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

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STRATEGIC FORCES

Supportability, Maintainability, and Readiness of the B-1B Bomber

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National Security and
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June 26, 1987

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

Dear Mr. Chairman:

This report summarizes the May 1, 1987, briefing we presented to your office on the supportability, maintainability, and readiness of the B-1B bomber. Issues discussed included shortages of spare parts, extension of contractor maintenance support, and numbers of mission-ready crews and aircraft on alert:

-- Spare parts shortages have resulted in the temporary grounding of aircraft, some of which have been cannibalized of parts for use in other aircraft. The primary cause is high demand resulting from spare parts that have not been as reliable as predicted and from false test failures of parts in operational aircraft.

-- Air Force in-house maintenance has been delayed primarily because of limited availability of repair instructions and lack of support equipment. Contractor repair costs, which will be incurred until in-house capability is achieved, are substantially higher than original estimates. Also, estimated funding requirements for sustaining engineering have increased substantially because the Air Force believes that several years of intensive contractor support will be required.

-- The Air Force is continuing to work toward its goals for readiness and training. Aircraft have been unavailable at times for training because of fuel leaks, engine vane icing, and other problems. As of the end of April 1987, the Strategic Air Command (SAC) had one B-1B on alert and 13 mission-ready crews for the 30 B-1Bs assigned to the strategic bombardment wings. SAC officials said that, in a national emergency, all B-1Bs would be available within days.

As requested, we are providing this report on work performed from January through April 1987. We are continuing to review the supportability, maintainability, and readiness of the B-1B. For this report, we obtained pertinent documents and information from Air Force officials at Dyess Air Force Base (AFB), Texas; Oklahoma City Air Logistics Center (OCALC), Oklahoma; SAC Headquarters, Nebraska; and the B-1B System Program Office, Aeronautical Systems Division, Wright-Patterson AFB, Ohio. In our work on spare parts, we focused our attention on a sample of 20 parts that were responsible for the grounding of the B-1B.

Our work was conducted in accordance with generally accepted government auditing standards. We discussed this report with officials of the B-1B System Program Office, Air Force Logistics Command, SAC, and OCALC. Their comments have been included as appropriate. As arranged with your office, unless you publicly announce its contents earlier, we will not distribute this report until 10 days after its issue date. At that time copies will be made available to appropriate congressional committees; the Director, Office of Management and Budget; the Secretaries of Defense and the Air Force; and other interested parties.

If you have any questions please contact Harry R. Finley, Senior Associate Director, on 275-4268.

Sincerely yours,

Frank C. Conahan

Frank C. Conahan
Assistant Comptroller General

Contents

ABBREVIATIONS

AFB	Air Force Base
AFLC	Air Force Logistics Command
ICS	Interim Contractor Support
IOC	Initial Operational Capability
MTBD	mean time between demand
OCALC	Oklahoma City Air Logistics Center
PMRT	Program Management Responsibility Transfer
SAC	Strategic Air Command

SUPPORTABILITY, MAINTAINABILITY, AND READINESS OF THE B-1B BOMBER

The decision to procure the B-1B was made in October 1981. At that time, an Initial Operational Capability (IOC) date of October 1, 1986, was set. IOC was defined as being reached when the fifteenth aircraft was 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 experience gained in the earlier B-1A program. The Air Force recognized that achieving that date would require a high degree of concurrent development and production. In fact, some development and production contracts were signed on the same day. The IOC date also compressed the test program due to the short period of time available for conducting tests. Program costs were capped by the Congress, and the President certified in writing that the program could be completed within the estimated time.

As of April 30, 1987, 42 B-1Bs had been delivered--26 to Dyess Air Force Base (AFB), Texas; 14 to Ellsworth AFB, South Dakota; and 2 to Edwards AFB, California. Delivery of the 100th and final B-1B is scheduled for April 1988. Contractually, delivery is to be not later than June 1988.

The B-1B System Program Office and the Air Force Logistics Command (AFLC) recently established a joint task force to identify residual, or remaining, B-1B support requirements, funding needs, and related issues as part of the planning for Program Management Responsibility Transfer (PMRT). This task force is expected to complete its work in the summer of 1987. PMRT is defined as the transfer of program management responsibility from the System Program Office to AFLC. PMRT includes the transfer of engineering responsibility, configuration management responsibility, and contracting functions. The B-1B PMRT is scheduled for January 1989 or several months after the last aircraft is delivered, as established in the November 1984 Program Management Directive.

