 1987	66	12	26
December 1987	66	13	31
January 1988	55	27	22
February 1988	47	33	N/A

Now on pp. 4, 30-31.

(p. 10, pp. 49-50/GAO Draft Report)

DoD RESPONSE: Concur.

- **FINDING L**: **Cannibalization**. The GAO explained that cannibalization refers to the removal of a needed part from one aircraft to install on another. The GAO found that higher than normal levels of cannibalization have contributed to an increased workload for B-1B maintenance crews. (The GAO cited, for example, at Grand Forks AFB, maintenance personnel performed 35 generator cannibalizations during the 3 months December 1987-February 1988. The GAO noted that, during this period, removal of generators from one aircraft and placement in another accounted for 13 percent of the not- or partially mission capable hours.)

  The GAO concluded that the extent of the additional workload caused by cannibalization of B-1B aircraft is

evidenced by comparing the overall Air Force rate to the rate at the B-1B main operating bases. The GAO noted the rate for all Air Force aircraft has been three to four cannibalizations per 100 flying hours; while the rate for the B-1B at Dyess, Grand Forks, and Ellsworth AFBs is, as follows:

CANNIBALIZATIONS PER 100 FLYING HOURS

	AFB		
Month and Year	Dyess	Grand Forks	Ellsworth
October 1987	31	59	25
November 1987	35	32	34
December 1987	35	33	21
January 1988	19	56	37
February 1988	26	62	N/A

The GAO found that maintenance personnel attempt to lessen the impact of cannibalization on the flying schedule by concentrating the cannibalization actions on as few aircraft as possible. The GAO concluded, however, that as more parts are removed, the time needed to return the aircraft to a flyable condition lengthens. The GAO further concluded that even more maintenance hours are required when one cannibalized aircraft is made flyable by cannibalizing parts for a different aircraft under a rotation policy. (pp. 50-52/GAO Draft Report)

Now on pp. 31-32.

DoD RESPONSE: Concur. The GAO finding does not, however, address the fact that B-1B system maturity does not occur until 200,000 flying hours, approximately 1994.

- FINDING M: Other Maintenance Problems. The GAO found that not-mission-capable-because-of-maintenance hours are further increased by the additional workload resulting from troubleshooting CITS false failure problems and from the relatively frequent failures of certain parts, such as tires and windshields. According to the GAO, when the CITS is not reliable and identifies a part as failing, additional testing is done to determine if the part actually did fail. The GAO concluded that the frequent failure of tires and windshields have contributed to additional B-1B maintenance hours. The GAO also found that the B-1B has experienced a higher level of flight cancellations due to maintenance and air aborts than SAC-established goals for mature bombers. According to the GAO, the SAC goals for mature aircraft is that B-52 aircraft experience a cancellation rate of no more than 5 percent and that FB-111 aircraft experience a rate of no more than 8 percent; however, SAC has not established a

goal for the B-1B. The GAO observed that, during the period, October 1987 through February 1988, the B-1B maintenance cancellations averaged 19 percent at Grand Forks, 15 percent at Dyess AFB, and 16 percent at Ellsworth. The GAO also observed the SAC goal is that no more than two percent of all B-52 and FB-111 airborne sorties be aborted (i.e, situations in which the condition of the aircraft requires that the sortie be terminated before mission completion); but again, SAC has not yet set a goal for the B-1B aircraft. The GAO found that, during the period of October 1987 through February 1988, B-1B air aborts averaged about 5 percent at Grand Forks and at Dyess AFBs, and were caused by a variety of maintenance problems. The GAO concluded that, when maintenance cancellations and air aborts occur, crews do not complete training (which has to be rescheduled). (p. 10, pp. 49-55/GAO Draft Report)

Now on pp. 32-33.

DoD RESPONSE: Concur. The B-1B continues to be a maturing weapon system. Maturity is defined as 200,000 flying hours (1994). The "growing pains" inherent in a concurrent production/logistics program continue to be a troublesome, but manageable, part of its development. The findings presented by the GAO are accurate in reference to increased work-hours required to troubleshoot CITS false alarms, windshield repairs, and main landing gear tires; however, these problems are being attacked.

