

Birth of a Hog: The Beginnings of the A-10 Warthog

Edward C. Mishler, Malcolm D. Wall, and George M. Watson
Compiled & Edited by R. Ray Ortensie

History and Heritage Directorate
Headquarters, Air Force Materiel Command



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A-10 rollout at Fairchild Republic factory

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First flight of the A-10B, two-seater.

Edited by R. Ray Ortensie

History and Heritage Directorate
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2021

Editorial Comments

What you are about to read is three various studies, written by Headquarters Air Force Systems Command History Office in the 1970s, on the development to production of the A-10 Warthog compiled into one product, "Birth of a Hog." Each of the studies was cleared for Public Release in the 1990s by HQ Air Force Materiel Command Public Affairs. Historical content of each study remains with only minor edits as far as formatting to help merge the three studies together. Every effort was made to find all the photographs from the original studies; however, over time, some of the photographs have been misplaced. In some places, historical photographs have been added to enhance the historical context of the product that may not have been available at the time of the writing of the study.

About the Authors

Major Raymond C. Harlan in 1981 served as an Assistant Professor of English at the Air Force Academy, previously serving as an Assistant Professor of Aerospace Studies (ROTC) at Bradley University in Peoria, Illinois (1972-76), and as a missile launch officer and member of the wing senior instructor crew at Malmstrom AFB, Montana (1968-72). His works appeared in *Newsweek*, *Theatre Crafts*, and *The New Mexico Humanities Review*. Major Harlan edited "The Development and Acquisition of the GAU-8/A: The A-10's "Tank Buster.""

Dr. Edward C. Mishler, born 21 November 1938, Moline, Illinois, authored "The A-X Specialized Close Air Support Aircraft: Origins and Concept Phase, 1961-1970." Dr. Mishler received his B.S.C.E. from Purdue University in 1960, his M.A. from University of Maryland in 1970, and his Ph.D. in 1975. Dr. Mishler served as an Intelligence Officers, U.S. Army from 1960 to 1967. Dr. Mishler taught at the University of Maryland University College from 1974 to 1975 and then began working as a Research Historian, Office of History, Headquarters Air Force Systems Command, in June 1975.

Malcolm Dale Wall, born December 17, 1915 in Warsaw, North Carolina, authored "The Development and Acquisition of the GAU-8/A: The A-10's "Tank Buster."" He received an undergraduate degree from the College of William and Mary, Williamsburg, Virginia, and completed three years of graduate work at University of Minnesota, Minneapolis, Minnesota, awarded a Master's degree in History in 1945. He was a member of the faculties of the University of Minnesota, Bemidji State Teachers College and Oklahoma State University. He joined the Air Force Historical Program at the Arnold Engineering Development Center, Tennessee, in 1951 and in 1963 joined the Air Force Systems Command History Office as the Senior Historian in the Office of History.

Dr. George M. Watson, Jr., born 3 July 1944, Portland, Maine, authored "The A-10 Close Air Support Aircraft: From Development to Production, 1970-1976. Dr. Watson received his B.A. from the University of Maine in 1960, his M.A. from Niagara University, New York, in 1966, and his Ph.D. from The Catholic University of America in 1974. Dr. Watson served in the U.S. Army from 1969-1971. He taught at Saint Francis College, Biddeford, Maine, and the University of Maryland, Far East Division. Dr. Watson started with the Air Force Historical Program in 1975 to 1977, and then moved to Air Force Systems Command History Office in November 1977.

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MASTER CHRONOLOGY

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Nov After additional joint studies with OSD the Air Force recommended the acquisition of the A-7D aircraft – a modification of the existing Navy A-7 as the interim lower cost tactical aircraft.

Dec The Secretary of Defense authorized the Air Force to acquire the A-7D.

1966

Air Force planners began to examine requirements for a future close air support (CAS) aircraft incorporating a large bore rapid-fire cannon.

June General John P. McConnell, Chief of Staff, USAF, directed a study of close air support be undertaken.

14 Aug Close air support study was completed and recommended among other things that the Air Force needed to acquire a specialized close air support aircraft for the 1960s and beyond.

- 8 Sept General McConnell directed that the Air Force take immediate action to design, develop, and obtain a specialized close air support aircraft.
- 22 Dec Headquarters USAF issued a Requirements Action Directive (RAD) for a specialized close air support aircraft designated the A-X.

1967

- 6 Mar Request for proposal (RFP) issued to industry for A-X system studies.
- 19 Apr The Deputy for Studies and Analyses, Systems Engineering Group, Research and Technology Division (RTD), located at Wright-Patterson AFB, Ohio, submitted a preliminary A-X proposal to AFSC to be used by a Headquarters USAF working group.
- 11 May The Air Force awarded study contracts to McDonnell-Douglas, Northrop Corporation (Norair), Grumman, and General Dynamics (Convair).
- 1 Sept The contractors completed their system studies.
- Late 1967 The desired characteristics of the aircraft and gun are identified.

1968

- January Air Staff concluded that a large bore rapid-firing aircraft cannon was both necessary and feasible.
- 5 Jan Air Staff issued Requirements Action Directive, "Air to Ground Systems for Close Air Support," instructing AFSC to plan the development and acquisition of an air-to-ground gun system including "associated rounds" as an integral component of the A-X (later A-10) close air support aircraft system.
- February As a result of a Requirements Action Directive (RAD), "Air-to-Ground Systems for Close Air Support," issued by the Air Staff in late 1967, a Close Air Support Gun System Study Group was established by AFSC.
- 1 Mar The Headquarters USAF working group completed the Concept Formulation Package (CFP).
- 13 May Review and revision of the Concept Formulation Package completed.
- 29 May An A-X Program Office (SPO) cadre was formed by drawing upon F-X SPO personnel. The A-X program had been managed by the F-X SPO since January 1967.
- 11 Dec The first Development Concept Paper (DCP 23) for the A-X was completed.
- 14 Dec The Director of Defense Research and Engineering (DDR&E) Dr. John S. Foster, Jr., reluctantly signed DCP 23.
- 16 Dec The Deputy Secretary of Defense approved the inclusion of \$12 million in the Fiscal Year (FY) 1970 budget for Contract Definition contingent on Air Force completion of supplemental studies to the CFP.

1969

- 21 May Volume II, Avionics, and Volume III, Survivability, of the CFP supplement were published.
- 28 May Weight and sizing studies were published as Volume I of CFP supplement.
- 9 June A prime/subcontractor strategy to the development of the gun and ammunition was approved.
- September The Close Air Support Gun System Study Group's final report recommended development of a 30mm internally-mounted Gatling gun system together with a family of associated rounds which would be developed especially for close air support.
- 22 Sept The Air Force forwarded the CFP supplement to OSD.
- 10 Oct Secretary of the Air Force Robert C. Seamans, Jr., approved the reorientation of the A-X Program to a competitive prototype approach.
- Dec The Office of DDR&E prepared a draft revised Development Concept Paper, DCP 23A.
- 19 Dec A Defense System Acquisition Review Council (DSARC) meeting was held to review the draft DCP 23A and the Air Force proposal to transition the A-X program from Concept Formulation to Contract Definition.

1970

- 16 Mar The final version of DCP 23A was completed.
- 6 Apr Deputy Secretary of Defense David Packard approved DCP 23A and the competitive prototype approach termed "Parallel Undocumented Development."
- 10 Apr Headquarters USAF issued AFSC a System Management Directive (SMD) formally authorizing the A-X program.
- 27 Apr The Air Force Systems Command established the A-X Systems Program Office (SPO) in the Deputy for Systems Management, Aeronautical Systems Division, Wright-Patterson AFB.
- 8 May The Air Force distributed a request for proposal (RFP) for the competitive prototype phase of the A-X aircraft to 12 companies.
- 18 May Col James E. Hildebrandt was appointed Systems Program Director and Chief of the A-X System Program Office.
- 7 Aug Six companies responded to the A-X Request for Proposal: Fairchild Hiller Corporation, the Boeing Company, Northrop Corporation, Cessna Aircraft Company, General Dynamics Corporation, and Lockheed Aircraft Corporation.

October The Armament Development and Test Center (ADTC) released a Request for Proposal for design, fabrication, and demonstration of a prototype gun.

23 Oct The Source Selection Advisory Council briefed its findings to the Source Selection Authority (Secretary of the Air Force Robert C. Seamans, Jr.).

16 Nov The Air Force released requests for proposals for the GAU-8 30mm cannon to industry.

December The A-X prototype fly-off began.

17 Dec The A-X System Program Director presented a source selection briefing to the DSARC.

18 Dec The Secretary of the Air Force announced the selection of the Fairchild Hiller Corporation and the Northrop Corporation as the contractors for the competitive prototype phase of the A-X program.

1971

1 Mar Air Force designated the two A-X prototypes as the Northrop A-9 and the Fairchild A-10.

June The Air Force awarded letter contracts to the General Electric Company and the Philco-Ford Corporation for the competitive development of the GAU-8 gun system and practice ammunition.

15 June Dr. John S. Foster, Jr., Director of Defense Research and Engineering, announced immediate release of funds for the prototype gun development.

19 Aug An Ad Hoc Group of the Air Force Scientific Advisory Board concluded that for the AX aircraft the 30mm Gatling type gun was superior to the Oerlikon revolver type.

1 Oct Dr. McLucas announced a modified acquisition program which would allow flight tests of the winning Gatling gun in the winning AX aircraft prior to the production decision to determine gun/aircraft interaction (vibration, recoil, gun, gas, etc.).

1972

9 Jan The Air Force negotiated a \$26.5 million cost-plus-incentive-fee contract (F33-657-C-0135) with AVCO Lycoming for development of the F100-LD100 turbofan engine.

10 May Fairchild's first flight of A-10 at Air Force Flight Test Center, Edwards AFB, California; competitive flight evaluation began.

30 May Northrop A-9 made first flight at Edwards AFB; competitive flight evaluation began.

Mid-1972 Contractors completed gun system fabrication and began firing tests in preparation for the competition shoot-off scheduled for January-April 1973.

10 Aug The Air Force completed and released Proposal Instructions (PI) containing all the essential requirements for continued development and operation test production.

10 Oct Flyoff between the A-9 and A-10 began at Edwards AFB.

December The A-X prototype fly-off, which began in December 1970, was completed.

9 Dec Flyoff between the A-9 and A-10 completed.

1973

3 Jan – 6 Apr The Air Force evaluation of the General Electric and Philco-Ford 30mm gun system prototypes was conducted with firing tests at AFSC's Armament Development and Test Center, Eglin AFB, Florida.

17 Jan Defense Systems Acquisition Review Council (DSARC) met to review A-X program and was briefed on the Air Force decision to select the Fairchild Republic Company as the winner.

18 Jan Deputy Secretary of Defense, Mr. Kenneth M. Rush, authorized the Air Force to make a source selection announcement and proceed with contract negotiations to include design-to-cost objectives, selecting the Fairchild Industries A-10 over the Northrup A-9 close air support aircraft

1 Mar The Air Force awarded Fairchild Industries as \$159,279,888 cost-plus-incentive-fee contract to continue prototype aircraft testing and to develop and build 10 preproduction aircraft.

1 Mar The Air Force awarded General Electric a \$27,666,900 contract to develop and deliver 32 TF34 engines.

19 Mar A-10 DT&E/IOT&E Phase I flight testing began.

18 Apr The A-X System Program Office was redesignated the A-10 System Program Office.

5 Jun The Defense Systems Acquisition Review Council (DSARC) II reviewed the GAU-8A program and recommended that the Air Force proceed with negotiations for the full-scale development of the GAU-8/A gun and ammunition.

21 Jun The Director of Defense Research and Engineering authorized the Air Force to enter into full-scale ammunition development.

21 Jun John L. McLucas, Acting Secretary of the Air Force, announced the award of the development contract for the GAU-8 gun system being development for the A-10 to General Electric. The award consisted of a fixed-price-incentive fee contract of \$23,754,567 for three preproduction systems.

- Jul The Senate Armed Services Committee cut the FY74 request for A-10 preproduction aircraft from 10 to 6. The committee also recommended a flyoff between the A-10 and A-7D.
- 19 Sept The Air Force agreed to the Congressional recommendation to conduct a flyoff between A-7D and A-10.
- 2 Oct Malcom Currie, Director of Defense, Research and Engineering, proposed a plan to complete the flyoff.

1974

- 22 Feb – 25 Mar Flight testing of the GAU-8A installed in the YA-10 aircraft was conducted at the Air Force Flight Test Center at Edwards AFB, California.
- 26 Feb First in-flight tests of A-10 #1 prototype with GAU 8A gun installed.
- 15 Apr – 9 May At the direction of the Congress, the Air Force conducted a joint comparative flight evaluation of the YA-10 prototype and the A-7D at Fort Riley Kansas. The data analysis, nicknamed Saber Compare, produced the observation that the YA-10 prototype was overall the more effective aircraft.
- 9 May The flyoff between the A-10 and the A-7D was completed.
- 11-12 Jun Flight tests conducted at Edwards AFB, California, demonstrated that a two-degree gun alignment angle would be best for the GAU-8A in the YA-10.
- 19 Jun The GAU-8/A 30mm gun was fired for the first time with combat ammunition.
- 9 Jul DSARC IIIA convened to discuss progress of the A-10.
- 31 Jul Deputy Secretary of Defense, William P. Clements, Jr., authorized the Air Force to proceed with initial production of the A-10 using \$39-million for long lead funding. He granted approval to procure 52 aircraft subject to provision that contract options to procure a smaller quantity be kept open.
- 4 Sept Air Force Vice Chief of Staff, General Richard H. Ellis, ordered a review of the A-10 Program. The review was headed by Lt Gen Robert E. Hails, Vice Commander, Tactical Air Command. The review took place from 4-22 September 1974.
- 11 Sept Compatibility launches of AGM-65A Maverick air-to-ground tactical missile with A-10 aircraft at Edwards AFB were completed.
- 18 Sept The Critical Design Review (CDR) of GAU-8/A 30mm gun was completed.
- 9 Oct After modifications were made to correct problems identified during the earlier flight tests, evaluations were again begun at Edwards with the GAU-8/A installed in the YA-10.

31 Oct Qualification tests of the TF-34-GE-100 engine completed.

6 Nov Col Jay R. Brill was appointed A-10 System Program Director, replacing Brig Gen Thomas H. McMullen (June 1973 – November 1974).

7 Nov The secondary gun gas ignition problem was considered solved by the A-10 Systems Office at HQ AFSC.

19 Nov A follow-up DSARC review was held to confirm milestone completions called for in the DSARC IIIA Review held in July 1974.

22 Nov Deputy Secretary of Defense Clements authorized procurement of 52 A-10 aircraft.

1975

Jan First A-10 development test and evaluation (DT&E) aircraft delivered to Edwards AFB for test purposes.

Feb Fairchild announced sweeping organizational and managerial changes for A-10 production. Changes were generated by recommendations of an Air Force study team headed by Lt Gen Robert E. Hails, Vice Commander, Tactical Air Command. Fairchild announced that it planned to move final assembly and flight testing of A-10 to Hagerstown, Maryland.

15 Feb First flight of DT&E A-10 aircraft at Edwards AFB.

19 Mar A-10 IOT&E Phase II testing began.

31 Mar Secretary of the Air Force announced that the Air Force was not adverse to Fairchild Republic Company's plan to move some of the A-10 workload from Farmingdale, Long Island, to Hagerstown, Maryland.

May The Air Force began an evaluation at Eglin AFB, Florida, of the GAU-8/A gun system including ammunition.

13 Jun A-10 IOT&E Phase II flight testing completed.

1 Aug Air Force, NASA, DDR&E agreed to drop requirement of 100-percent airload prior to DSARC IIIB.

23 Sept With approximately 80 percent of A-10 lifetime testing completed, a crack was observed in the fuselage frame.

Oct-Nov The A-10/GAU-8/A weapon system proved its worth as an anti-armor weapon in lethality tests conducted at Nellis AFB.

21 Oct The first flight of a production A-10 was completed at Farmingdale.

28 Oct Testing of reinforced cracked fuselage frame completed – 6,000-hour mark attained.

13 Nov A-10 successfully demonstrated GAU-8 30mm lethality against tank targets.

1976

- 10 Feb Deputy Secretary of Defense Clements signed Development Concept Paper 23B authorizing the Air Force to proceed with full production of the A-10 at a rate of 15 aircraft per month.
- 30 Mar The A-10 formally accepted by the Commander, Tactical Air Command, General Robert J. Dixon, from Commander of Air Force Systems Command, General William J. Evans.



A-10 with an AN/ALQ-119 electronic countermeasure

**PART I:
The A-X Specialized Close Air Support Aircraft:
Origins and Concept Phase, 1961-1970**



**The A-X Specialized Close Air Support Aircraft:
Origins and Concept Phase, 1961-1970 (U)**

by

Dr. Edward C. Mishler

Office of History
Headquarters
Air Force Systems Command
United States Air Force

FOREWORD

This monograph is the first of a two-volume series which will encompass the history of the A-10 Close Air Support aircraft from its conception through final production. It is significant that this was the first aircraft specifically designed for the Air Force's close air support mission. This volume covers the story from its conception, as the A-X, in 1961 to the selection of the competitive prototype contractors in December 1970 – a first attempt – the Air Force at dual prototyping. A second volume will continue the story through the production stage. The author of this study, Dr. Edward C. Mishler, is a member of the staff of the Office of History, Headquarters Air Force Systems Command.