AFLC acquired spare parts for the B-1B through a method called expanded advance buy. By this method, AFLC purchased spare parts in quantities anticipated to be needed to support the B-1B aircraft for 4 years. In managing reparable spare parts,[1] the

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[1]Aircraft parts can be divided into two categories--those that are thrown away after they are used and fail and those that are repaired and reused. The latter category is "reparable parts." The Air Force manages about 9,000 different reparable parts (stock numbers) for the B-1B.

Air Force generally buys enough parts to fill the repair pipeline--the time a part is removed to the time it is repaired and on the shelf for reuse. Complete units are procured when an item is condemned because it is no longer economical to repair. The cost of spares purchased through fiscal year 1986 for the B-1B totaled about $2.3 billion. Deliveries of these spare parts will be spread over the next several years to coincide with anticipated needs.

SHORTAGES OF SPARE PARTS

Shortages of some spare parts have been an Air Force concern since delivery of the first B-1B at Dyess AFB. These shortages have resulted in the temporary grounding of 6 to 14 aircraft at a time and the cannibalization of parts from 2 or 3 of these grounded aircraft at a time through April 1987. Parts to meet shortages on these 2 or 3 aircraft, in time of war, would have to be provided from the production line, which will be active until the final B-1B is delivered.

In our work on spare parts, we focused our attention on reparable parts that were responsible for the grounding of the B-1B. The number of high-priority requisitions for spare parts was averaging about 200 daily as of March 1987; in about 60 percent of these cases, lack of parts resulted in grounding of the aircraft. Using a list of parts for which at least 5 high-priority requisitions had been made and a list of 25 critical parts being overseen by a B-1B Resource Executive Working Group, we selected 20 parts whose shortages were grounding the B-1B.

The shortages of spare parts have primarily resulted from service lives for some spare parts being shorter than anticipated and false failures indicated by test procedures and equipment. Other problems causing spare parts shortages have been the backlog of design changes and the delivery of spare parts at a rate slower than demand requires.

Reliability shortfalls

The service life of a spare part is expressed as mean time between demand (MTBD). A part's estimated service life is used in calculating the quantity of spare parts needed. The shorter the MTBD, the more spare parts required. In buying spare parts for the B-1B, the Air Force generally used shorter MTBDs than had been projected by contractors.

Eighteen of the 20 parts we sampled had service lives that were shorter than contractors had predicted or the Air Force had estimated. Table I.1 shows Air Force data on the MTBD. In most cases, the parts had actually failed. However, a significant number of the test failures were not actual part failures, but false test failures. That is, a part was removed because test results showed that it had failed, but subsequent tests by a repair contractor showed that the part had not failed. Table I.2 shows the number and percent of the failures that were false.

Table I.1: Mean Time Between Demand

Item	MTBD Contractor-projected	Air Force estimate	Actual[a]
	- - - - - - - -	(hours)	- - - - - - -
Antenna assembly	2,604	800	85
Blower assembly	357	357	217
Anti-ice controller	2,551	2,551	347
Vertical display unit	329	329	186
Electronic display	1,000	300	136
Radar transmitter	523	82	75
Fan temperature control	1,923	1,923	79
Digital unit	2,364	1,277	868
Signal conditioning unit	506	273	75
Gyro switch	7,218	4,000	143
Spoiler computer	1,610	1,002	182
Radar transmitter	302	302	139
Data acquisition unit	13,333	378	283
Distribution box	13,514	1,307	273
Fan temperature control	1,923	1,923	79
Radar processor	112	65	52
Servocylinder assembly	275	2,000	318
Flight controller	138	159	402
Electronic amplifier	2,125	1,886	347
Starter valve	436	400	1,910

[a]Calculation of actual MTBD includes parts that have had false test failures.