The GAO found "that not-mission-capable-because-of-maintenance (NMCM) hours are further increased by additional workload resulting from troubleshooting CITS false failures problems..." and "When CITS is not reliable and identifies a part as failing, additional testing is done to determine if the part actually did fail." These statements are true to a degree, but the overall impact may be minimal. For the Rockwell CITS, an average of 16 CITS Maintenance Codes (CMCs) are issued per flight. Of these, 22 percent will be repaired, 13 percent deferred, 39 percent cannot be duplicated, and 26 percent cancelled. Less than 1 percent of all known true CMCs are considered a not flyable condition, and, from these, only a very small number could make an aircraft NMCM. The CMCs issued against the Boeing system have virtually no effect on NMCM hours because only one or less CMCs are issued per flight. The issue of additional testing is also true to a degree. Currently, both the Rockwell and Boeing CITS generate three CMCs that require analysis (for a total of six) per flight. The majority of these are resolved through analysis conducted by the contractors and only a small percentage involves on-aircraft work by maintenance technicians.

A two-man team stationed at Dyess is currently effecting repairs on delaminated windscreens through injection of an

epoxy into delaminated areas which do not exceed four inches in diameter. The benefits produced by these repairs are twofold. First, the obvious benefit is the slowing and even stoppage of further delamination in the repaired area. Secondly, and even more importantly, is the subsequent decrease in work-hours which would otherwise be required to remove and replace those windscreens. With 48 work-hours required to change the windscreen versus 4 work-hours to repair, a net savings of 44 work-hours will be realized per repair. These repairs continue to be our best course of action until improved technology and required funding become available to develop an improved windscreen.

In reference to the main landing gear tire problem, current testing is underway to study the improved performance and durability of a five groove versus the four groove tire currently used on the B-1B. Three aircraft have been outfitted with the five groove tire and testing is ongoing. Experience with the KC-135 has shown the five groove tire should greatly improve dependability and reliability. If testing is successful, there should be a significant decrease in work-hours spent on tire changes. This potential benefit will be delayed, however, until the present stock of over 2,000 tires is depleted and a buy of the five groove tires is accomplished.

In reference to the air abort/cancellation rate of the B-1B versus FB-111 and the B-52, there is no question that both of these aircraft presently have significantly lower rates. However, during the early FB-111 years (July 1972-December 1978), the cancellation rate for the FB-111 ranged from a low of 12 percent to a high of 16 percent for supply cancellations alone and the air abort rate ranged from 1.5 to 3.6 percent. Before SAC B-1B standards can be definitized, the weapon system needs to stabilize and mature (i.e., spares, test package sets, intermediate automatic test equipment, technical data, and support equipment are in place).

The B-1B weapon system continues to undergo system modifications to increase its capabilities. The Bird Strike Vulnerability Reduction (BSVR) modification, which is currently underway, is designed to greatly enhance the safety of the aircraft at low altitude. The flight control modifications also will improve the aircraft's flight performance through stability enhancement and better pilot cues. The anti-ice modification, scheduled to take place in the May-June 1989 timeframe, should significantly reduce the number of sortie cancellations experienced during the winter months, as well as reduce the number of engines experiencing ice damage. These and other modifications are being performed while continuing to provide airframes for

operational training needs. We share the GAO concern over the present B-1B abort/cancellation performance. The completion of planned modifications, as well as matured support systems, should go a long way in improving its readiness and bring the B-1B more in line with the FB-111 and B-52 weapon system performances.

- FINDING N: Training Limitations. The GAO found that, because of the shortages of flyable aircraft and limitations on the performance capabilities of the aircraft able to fly, the SAC has not been able to train all of its aircrews to fly the low level bomber mission, as planned. The GAO reported that the limited availability of flyable aircraft has (1) prevented crews from completing the training needed to be certified mission ready, (2) contributed to reducing the number of crews per aircraft to be trained, and (3) delayed the placing of additional aircraft upon alert.

  - The GAO found, for example, that, as of March 31, 1988, at Grand Forks AFB none of the crews had been trained to perform the low-level B-1B mission; and, of the 17 B-1B crews assigned to Grand Forks, only ten were considered mission ready (except for the low level events). The GAO reported that, according to Grand Forks officials, parts shortages prevented the wing from flying the sorties needed to train crews to the mission-ready level. The GAO noted that, in addition, these officials cited other problems, such as icing on engines and generator problems, also slowed training.