WALTER L. KRAUS
Chief/Command Historian
Office of History
15 June 1977

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Biographical Sketch

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Chapter 1: THE NEED FOR A CLOSE AIR SUPPORT AIRCRAFT

On 22 December 1970 the Secretary of the Air Force, Robert C. Seamans, Jr., authorized and directed the award of contracts to the Fairchild Hiller Corporation and the Northrop Corporation for each to build two prototype A-X Specialized Close Air Support (CAS) aircraft. The Air Force designated the Northrop version the A-9 and the Fairchild version the A-10. This action inaugurated the first United States Air Force (USAF) attempt at dual prototyping.¹ More significantly, the A-X was to be the first Air Force aircraft specifically designed for the close air support mission. A little over four years had elapsed since the Air Force Chief of Staff John P. McConnell had directed that acquisition action be taken for such an aircraft. Originally, the intent was to have this new aircraft enter the inventory in 1970.² Because of various factors, including changes in aircraft capabilities and requirements, technological advances, and the decision to have a competitive prototype program, the planning schedule lengthened. Equally important, the conceptual aircraft of 1970 differed from the preliminary conceptual design and was bigger, more survivable, and carried over twice the payload.

Background

Behind the decision to build competitive prototypes of the A-X lay a lengthy history of controversy over the close air support mission of the Air Force and a continuing interservice dispute with the Army over tactical roles and missions, especially in relation to air support. This dispute did not end with Secretary Seamans' action at the end of 1970. A contributing factor to the disagreement was an Air Force doctrine in the 1950s that emphasized the strategic aspects of its roles to the detriment of the tactical role. That emphasis continued dominant into the early 1960s.³

The advent of the President John F. Kennedy Administration in 1961, which deemphasized the U.S. defense strategy of massive retaliation through the use of nuclear weapons as a deterrent to aggression, contributed to both a continuance and intensification of the interservice dispute and a reappraisal by the Air Force of its close air support mission. Limited war, counterinsurgency operations, flexible response, and multiple options became the bywords of military planners throughout the next decade. As a result, the Office of the Secretary of Defense (OSD) allowed the Army to embark on a diversification of its weapon systems that opened up the possibility of the Army's assuming an important share of the tactical air role and missions that belonged to the Air Force, especially the close air support mission. Increased U.S. military involvement in a limited war in Southeast Asia in the 1960s gave the Army an opportunity to try out new tactics of air mobility and to justify the need for new weapon systems to support these tactics. The expansion of Army aviation and its use of large numbers of armed helicopters in the close support of ground and air mobile forces during this period further underscored the divergent views of the Services as to the tactical air role and missions.⁴

The Air Force recognized the Army's need for increased mobility and combat effectiveness but viewed the growth of Army aviation in the 1960s as impinging on the Air Force tactical missions. Army air mobile units required greater numbers of organic aircraft than the standard ROAD (Reorganized Objective Army Division) units. The standard ROAD unit in the early 1960s had 101 aircraft while the new air mobile division would have 434 aircraft of which all but

6 were helicopters. These six were *Mohawk* fixed-wing observation aircraft. The Army also wanted to employ the *Caribou* light transport in forward operating areas to provide supply services. Secretary of Defense Robert S. McNamara, however, on the basis of cost effectiveness comparisons among Air Force aircraft and the *Caribou* and *Mohawk*, deleted the *Mohawk* from the Army's Fiscal Year 1965 budget and greatly reduced the number of *Caribous* to be purchased.⁵ In 1966 the Army agreed to transfer its fixed-wing tactical airlift aircraft to the Air Force. Although losing out in these two instances, the Army's interest and activity in another area of the air ground support role – close air support – was a major concern to the Air Force.

Close Air Support

The Army had never been completely satisfied with the close support provided to its ground forces in World War II, in Korea, and, as events would unfold, in Vietnam. On various occasions Army leaders had expressed the belief that a specialized aircraft dedicated to close air support was needed. The Air Force position was that such an aircraft, if optimized for close air support, would lack versatility. Air Force leadership believed that tactical aircraft must be able to perform a variety of missions at any given moment including air superiority, interdiction of the battlefield, and close air support.* When given the opportunity by the Air Force in the early 1960s to select an aircraft to perform the close air support role, the Army backed down. This was largely caused by the Army's concern that its budget would have to pay for part of the cost of such tactical aircraft, and also because the candidate aircraft were high performance planes. As the airmobile concept developed, the Army apparently believed that it could assume more of the close support function through the use of missiles and armed helicopters. This concept had the additional plus of putting a certain portion of close air support under Army control, and the Army had continually sought to acquire more control over close air support.⁶

From its inception as a separate service through 1965 the Air Force predilection was for multi-purpose fighter aircraft. As defense planners began in the late 1950s and early 1960s to reappraise the need to build up general purpose forces, the Air Force examined its requirements for future fighter aircraft. In 1960 the Air Force was developing the requirements for operational aircraft to enter the inventory in the mid-1960s. One idea under consideration was a short takeoff and landing (STOL) aircraft or a variation thereof, the vertical takeoff and landing (VTOL) aircraft. These were to be multipurpose aircraft but the future depended upon the development of new engine technology and techniques and new materials.⁷ In 1960 the Air Force also developed a specific operational requirement (SOR) for an advanced fighter aircraft to perform air superiority, strike, and reconnaissance aircraft.⁸ In June 1961 Secretary of Defense McNamara authorized the Air Force to develop a new "air superiority" aircraft to be used by both the Air Force and the Navy. A revised SOR was prepared for an Armed Forces Fighter Aircraft. The new requirement called for a basic tactical fighter design as specified in the 1960 SOR and added two versions: a long range interceptor and a naval fighter.⁹ In the concept development phase this aircraft was known as the TFX. An Air Force fighter, the F-111, would be developed and be placed in the

* In 1960 close air support was defined as: Air strike and reconnaissance operations to supplement and enhance friendly ground force firepower area maneuver in consonance with mission objectives, a form of support provided specifically by air forces.

inventory as the result of this requirement.

At the same time that Secretary McNamara authorized the Air Force to develop a new “air superiority” aircraft to be used by both services, he also authorized the Navy “to develop a new close support aircraft to be used, when required, by both the Air Force and the Navy to replace the F-105 and the A-4D.” To provide effective close air support for the Army and the Marines, he concluded, “the Air Force and the Navy must utilize aircraft design for this purpose” in that aircraft “optimized for ‘air superiority’ missions are not fully effective in the air support role.”¹⁰ Subsequently, the Navy recommended the development of a visual light-attack (VAL) aircraft and in 1963 secured approval from the Secretary of Defense. This VAL would become the A-7 Corsair II.^{11*}



The A-7D began its testing program at Edwards on 14 September 1968. This vehicle carried more ordnance than the B-17 of WWII.

Initially the Air Force expressed little interest in the Navy close air support aircraft. Such a vehicle would be subsonic, have a long loiter time, and carry a large conventional bomb load. The Air Force preferred a high performance aircraft that could carry out air superiority and interdiction missions. In short, it wanted the TFX which fitted existing Air Force doctrine as to roles and missions.¹² Experience in Vietnam caused the Air Force to moderate its views. In order to meet the need of ground force operations the Air Force had to resort to using piston-driven attack airplanes in a close support role and in special air warfare (SAW) operations. Examples of these aircraft were the A-1E Skyraider, used for close air support, and the B-26K and armed T-28, used in SAW operations.

By the fall of 1964 the Department of the Air Force recognized that a replacement for the A-1E aircraft was needed as it could not be indefinitely supply from Navy resources.¹³ At the direction of the Air Staff in September and October 1964, the Air Force systems Command (AFSC) undertook studies on Light Ground Attack (LGA) aircraft. The AFSC instructed its Aeronautical Systems Division (ASD) and Research and Technology Division (RTD) to perform the studies. The first effort explored the feasibility of developing an optimum aircraft for the upper range of counterinsurgency ground attack mission and one which would have potential for limited war. The second study included a review of existing aircraft to determine whether or not any of them

* This aircraft was a variant of the Navy F-8 Crusader.

could be modified to meet desired performance levels. It also contained preliminary designs of new aircraft for development that could meet performance and schedule requirements.¹⁴

In December 1964 Secretary of the Air Force Eugene M. Zuckert requested \$50 million for expansion and modernization of Air Force SAW strike and reconnaissance forces. In his response of 7 January 1965, Secretary of Defense McNamara encouraged the Air Force to conduct tests and studies to “define an aircraft optimized for close support, having general capability in the ground attack role, and useful in SAWF [special air warfare forces], with the additional proviso that this aircraft be acceptable for the tactical fighter forces.” Secretary McNamara was unwilling to approve the reprogramming and funding levels



A-1E Skyraider with M116 fire bombs and MK-64 general purpose bombs.

wanted by the Air Force. He considered “the need for such an aircraft so important,” however, that he included \$10 million RDT&E (research, development, test and evaluation) funds in the Fiscal Year (FY) 1966 budget request “to initiate necessary engineering modifications to an existing production aircraft for the close air support/SAW requirements.” Furthermore, Secretary McNamara requested the Air Force to examine “the considerations of capability, cost, and technical characteristics of aircraft that can effectively and efficiently be utilized for close fire support of ground troop operations and other ground attack roles.” Use of such aircraft in appropriate contingencies from counterinsurgency through major conflicts was to be considered with an underlying assumption that air cover would be available in all cases. Technical characteristics for suitable close air support aircraft were to be established disregarding consideration “such as force composition doctrine, political constraints, postulated rules of engagement or roles and missions...”¹⁵

Secretary McNamara believed the Air Force had prematurely eliminated the F-5, A-6, and A-7 aircraft as candidates. For the near term through 1970 the Air Force would be limited to existing production aircraft such as the A-7, the A-6, the F-5, or simple modifications to one of them. The Secretary of Defense also wanted the Air Force to consider the long term as well, and in its examination of close support requirements to formulate “recommendations for a follow-on development in terms of characteristics and performance objectives and timing...”¹⁶

At this same time the Army was taking steps which the Air Force considered a more serious challenge than previous Army questioning of Air Force capabilities to provide close air support. The Army proposed to develop an advanced aerial fire support system (AAFSS). With the increase of organic aircraft available to the airmobile units, it was only natural that Army commanders would utilize some of the aircraft as aerial fire support platforms. Armed escort helicopters provided protection to the transport helicopters and they could also be used to give close air support to the ground troops. Both uses intruded into the tactical close air support role of the Air Force. In 1965, however, available helicopters did not provide the Army with what it considered to be the optimum vehicle for accomplishing the two tasks. On 19 February of that year the Army let program definition phase contracts for advanced aerial fire support system to have a speed exceeding 200 knots. This AAFSS was envisioned as an armed helicopter since the Army was precluded from using or developing heavy, fixed-wing aircraft.¹⁷ The buildup of general purpose forces in the early 1960s to enable the U.S. to meet the challenge of limited war as well as general war, that is, the ability for a flexible response, and the concomitant development of the airmobile Army units had brought the issue of close air support into focus.

Up through 1965, then, the Air Force had resisted developing an aircraft specifically designed for the close air support role. The preference was for a multipurpose tactical fighter having the versatility to perform all aspects of tactical air operations: air superiority, interdiction, reconnaissance, and close air support. In short, the Air Force wanted an aircraft more suited to a general war than to a limited or counterinsurgency-type conflict like that which developed in Southeast Asia in the 1960s. Given the air superiority that U.S. forces enjoyed in the areas where ground forces operated, such as in Southeast Asia, the Secretary of Defense and other DoD officials believed that a relatively low cost close support aircraft would perform the mission better than a multipurpose aircraft and would be more cost effective. The Air Force had been forced, in Southeast Asia, to find older, subsonic aircraft to perform close support and special air war operations. At the same time, the Army had begun an expansion of its organic air forces in support of new concepts of air mobility. Also, the Navy had under development a new attack aircraft, the A-7. In 1965 the Air Force out of necessity and to insure that its tactical air roles and mission was not diminished, was forced to reappraise its aircraft needs for close support and SAW. As a result, the Air Force was forced to take two measures. It had to find an existing production aircraft to meet its interim, near-term needs, and, more importantly, the Air Force had to consider the development of a new aircraft designed to meet close support requirements of the ground forces.

The A-7, An Interim CAS Aircraft

The Air Force had been conducting a broad study of the tactical fighter force mix since August 1964. There was a reluctance, however, to consider the development of a close air support aircraft: that lacked some air-to-air capability for inclusion into the force.¹⁸ In a status report of 2 February 1965 on the close support and SAW aircraft study requested by Secretary McNamara, Secretary Zuckert stated that:

Any decision as to the utility of various types and quantities of close support aircraft in other than the SAW role will necessarily depend on consideration of the factors included in this broader study. For example, as you have implied in your memorandum, it is

*necessary that our forces be adequate to insure air superiority in all circumstances.*¹⁹

As already noted, Secretary McNamara had predicted the use of such an aircraft on the assumption of air superiority. In line with his instructions and the previous Light Ground attack aircraft studies of late 1964, Mr. Zuckert informed the Secretary of Defense that the Air Force had narrowed the candidate close support/SAW aircraft to the F-4, stripped, the F-5, the A-6 stripped, and the A-7.²⁰ A final evaluation would require a reconciliation with the findings and conclusions of the broader Air Staff effort.

The Air Staff study on the tactical force structure was completed on 1 March 1965. This study, "Force Options for Tactical Air," recommended acquisition of a mixed force of tactical aircraft to include the high cost F-111s and F-4s and less expensive tactical fighters. This mixed



A-7D during aerial refueling, 19 December 1969.

force would be more cost effective for limited war contingencies than one having only F-111s and F-4s.²¹ In a meeting on 12 March between Dr. Harold Brown, Director of Defense Research and Engineering (DDR&E), and members of the Air Staff to discuss the study, Dr. Brown strongly favored the recommendation. He believed that it might be necessary to make an early decision to

introduce a low cost aircraft into the force and that the choice was between the A-7 and an improved F-5.²²

The Air Force position was that the procurement of the A-7 or F-5 aircraft would only an interim measure. The two aircraft were the most suitable of those available, but they did not possess the optimum attributes of the desired lower cost tactical fighter, that is, "optimized for close support, have general capabilities in the ground attack role, be useful in SAWF, and acceptable for the tactical fighter forces." Additionally, the aircraft needed the "capability to survive air-to-air defense as well as ground defenses..." This point was considered critical to the selection process.²³ Although optimized for close support, the other desired attributes supported procurement of a multipurpose fighter. This support followed Air Force thinking that a fighter should be able to perform, to some degree, all tactical missions.

The Air Force choice for the interim lower cost tactical fighter of the improved F-5 with

its air-to-air capability underscored this thinking. On 16 March 1965 Secretary of the Air Force Zuckert forwarded to the Secretary of Defense the Air Force recommendation for the procurement of two wings of F-5 aircraft (improved version) as an addition to the approved force. For the long term, Secretary Zuckert directed the Air Staff to proceed with the definition of the optimum tactical fighter as defined above. He anticipated source selection in 1966 with an initial operational capability (IOC) in 1969.²⁴

In April 1965 the Director of Defense Research and Engineering accepted the Air Force choice of the F-5 aircraft and authorized development of the F-X. The F-X aircraft was to be a lower cost multipurpose fighter, not a specialized CAS aircraft. The F-5, however, was not destined to be procured. During the summer and fall of 1965, the Air Force and the Office of Secretary of Defense (OSD) conducted a joint study on the cost effectiveness of alternative aircraft to meet Air Force needs and Army requirements. As a result, in November 1965 the Air Force recommended acquisition of the A-7D aircraft a modification of the existing Navy A-7. The A-7D was expected to be low cost and quickly obtainable. It was to be a general purpose light attack aircraft capable of close support, interdiction, and fairly deep penetration of enemy territory. In December 1965 the Secretary of Defense authorized the Air Force to acquire the A-7D.²⁵

Army Armed Helicopters

While the Air Force and OSD were agreeing on the A-7D aircraft, the Army moved forward with its plans for armed helicopters. In June 1965 the Army received approval for the Air Cavalry Division which required expanded aviation requirements, chiefly the employment of helicopters. In September 1965 Secretary McNamara in a memorandum to the Secretary of the Air Force supported the development of antitank and other medium armament for Army helicopters. He believed that any aircraft which might operate in battle should be armed for self-defense and, when appropriate to its mission, contribute to U.S. battle success.²⁶

Beginning in September 1965 the Air Force entered into a series of informal understandings with OSD that placed restrictions on its acquisition and use of helicopters. These understandings culminated in an agreement between the Army and the Air Force Chiefs of Staff in April 1966 which recognized the Army's claim in the area of helicopter capabilities and the Air Force's claim for fixed-wing tactical airlift aircraft. The Air Force gave up claims for helicopters used for intra-theater movement, fire support, and resupply of Army forces, and the Army agreed to transfer its fixed-wing tactical airlift aircraft to the Air Force.²⁷

In June 1966 General John P. McConnell reacted to the growing of armed helicopters in Vietnam and to the increased Army spending for Cobra helicopter gunships (UH-1Hs) by directing that a study of close air support be undertaken. He wanted to know what aspects of Air Force close air support were unsatisfactory to the Army and what should be done to acquire the equipment to meet deficiencies. The study was completed on 14 August 1966 and concluded that the available evidence indicated Army satisfaction with called-for Air Force CAS, but that "the Army was withholding some categories of close air support for fulfillment by organic Army aerial vehicles." Furthermore, Air Force aircraft lacked the "capabilities to perform the helicopter escort and suppressive fire roles."²⁸ To fill the gap the Army used armed helicopters. The study recommended among other things that in order to meet the needs for the period of the 1970s

and beyond, the Air Force needed to take action to acquire a specialized close air support aircraft. It had to be simpler and less expensive than the A-7, and have equal or better characteristics than the A-1.²⁹

On 8 September 1966 General McConnell directed that “the Air Force take immediate and positive action to obtain a specialized close air support aircraft specifically designed for the lower spectrum of the close air support mission in low order conflict.”³⁰