Table I.2: Number and Percent of False Failures

Item	Part Failures: Test failures	False failures	Percent false failures
Antenna assembly	45	9	20
Blower assembly	29	7	24
Anti-ice controller	14	12	85
Vertical display unit	33	6	18
Electronic display	52	11	21
Radar transmitter	103	15	14
Fan temperature control	43	10	23
Digital unit	39	14	36
Signal conditioning unit	51	33	65
Gyro switch	15	5	33
Spoiler computer	14	3	21
Radar transmitter	9	4	44
Data acquisition unit	50	39	78
Distribution box	19	2	11
Fan temperature control	a	a	a
Radar processor	154	46	30
Servocylinder assembly	17	0	0
Flight controller	17	7	41
Electronic amplifier	11	2	18
Starter valve	3	0	0

[a]Included in figures for fan temperature control above. These items are different configurations of the same part and have different stock numbers.

Air Force officials said that false failures have a number of causes and that maturing the system, gaining operational knowledge, and correcting deficiencies tend to eliminate these causes. One of the major causes of false failures is the immaturity of the central integrated testing system. System Program Office officials said that this on-board diagnostic system, designed to monitor and isolate malfunctions, is registering about 30 to 40 false alarms per sortie. In some cases, parts have to be removed and tested to determine whether the part has actually failed. The Air Force has tasked the contractor to reduce the system's false alarms to 10 per sortie by the fall of 1987.

The B-1B program office is taking action to improve reliability on 17 parts in our sample for which reliability was less than projected. Actions on another part, the flight controller, were being taken as part of an improvement to the flight control system. In our research on the remaining two items, we found that the equipment specialist for the electronic amplifier thought an unrealistically high service life estimate had been used when determining the number of parts to be bought. The actual service life of the part is equivalent to the service life of like items and is not considered a reliability problem. The starter valve has been a problem in that there is a shortage of this part because of limited delivery from the contractor.

B-1B program officials said that actions to improve parts reliability have been hampered by concurrent development and manufacture of the B-1B, the program funding cap, and the lack of a contractual requirement for contractors to meet reliability specifications. Actions on the 17 parts for which reliability has been substantially less than projected have ranged from tracking failures (to identify the causes of problems) to making engineering changes to increase reliability.

The total extent of reliability problems with B-1B parts is unknown. The problems identified are those that have surfaced during the initial months of operation. To identify the extent of reliability problems, the Air Force has tasked the prime contractors with tracking failures and analyzing causes. We will review contractors' results as a part of our continuing work.

Item managers and equipment specialists at the Oklahoma City Air Logistics Center (OCALC) estimate procurement requirements on the basis of past failures. OCALC officials identified procurements on 9 of the 20 sampled items to cover the deficiency in MTBD. At the time of our work, MTBD deficiencies had not resulted in the ordering of parts for other sample items. As shown in table I.3, procurement costs for the nine items that have been ordered are over $32 million. System Program Office officials had not provided OCALC with information on whether planned improvements either to the parts or to testing systems might increase MTBD and decrease future requirements for parts.

Table I.3: Spare Parts Procured Due to Reliability Shortfalls

Item	Number ordered	Estimated cost
Blower assembly	38	$1,795,576
Vertical display unit	10	450,000
Electronic display	62	5,755,770
Radar transmitter	6	2,411,016
Signal conditioning unit	27	4,929,911
Gyro switch	20	700,000
Radar transmitter	17	5,123,120
Data acquisition unit	1	274,173
Radar processor	23	10,780,120
Total		$32,219,686

These additional procurements will not have a current impact on parts shortages. For most, delivery dates have not been established. The dates that have been established generally start in 1989. For example, the first 10 of the 23 radar processors are scheduled for delivery in October 1989.

Improvements in parts reliability and/or reductions in false test failures could totally or partially negate the need for these future deliveries. Effective coordination between the offices responsible for procurements, reliability improvements, and reductions of false test failures could help ensure that future procurements are limited to parts that will be required when delivered. Statistics on the blower assembly illustrate the need for coordination before procurements are initiated. Of 74 on order, 38, costing $1.8 million, were justified to cover requirements resulting from the reduced MTBD of the item. As shown in table I.1, the actual service life was 217 hours compared to the Air Force's estimated 357 hours. Seven of the 29 items (24 percent) sent by the Air Force for repair were found not to be defective by the repair contractor. In estimating repair and procurement requirements, OCALC included both defective and nondefective parts. OCALC officials said that items sent to contractors, whether defective or only false test failures, required spares in the supply system because replacements are needed when parts are with repair contractors.