  - The GAO found that for the training periods ended June 30, 1987, and December 31, 1987, at Dyess AFB many of the pilots assigned to the B-1B bombardment squadron were unable to complete all of the SAC flight training required and, therefore, could not be placed on alert status. The GAO noted that the Dyess training report states that lack of available aircraft due to maintenance was the reason individuals could not complete the required training. The GAO further found an additional limitation in training is the delay in bringing the weapons system trainers on-line at the combat crew training at Dyess AFB. The GAO observed that, until weapon system trainers are on-line, crews accomplish ground training with cockpit procedures trainers, which are considerably less effective. (p. 10, pp. 55-58/GAO Draft Report)

Now on pp. 34-35.

DoD RESPONSE: Partially concur. Training was not inhibited by limitations on the performance capabilities of the aircraft able to fly, but rather by the limited availability of flyable aircraft:

- The SAC possessed flyable aircraft during the BSVR modification. The Air Force made a conscious decision not to fly high speed low level until aircraft were BSVR modified based on safety of flight considerations. This decision artificially limited the ability to train low level for a period of time. The combat crew training continued as planned and all flight regimes, other than high speed low level, were routinely flown. High speed low level training resumed in March 1988.

- Any change to crew ratios always takes into consideration the number of aircraft in a modification cycle at any given time. The SAC recognized in early October 1987 that future modifications could tie up approximately 20 aircraft at a time. The fact that those aircraft would be unavailable to fly due to modifications led the SAC to temporarily limit the number of aircrews per aircraft.

Placing additional aircraft on alert is a SAC decision based upon a delicate balance between current world situation, aircrew training, and aircraft availability. Additional aircraft will be placed on alert as the SAC ability to support the alert line and necessary aircrew training enables them to do so. As always, each B-1B is assigned an Emergency War Order mission, and the SAC possesses manning in excess of one crew per aircraft to man them in the event of a national emergency.

RECOMMENDATIONS

- None

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Comments From Boeing Military Airplane Company

BOEING MILITARY AIRPLANE COMPANY
A Division of The Boeing Company
Mail Stop
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Wichita, Kansas 67277-7730

11 August 1988
3-1130-128-98

Air Force Plant Representative Office (AFPRO)
Detachment 34 - TMD/ E. Ballard
P. O. Box 7730
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Wichita, Kansas 67277-7730

United States General Accounting Office (GAO)
National Security and International Affairs Division

Attention: Frank C. Conahan, Assistant Comptroller General
Washington, D.C. 20548

SUBJECT: GAO DRAFT REPORT ON B-1B STRATEGIC BOMBERS - MAINTAINABILITY DEPENDENT ON CONTRACTORS DATED 20 JULY 1988

1. The Boeing Company wishes to express its appreciation for the opportunity to review and comment upon the draft report entitled STRATEGIC BOMBERS: B-1B Maintainability Dependent on Contractors and Increased Funds (Code 392366). The company will have no oral or written comments on the draft report.

2. It is requested that Boeing be provided a copy of the final report when available. Please direct the report to the undersigned.

T. E. Mohn
Contracts Manager
B-1B Avionics Program

cc: OCALC/PMWAA, S. Healea

BOEING

Comments From Eaton Corporation

Eaton Corporation
AIL Division
Commack Road
Deer Park, New York 11729

17 August 1988

Mr. Frank C. Conahan
Assistant Comptroller General
US General Accounting Office
Washington, DC 20548

Dear Mr. Conahan:

EATON

We have reviewed the draft of Strategic Bombers: B-1B Maintainability Dependent on Contractors and Increased Funds (Code 392366). We have reviewed the draft and have found it very informative. We do not have any substantive comments at this time, but thank you for including us in your review cycle.