NOTES

1. Memo, Memorandum for Commander, Aeronautical Systems Division, Air Force Systems Command, from Robert C. Seamans, Jr., [Secretary of the Air Force], subj: Source Selection Decision for the Competitive Prototype Phase of the A-X Program, 22 Dec 1970 (Doc 1).
2. AF Form 71, Requirements Action Directive (RAD), Maj Gen Kenneth C. Dempster, Dir of Opnl Regs & Dev Plans, DCS/R&D, HQ USAF, to AFSC, subj: Requirement for a Specialized Close Air Support Aircraft (A-X), RAD 7-69-(1), 22 Dec 66 (Doc 2); AFSC Form 56, AFSC Program Direction, subj: Specialized Close Air Support Aircraft (A-X), No. 7990-5-67-87, 18 Jan 67 (Doc 3).
3. For additional background on the interservice disagreement and the Air Force emphasis on this strategic role, see the following: Robert Frank Futrell, *Ideas, Concepts, Doctrine: A History of Basic Thinking in the United States Air Force, 1907-1964* (Air University, Maxwell AFB, Alabama, 1971) [hereinafter cited as Futrell, *Ideas, Concepts, Doctrine*], RAND Rept, Alfred Goldberg and Lt Col Donald Smith "Army-Air Force Relations: The Close Air Support Issue," R-906-PR, Oct 71, pp 1-17 [hereinafter cited as RAND Rept, Goldberg and Smith, "The Close Air Support Issue"].
4. Futrell, *Ideas, Concepts, Doctrine*, pp. 398-416; RAND Rept, Goldberg and Smith, "The Close Air Support Issue," pp 17-31.
5. Futrell, *Ideas, Concepts, Doctrine*, pp 414-416; RAND Rept, "The Close Air Support Issue (U)," pp 21-27.
6. Futrell, *Ideas, Concepts, Doctrine*, pp 406-411; RAND Rept, "The Close Air Support Issue," pp 2-4, 9-13, 17-19.
7. System Development Requirement, SDR for Short Take-Off and Landing (STOL) Fighter System, SDR No. 17, 5 Feb 60 (Doc 4); Futrell, *Ideas, Concepts, Doctrine*, pp. 265, 439.
8. SOR, Specific Operational Requirement for an Armed Forces Fighter Aircraft, SOR No. 183 (14 June 60, Prelim Rev, 8 Sep 61, in files, Office of Hist, Hq AFSC.
9. *Ibid.*; Memo, Memorandum for the Secretaries of the Navy, the Army, the Air Force from Secretary of Defense Robert S. McNamara, subj: [Close Air Support and Air Superiority Aircraft], 7 June 61 (Doc 5).
10. Memo, Memo for Secs of the Navy, the Army, the Air Force from SECDEF McNamara, subj: Close Air Support and Air Superiority Aircraft, 7 Jun 61, (Doc 5)
11. Futrell, *Ideas, Concepts, Doctrine*, pp 379-380.
12. *Ibid.*
13. Memorandum for the Secretary of the Air Force from the Secretary of Defense, subj: Close Support and SAW Aircraft, 7 Jan 65 (Doc 6).
14. History of the Aeronautical Systems Division, Jan-Dec 65, I-A, pp 127-129 [hereinafter cited as Hist of ASD]. The second study provided 33 different versions of new and modified aircraft for consideration.
15. Memo for SECAF from SECDEF, subj: Close Support and SAW Aircraft, 7 Jan 65 (Doc 6).
16. *Ibid.*
17. Futrell, *Ideas, Concepts, Doctrine*, p 415.
18. For additional discussion see Rept, Jacob Neufeld, *The F-15 Eagle: Origins and Development, 1964-1967*, Nov 74, pp. 6-10 [Hereinafter cited as Rept, Neufeld, *The F-15 Eagle*].
19. Memorandum for the Secretary of Defense from the Secretary of the Air Force Eugene M. Zuckert, subj: Close Support and SAW Aircraft, 2 Feb 65, w/atrch: Project Outline (Doc 7).
20. *Ibid.*
21. Memo, Memorandum for the Secretary of Defense from the SECAF, subj: Hq USAF Study on "Force Options for Tactical Air," 16 Mar 65 (Doc 8).
22. Ltr, Maj Gen A.J. Kinney, Asst DCS/R&D (AFRDC), HQ USAF, to Gen (W.H.) Blanchard, AFCVC [VCS USAF], subj: Meeting with Dr. Brown Re Tactical Air Options, 12 Mar 65 (Doc 9).
23. Ltr, Gen John P. McConnell, CSAF USAF (AFCCS), to Secretary of the Air Force (OS), subj: Hq USAF Study on "Force Options for Tactical Air," 15 Mar 65 (Doc 10).
24. Memo, Memo for SECDEF from SECAF, subj: Hq USAF Study on "Force Options for Tactical Air (U)," 15 Mar 65 (Doc 8).
25. RAND Rept, Goldberg and Smith, "The Close Support Issue," pp 30-31. Changes in the configuration of the A-7D resulted in an increase in the unit cost price from the original \$1.5 million to approximately \$3.4 million by 1971 and a delay of over 2 years in the IOC. For a more detailed discussion of the decision to pick the A-7D and proceed with the F-X, see Rept, Neufeld, *The F-15 Eagle*, pp 8-15.

26. RAND Rept, Goldberg and Smith, "The Close Support Issue," pp 28-29.
27. *Ibid.*, pp. 29-30.
28. From the conclusions of the study as cited in RAND Rept, Goldberg and Smith, "The Close Support Issue," p 33.
29. *Ibid.*, pp 31-32; RAD 7-69-(1), subj: Requirement for a Specialized Close Air Support Aircraft (A-X), 22 Dec 66 (Doc 2).
30. RAD 7-69-(1), subj: Requirement for a Specialized Close Air Support Aircraft (A-X), 22 Dec 66 (Doc 2).

Chapter 2: PRELIMINARY CONCEPT FORMULATION

A-X Design Guidelines

In December 1966 the Air Staff directed Air Force Systems Command (AFSC) to prepare a Concept Formulation Package (CFP) and a Preliminary Technical Development Plan (PTDP) for the specialized close air support aircraft designated the A-X. The urgent need for the aircraft dictated “maximum employment of state-of-the-art technology in its design” and this would allow compression of the conceptual phase as exemplified by concurrent preparation of the CFP and PTDP. The Air Force wanted the earliest possible Office of Secretary of Defense (OSD) approval to initiate the Contractor Definition Phase (CDP).¹

The Requirements Action Directive (RAD), issued 22 December 1966, reiterated the recommendation of the August 1966 study and called for an A-X “simpler and cheaper than the A-7, but with close air support mission capabilities equal to or better than the A-1.” It was to be devoted to close support missions to include close air support of ground units, escort of helicopters and low performance aircraft, and protection of airmobile landing forces, surface assault forces, and troop and vehicle columns as well as armed reconnaissance.² These missions, especially the escort and the protection of airmobile landing forces, were obviously aimed at filling the identified close air support gap that the Army supplied with armed helicopters. The A-X was to be the first United States Air Force designed aircraft lacking the multipurpose capabilities of tactical fighters to enter the force structure since World War II.

The A-X was to be a one-man, lightweight aircraft with a desirable gross weight of 22,500 pounds, but an allowable maximum weight of 30,000 pounds. It needed to carry a large payload of mixed ordnance and to deliver it accurately: 8,000 pounds desired, 6,000 pounds required, and have “sufficient range and loiter time to carry a maximum payload at low altitude from a Main Operating Base (MOB) to a forward area, loiter on station, conduct armed reconnaissance or perform a close air support mission.” A combat radius of 250 NM (nautical miles) and a loiter time of 2 hours were required. The required normal cruise speed was 250 KIAS (knots indicated air speed) with 200 KIAS desired and a required ferry range of 2,600 NM.³

Maneuverability was to be stressed with emphasis on agility in attack and reattack maneuvering at low speed. The desired minimum maneuvering speed at 5,000 feet was 120 KIAS with 150 KIAS required and a combat weight turn radius of 1,000 feet was desired with 2,000 feet required. Along with maneuverability, the A-X required stability throughout a weapon release speed range from 200 to 400 KIAS. Design speed limit speed at sea level (S.L.) with maximum external ordnance was to be 450 KIAS with 550 KIAS desired.⁴

Survivability, like maneuverability, was an essential characteristic for the A-X. This essentiality was necessitated by the likelihood of a hostile ground fire environment during the close air support missions. Structural and systems design were to be oriented toward inherent survivability, taking into consideration the environment and the desired performance and cost. Where needed armor to protect the pilot and components was to “be capable of defeating 14.5mm (millimeter) projectiles at 40° obliquity at 500 feet range.” Internal fuel tanks were to be self-sealing and, if power flight controls were employed, the aircraft would need a manual backup flight control system.⁵

To achieve an early initial operational capability (IOC) an existing state-of-the-art engine,

the type and number required to be determined by analysis of trade-offs between performance, costs, survivability, and maintainability, was to be employed. Avionics communications, navigation, and weapons delivery systems were to be adequate for the CAS mission and also to consist of state-of-the-art equipment. Communications equipment was to have range adequate for the low-altitude mission and be compatible with the Tactical Air Direction System, Forward Air Control (FAC) equipment, and Army airborne vehicles. Navigation equipment should be capable of night and adverse weather navigation from the Main Operating Base (MOB) to the target area, over-water on a maximum-range ferry flight, and in the CONUS (continental United States) airways using conventional radio-navigation facilities. The desired weapons delivery system should provide delivery accuracies, for weapons delivery accuracies, for weapons delivered in the dive mode, of 10 mils CEP. This system required as a minimum a depressible-reticle fixed optical sight, and, if feasible with cost, availability, reliability, and accuracy, a slant-ranging device and an automatic weapon release system.⁶

The A-X was to be equipped with fixed internally-mounted guns with a destructive “capability equal to or better than four M-39 20mm guns.” The directive added that provisions for incorporation of a large caliber semiautomatic recoilless rifle be considered. A minimum of six ordnance stations were required, in addition to fuel stations, to carry and deliver all the types of conventional ordnance needed for the CAS mission as projected for use in the 1970-1985 time period. Although the scenario called for the A-X to operate in a permissive environment (air superiority provided), the preparers of the CFP were to consider the “feasibility of incorporating a limited air-to-air missile capability as a defensive measure.”⁷

The primary design objectives of the Air Force were “to minimize the total system cost and aircraft attrition, and maximize target destruction on the specified missions...” Through use of state-of-the-art technology, design that emphasized maneuverability and survivability, and the capability to deliver a large payload of ordnance for the CAS mission, it was believed that the A-X was the best aircraft for the long-term close support mission. Furthermore, the aircraft was to “incorporate qualitative maintainability characteristics which will make it possible for this system to meet its combat operational objectives with a minimum of maintenance effort and expenditure.” Based on contractor and AFSC estimates and studies, the Air Force estimated a unit flyaway cost for the A-X of \$1,000,000 to \$1,200,000 depending on numbers purchased. Research and development costs were estimated to be \$240 million.⁸

Preliminary Design

The Air Force Systems Command assigned management responsibility for the A-X to the Aeronautical Systems Division (ASD), Wright-Patterson Air Force Base, Ohio.⁹ At ASD the F-X System Program Office (SPO), established in August 1966 within the Deputy for Advanced Systems Planning, was assigned supervision of the A-X planning activities.¹⁰ On 18 January 1967 AFSC directed ASD to perform a study and analysis of the A-X proposal and provide data contributing to the Concept Formulation Package (CFP).¹¹ Simultaneously, a request for proposal (RFP) to industry for system studies was prepared but withheld from distribution by the Director of Defense Research and Engineering (DDR&E) until 6 March 1967. Contract proposals were to be received by 3 April 1967. On 1 May 1967 the final selection and award of contracts to four contractors occurred. The four were: McDonnell-Douglas, St. Louis, Missouri; Northrop Corporation (Norair), Hawthorne, California; Grumman, Bethpage, Long Island, New York; and General Dynamics (Convair), San Diego, California. Studies from the contractors, due 1 September 1967, were to

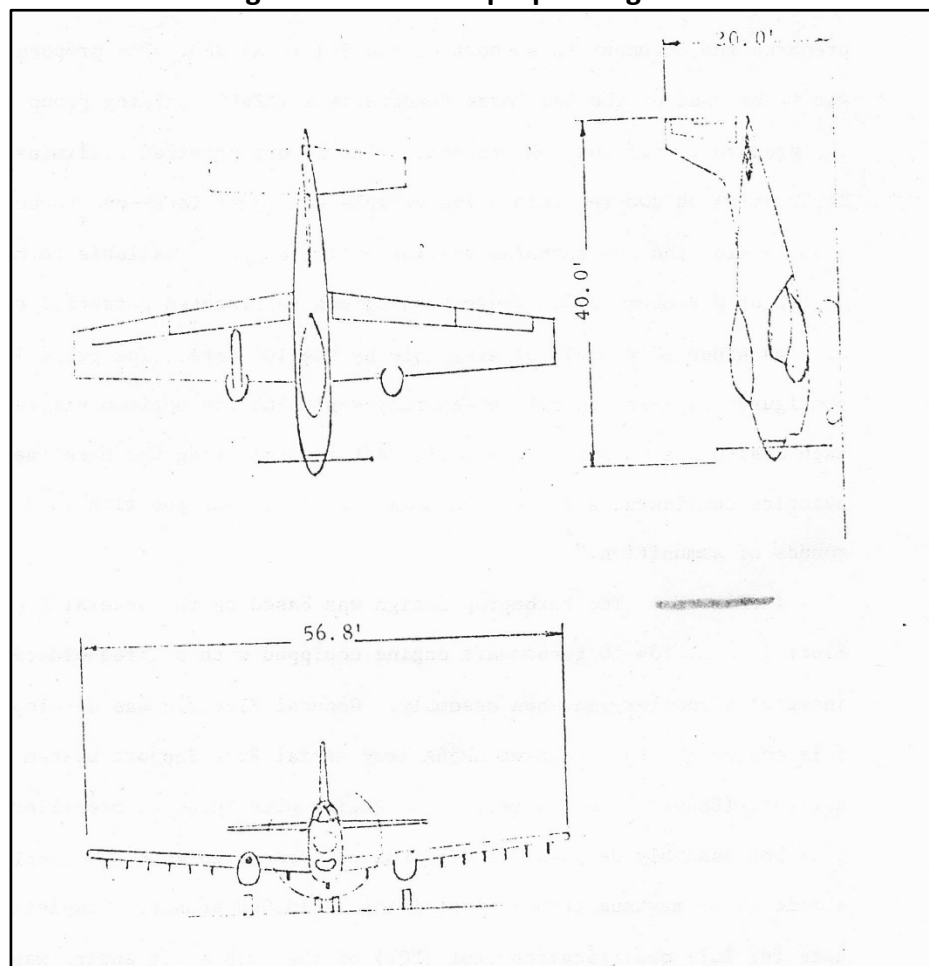
include point designs, supporting data, and detailed development plans. These reports would contribute to the preparation of an Air Force CFP and PTDP.¹²

Prior to the selection of the contractors, on 19 April 1967 Colonel Robert P. Daly, Director, F-X SPO, forwarded a preliminary AFRDQ (Directorate of Operational Requirements and Development Plans, Deputy Chief of Staff/Research and Development at Air Force Headquarters) A-X proposal to Command Headquarters. The Deputy for Studies and Analyses, Systems Engineering Group, Research and Technology Division (RTD), located at Wright-Patterson Air Force Base, had prepared the document in support of the F-X (A-X) SPO. The proposal was to be used by the Air Force Headquarters (AFRDQ) working group in its preparation of the A-X proposal. The report provided preliminary information on two representative vehicle configurations one turbo-prop version and one turboprop version – using engines available to meet an IOC of December 1970. These two engines represented potential candidates since they would be available by the IOC date. The preliminary configuration A-Xs did not necessarily represent the optimum aircraft. Each design was “a single plane aircraft incorporating the baseline avionics complement and a single 30mm modified M-61 gun with 1000 rounds of ammunition.”¹³

The turboprop design was based on the General Electric (GE) T64-16 turboshaft engine equipped with a three-bladed integral propeller-gear box assembly. General Electric was developing this

engine for the Lockheed AH56A Army Aerial Fire Support System aircraft (Cheyenne helicopter). The engine plus integral propeller-gear box assembly weighed 1,600 pounds and was rated at a sea level static (SLS) maximum thrust (installed) of 10,080 pounds. Completion date for full qualification test (FQT) of the turboshaft engine was to be March 1968, and production delivery required a lead time of 18 months. As shown in the three-view drawing in Diagram 1, to avoid firing

Diagram 1: A-X Turboprop Configuration



Source: AFRDQ A-X Proposal (X/XGDS-UNO), p 6.

through the propeller necessitated “a somewhat undesirable outboard location” of the single internal gun but no major problems were expected. The airplane design characteristics were as presented in Table 1 with the weight breakdown as shown in Table 2.¹⁴

According to existing information, an aircraft to perform the A-X role would require engine sizes in the thrust range of 3,000 to 14,000 pounds, or 1,100 to 4,800 horsepower for turboprops. The lower number represented the minimum size for a twin-engine aircraft and the higher figure represented the maximum size for a single engine aircraft based on the desired gross weights and thrust loadings of the vehicle. To meet the proposed IOC date meant that only production engines or those requiring only moderate development could be considered. If the Air Force delayed the IOC or wanted growth potential, then engines requiring major development could be considered.¹⁵

Design for the turbofan configuration was predicted on the General Electric CF700-2C engine. The study group picked this engine because “it was the only turbofan type available in the thrust class of interest for a twin engine configuration” to meet the IOC date. This engine was an aft fan version of the CJ610/J86 turbojet engine. The CF700 powered the twin-engine Fan Jet Falcon (Dassault Mystere 20). It had a Federal Aviation Administration (FAA) certification and the Air Force had given it a military designation, the TF-37. Lack of military applications for the engine caused the Air Force to terminate testing after completion of the 150-hour sea level test cell requirements. The engine weighed 725 pounds and SLS maximum thrust was 3,800 pounds (installed). By agreement with the Air Force, General Electric would complete testing at Government facilities upon request.