System Program Office information showed that two engineering changes are being made to the blower assembly, which should increase the MTBD. One change, closing off air to the blower assembly while in flight to prevent reverse rotation, reduces wear and lengthens the service life of the blower. The other change involves replacing the solenoid that controls the blower. B-1B program officials had not developed a new MTBD but believed that the changes should provide some improvement. The equipment specialist at OCALC did not have information on these changes and was estimating procurement requirements on the basis of past failures. If the false failure rate and MTBD improve significantly, the additional 38 items being procured based on the initial high failure rates might not be needed. These items are scheduled for delivery beginning in February 1989.

Another example of the need for coordinated action involves the signal conditioning unit. Of the 35 on order, 27, costing $4.9 million, were justified to cover the reduced MTBD. As shown in table I.1, the actual MTBD was 75 hours compared to the Air Force's estimated 273 hours. The MTBD was based on 51 failures; however, 65 percent of these failures (33 of 51) were not found defective by the repair contractor.

System Program Office information showed that the production contractor had initiated a manufacturing change for the signal conditioning unit beginning with aircraft number 42. This change is to provide a correct indication of when the unit is operating within specified limits and should eliminate the false failure indications. The first 41 aircraft are to be modified, but the contractor had not submitted a proposal by the end of April 1987. Again, the equipment specialist at OCALC was not aware of the changes being made and was estimating procurement requirements on the basis of past failure and false test results. In view of the improvements made and planned, the additional 27 spares to compensate for the initial low service life of this item might not be required.

Backlog of design changes

During development of a system, design changes normally occur to enhance performance, maintainability, and reliability of a part. A recent projection of the number of design changes to the B-1B, however, is about five times the total projected in 1985. For the B-1B, OCALC has been responsible for processing all design change notices received from contractors. Processing involves introducing the new part numbers into the supply system and allows supply transactions to be processed automatically. The large number of design changes resulted in a backlog at OCALC. The backlog slows issuance of parts to the field because contractors are not authorized to ship parts until processing is complete or a special waiver is granted.

Table I.4 shows the projected numbers of design change notices and numbers received as of February 1987 and as of March 1987.

Table I.4: Design Change Notices

	Number of design change notices
1985 projected total	34,250
Projected total (February 1987)	133,531
Projected total (March 1987)	162,000
Received (February 1987)	80,542
Received (March 1987)	118,260

As of April 30, 1987, about 14,000 design changes had not been processed by OCALC, and orders for parts awaiting processing totaled about $226 million. Contractors are storing some of these parts until shipment authorization is received.

We discussed this matter with OCALC's management on April 29, 1987. Subsequently, OCALC officials by letter dated June 1, 1987, transferred processing of design change notices to the Air Logistics Centers managing the individual parts. They believe that dispersing the work load will result in faster processing.

Deliveries of spares

The Air Force, in buying spares for the B-1B, used projected MTBDs as a basis for scheduling deliveries from vendors and in estimating overhaul requirements. Deliveries of spares are scheduled over a number of years to meet projected demands as they occur. However, higher-than-anticipated failure rates for some parts have increased demands beyond the number of items delivered and have resulted in grounded aircraft. Table I.5 shows that, as of April 30, 1987, 124 of the 813 spare parts ordered for the 20 items included in our sample had been received. In some cases, the delivery of spares on order would relieve the shortage of spare parts in the field, but to get earlier deliveries, the Air Force might need to slow aircraft production, an action it does not deem desirable.