Very truly yours,

James M. Smith
Executive Vice President
Operations
B-1B AN/ALQ-161
Program Director

TWX 510-227-6073

Comments From Rockwell International

North American Aircraft Operations
Rockwell International Corporation
P.O. Box 92098
Los Angeles, California 90009

Rockwell International

August 20, 1988

Mr. Frank C. Conahan
Assistant Comptroller General
United States
General Accounting Office
Washington, D.C. 20548

Dear Mr. Conahan:

Thank you for the opportunity to comment on your draft report STRATEGIC BOMBERS: B-1B Maintainability Dependent on Contractors and Increased Funds. As manufacturer of the B-1B airframe we are quite proud of the performance of the B-1B production team and the resulting weapon system.

As a corporation, Rockwell International has supported and will continue to support the B-1B system. At present we have a cadre of personnel working with the Air Force to resolve the difficulties associated with the Defensive Avionics system.

Our limited comments on your draft will focus on two areas: (1) CITS and (2) Sustaining Engineering. The lack of additional comments should not be interpreted to mean that Rockwell agrees or disagrees with the content of this draft report.

(1) CITS

The Central Integrated Test System (CITS) on the B-1B Strategic Bomber is the most extensive application of on-board test technology of any existing weapon system. The CITS monitors thirty-four aircraft/avionic systems, identifies over 10,000 failure modes, and isolates these failures to the line replaceable unit level. To develop this system required extensive systems engineering effort to develop the test requirements using internal and vendor supplied data. Several meetings were held with the AFOTEC to renew the Rockwell CITS software process of analyzing CITS outputs, changing software requirements, modifying the software and testing the revised code. In February 1987 a fifth and final meeting was held where Rockwell and AFOTEC jointly defined the documentation Air Force would need to maintain the CITS software.

Although Rockwell has exceeded B-1B CITS specification requirements and Rockwell maturation goals, Rockwell is continuing to improve the CITS software in the area of false indications. Three software releases are scheduled from September of 1988 to March 1989 that will include corrections to false indications identified during the present support contract.

The CITS CAMS interface system (filter) incorporated at the MOB's serves several purposes:

1. Identify known false indications to prevent issuing a work order.

2. Identify CITS maintenance codes where data analysis is needed before issuing work order.

3. Identify CITS maintenance codes with open work orders (scheduled maintenance but not worked).

4. Identify CITS maintenance codes resulting from Aircraft configuration on known hardware changes.

The CCIS capability is planned to be included in the CITS Expert Parameter System. Evaluation of the Rockwell CITS Expert Parameter System (CEPS) reported by AFOTEC used preliminary information to report that Rockwell's demonstration was inconclusive as to effectiveness was due to lack of support or interest from base personnel. Boeings demonstration which followed and did have better base support showed potential. The AFOTEC assessment letter stated the following:

"6. The RI CEPS Phase II evaluation/demonstration at Dyess AFB was the catalyst for changes in 96 BMW maintenance policy which resulted in efforts to resolve coordination problems between Rockwell personnel and maintenance evaluators/technicians. A team of maintenance technicians has been dedicated to ensure improved CAMS documentation. Now all CMCs on all B-1B aircraft (including 5080) will be worked. These actions may give other contractors a slight advantage over Rockwell during their evaluation/ demonstration phases."

Post CEPS demonstration analysis of the CITS recorded failure data associated with the CITS/CEPS recommendations indicated that the majority of the recommendations were valid.

Mr. Frank C. Conahan
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August 20, 1988

(2) SUSTAINING ENGINEERING

There is an aspect of the B-1B Program that is unique as compared to other programs and this unique feature is the Program Management Responsibility Transfer (PMRT). In other programs PMRT occurs during production somewhere between 1/3 and 1/2 way through production. What this means to sustaining engineering support costs is sustaining support is drawn from production support teams.In the case of the B-1B PMRT it will occur in January 1989, eight months after the production of the last aircraft was complete. The production support activities and personnel are no longer assigned to the B-1B program and cannot be efficiently drawn up for sustaining activities. This may have the effect of increasing cost of sustaining engineering as compared to other programs. We believe the early AF funding estimates may have been based on previous experience on other programs and did not account for lack of on going production activity.

Again thank you for the opportunity to comment on your draft report and we trust our comments will be helpful.

H.E. Chambers
H. E. Chambers
Vice President and
B-1B Program Manager

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