Table 1: A-X TURBOPROP CONFIGURATION DATA		
WEIGHTS		
	Gross Weight – Lbs.	27,700
	Weight Empty – Lbs.	14,260
	Combat Weight – Lbs.	25,800
GEOMETRY		
	Wing Area – Ft. ²	462
	Wing Span – Ft.	56.9
	Aspect Ratio	7
	Overall Length – Ft.	40.0
	Wing Loading (W/S)	60
PROPULSION		
	Engine	T64-16
	Number	1
	SLS Maximum Thrust (Installed) – Lbs.	10,000
	Type	Turboprop
	Installed Thrust-To-Weight (T/W)	.364
<i>Source: AFRDQ, A-X Proposal, p 8.</i>		

Table 2: A-X TURBOPROP GROUP WEIGHT STATEMENT		
Structural Components		8940
Wing	3730	
Tails	805	
Body	2360	
Alighting gear	1035	
Surface Controls	560	
Nacelles	450	
Propulsion Group		2950
Engine	700	
Prop & gear box	900	
Fuel System	870	
Controls, lube, etc.	480	
Fixed Equipment		2390
Furnishings & Equip.	250	
Electrical	500	
Electronics	570	
Hydraulics	140	
Instruments & Nav.	110	
Armament	550	
Other (Air Cond. & A.I.)	270	
Useful Load		13,420
Crew	215	
Oil, trapped fuel, etc.	200	
Gun & Ammo	1560	
Fuel	4785	
Payload	5810	
Payload Prov.	850	
Weight Empty		14,280
Gross Weight		27,700
<i>Source: AFRDQ, A-X Proposal, p 9.</i>		

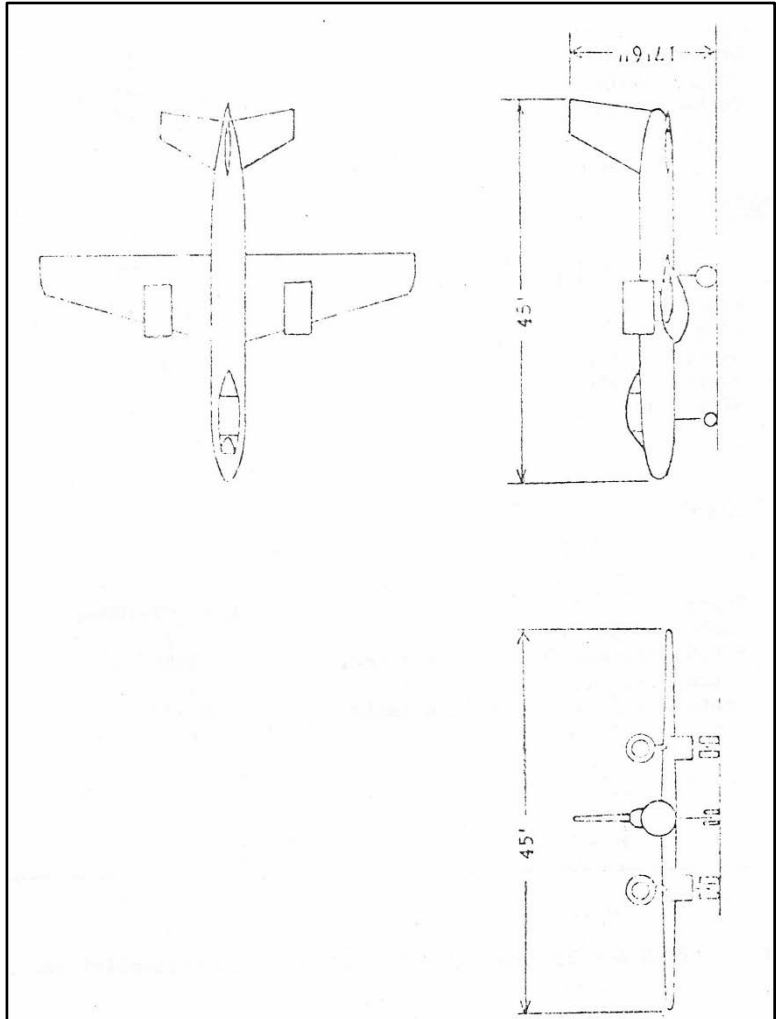
Lead time for first production delivery of the engine after go-ahead would be 15 months for the A-X. A high SFC (specific fuel consumption) and the low thrust level provided by the engine compromised the turbofan configuration, and the proposal presented limited data on this design because of its “unattractive performance.” As shown in the three-view drawing in Diagram 2, the turbofan engines were mounted on top of the wings. This placement helped to shield the engine

from ground fire and to block the engine infrared (IR) signature from the ground. Design characteristics for the airplane were as presented in Table 3 with the weight breakdown as indicated in Table 4.¹⁶

To select the avionics complement for the A-X the planners first developed a baseline technology package using state-of-the-art equipment and those undergoing final test stages. Enhancements to the baseline or “add-on” groups to improve weapon delivery accuracy, additional or better weaponry, and night and all-weather capability were also considered. An avionics package to meet the minimum mission requirements was determined to be as listed in Table 5. These avionics provided an adequate capability to perform close air support, escort of helicopters and low performance aircraft, and protection of airmobile and surface forces. They gave a bare minimum capability for armed reconnaissance in the immediate battlefield area.

Three add-on avionics packages, as described in Table 6,* would provide enhancement to mission performance in various ways.

Diagram 2: Conceptual Drawing of the Turbofan Aircraft



Source: AFRDQ A-X Proposal, p. 11.

Table 3: A-X TURBOFAN CONFIGURATION DATA		
WEIGHTS		
Gross Weight	28,000	Lbs.
Weight Empty	13,500	Lbs.
Combat Weight	25,500	Lbs.

* Table 6 has a “skeleton” avionics package which the planning group believed to be inadequate in that the pilot would lack the ability in bad weather or at night to navigate from one map location to another. Range information for more accurate weapon delivery was also required.

GEOMETRY		
Wing Area	333	Ft ²
Wing Span	45	Ft
Aspect Ratio	6.0	
Overall Length	45	Ft
Wing Loading	84	Lbs/Ft ²
PROPULSION		
Engine	G.E. CF-700-2C	
Number of Engines	2	
S.L.S. Maximum Thrust (Installed, tropical day)	3880	Lbs.
Installed Thrust-to-Weight Ratio	0.277	
<i>SOURCE: AFRDQ, A-X Proposal, p 12.</i>		

Table 4: A-X TURBOFAN GROUP WEIGHT STATEMENT		
Structural Components		8200
Wing	3100	
Tail	570	
Body	2300	
Alighting Gear	1050	
Surface Controls	710	
Nacelles	470	
Propulsion Group		2710
Engines (2)	1450	
Fuel System	890	
Other Propulsion Systems	370	
Fixed Equipment		2610
Furnishings & Equipment	250	
Electrical	620	
Electronics	570	
Hydraulics	160	
Instruments & Nav.	180	
Armament	550	
Air Cond. & A.I.	280	
Useful Load		14,480
Crew	215	
Oil, Trapped Fuel, etc.	180	
Gun and Ammo		1260

Fuel	6165	
Payload	5810	
Payload Prov.	850	
Weight Empty		13,520
Gross Weight		28,000
<i>SOURCE: AFRDQ, A-X Proposal, p 13.</i>		

Table 5: Minimum Close Air Support Avionics Package Estimated Weight, Volume, Cost, and Power Input Requirements

Equipment Function	Representative Type	Weight Lbs.	Vol Cu. Ft.	Cost (in \$)	Power (in watts)
VHF/FM (with Homer)	ARC-114	20	0.4	2500	50
UHF/AM	ARC-109	43	0.5	8400	350
IFF (A-G)	APX-72	20	0.3	4000	65
Voice Scrambler		3.5	0.1	7000	---
Intercom	AIC-18	7	0.1	1050	10
TACAN	ARN-74	30	0.3	20800	130
UHF/ADF		17	0.4	1400	55
Doppler Nav	APN-153	53	0.6	14000	45
Radio Altimeter	AN-141	20	0.3	4000	120
ILS	ARN-58	24	0.3	2030	45
Air Data Converter (Computer)		6	0.2	7000	25
Attitude, Heading & Reference		20	0.4	12000	110
S-Band Beacon		6	0.1	2000	50
Continuous-Solution Stabilizing Sight (Depressible Optical Sight)		40	1.0	10000	225
Radar Ranger		30	1.0	20000	150
Gun Camera (2) Maurer 200		20	0.6	1600	
Integrated Armament Control System		*50	0.7	*35000	
TOTALS		440	7.3	\$161,780	1430
<i>*There may be about a two-million dollar RDT&E cost for production development.</i>					
<i>SOURCE: AFRDQ, A-X Proposal, p 59.</i>					

Table 6
Table 6: A-X AVIONICS EQUIPMENT

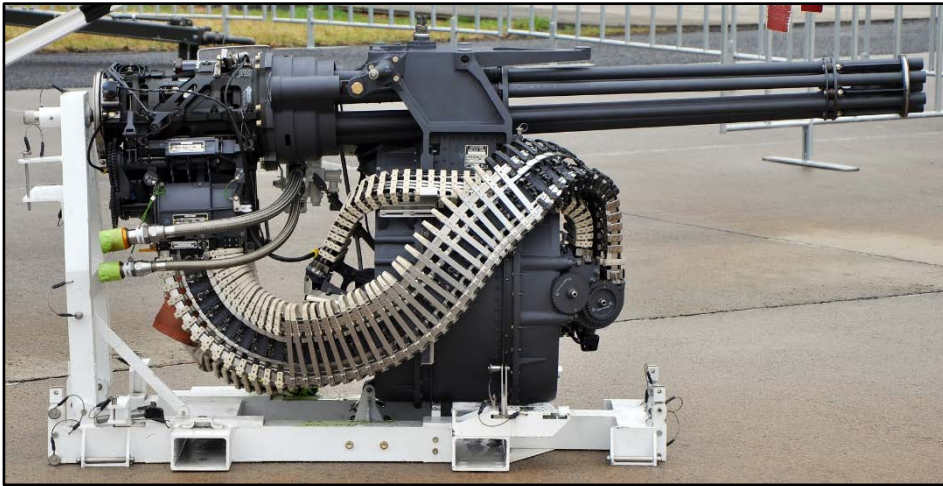
"SKELETON" Below Minimum	"Lean" Minimum	"Lean" Plus 1st Add-On	"Lean" Plus 2d Add-On	"Lean" Plus 3d Add-On Maverick
VHF/FM (With Homer)	Doppler Navigator	Radar Added Functions	MTI to Radar	
UHF/AM (ADF)	Radar Ranger	Terrain Avoidance	Inertial Nav.	
IFF (A-G)	VHF/FM (With Homer)	(Manual)	Night Sight	
Voice Scrambler	UHF/AM (AUF)	PPI Map	(Optical)	
Intercom	IFF (A-G)	Beacon Interrogation		
TACAN	Voice Scrambler			
UHF/ADF	Intercom			
Radio Altimeter	TACAN			
ILS	UHF/ADF			
Air Data Converter	Radio Altimeter			
(Computer)				
Attitude, Heading, Reference	ILS			
S-Band Radar Beacon	Air Data Converter			
	(Computer)			
Continuous-Solution	Altitude, Heading Reference			
Stabilized Sight				
(Depressable Optical Sight)				
Gun Camera (2) Maurer 220	Continuous-Solution			
	Stabilized Sight			
	(Depressable Optical Sight)			
	Gun Camera (2) Maurer 220			
Integrated Armament	Integrated Armament			
Control System	Control System			
COSTS	\$127,780	\$10,000	\$20,000	\$16,000
Accumulative Costs	161,780	171,780	191,780	207,780
Weight (Pounds)	83	20	35	40
Accumulative Weight	367	470	505	545

SOURCE: AFRDQ A-X Proposal, p 66.

The first enhanced the navigational capability of the radar and provided a means of locating

friendly forces and the enemy. A second add-on group increased the ability of the A-X to locate groups of moving vehicles, improved the navigation accuracy, and aided nighttime target acquisition. The final addition gave the A-X an increased strike capability by the provision for the addition of the Maverick missile. If the A-X should become a two-place aircraft, additional avionics such as Low Light Level Television (LLL/TV) and Forward Looking Infrared (FLIR), both of which were in the advanced experimental stages, might be reconsidered. In the development of the baseline avionics package and add-on packages, mission priorities and the added cost in dollars and weight to the baseline aircraft were considered.¹⁷

The Air Force Systems Command's Air Armament Laboratory (AFATL) at Elgin Air Force Base, Florida, provided the information covering weapons and recommended guns and munitions for the A-X in the study. The Laboratory recommended an internal high rate-of-fire gun system and provided two options. Option I called for modification of the M-61 20mm gun rebarreled to fire the Army WECOM (Weapons Command) 30mm round. The WECOM 30mm featured a 3,200-grain combination shaped charge/fragmentation projectile in addition to a fragmentation round.



M61 Vulcan Gatling-style rotary cannon

It was primarily an air-to-ground weapon and its use fit the schedule of the A-X. The dimensions and weight of the gun system were expected to be approximately the same as the M-61. The gun would have 6 barrels, a muzzle velocity of 2,200 feet per second, and a selectable rate-of-fire up to 6,000 rounds

per minute. Weight of a round was one pound.

Option II was for a 25mm gun that would provide an air-to-ground and air-to-air capability; however, the earliest delivery date of a fully-qualified gun system would occur in 1972. The gun was to employ caseless ammunition having a round weight of 0.90 pounds and a projectile weight of 3,000 grains. It was to have a muzzle velocity of 4,000 feet per second and a selectable rate-of-fire up to 6,000 rounds per minute. The gun was to be slightly longer than the M-61 and have a recoil 2.6 times greater than the M-61. The number of barrels was to be determined and the gun system was to weigh approximately 3,000 pounds.¹⁸

In addition to the recommended options for a gun system, the AFATL provided a list of other munitions recommended for employment by the A-X against five types of targets. These were munitions that would be available during the planning operational time period of the aircraft. As in the case of the avionics packages, the planned IOC, cost, and weight of the A-X were limiting factors in considering recommendations for guns and munitions.¹⁹

To meet the December 1970 IOC necessitated an unconventional approach to planning, which was reflected in the compressed A-X planning schedule. Normally, the Contract Definition

phase ran 18 to 21 months, but in the case of the A-X the time available appeared to be only 4 months. The AFSC planners did not believe this to be detrimental with respect to engineering development as the system was considered to be within the existing state-of-the-art. This shortened time period limited the detailed engineering design effort and, therefore, required that adequate data be produced in the Concept Formulation Phase to allow confidence in a compressed Definition Phase. The Definition Phase would be reduced to a competitive source selection of design proposals, which meant that by April 1968 the Air Force would award a development contract to include a productive go-ahead for the total system. Because of the compressed schedule, it would not be possible “to satisfy any fly-before-you buy restraints.”²⁰

The planning schedule also required concurrency of effort among several items such as the wing tunnel test, engineering design, design and fabrication of tooling, and manufacture of aircraft. Significant design changes could adversely affect the other efforts and the IOC. Concurrency also extended to flight testing with Category (I, II, III) testing overlapping although Air Force regulations provided for Category III testing to follow Category II. The flight test program itself was optimistic and provided for only 150 hours of flight time for Category I and 350 hours for Category II. Any major design changes resulting from this testing could affect the program cost and schedule. Experience taught that “Almost without exception, all previous aircraft programs” had “some degree of trouble that has resulted in an increase in cost and time.” The planners cautioned that an unpredictable or unknown factor resulting in a cost and schedule escalation was highly probable and that “a more realistic schedule would be one in which the IOC date is delayed at least 12 months.”²¹

This preliminary study made it clear that the A-X schedule was predicated upon the following assumptions and conditions:

- a. Production go-ahead is included in Phase II go-ahead and not separately or subsequently constrained by achievement of any given design or development milestone.
- b. IOC is interpreted as delivery of first 18 aircraft to operational inventory.
- c. Lead times for engine, propeller, gear box, or other critical items can be compressed through high priority program support.
- d. All participating, review, and approval activities can be accomplished as indicated through application of “extraordinary effort” by responsible organizations.²²

An IOC in December 1970 was achievable following the compressed schedule, but a high degree of risk existed for both schedule achievement and costs if major problems developed in the design effort or the flight test program. Given a minimum of problems, the projected total average unit cost in 1966 dollars for a buy of 400 aircraft was \$0.937 million for the turboprop version and \$1.092 million for the turbofan version. For a 600 buy the figures were \$0.837 million for a turboprop A-X and \$0.989 million for a turbofan A-X.²³

These two preliminary configurations met the general design requirements of a maximum gross weight aircraft of 30,000 pounds with a payload range of 6,000 to 8,000 pounds. Because of the unattractive performance of the available turbofan engines, the Air Force preferred the turboprop; however, neither configurations necessarily represented the optimum aircraft. This initial effort plus additional studies by AFSC and contractors culminated in a Concept Formulation Package (CFP) in March 1968. This CFP representative A-X would differ significantly from the

preliminary configuration in that it would be a twin-engine turboprop having a maximum gross weight of 44,000 pounds and a 16,000-pound payload.²⁴

NOTES

1. AF Form 71, Requirements Action Directive, Maj Gen Kenneth C. Dempster, Dir of Opnl Regs & Dev Plans, DCS/R&D, HQ USAF to AFSC, subj: Requirements for a Specialized Close Air Support Aircraft (A-X), 22 Dec 66, RAD 7-69-(1), p 1 (Doc 2).
2. *Ibid.*, pp 1-2.
3. *Ibid.*, pp 2-3. The combat radius and loiter time was for a low-low-low profile, 5,000-foot altitude, hot day, 6,000 pounds ordnance, 15 minutes ground and taxi time, 15 minutes sea level military power at target, 30 minutes reserve.
4. RAD 7-69-(1), 22 Dec 66, pp. 3-4
5. *Ibid.*
6. *Ibid.*, p 4.
7. *Ibid.*, p 5.
8. *Ibid.*, p 1.
9. *Ibid.*, p 6.
10. Hist, History of the Aeronautical Systems Division, Jan-Dec 66 (U), [Hereinafter cited as Hist of ASD], I, 207; Hist of ASD, Jan 67 – Jun 68 (U), I, 298.
11. AFSC Form 56, AFSC Program Direction, subj: Specialized Close Air Support Aircraft (A-X), No. 7990-5-67-87, 18 Dec 67, (Doc 3)
12. Working Paper, History of Tactical Division, Directorate of Operational Requirements and Development Plans, DCS/R&D, HQ USAF, 1 Jul – 31 Dec 67, in files, Ofc of Hist, Hq AFSC.
13. Ltr, Col Robert P. Daly, Dir, F-X SPO, Dep for Adv Sys Plng, ASD, to AFSC (SCLAP/Maj Kalb), subj: AFRDQ Proposal for the A-X (U), 19 Apr 67, w/atch: SESS Rept, AFRDQ A-X Proposal (U), Apr 67, pp 1-5, located in files, Hq AFSC. [Hereinafter cited as AFRDQ A-X Proposal.] The proposal contained the systems' description, avionics rationale, cost, schedules, candidate engines, vulnerability analysis, and aircraft survivability, analysis as well as a section prepared by the Air Force Armament Laboratory (AFATL), Eglin AFB, Florida, on optimum weapons and delivery conditions.
14. AFRDQ A-X Proposal pp 5, 8, 21.
15. *Ibid.*, pp 36, 41-41. A candidate for major development was the GE TF34-2 to be used on a single-engine turbofan configured aircraft. A variation of this engine, the GE TF34-100, would be used on the twin-engine turbofan design, the A-10.
16. *Ibid.*, pp 5, 35.
17. *Ibid.*, pp 52, 58-65.
18. *Ibid.*, pp 179.
19. *Ibid.*, p 169. See pages 180-182 for a description of the munition types.
20. *Ibid.*, p 161.
21. *Ibid.*, p 162-163.
22. *Ibid.*, p 164.
23. *Ibid.*, p 149, 155.
24. CFP, A-X Concept Formulation Package (U), 1 Mar 68, revised 13 May 68, p IV-7, in files, Ofc of Hist, Hq AFSC.