Table I.5: Spares Delivered for Sample Items as of April 30, 1987

Item	Number of spares Ordered	Number of spares Delivered
Antenna assembly	9	4
Blower assembly	74	13
Anti-ice controller	15	2
Vertical display unit	54	4
Electronic display	84	1
Radar transmitter	85	8
Fan temperature control	34	11
Digital unit	48	16
Signal conditioning unit	35	6
Gyro switch	44	0
Spoiler computer	22	6
Radar transmitter	49	7
Data acquisition unit	16	7
Distribution box	16	2
Fan temperature control	4	4
Radar processor	108	22
Servocyclinder assembly	12	4
Flight controller	14	1
Electronic amplifier	50	3
Starter valve	40	3
Total	813	124

Manufacturer's responsibility for parts reliability

According to Air Force officials, production contracts for the B-1B do not require that the MTBD of individual parts meet the contractors' or the Air Force's estimates. The contracts contain correction of deficiencies warranties, which cover design deficiencies, materials and workmanship, and latent defects. Correction of deficiencies could extend the reliability of parts.

An OCALC official said that the Air Force does not monitor warranty repairs. They said that this monitoring was the responsibility of the prime contractors. Prime contractors require warranties on parts purchased from subcontractors and enforce these warranties on behalf of the government. We noted that warranty repairs had been made on 12 of the 20 parts in our sample. We are examining this matter as a part of our continuing work.

MAINTENANCE CAPABILITY AND SUSTAINING ENGINEERING

The Air Force intends to establish in-house, or organic, intermediate and depot level maintenance for essentially all systems on the B-1B. Organic intermediate maintenance is defined as repair of components in shops at Air Force bases. Organic depot maintenance is defined as overhaul of an item at one of the Air Force's logistics centers. Currently, most intermediate and depot level maintenance is performed by contractors under what is termed Interim Contractor Support (ICS). Most organic support was expected to be available by 1988, but the estimated date has slipped 2 years to 1990.

The Air Force's organic intermediate and depot level maintenance capability (with the exception of the maintenance of engines, wheels, and tires) has been delayed primarily because of a lack of technical orders (repair instructions) and some test equipment. Moreover, the date for organic repair of the defensive avionics system (ALQ-161) will be determined after the design changes currently being made to the system are firmed up. Table I.6 shows the changes in projected dates for organic intermediate and depot level maintenance capability. These dates are estimates of when organic capability for nearly all parts will be achieved. Organic repair for some parts may occur at various dates.

Table I.6: Projected Dates for Organic Maintenance

	Projected date	
Maintenance level	Original	Revised
Intermediate:		
Nonavionics	09-30-86	09-30-88
Avionics[a]	06-30-87	12-31-89
Depot:		
Nonavionics	06-30-87	12-31-89
Avionics[a]	06-30-88	12-31-90

[a]Does not include defensive avionics.

The delays in establishing organic repair have increased ICS costs. Table I.7 shows the prior estimated cost of contractor repairs compared to the present estimate for fiscal years 1984 through 1994.

Table I.7: Contractor Repair Costs

Fiscal year	Original est. (1981 base year)	1981 indexed to 1987 dollars[a]	1987 estimate
	- - - - - - - - - -	(millions) - - - - - - -	- - - - - -
1984	$ 4	$ 5	$28[b]
1985	5	6	42[b]
1986	9	12	52[b]
1987	48	62	77
1988	111	144	107
1989	20	26	100
1990	0	0	49
1991	0	0	31
1992	0	0	14
1993	0	0	7
1994	0	0	6
Total	$197	$255	$513

[a]Based on indices provided by the Office of the Secretary of Defense, Comptroller.

[b]Actual.

The Air Force views ICS as more costly and less timely than organic maintenance. As shown in table I.8, contractor repairs to B-1B parts are taking longer than Air Force standard repair cycle times. Longer repair cycles could require more parts in the supply pipeline. Air Force officials said that meeting standards may require a period of repair experience after organic maintenance is achieved.

Table I.8: Comparison of Average Time for Repair Cycle to Air Force Standards

		Repair cycle time	
Contractor	Type of repair and location	Average	Air Force standard
		- - - - - -(days)	- - - - -
A	Intermediate level - on base	24	7
	Intermediate level - off base	17	
	Depot level - off base	72	26
B	Intermediate level - on base	4	7
	Intermediate level - off base	27	
	Depot level - off base	35	26
C	Intermediate level - on base	12	7
	Depot level - off base	50	26

Availability of verified and validated repair instructions will pace the transfer of maintenance from contractors. System Program Office officials said that transfer of maintenance from contractors is to be done on a part-by-part basis. On a few selected items, the Air Force has established target dates for transferring maintenance from contractors to the Air Force. However, Air Force officials said that dates have not been set for the vast majority of parts; neither have priorities been set using such factors as numbers of false tests, expected field repair rates, and repair costs. OCALC officials said that information on amounts paid to ICS contractors for repair of individual parts was not available.