Chapter 3: FINAL CONCEPT FORMULATION DELAYED

By 1 September 1967 the four contractors had prepared their systems studies and by 1 March 1968 the Working Group, headed by the Air Staff Director of Operational Requirements and Development Plans (AFRDQ), finished the Concept Formulation Package (CFP). The original goal of a December 1970 initial operational capability (IOC) might have been met if the Office of the Secretary of Defense (OSD) had approved this CFP expeditiously and had the Air Force been allowed to award a development contract in April as planned. This was not the case. First, the Air Staff reviewed and revised the CFP. Consequently, the proposed schedule in the revised version of 13 May 1966 provided for IOC to occur at the end of Fiscal Year (FY) 1971 a six month slip. Finally, the review process within the OSD, especially the reservations that the Director of Defense Research and Engineering (DDR&E) expressed, could delay concept approval until FY70 which would result in a further slip in schedule.¹

Concept Formulation Package

In the Concept Formulation Package the Air Force defined the close air support (CAS) mission as having three tasks: close support fire (CSF), armed escort (AE), and armed reconnaissance (AR). Close support fire and armed escort, which differ slightly in function, were the most important of three tasks. The two roles placed similar demands on the CAS aircraft in that on the CAS aircraft in that they dictated positive target acquisition/identification by a Forward Air Controller (FAC) and strict control of gross delivery errors because of the nearness of friendly forces. Most CSF operations took place under daylight visual conditions but by the mid-1970s the Air Force expected a requirement for expansion of such operations at night and in adverse weather. Air Force emphasis, then, centered on an A-X with CSF and AE capabilities. Such an A-X would have an inherent capability for visual and night armed reconnaissance. Development of new tactical air control systems were expected in the near future to improve significantly night and nonvisual weapon delivery in close support fire.²

There were four system characteristics identified as most important for effective performance of the CAS task. The CAS aircraft needed to be responsive, lethal, survivable, and simple. Speed was not the determinant of responsiveness. Instead, forward area basing from an austere facility or an adequate loiter capability to allow airborne aircraft in the battle area to answer calls for immediate air support was most important. ACAS aircraft having both a forward basing capability and good loiter capability was even more preferable. Onboard equipment to interface with both the Army and the Air Force command, control, and communications (C³) systems was also needed. To achieve lethality the CAS aircraft required the ability to carry a varied payload of bombs and rockets in addition to guided weapons and guns. The CFP study found that, against armored personnel carriers, tanks, and personnel targets, a new large-caliber high-velocity, high-rate-of-fire gun would be especially effective.³

Survivability of the close air support aircraft depended on its ability to survive the predicted threat environment. Ground fire particularly from small arms and machine guns (7.62mm to 14.5mm) and from 23mm antiaircraft artillery (37mm and 57mm in division areas), was considered to be the primary threat. The majority of missions against Soviet-type ground forces could also expect to encounter enemy REDEYE-type missile defenses and possibly surface-to-air missiles (SAMs). To reduce attrition during dive recovery, escape, and evasion, an aircraft "should have capability for maximum structural limit load factors of 6g or more, plus capability

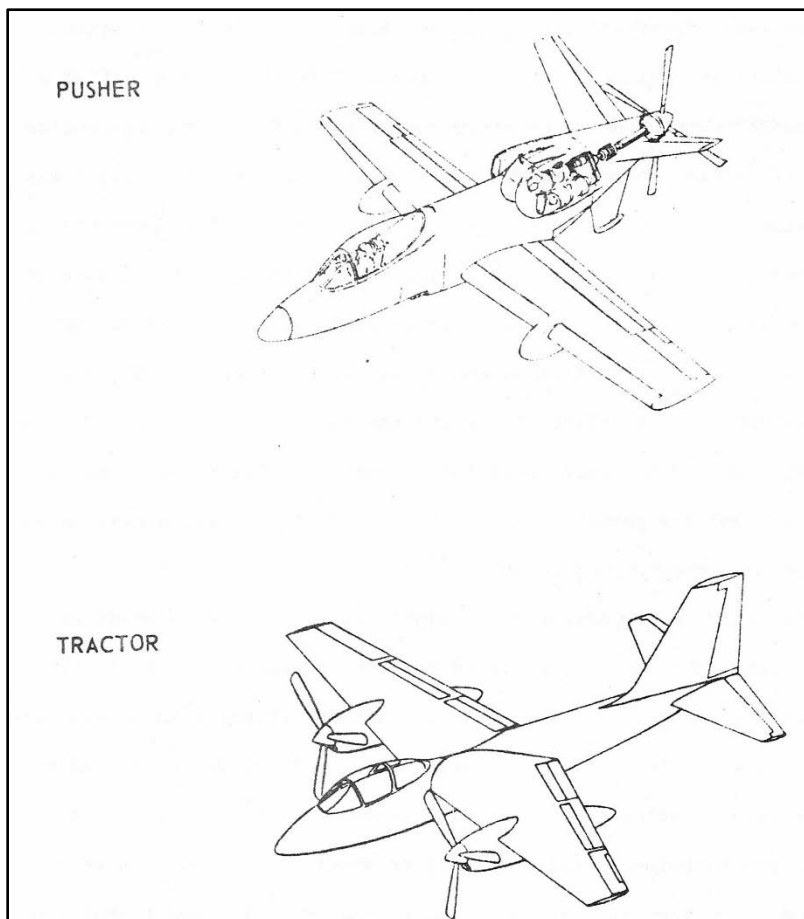
to sustain load factors of 2 to 4g at typical delivery speeds (250 to 400-plus knots) without loss of airspeed or altitude.” Other design features contributing to survivability included redundancy and/or shielding of critical subsystems, shielding for the pilot, small size, shielding of IR sources, “and weapon delivery systems which reduce the time in a vulnerable zone and permit different approach paths and different modes of weapon delivery.” Finally, simplicity of design consistent with required performance would lead to lower development, investment, and operating costs. Design simplicity would also reduce maintenance and increase the sortie rate and ability to operate from austere bases.⁴

An examination of existing and programmed Air Force fighter/bomber and attack aircraft found two programmed attack aircraft – the A-37B and the A-7D – to be the most suitable for close air support, but neither aircraft was as good as was needed. The A-37 was a modified version of the T-37 jet trainer and had demonstrated in permissive environment areas of Southeast Asia certain desirable characteristics: “good take-off and landing performance, low speed maneuverability, simplicity and reliability, and low investment, maintenance, and operation costs.”⁵ The aircraft had, however, limited maximum payload radius and loiter capabilities; minimum armor protection; and little growth capacity. The largest rapid-fire guns it could mount were 7.62mm. On the other hand, the A-7D could carry a larger payload, had high operating speeds, had avionics to aid both blind and visual weapons delivery, and incorporated changes to the basic A-7 design to enhance survivability. The A-7D required, however, a much longer runway and had less low speed maneuverability than the A-X and the A-37 aircraft. Available runway length and radius/loiter requirements might also restrict the payload capacity of the A-7D.⁶

To arrive at representative A-X designs as shown in Diagram 3, the various contractor and Air Force Systems Command studies examined a wide range of technological alternatives. Those alternatives included pushers, tractors,

vertical/short takeoff and landing (V/STOL), jets, fans, turboprops, and mixed propulsion systems. The resulting parametrically-developed design, that is, a design “selected from a series

DIAGRAM 3: REPRESENTATIVE TWIN-ENGINE CONCEPTS



Source: A-X CFP, 1 Mar 68, revd 13 May 68

of designs for which data were produced by computerized performance and costing models,” was believed to combine the aircraft characteristics needed to meet the mission demands.⁷ The principal design choices were made in four areas: airframe and propulsion, avionics, armament, and survivability.⁸

Airframe and Propulsion

The choice of airframe construction was an easy decision. All contractors recommended “Aluminum airframes of conventional multi-spar skin-stringer construction” in that the specific A-X performance regime created no unusual design requirements. The choice of the propulsion systems, however, was another matter. Propulsion was “a driving factor in the design selection” and required assessments of a variety of competing systems.⁹ The contractors quickly eliminated reciprocating engines, turbojets, tip turbine fans, and combination turboprop-turbojets. A more extended evaluation of two V/STOL configurations, the lift plus lift/cruise and the tilt wing turboprop configurations, resulted in their rejection because of inferior performance, high cost, and development risks. The choice of propulsion systems was narrowed to turboprop and turbofan.¹⁰

After a comparison of available turboprop and turbofan propulsion systems, the studies concluded that the turboprop was more desirable than the turbofan. This conclusion did not change even if the time constraint was eliminated by extending the IOC to allow for consideration of future turbofan systems. The thrust of the turboprop exceeded that of the turbofan at all speeds up to about 400 knots, when equal size and technology gas generators were assumed. This meant that the turboprop would have a higher performance, shorter takeoff distances, and lower specific fuel consumption. From the standpoint of performance in the operating regime of main interest, the turboprop was the preferred propulsion system for the A-X.¹¹

The four contractors narrowed their choices to two engines, the General Electric Company’s T-64 and the Avco Corporation’s (Lycoming Division) T-55. The earlier AFRDQ A-X Proposal had based its turboprop design on the T-65.¹² In weight, size, and power level the two engines were about equal, however, the T-55 was somewhat simpler, more rugged, and less expensive to produce. Both engines had considerable potential for growth in horsepower for a modest investment in development expenditures. Final choice of engine would be made in Contract Definition.¹³

Avionics

The second area of principal design choice was avionics. Each contractor recommended an avionics package for his point design and indicated a number of possible avionics growth options. The avionics subsystem for the representative A-X as shown in Table 7 was partly based on the contractor studies although it was taken from the AFSC recommended equipment list for the A-X. The AFSC list was used in the cost and weight calculations of the representative A-X aircraft. Technical risks with the basic avionics package were considered to be low. All pieces of equipment were either in production or in engineering development with suitable alternatives items available if selected equipment failed to meet specifications.¹⁴

The CFP avionics package differed significantly from the minimum avionics package

recommended in the preliminary AFRDQ A-X Proposal* in that the CFP proposal cost half as much, weighed 145 pounds less, and required about 2 cubic feet in less in volume. A large part of this difference was due to the elimination of the Integrated Armament Control System (ICAS), Air Data Converter, and Doppler Navigation, and the substitution of a less expensive TACAN (tactical air navigation). The deleted items were added to a list of avionics growth options for future study along with the following items: (1) communication – data link; (2) navigation – LORAN C/D, Displays; (3) target acquisition – low light level television (LLTV), forward looking infrared (FLIR) sensors, moving target indicator (MTI) for radar, close air support system (CLASS), tactical air support system (TASCS), and night observation devices (NOD); (4) weapon delivery – aided visual systems, heads-up display (HUD), and Maverick display and controls; and (5) various penetration devices. As in the case of engine selection, the final components of the avionics subsystem would be determined during Contract Definition.¹⁵

Table 7: BASIC A-X AVIONICS SUBSYSTEM		
FUNCTION	WEIGHT (LBS)	COST (\$)
COMMUNICATIONS		
UHF/AM (AN/ARC-109)	30.0	9,500
VHF/FM (AN/ARC-114)	7.5	1,900
VHF/AM (AN/ARC-115)	8.0	1,500
IFF/SIF (AN/APX-72) w/secure mode	18.5	4,000
Intercom (AIC-25, Mixer Unit)	6.0	500
Secure Voice (KY-28)*	1.5	500
HF/SSB (AN/ARC-123)*	5.0	800
NAVIGATION		
TACAN (AN/APN-65)	55.0	6,500
UHF/ADF (AN/ARA-50)	20.0	1,150
HARS (A24G-5A)	40.0	15,000
VOR/ILS*	6.0	400
TARGET ACQUISITION		
Laser Target Designator Seeker	60.0	20,000
WEAPONS DELIVERY		
Optical Sight (Ferranti)	3.6	5,000
Armament Control Panel	15.0	5,300
X-Band Transponder (SST-181X)	3.8	2,700
Gun Camera (KS-27C)	5.7	2,000

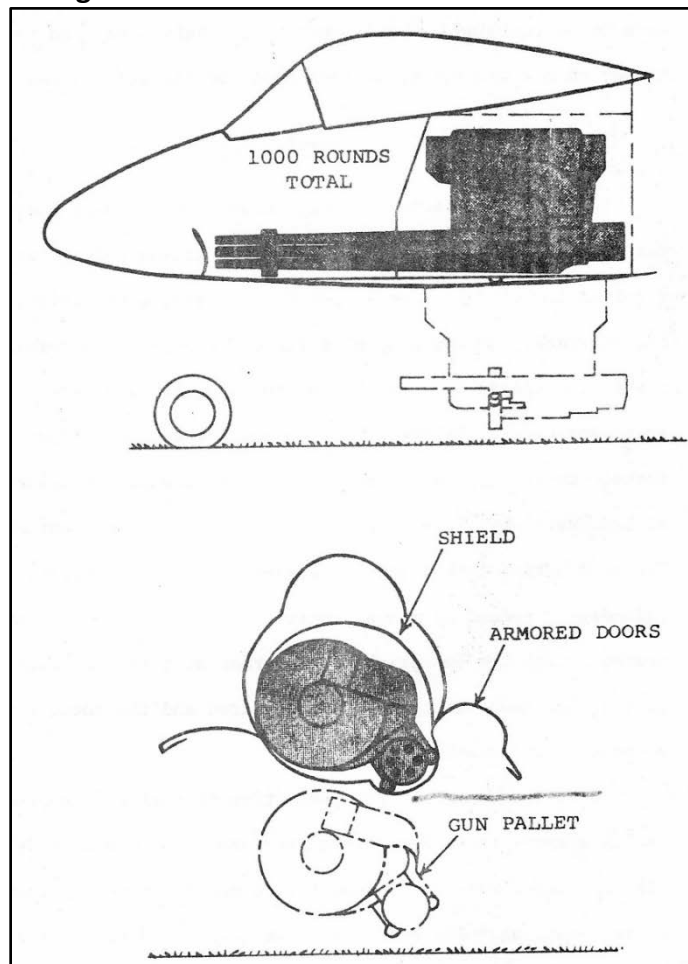
* See Chapter 2, Table 5.

PENETRATION AIDS	.0	-0-
RHAW*		
IRW*	NOT COSTED	
TOTALS	295.6	76,750
Total Volume 5.36 cubic feet		
Total Power 1,640 watts		
* Complete provisions including mountings and wiring		
SOURCE: CFP, A-X CFP, 1 Mar 68, revd 13 May 68.		

Armament

Armament was the third area of design choice and had three aspects of primary interest: internal/external gun installation, external store configuration, and provisions for use of new weapons (under development or proposed). All contractors recommended an internal, "large-caliber cannon with a larger supply of ammunition as critical to system effectiveness."¹⁶ For the CFP analysis the gun was specified to be a 30mm cannon with the same rate of fire as the M-61 (6,000 rounds per minute) and 1,200 rounds of high velocity ammunition. The gun should be palletized to permit off-aircraft bore-sighting and to minimize maintenance requirements. The installation of the gun as shown in Diagram 4* was typical of the recommendations submitted by the contractors. The Air Force expected to complete a Close Ai Support Gun Study by November 1968 which would result in the definition and development of an internal gun for the A-X. Under examination were the "best combinations of projectile size (for lethality), muzzle velocity

Diagram 4: TYPICAL 30-MM GUN INSTALLATION



Source: A-X CFP, 1 Mar 68, revd 13 May 68.

* Diagram 4 shows the installation recommended by McDonnell-Douglas Aircraft Corporation.

(for accuracy), and rate of fire (for increased number of hits).¹⁷ This gun might not be available for installation in the first production line aircraft because of the development time required. The A-X gun bay would need sufficient volume to accommodate any foreseeable internal gun configuration and to permit rapid and easy change of the gun.¹⁸

Air Force studies also examined the development of external podded guns. These guns were of two types: (1) small-caliber guns with high rate of fire and high velocity for destruction of personnel targets, and (2) large-caliber automatic recoilless rifles (57mm and 152mm) for destruction of bunkers, mortars, and gun emplacements, and equivalent targets. Such large weapons would require special mounting provisions.¹⁹

To carry the maximum number and types of external weapons, a larger number of hard points were required. At least 10 store stations with a total capacity of 18,600 pounds were desired, enabling the A-X to carry almost all the conventional ordnance then in the inventory. Commonality of bomb racks was to be stressed in Contract Definition and provisions for self-defense air-to-air missiles were to be included. The A-X was to be configured also to deliver a number of new weapons to be developed for use against CAS targets.²⁰

Survivability

The final area of design choice and a primary design objective was survivability. Close air support of ground forces generally required low-altitude for target recognition, acquisition, surveillance, and reattack and for weapon release. In order to accomplish these tasks, low speeds were often required as well as a close approach to enemy positions. Vulnerability to machine-gun fire – the principal threat – therefore, had to be kept low and the vulnerability to heavy anti-aircraft artillery (AAA) had to be kept within acceptable bounds. The contractors agreed that extensive fuel system protection, structural redundancy, redundant manual controls, and extensive use of armor was needed. With the exception of the armor suit the contractors were in general agreement as to what was required and the cost, weight, and effects on vulnerable areas.²¹

For protection of critical components against 14.5mm weapons the A-X required separated dual manual flight controls. All fuel tanks were to be foam filled and the fuselage tanks were to be self-sealing. The two engines were to be separated and armored on the inlet, turbine, and compressor sections for protection against the inlet, turbine, and compressor sections for protection against small arms fire. The internal gun ammunition was to be stored in the fuselage in vented and protection compartments provided with blow-out panels. Pilot protection was to be accomplished by a combination of masking and armor. Two concepts for the armor suit were to be studied during the Contract Definition. One approach was to specify armor to meet a desired high level of protection. The second approach was to armor to a low protection level with provisions to “strap on” additional armor when needed. A basic protection against 7.62mm weapons was assumed and augmentation by strap-on armor was to raise the level of protection to withstand 14.5mm fire. The estimated total armor weight for the A-X assuming the highest level of protection was 1,050 pounds. With its various provisions for protection against ground fire, the Air Force considered the A-X the only CAS candidate with significant protection against 14.5mm guns.²² All aspects of the A-X concept reflected a heavy emphasis on survivability.

The A-X aircraft described in the CFP, then was to be a rugged multi-spar, skin-stringer aluminum structure with twin turboprops. Because of its high thrust-to-weight ratio (8,600

horsepower and an 18,000 pound empty weight) and a light wing loading, the A-X would have a wide usable speed range and be highly maneuverable at all speeds below 300 knots. These characteristics would permit heavy combat payloads to be flown from short combat areas strips.²³ The wing would have a span of 55 feet and a reference area of 550 square feet. A summary weight statement of the representative A-X design* is show in Table 8.²⁴ The estimated total system costs for this concept based on 600-aircraft buy in millions of 1967 dollars are shown in the following tabulation:²⁵

Development cost	\$137.2
Investment cost (600 A/C)	903.9
(Recurring flyaway cost – 600 A/C)	(1.22)
Operating cost (one wing – 10 years)	194.7

	Flight Condition* (pounds)	Design Maximum Overload Conditioned**
Airframe	6,660	6,660
Landing and arresting gear	1,520	1,520
Propulsion system	5,440***	5,440
Power generation	700	700
Flight controls	500	500
Avionics	250	250
Crew provisions	450	450
Gun installation	1,000	1,000
Armor	<u>1,000</u>	<u>1,000</u>
Weight Empty	17,520	17,520
Crew and provisions	320	320
Trapped fuel and oil	300	300
Ammunition	<u>1,000</u>	<u>2,000</u>
Operating weight empty	19,140	20,140
Pylons and racks	1,050	2,645
External Payload	3,180	14,215
Internal fuel	<u>1,980</u>	<u>7,000</u>
Flight design gross weight	25,350	
Maximum takeoff gross weight		44,000
* As specified in parametric design study ground rules. ** Based on 3-g taxi load limitations. *** Without allowance for cross-shafting.		
SOURCE: CFP, A-X CFP, 1 Mar 68, revd 13 May 68.		

* For a comparison with the preliminary AFRDQ A-X Proposal weights see Chapter 2, Tables 3, 4 and 5.

Because of the A-X concept's simplicity and lack of technical risk the Air Force assumed that the Contract Definition phase could be completed within seven months after receipt of the Definition Directive. Based upon the receipt of the Definition Directive by 1 July 1963, the Air Force believed a fixed price contract for the Total Procurement Package (TPP) could be awarded by the first of February 1969 with IOC to occur at the end of June 1971. This, of course, necessitated a rapid approval of the A-X CFP concept by the interested OSD offices.²⁶

Development Concept Paper (DCP)

On 17 June 1968 the Secretary of the Air Force, Dr. Harold Brown, submitted the CFP to the Secretary of Defense. Secretary Brown requested approval to conduct contract definition and start development in FY69. The A-X IOC under the proposed schedule was to be the end of FY71, a six-month slip from the tentative date used in the preliminary study. This date was further slipped to FY72 in the Air Force Program Change Request of 31 August 1968. TO undertake Contract Definition and begin development, the Air Force FY69 Research, Development, Test and Evaluation (RDT&E) apportionment request included \$8 million. The Director of Defense Research and Engineering (DDR&E) authorized release of \$1 million in FY69 funds for continuation of the A-X study pending a decision of the Air Force request.²⁷

The office of the DDR&E prepared a Development Concept Paper (DCP) on the A-X which was submitted to the Deputy Secretary of Defense in December 1968. This DCP addressed the management issue of whether the Air Force had satisfied the prerequisites for initiating A-X Contract Definition. Four subissues or questions were involved as follows:

- a. Would an appropriately modified, existing aircraft meet the requirement?
- b. Should the initial development be a single-place A-X with minimum avionics for visual attack only, or should concurrent development proceed with a two-place version equipped with avionics for night/adverse-weather close support?
- c. Should competitive prototypes be developed and flown before selecting "the basic A-X configuration (Tractor turboprop vs. pusher turboprop)?"
- d. Should the A-X be bought instead of some of the already programmed A-7s or F-111s, or, as the Air Force proposed, as an addition to the tactical Air Force structure?²⁸

The Air Force answers to the questions were to proceed immediately with Contract Definition and then to enter development and production with an IOC of FY73. A new aircraft was needed rather than a modification of an existing one. Initially, the A-X would be a "single-place version with minimum avionics, which would be added to the existing approved force structure." Competitive prototypes were unnecessary as "the technical approach selected for A-X involves very little advanced technology" which "should permit rapid development with low risk at lower development and procurement costs..." This plan required \$19 million in FY70 to begin development. The DCP presented this preferred Air Force approach as Alternative 1.²⁹

Alternative 2 was variation of number 1. Contract Definition would be initiated "to obtain firm price and design estimates by early FY70." The cost to develop and procure an A-X with the desired performance was a major concern and this approach would allow solicitation of firm estimates on cost and performance while only committing the Government to the \$5 million needed for Contract Definition. Then, if the A-X concept still looked promising, proceed with

development. Under this alternative, however, the A-X procurement would be in lieu of A-7Ds or F-111s, and the FY70 funding for A-X RDT&E or production would be reprogrammed from A-7D, F-111, or other USAF General Purpose Force funds. The thinking behind this was that “in view of the limited results obtainable with an interdiction campaign in a major war in SEA, Korea or Europe” more effort should be devoted to close support. As it was, 43 percent of the programmed funds for Air Force fighter/attack aircraft was for F-111s and only 12 percent for the A-7Ds.³⁰

The third alternative (the one preferred by Dr. John S. Foster, Jr., DDR&E) was to defer the A-X Contract Definition. Instead, the concept formulation studies would be continued to determine an optimum close support system, but the initial advanced development of a gun suitable for use on the CAS system should be begun in FY69. There were several arguments for this approach. Survivability of the proposed A-X was questionable in that the design emphasized survivability against small arms (14.5mm) defenses. According to the CFP, existing CAS aircraft were more survivable against the expected heavier defenses than the A-X. Furthermore, in the near future operational data on the Air Force A-37, the Marine and Air Force OV-10s, and the Navy A-7s, as well as test results of the new A-7D/E avionics should become available which would provide useful information for configuring major aspects of the A-X. Proponents of this alternative believed the proposed optimum CAS aircraft represented goals “difficult to attain in a single aircraft within the present state of the art.” The A-X would be an improvement for close air support, but whether the proposed A-X was the best way and justified an investment of over \$1 billion needed to be reexamined.³¹

Dr. Foster recognized that the A-X had a number of significant features and that a need existed to improve close support, but on 14 December 1968 he reluctantly recommended Alternative 3 for the following reasons:

I am not convinced however that we have finished concept formulation. Specifically, the proposed aircraft seems to be too larger, and has too much range/payload at this early stage. It is so similar to A-7 that it is hard to justify when we already have the A-7. A smaller, less costly, quick-reaction aircraft seems more appropriate. I am confident however that with additional attention to the AX concept we can complete concept formulation and be ready to proceed with contract definition in FY70. I therefore propose that \$12M be placed in the A-X program element for this purpose.³²

Secretary Brown preferred Alternative 1, but recognized “the validity of the points made in the DDR&E recommendation” and believed “that Alternative #3 can lead to an acceptable result.” If Alternative 3 was chosen, the Air Force would rapidly reexamine the A-X sizing and be ready to proceed with Contract Definition at the beginning of FY70.³³

After reviewing the DCP, on 16 December 1968 the Deputy Secretary of Defense approved the inclusion of \$12 million in the FY70 budget for Contract Definition. This action was contingent on the Air Force’s completing supplemental studies in three areas: size and weight of the A-X, survivability of the A-X in the anticipated threat environment, and methods to improve the aircraft night/adverse weather capability.³⁴

To accomplish the requested studies the AFRDQ A-X Working Group was reconstituted

with representation from the Deputy Chief of Staff/Plans and Operations (AFXDC) at Air Force Headquarters, the Air Force Systems Command, and the Tactical Air Command. The Air Force objective was to accomplish the efforts by May 1969 to enable release of RFPs to industry by June 1969. The Air Force Systems Command received the task of performing a technical study of the size and weight of the A-X. This study was to be completed by 21 April for inclusion in a CFP supplement. The AFSC was also to provide information and technical assistance for preparation of an avionics and threat analysis section to the CFP supplement. Furthermore, by 1 May 1969 the Air Force Systems Command was to provide a Technical Development Plan (TDP) as the technical exhibit for Contract Definition approval. The TDP would address those items not covered in detail in the CFP but necessary for CD approval, and then be attached to the CFP to provide the technical basis for Contract Definition justification. As a final task, AFSC received direction to prepare for a release of an RFP on 2 June 1969.³⁵

The Air Force Systems Command designated the Aeronautical Systems Division (ASD) as the lead organization in the preparation of the supplements to the CFP. The System Integration Division, Directorate of Advanced Systems Design, Deputy for Development Planning ASD, completed the weight and sizing studies, and the data were forwarded to AFSC on 23 April 1969. After review and revision these studies were published on 28 May 1969 as Volume I of the CFP supplement. Based upon data provided by ASD, on 21 May 1969 ARDDQ published Volume II, Avionics; and Volume III, Survivability. The Directorate of Tactical Systems Plans, Deputy for Development Planning, ASD, prepared the TOP using the conclusions of the CFP supplement. After a series of reviews by AFSC and the Air Staff, the final revision of the TOP was sent to the Air Staff in June 1969. Work on the RFP proceeded slowly and its planned release date was moved forward to 1 September 1969.³⁶

NOTES

1. Working Paper, History of Tactical Division, Directorate of Operational Requirements and Development Plans, DCS/R&D, HQ USAF, 1 Jul – 31 Dec 67, in files, Ofc of Hist, Hq AFSC; CFP, A-X Concept Formulation Package, 1 Mar 68, revd 13 May 68, in files, Ofc of Hist, Hq AFSC.
2. CFP, A-X Concept Formulation Package, 1 Mar 68, revd 13 May 68, pp I-1 to I-7; Development Concept Paper (DCP), AX Close Air Support Aircraft, DCP 23, revd 11 Dec 68, pp 3-4 (Doc 11). [Hereinafter cited as DCP 23.]
3. DCP 23, rev 11 Dec 68, pp 4-5 (Doc 11).
4. *Ibid.* See also CFP, A-X Concept Formulation Package, 1 Mar 68, revd 13 May 68, pp I-22 – I-24, I-34 – I-101.
5. DCP 23, revd 11 Dec 68, p 2 (Doc 11).
6. *Ibid.*, pp 2, 6. See also CFP, A-X CFP, 1 Mar 68, revd 13 May 68, pp III-1, III-2.
7. CFP, A-X CFP, 1 Mar 68, revd 13 May 68, p IV-1.
8. *Ibid.*, pp II-1 – II-2.
9. *Ibid.*, pp II-2.
10. *Ibid.*, p II-5. See also pages II-2 – II-6 for a fuller discussion of the rationale for eliminating all other engine systems.
11. *Ibid.*, pp II-5.
12. See Chap 2.
13. CFP, A-X CFP, 1 Mar 68, revd 13 May 68, pp II-9 – II-11.
14. *Ibid.*, pp II-44, IV-17 – IV-18. For additional discussion of the avionics see pages II-45 – II-57 and IV-19 – IV-21.
15. *Ibid.*, pp II-45 – II-57.
16. *Ibid.*, pp II-58.
17. *Ibid.*, p IV-22.
18. *Ibid.*, pp II-58 – II-62, III-33, III-36 – III-38, IV-22.
19. CFP, A-X CFP, 1 Mar 68, revd 13 May 68, p IV-23.
20. *Ibid.*, II-58, IV-23.
21. *Ibid.*, pp II-63, III-45.
22. *Ibid.*, pp II-63, III-45 – III-53.
23. *Ibid.*, p 4.
24. *Ibid.*, pp IV-6 – IV-7
25. *Ibid.*, p IV-30.
26. *Ibid.*, pp IV-35 – IV-44
27. DCP 23, revd 11 Dec 68, p 1 (Doc 11).
28. *Ibid.*
29. *Ibid*, pp 16-17.
30. *Ibid.*, pp 17-18.
31. *Ibid.*, pp 18-19.
32. *Ibid.*, p 19. Dr. Foster's final recommendation was dated 14 Dec 68. His earlier recommendation of 11 Dec, the pertinent parts of which are cited below, was more condemnatory: "However, our major problem in Close Support are finding and destroying targets and the AX does not, in itself, offer significant improvements here. Further, I am concerned that the aircraft may be too larger and have too much range/payload. It is too similar to an A-7 and, therefore, hard to justify when we have A-7's. A smaller, quick-reaction aircraft which can and must be stationed, closer to the FEBA may be the kind of close support aircraft we need. In summary, the AX does not provide a unique capability, and does not solve the most pressing problems of Close Support. We must, however, continue priority efforts toward an optimum close support system including sensors, weapons, control and aircraft. Toward this end, for FY70, I have established a new Program Element (6.3XXXF) with \$5M for advanced development work on a new Close Support Weapon System and I support \$1M in the AX program element for continued studies."
33. DCP 23, revd 11 Dec 78, p 19 (Doc 11)
34. DCP, Development Concept Paper, AX Close Air Support Aircraft, DCP 23A, 16 Mar 70, p 1.
35. RAD, Requirements Action Directive, A-X Specialized Close Air Support Aircraft, RAD 7-69-(2), 25 Feb 69 (Doc 12); RAD (C/GDS-81), A-X Specialized Close Air Support Aircraft, RAD 7-69-(3), 16 Apr 69 (Doc 13).
36. Semi-Annual Historical Report of A-X SPO (ASZX), Jan-Jun 69, A-X Specialized Close Air Support Aircraft (Doc 14); see also AFSC Form 56, AFSC Program Direction, subj: Specialized Close Air Support Aircraft (A-X), 329A-2-69-272, 4 Mar 69 (Doc 15).

Chapter 4: GO-AHEAD FOR CONTRACT DEFINITION

On September 1969 the Air Force forwarded the supplement to the Concept Formulation Package (CFP) to the Office of the Secretary of Defense (OSD).¹ The Office of the Director of Defense Research and Engineering (ODDR&E) then prepared a draft revised Development Concept Paper, DCP 23A, which was completed in early December 1969. At this time the Air Force requested a Defense Systems Acquisition Review Council (DSARC) meeting to review the revised draft DCP and the Air Force proposal to transition the A-X program from Concept Formulation to Contract Definition.²

DSARC Review

The DSARC met on 19 December 1969 and several questions were raised. The first question dealt with the Air Force estimate of \$1.2 million for the unit aircraft cost (airframe, engines, gearbox, propeller, and avionics). An independent study by the Office of the Assistant Secretary of Defense for Studies and Analyses (OASD(SA)) had arrived at a higher figure of \$1.5 million. An effort was underway to reconcile the differences. The Army representatives brought up two issues: (1) could an aircraft dedicated to close air support (CAS) be afforded, considering the relative priorities for air superiority. Interdiction, and close air support; and (2) would its proposed capability meet the needs for night and all-weather operations. The final consideration discussed was the use of the Maverick missile with the A-X system.³

Dr. John Foster, Chairman of the DSARC, requested the OASD (SA), the Air Force, and the Army to take the following actions:⁴

1. OASD (SA) will determine what can be done to analyze the cost/effectiveness of a force mix with the A-X versus a force of multi-mission aircraft [e.g., F-4, A-7, F-15 types] without A-X.
2. The Air Force will consider the integration of the MAVERICK missile into the A-X system.
3. The Army will specify the mission they want accomplished and close the loop with the Air Force on the avionics package acceptable with respect to the IOC date.
4. All recipients of the DCP are to submit comments as soon as possible so that the task of revising the DCP can be expedited.

Based on the results of the tasks the draft revised DCP was to be changed to reflect the additional inputs.

There was an important area of general agreement at the review. A need existed for a parallel program “for the development of sensors, weapons and command and control equipment to improve Close Air Support under low visibility conditions.”⁵ This would also be addressed in the revision of the draft DCP.