Costs for sustaining engineering--contractor engineering support to the B-1B after it is fielded--are also expected to increase. The Air Force believes the B-1B will require extensive engineering support to resolve the numerous technical problems that will be encountered. OCALC officials expect several years of intensive technical support to adequately correct problems and deficiencies with the complex avionics and software of the weapon system, the mechanical systems, weapons compatibility, and support equipment and to identify problems that involve several aircraft systems. This support is required if the B-1B is to maintain a high state of readiness and probability for mission success. Table I.9 shows the fiscal year 1988 budget estimates compared to OCALC's latest estimated costs.

Table I.9: Increased Funding for Sustaining Engineering

Fiscal year	Current OCALC estimate	FY 1988 budget	Difference
	(millions)		
1988	$ 2.0	$ 3.6	$ -1.6
1989	73.1	23.7	49.4
1990	97.5	28.2	69.3
1991	105.0	18.5	86.5
1992	105.3	27.4	77.9
Total	$382.9	$101.4	$281.5

AIRCREWS AND ALERT AIRCRAFT

To meet its operational goals for the B-1B, SAC intends to provide 1.37 mission-ready crews per aircraft. Also, SAC's general criterion is that 30 percent of its bombers be on continuous alert. As of the end of April 1987, SAC had 13 mission-ready crews trained for the 30 B-1Bs assigned to the strategic bombardment wings.[2] Only one aircraft was on alert. SAC officials said that, in a national emergency, all B-1Bs would be available within days.

Crew training

The B-1B has a crew of four: pilot, copilot, defensive systems officer, and offensive systems officer. As of April 1987, SAC officials said that by using instructors and non-flight qualified copilots, they would be able to provide about 45 crews. Operational restrictions in critical areas have prevented some training. Problems with terrain-following radar have prevented crew training at low altitude, which is critical to B-1B penetration of hostile airspace. Problems with defensive avionics and flight controls limit other training. Therefore, no crews have been trained to use the full, planned capability of the B-1B. Table I.10 provides the number of trained crew members by position.

Table I.10: SAC's Trained Crew Members

Crew position	Number trained as of April 1987
Instructor pilots	33
Pilots	16
Copilots	22
Non-flight qualified copilots[a]	18
Total	89
Instructor offensive systems officers	29
Offensive systems officers	15
Total	45
Instructor defensive systems officers	30
Defensive systems officers	15
Total	45

[a]SAC officials said these copilots have not completed flight training but could be used in the event of a national emergency.

[2]Forty-two aircraft had been delivered; however, 12 were not assigned to operational wings.

SAC officials reported that, as of April 30, 1987, 13 crews were considered mission ready. A mission-ready crew is a crew that has trained together and participated in a structured program to train for specific Single Integrated Operational Plan missions. SAC anticipates having a ratio of 1 mission-ready crew to 1 B-1B before the end of 1987 and plans to achieve the ratio of 1.37 crews to 1 aircraft by December 1988.

Aircraft on alert

Aircraft have been unavailable for training at times because of such problems as fuel leaks, engine vane icing, and shortages of repair parts. These problems have adversely affected crew training and limited SAC's ability to place aircraft on alert.

As of April 30, 1987, one B-1B was on alert at Dyess AFB. A SAC official said that in another month or two another B-1B would be on alert at Ellsworth AFB. To meet SAC's criterion for a bomber alert force (30 percent of the bomber force assigned to the strategic bombardment wings), SAC would need nine B-1Bs on alert (30 percent of 30 aircraft assigned to bombardment wings). SAC officials said that placing more B-1Bs on alert would limit the availability of aircraft for crew training and other demands such as testing and verifying and validating repair instructions. They said that the plan for obtaining full operational capability involved maturing the B-1B system in a safe and effective manner. Decisions to place additional aircraft on alert will be based on logistics capability, aircrew training requirements, and force maturity. SAC's present projections are to meet the 30 percent criterion in early 1990.

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