DCP 23A

The final version of DCP 23A, dated 16 March 1970, incorporated the new inputs and changes necessary for acceptance by the interested DoD offices. To enable the Secretary of Defense to make a decision whether to initiate, defer, or disapprove development of the A-X, the DCP addressed the following three subissues:⁶

- a. Is the acquisition of a single purpose CAS aircraft, AX, a wise decision in view of the fact that forecast budget limitations would require reduction in tactical

air force resources for air superiority and interdiction to provide resources for the AX?

- b. Is the proposed AX capable of meeting the CAS needs of the Army ground forces? Should AX be developed initially with avionics designed primarily for visual attack; should a version equipped with more comprehensive avionics be included in a portion of the fleet; or should only the comprehensive version be developed? Can CAS requirements be met by a mix or modification of existing aircraft?
- c. If a decision to initiate development of AX is made, should the aircraft (airframe/engine) configuration and contractor be selected by conventional CD or by flyoff competition between prototypes?

These management subissues, although differing in number and somewhat in wording, were substantively the same as the four subissues discussed in the December 1968 DCP.*

The answers to the first two subissues by the Air Force and others in the Department of Defense who supported the A-X concept remained basically the same as in December 1968. Supporters of Alternative I (Approval of the A-X Development) believed that one of the essential "payoffs" of tactical air was the CAS mission and that the mission was "one of the most neglected in terms of resource allocation." A specialized aircraft would be cost-effective in that it would not be penalized by multi-mission requirements such as airframe density, limited low speed maneuverability, and fuel limitations. Also, the relatively low development and production costs would allow the procurement of "a sizeable force of very effective aircraft for a fraction of the cost of a similar size force of multi-purpose aircraft, whose effectiveness in close support is marginal." A CAS aircraft would free many multi-mission aircraft for counterair and interdiction missions "for which they were primarily designed and in which they are most effective."⁷ Although the OASD(SA) force mix analysis did not examine all alternatives, it was clear that justification of the A-X depended on the type of threat. Where air superiority/interdiction was not necessary, such as in South Vietnam, the CAS advantages of the A-X were evident but "in a high intensity conventional war, the demand for air superiority/interdiction becomes critical, and the justification for reduction of those capabilities in order to acquire AX is questionable."⁸

To the Air Force, however, the A-X appeared to be the only CAS candidate "adequate in all the design characteristics critical to developing a true CAS capability for all levels of conventional war." The A-X specialized airframe was a key element in that it allowed high maneuvering performance in the 150-300 knot region in conjunction with a relatively high survivability against machine gun fire which, numerically, would dominate the close air support ground threat. Other important A-X characteristics were its long loiter endurance, high surge sortie rates, and heavy payload capability from austere bases. Existing or modified versions of current aircraft would not have all these desired CAS capabilities.⁹

The DCP basic avionics package was designed for day and night visual attack in keeping with the goals of simplicity and low cost. A growth potential existed for the incorporation of advanced avionics as shown in Table 9.* The A-X airframe volume and internal arrangement of components were configured to minimize problems of incorporating new equipment designed to enhance all-weather capability. The A-X program office would monitor the parallel development programs for advanced avionics systems and, when appropriate, would consider

* See Chapter 3.

* An estimated cost was \$79,000 per aircraft for an avionics package similar to that proposed in the CFP. (See Chapter 3, Table 7.)

them for inclusion in the single-place A-X. Depending on the future avionics equipment required, a two-place version of the A-X might be needed. The A-X would also be capable of carrying advanced weapons being developed for parallel programs such as the 30mm gun proposed for installation in the A-X for antitank, antivehicle, and antipersonnel use,¹⁰ but “due to the considerable space, weight and power available in the AX baseline design, and the desire not to complicate the aircraft, these avionics/ordnance improvements are not being considered as an integral part of the AX configuration.”¹¹

Table 9: BAISC A-X AVIONICS SUBSYSTEM	
Communications:	UHF/AM, VHF/FM, VHF/AM, IFF/SIF, Intercom
Target Acquisition:	Laser Target Designator Seeker
Navigation:	TACAN, UHF/ADF, HARS
Weapons Delivery:	Dual Reticle Sight, Armament Control Panel, X-Band Transponder
<p><i>NOTE: Provisions (wiring, brackets) are included for Guided Weapons Displays and Control, LORAN C/D, Data Link, Strike Camera, RHAW, IRW, HF/SSB, Secure Voice, COR/ILS; a gun camera is included for weapons delivery recording.</i></p> <p><i>SOURCE: DCP 23A, 16 Mar 70, p 7.</i></p>	

Proponents of Alternative II (Disapproval of the A-X Development) did not believe the A-X would satisfy the CAS mission under all visibility conditions. They were of the opinion that the A-X visual weapon delivery accuracy might not be better than that of other aircraft and in the case of the A-7D with its aided visual system the A-X would be inferior. They also questioned the survivability of the A-X against the range of potential enemy defense weapons systems. The A-X opponents believed that instead of procuring a specialized aircraft some of the resources might be better spent in developing avionics equipment to correct CAS deficiencies and incorporating modifications in current inventory aircraft.¹²

The ODDR&E believed that development of the A-X offered an opportunity for the following precedents:¹³

- a. The first USAF aircraft designed for CAS,
- b. A departure from the multi-mission trends of the last 10 years,
- c. A level of austerity and simplicity unseen in DOD first-line aircraft proposals since the A-4A
- d. Growth potential for the incorporation of future avionics which may provide an all-weather capability and (e) an ideal opportunity for testing new management approaches to competitive prototyping.

Inclusion of competitive prototyping in the list of precedents denoted a significant shift in systems acquisition philosophy. Whether to go with competitive prototyping or to select an A-X configuration and a contractor by conventional Contract Definition was the final management subissue addressed in the DCP.

Prototyping, The Answer

Previously the Air Force had preferred the conventional approach which involved a paper

competition and a selection of one contractor to develop the winning design. As late as June 1969, when the CFP supplement and TDP were submitted to the Secretary of the Air Force, conventional Contract Definition had been the first choice. Subsequently, the program was reoriented to a competitive prototype approach which Secretary of the Air Force Robert C. Seamans, Jr., approved on 10 October 1969.¹⁴

Prototyping was not a new idea, but it was a concept that had been out of favor during Robert S. McNamara's tenure as Secretary of Defense from 1961 to early 1968. Although there were those who advocated the value of prototyping, not until after Secretary McNamara's resignation did the public discussion of the concept get underway.¹⁵ The question of following a competition prototype approach in the case of the F-X (F-15) had been resolved in favor of conventional Contract Definition, that is, selection of a contractor based on a paper competition. This decision on the F-X occurred in September 1968 just as ODDR&E began preparation of the first A-X DCP.¹⁶ That



McDonnell Douglas F-15A during the type's first flight on 27 July 1972.

same month Dr. Foster, DDR&E, publicly stated the need for a DCP on a major weapon system "to analyze the appropriateness of contract definition or of competition in hardware, or of other forms of program management."¹⁷ Although the Air Force position in 1968 was that competitive prototypes were unnecessary in the case of the A-X, prototyping was discussed briefly in the completed DCP of 11 December 1968.¹⁸ These two instances demonstrated the reemergence of the prototyping as a development concept.



General James Ferguson- Commander, Air Force Systems Command

Within the Air Force Systems Command support existed for the prototype concept.¹⁹ General James Ferguson, AFSC Commander, in a speech delivered on 12 December 1968 to a joint meeting of the National Security Industrial Association and the American Ordnance Association criticized the Air Force procedure of generating a paper competition for an airplane development contract. He termed the winning configuration as "paper aircraft" which were "generally conservatively designed" embodying "the state-of-the-art at a point in time 5-7 years prior to initial operational capability." Consequently, "ingenious, radical, perceptive advances" were not presented "as they entail high risk and are likely to be judged negatively as a result." This resulted in technological inertia, forced the Air Force to select a contractor based on paper, and committed the Air Force "to a whole development and production run – spares and all – before any tin is bent." General Ferguson

questioned the contention of advocates of total package procurement that time and money were saved by not building prototypes. Systems had to be built and tested which often resulted in increased costs and additional time to make them run. As prototype meant different things to people, General Ferguson advocated:²⁰

For our new weapons a contract definition in hardware – what can be called a competitive “initial development.” Then our source selection can be based on a hundred cubic feet of hardware rather than a hundred cubic feet of paperwork.

The change of national administrations in 1969 also contributed to the discussion of prototyping within the DoD. On 12 March 1969 Dr. Foster maintained the necessity for paper analysis, but conceded the utility of competitive prototyping for reducing technical risks in the case of components or subsystems. In some instances, prototyping of a major system might be required.²¹ The new Deputy Secretary of Defense, David Packard, established several panels within the Industry Advisory Group (IAG) to examine the problems associated with weapon system acquisition.²² As a result of the initial panel reports, on 31 July 1969 Secretary Packard issued a memorandum to the Secretaries of the Services setting forth what he considered to be the basic causes of cost growth in systems acquisition and giving initial guidance for solving them.²³



David Packard - Deputy Secretary of Defense

In addition, he touched on two other items not directly linked with the cost growth problem. The first item related to the use of competitive prototyping in systems acquisition. Mr. Packard believed that the Defense Department would benefit by a “judicious increase” in “dependence on hardware demonstration and competition, with some corresponding reduction in dependence on paper analysis.” Finally, he thought the tendency had been “to drift too far in the direction of concurrency, and this must be reversed.” Secretary Packard proposed to review the Services’ approaches for implementing his guidance and then would provide further direction if needed.²⁴



*Robert C. Seamans, Jr.
Secretary of the Air Force*

It was in this atmosphere that Secretary of the Air Force Seamans acted when he approved competitive prototyping for the A-X. This reorientation in the A-X development approach by the Air Force occurred during the review of the TDP. In August 1969 the office of the Assistant Secretary of the Air Force (Installations and Logistics) (SAFIL) requested new schedules and costs for different development approaches from AFSC. The Aeronautical Systems Division (ASD) prepared a Contract Definition and an Initial Development schedule with associated costs. Secretary Seamans reviewed the schedules on 16 September 1969. He concluded that the Contract Definition schedule was too short while that for Initial Development was too long. When he forwarded the TDP and CFP supplements to OSD on 22 September, Dr.

Seamans indicated that the development approach remained to be resolved.²⁵

Parallel Undocumented Development

The Air Force Systems Command developed four new schedules with associated costs. These were a revised CD schedule calling for a CD of 11 months and 44 months for development, and 3 prototype schedules of about 60 months each from initiation to initial operational capability (IOC). At all levels of review, the third prototype alternative was selected for implementation. Secretary Seamans agreed with this selection on 10 October. This alternative was termed "Parallel Undocumented Development" and envisioned a minimum of required documentation during the competitive prototype phase to encourage a maximum of contractor initiative and innovation in meeting the A-X design requirements. There was a similarity between this approach and General Ferguson's competitive "initial development" concept. However, this approach needed to be more clearly defined in the absence of official Air Force guidance in order to structure a program that would achieve the advantages of the concept.²⁶

There were several arguments in favor of this approach as summarized in DCP 23A:²⁷

1. Better cost and performance data would be presented at an earlier stage of development. First flight would be within 20 months of RFP release, versus 35 months for normal CD.
2. Source Selection would be based upon competitive testing of actual hardware, rather than paper designs. Contractors would be motivated to produce aircraft with the best possible flying qualities. Subsequent decisions would be made with a high degree of confidence.
3. Concurrency would be minimized.
4. There would be maximum program flexibility. No production commitments would be made until successful completion of prototype testing.

On the other hand, selection of a contractor by normal Contract Definition had the attractions of an earlier IOC (by 6 months), lower RDT&E costs (estimated to be \$155.1 million versus \$194.0 million for prototype), and the belief that few uncertainties could not be resolved because the A-X was a low technical risk program.²⁸ The differences in approach and costs can be seen in Tables 10 and 11.

On 6 April 1970 Deputy Secretary of Defense Packard approved Alternate IB (prototype approach). He did so "with the understanding that there will be future discussion with AF & Army cooperation in this program and coordination with AAFSS program."²⁹

This proviso was apparently in response to the joint Army and Air Force recommendation of 26 March 1970 to Mr. Packard that research and development be continued for both the A-X and the Army's Advanced Aerial Fire Support System (AAFSS) through prototype development. The two Services had not been able to agree "on the degree to which the two systems are competitive and/or complementary" or to arrive "at a joint recommendation for programming either system into the force structures of the Services." The Army and Air Force recommendation was in reply to a 22 January 1970 request by Mr. Packard for a "joint statement of the requirements and the complementary roles of systems involving cross service support."³⁰ The question of whether there was a need for both systems was involved as well as the issue of roles and missions. In addition, the Marine Corps wanted its own fixed-wing V/STOL aircraft, the Harrier. Budgetary constraints and the Congress would eventually cause the Department of Defense to reexamine the roles and missions and the aircraft choices to perform close air support.³¹

Alt (Contract Definition)***	IA			38.6	61.7	311.4	292.0	127.8	831.5
Alt IB (Prototype)***					52.5	112.5	269.8	287.4	831.5
<i>* Includes 10 test aircraft.</i> <i>** Includes 4 prototype (2 per contractor) and 10 test aircraft.</i> <i>*** Six hundred aircraft plus spares and support.</i>									
SOURCE: DCP 23A, 16 Mar									

The Representative A-X, March 1970

The representative A-X differed somewhat from that described in the December 1968 DCP. It was somewhat smaller with a decrease in wing area from 550 square feet to 480 square feet and lighter with an empty weight of 1,000 pounds less. The projected average unit flyaway cost for a buy of 600 aircraft in 1970 dollars was \$1.17 million compared to \$1.28 million for the earlier version.³² These differences were largely the result of the supplemental studies (to the June 1968 CFP) conducted by AFSC in the first half of 1969. A cost, schedule, and characteristics comparison of the two versions are provided in Table 12.

The size and weight of the representative A-X was less than the year earlier configuration and the avionics package was reduced, but the useful load and aircraft capabilities remained essentially the same. A significant change occurred in the schedule. This change resulted from the additional requirements levied by the Deputy Secretary of Defense in December 1968 which delayed Contract Definition start by a year and from the decision to competitive prototype.

Prototyping did cause a problem where the new 30mm gun was concerned. Preproduction guns for aircraft compatibility tests would be available in the third quarter of Calendar Year 1972 based on an RFP release on the gun in early 1970. Consequently, an A-X competitive flyoff would be conducted using the M-61 20mm gun.³³ Prototyping had a positive impact in that the propulsion development risk would be reduced. Growth versions of production turboprop engines, the T-55 and T-64, were under consideration for the A-X engines. In addition, the Request for Proposal was "to be broad enough that both turboprop and turbofan aircraft may be considered." The concept formulation studies had picked turboprop propulsion as a better choice than turbofan, however, during preparation of DCP 23A it became apparent that a potential engine for a twin turbofan A-X existed. This was the TF34-GE-2 engine being developed for the Navy S-3A aircraft. Competitive prototyping would allow additional development time for all engines under consideration.³⁴

Table 12: COST, SCHEDULE, AND CHARACTERISTICS COMPARISONS		
First DCP (#23) 11 Dec 68 Alternatives 1 and 2		Second DCP (#23A) Feb 70 Alternative IB
<u>Cost:</u> (Millions of 1970 \$)		
Total Program Cost, 10 yrs.	2536	2180
RDT&E	137	194
Production Cost (including initial spares	1169	831
No. of production aircraft	723	600
10 year O&M, 5 wings	1230	1155
<u>Schedule:</u>		

Contract Definition Start	Mar 69	Mar 70
Award Development Contract	Feb 70	Jul 70
First Flight	Dec 71	
Competitive Flyoff		Apr 72
Award System Contract		Jun 72
IOC (first squadron)	Mar 73	Feb 75
Significant Program Characteristics:		
Operating weight empty (lbs.)	20,140	19,925
Maximum gross weight (lbs.)	44,000	38,000
Cruise speed, kt	300	300
Useful load (Operating from 1000 ft. aircraft) lb.	6,500	6,500
Loiter time at 250NM radius, 18 MK82, hours	2	2
Bombing accuracy, MK82, CEP, ft.	112	112
Strafing accuracy, CEP, mils	10	10
Sustained load factor, 6 MK82, 275 kt, g	3.8	3.5
Maintainability, manhours/ft hr.	12	12
<i>SOURCE: DCP 23A, 16 Mar 70, p 20.</i>		

The recommendation of Dr. Foster, DDR&E, in December 1968 to defer Contract Definition on the A-X and the decision the same month by the Deputy Secretary of Defense requesting the Air Force to conduct supplemental efforts to the Concept Formulation Package had an important impact on the A-X program. That impact could be likened to a chain reaction. The key to the reaction was the stretching out of the concept formulation phase of the program. This, in turn, allowed consideration and acceptance of an old but out of favor acquisition concept – competitive prototyping. Finally, because of the additional time new studies on turbofan engines became available which resulted in direction being given to permit competitors for the A-X to consider a turbofan configuration. The original goal of a December 1970 IOC had been extended to early 1975 and the aircraft had grown in size and weight (up to 10,000 pounds) from that envisioned in 1966. Whether the new schedule, size and weight, and cost goals could be met waited to be seen. The first major schedule goal was to award development contracts in July 1970, and it would not be met!

NOTES

1. DCP, Development Concept Paper, AX Close Air Support Aircraft, DCP 23A, 16 Mar 70, in files, Ofc of Hist, Hq AFSC. [Hereinafter cited as DCP 23A.]
2. Minutes, Minutes of the Defense Systems Acquisition Review Council (DSARC), subj: Review of AX Aircraft Program – Milestone #1, 19 December 1969, 31 Dec 69 (Doc 16).
3. *Ibid.*
4. *Ibid.*
5. *Ibid.*
6. DCP 23A, 16 Mar 70, p 1.
7. *Ibid.*, p 17.
8. *Ibid.*, p 12.
9. *Ibid.*, p 17.
10. *Ibid.*, pp 7-8.
11. *Ibid.*, p 12.
12. *Ibid.*, pp 18-19. The Secretary of the Navy summarized this view in his recommendation on the DCP coordination page (p 19) as follows: "I recommend alternative #II; as it will concentrate scarce resources toward rectification of major deficiencies in current CAS systems, i.e., lack of night and all-weather capability. Navy and Marine Corps have no requirement for a single mission aircraft. The AX concept of survivability is questioned, and the AX unit cost seems low compared to current aircraft procurement costs."
13. *Ibid.*, p 18.
14. Determination and Findings (D&F), Authority to Negotiate Contracts [for an A-X prototype aircraft,] D&F No. 70-11c-93, 22 Apr 70, signed by Grant L. Hansen, Asst SECAF (R&D), w/atch: Advance Procurement Plan P-70-1-329A (Doc 17).
15. Hist, History of Air Force Systems Command, FY70, I, 5-9. [Hereinafter cited as Hist of AFSC.]
16. For a brief discussion of the F-X prototyping issue see Rept, Jacob Neufeld, *The F-15 Eagle: Origins and Development 1964-1972*, Nov 74, p 32. [Hereinafter cited as Rept, Neufeld, *The F-15 Eagle*.]
17. As cited in Speech, Brig Gen F.M. Rogers, DCS/DP, Hq AFSC, to National Security Industrial Assoc, Dayton, Ohio, Chapter, 27 Feb 69, pp 12-13 (Doc 18).
18. See Chapter 3.
19. This support apparently went back to early discussions on the F-X. See Rept, Neufeld, *The F-15 Eagle*, 32, explanatory footnote.
20. Speech, Gen James Ferguson, Comdr AFSC, to Joint Meeting National Security Industrial Association and the American Ordnance Association, Washington DC, subj: "Joint Architects of the Future Air Force," 12 Dec 68, p 8, 9 (Doc 19). Brig Gen Felix M. Rogers, DCS/Development Plans, Hq AFSC, on 27 Feb 69, publically added support to the initial development approach. (Speech, Brig Gen Rogers, 27 Feb 69 (Doc 18).)
21. Hist, Hist of AFSC, FY70, I, 9.
22. One panel, Panel A, established on 1 Feb 69, and co-chaired by Dr. Foster, was "A working panel of the IAC to study and review ways and means of increasing the effectiveness of the major systems acquisition process." Gen Ferguson chaired its Subpanel 1, Alternative Patterns of Acquisition. (Hist, Hist of AFSC, FY70, II, Docs 7 and 8.)
23. Memo, David Packard, DEPSECDEF, to Secs of Army, Navy, Air Force, subj: Improvement in Weapon Systems Acquisition, 31 Jul 69 (Doc 20).
24. *Ibid.*
25. Semi-Annual Historical Rept for A-X SPO (ASZX), Jul-Dec 69, A-X Specialized Close Air Support Aircraft (Doc 21).
26. *Ibid.*, Program History, 1 Jan – 30 Jun 70, A-X Specialized Close Air Support Aircraft, 27 Oct 70 (Doc 22). Another force prompting "Parallel Undocumented Development" was the Congress. At the behest of the Congress in Oct 68, the General Accounting Office (GAO) undertook an evaluation of "two methods proposed for enhancing competition in the procurement of weapon systems, components, spare parts and other defense items." These proposed methods were "Parallel Undocumented Development" and "Directed Technology Licensing." The findings of the evaluation favored Parallel Undocumented Development and advanced as possible candidates for this approach the F-15, the Subsonic Cruise Armed Decoy (SCAD), and the A-X CAS aircraft. The final report did not favor the other approach. The GAO report made no specific recommendations for DoD action and pointed out that the DoD was reexamining its procurement policies relating to weapons systems. (Report to the Congress, *Evaluation of Two Proposed Methods for Enhancing Competition in Weapons Systems Procurement: Department of Defense*, by the Comptroller General of the United States, 14 Jul 69).
27. DCP 23A, 16 Mar 70, p 18.
28. *Ibid.*

29. *Ibid.*
30. Memo, Memorandum for the Deputy Secretary of Defense from Secretaries of the Army and the Air Force, subj: Systems for Air Delivered Fire Support of Ground Forces, 26 Mar 70, w/3 atch: (1) Tasks of Combat Air Support, (2) Weapon System Application I – Army, (3) Weapon System Application II – AF (Doc 23).
31. For additional discussion see RAND Rept, Goldberg and Smith, “The Close Air Support Issue,” pp 31-37; and Report to the Chairmen, Appropriations and Armed Services Committees, Congress of the United States, *Close Air Support: Principal Issues and Aircraft Choices*, by the Comptroller General of the United States, 8 Dec 71.
32. DCP 23A, 16 Mar 70, p 9.
33. *Ibid.*, p 14.
34. *Ibid.*, pp 9, 14. On 10 Oct 69 the Deputy for Development Planning, ASD, completed a turbofan study for the A-X using the TF34-GE-2. The study found the turbofan propulsion concept to be competitive with turboprops. (Semi-Annual Historical Rept of A-X SPO (ASZX), Jul-Dec 69 (Doc 21).

Chapter 5: AWARD OF DEVELOPMENT CONTRACTS

Deputy Secretary of Defense David Packard approved prototype development for the A-X Close Air Support (CAS) aircraft on 6 April 1970. On 10 April 1970 the Air Staff transmitted the System Management Directive authorizing the A-X program to the Air Force Systems Command (AFSC) and to AFSC's Aeronautical Systems Division (ASD). The Directive instructed AFSC to prepared all documentation to initiate a definition phase leading to a competitive prototype development program. At the end of this phase the Air Force would select two contractors to compete in a prototype development program. The project award date for development contracts was September 1970. All significant schedule milestones were moved forward two months and initial operational capability (IOC) was moved to May 1975 as shown in Table 13.^{1*}

Milestone	Date
IOC (1 sq/24 UE)	May 75
Award Development Contracts	Sept 70
Engineering Designs Complete	July 71
Received Phase II Proposals	Dec 71
Competitive Flyoff Phase Begins	Dec 71
Competitive Flyoff Ends	Jun 72
Award System Contract	Aug 72
First Flight (Production Configuration)	Jul 74
<i>SOURCE: SMD, SMD-0-379-329A(1), 10 Apr 70, p 3 (Doc 24).</i>	

Program Element 64211F and Weapon System 329A were used to identify the A-X program in the USAF Force and Financial Program. The latest proposed financial program by fiscal year which was in the 26 January 1970 Five Year Defense Program (FYDP) is shown in Table 14.²

Financial Program	FY70	FY71	FY72	FY73	FY74	FY75	To Comp	Total
RDT&E	2.0	27.9	38.0	69.9	44.7	11.5		194.0
Procurement* Above Line				42.7	230.8	286.5	426.7	986.6
Initial Spares*				4.4	34.8	49.4	45.8	134.4
Total Acquisition*	2.0	27.9	38.0	117.0	310.3	347.3	472.5	1315.0
<i>* FYDP 26 Jan 70 and are subject to change.</i>								
<i>SOURCE: SMD, SMD-0-379-329A(1), 10 Apr 70, p 4 (Doc 24).</i>								

The Air Force Systems Command was to take immediate action to establish a System Program Office (SPO) and appoint a System Program Director.³ The SPO would be located at ASD

* Compare Table 13 with Table 12.

which had the lead responsibility for the concept phase of the A-X program. Preparation of the Request for Proposal (RFP) was already well underway within the Deputy for Development Planning at ASD.

Program Management

Within the A-X Concept formulation effort had been managed by the F-X System Program Office as an additional duty.⁴ On 29 May 1968, upon completion of the CFP and in expectation of authorization to go ahead with Contract Definition, an A-X SPO cadre was formed by drawing upon F-X personnel. Lieutenant Colonel Robert B. Shaw, who had been the A-X program manager within the F-X SPO since the beginning of the conceptual studies in January 1967, became the Acting Director of the new cadre. The new A-X Close Air Support Aircraft SPO (ASZX) was operationally under the Deputy for Development Planning (ASB), but received administrative support from the Deputy for Systems Management (ASZ).⁵ Beginning in October 1968, when the anticipated authorization to proceed with the program was not forthcoming and it became apparent that other delays in the program might occur, the A-X SPO was gradually drawn upon for personnel to form a new system program office of cadre for the Subsonic Cruise Armed Decoy (SCAD) missile. The following month Lieutenant Colonel Shaw became Director of the SCAD Program Office.⁶ From a high of 22 people the cadre was eventually reduced to 3 within a year after its establishment. On 31 October 1969 Major Richard A. Chipman was designated Acting Director for the A-X program.⁷

Throughout 1969 and into early 1970 the Deputy for Development Planning, ASD, provided the management and resources for the various A-X studies undertaken by the director of AFSC. These efforts included the supplements to the CFP, the Technical Development Plan (TDP), a draft Request for Proposal (RFP) for the A-X propulsion subsystem, the new schedules and costs for different A-X development approaches, and the turbofan study completed in October 1969. In October 1969 the deputy stimulated the establishment of an ad hoc group at ASD to examine source selection, performance specifications, an A-X RFP, and flight testing. The group eventually consisted of representatives of various ASD deputies and offices as well as the Tactical Air Command and the Air Force Logistics Command. In November the ad hoc group began an examination of the Parallel Undocumented Development (PUD) approach (competitive prototyping) for development of the A-X approved by the Secretary of the Air Force on 10 October 1969. It also initiated work on a draft "strawman" RFP to enable ASD to release an RFP 30 days after receipt of a System Management Directive (SMD).⁸

In response to the SMD of 10 April 1970 authorizing an A-X program, ASD officially established an A-X SPO on 27 April 1970 within the Deputy for Systems Management. Both operational and administrative control of the program were now under the Deputy for Systems Management.⁹ Colonel James E. Hildebrandt, formerly Chief of the Management Operations Office, Deputy for Systems Management, became Program Director.¹⁰ The new A-X SPO was to be manned on an austere basis "using an absolute minimum of manpower, in keeping with the program philosophy of minimum interference with, and requiring minimum data for each contractor."¹¹ Minimum manning was to apply during the Competitive Prototype Phase (CPP) of the A-X program.

Request for Proposal

Although the term competitive prototyping was most commonly used to describe the first phase of A-X development, a more appropriate label for this management concept was Parallel Undocumented Development – the concept approved by Secretary Seamans. The ASD ad hoc

group that began preparing the draft Request for Proposal (RFP) in November 1969 was conscious of the need to define the Parallel Undocumented Development concept. Consequently, it was necessary for the concept to be inherent in the RFP which required the development of a new RFP format.

The Parallel Undocumented Development concept was competitive prototype approach but permitted a large degree of contractor freedom from Government intervention during fabrication of the competitive prototypes. Many management and technical reporting requirements usually found in Air Force industry contracts were to be deleted although the Government retained the right to maintain visibility into the contractors' efforts when necessary and as identified in the Request for Proposal. With a minimum of Government restraints it was envisioned that the contractors would react to the technical demands and "exercise their own initiative, inventiveness, and competitive aggressiveness to provide the best flying system for evaluation and demonstration within the cost constraints of a firm fixed-price contract." The commitment to logistics and production would be delayed, thus decreasing "later changes and/or excessive early costs." With less required reporting it was assumed that fewer contractor resources would be applied to the documentation efforts. The expectation was that "the Parallel Undocumented Development of two competitive prototypes without substantial 'reporting' will allow management and design flexibility, reduce cost, and defer costly production commitment by the Air Force."¹²

An A-X RFP prepared by the ASD group and reflecting the Parallel Undocumented Development approach was in final draft form at the time of the SMD transmittal. Four days later, on 14-15 April, a two-day review of the RFP took place at Command Headquarters. Over 50 representatives from OSD, the Air Staff, AFSC, ASD, and the Tactical Air Command (TAC) attended to resolve issues regarding the draft RFP content. A procurement evaluation review (known as the "Murder Board") was held on 22 April to deal with unresolved issues and to insure that the new approach was clearly spelled out in the RFP.¹³

One major issue surfaced at this time and was quickly dealt with by General John D. Ryan, Air Force Chief of Staff. The Tactical Air Command did not want the proposed aircraft. Instead, it preferred a smaller and simpler aircraft capable of operating "under low ceiling and not in the weather." This aircraft would carry a maximum of 6,000 pounds of munitions instead of 16,000, utilize air refueling, and have a reduced load factor (7.33 Gs versus 8 Gs). Furthermore, the 1,000-foot takeoff and landing requirements would be relaxed to 2,000 to 2,500 feet, and the night and all-weather requirement eliminated. As proposed in the DCP and RFP, the TAC believed the performance requirements were too stringent, unrealistic, and unsupportable based on Air Force experience in Southeast Asia.¹⁴

On 23 April 1970 General Ryan met with Generals John C. Meyer, Air Force Vice Chief of Staff; James Ferguson, AFSC Commander; and William W. Momyer, TAC Commander, to discuss



Convair A-X concept art

the A-X point design. Purportedly General Ryan made it clear that the Air Force would support the A-X described in the RFP, and not a new TAC proposal. General Ferguson proposed that certain revisions could be made in the A-X system design requirements by the contractors considering tradeoffs for possible weight and cost reductions. General Ryan agreed, however, these revisions were to be treated in an RFP supplement.¹⁵

On 29 April 1970 the Secretary of the Air Force and General Ryan received a briefing on the RFP and the resulting comments from their staffs were incorporated in the Proposal.¹⁶ On 2 May 1970 Secretary Seamans, as Source Selection Authority for the A-X competitive Prototype Development procurement, appointed the ASD Commander as Chairman of the A-X Source Selection Advisory Council (SSAC). Under Air Force Regulation 70-15 the SSAC Chairman was to set the criteria for the development of a source list, establish the evaluation criteria, and approve the RFP and the source list. Approval of the RFP was based on two additional requirements. Approximately two weeks after release of the RFP a model contract would be provided to the interested bidders. At the same time, the bidders would receive a supplemental RFP along the lines agreed upon by Generals Ryan, Ferguson, and Momyer.¹⁷



Boeing's A-X concept art

The A-X Request for Proposal, dated 7 May 1970, was released on 8 May 1970 to the 12 companies* selected to receive it.¹⁸

The A-X RFP, “including all boiler plate,” was only 104 pages and each contractor response was to be limited to a 585-page proposal. Deputy Secretary of Defense Packard considered this a “major breakthrough,” and the establishment of a precedent “worth far more than volumes of instructions and hours of conversation.” He recognized that:

This dramatic reduction in RFP size and the response limitation was enhanced because of the use of

competitive prototyping and we may not normally be able to go this far in more conventional programs. However, this is clearly the direction we want to go regardless of the kind of procurement plan we use.¹⁹

The A-X Competitive Prototype Phase was the first use of the Parallel Undocumented Development concept and in a sense was a trial run for the concept. Each management document, therefore was unique and was establishing a pattern for future programs that might follow the same procurement approach.

The RFP, as shown in Table 15, was composed of eight product sections and one

* The 12 companies selected were: Beech Aircraft Corporation; The Boeing Company; Cessna Aircraft Company; Fairchild Hiller Corporation; General Dynamics Corporation; Grumman Aerospace Corporation; Lockheed Aircraft Corporation; McDonnell Douglas Corporation; North American Rockwell Corporation; Northrop Corporation; LTV Aerospace Corporation; and, Textron, Inc.

administrative section. Each section defined the specific requirements for a particular function such as engineering, test, or management. For each functional area there was a requirements document that defined the A-X requirements for that area “in concise but prototype oriented terms.”²⁰ These requirements documents were, “in effect.... a new form of a work statement,” and reflected the development approach envisioned for the A-X. Each document consisted of two sections. The first section described the work expected during the Competitive Prototype Phase, while the second described, in more general terms, the anticipated Acquisition Phase proposal requirements.²¹

Table 15: Table of Contents: A-X REQUEST FOR PROPOSAL	
Title	Page No.
Introduction	1
Engineering Proposal Requirements	5
Test/Evaluation Proposal Requirements	7
Training Proposal Requirements	8
Management Proposal Requirements	9
Technical Criteria Proposal Requirements	12
Logistics Proposal Requirements	13
CFE/GFE/GFAE Proposal Requirements	14
Contract/Cost Proposal Requirements	15
	Atchs
Engineering Requirements Document	A
Test/Evaluation Requirements Document	B
Training Requirements Document	C
Management Requirements Document	D
Technical Criteria Requirements Document	E
Logistics Requirements Document	F
CFE/GFE/GFAE Requirements Document	G
Contract/Cost Requirements Document	H
General/Administrative Instructions	I
<i>SOURCE: RFP, A-X Specialized CAS Aircraft, 7 May 60, p ii (Doc 35).</i>	

Two crucial goals were the achievement of weapon system effectiveness and low costs. Approval to proceed into the acquisition would be denied unless the acquisition, operational, and maintenance costs were minimized. The RFP established a design-to-cost goal of \$1.4 million per unit flyaway recurring costs in Fiscal Year (FY) 1970 dollars for a 600 aircraft buy. As stated in the RFP, the Competitive Prototype Phase was to consist of:

a month competitive development period during which two contractors will design, develop, and fabricate two prototype aircraft each. The contractors will flight test their prototype aircraft. The Air Force will then evaluate both contractors' aircraft. This evaluation is intended to provide the Government with a level of confidence that the selected acquisition phase contractor will, in fact, develop a capable weapon system that is low in cost and that is

simple to maintain. A concurrent, but minimal effort contract definition-type of activity will be initiated by the contractors sixteen months after the competitive prototype phase contract award date...to give the contractors four months to prepare their acquisition phase proposals. The acquisition phase proposals will be jointly evaluated with the results of the Air Force Flight Evaluation (AFFE) to select the contractor who will receive the acquisition phase contract.²²

Bidders were to have three months to prepare their proposals with costs proposals to be submitted two weeks later. Within a 75-day period the Government would evaluate the proposals and then award firm fixed price (FFP) contracts to two competing contractors.²³

The Air Force reasons for selection of an FFP level of effort contract for the A-X prototype phase were as follows:

- a. It was the “most compatible contract typed for this particular competitive prototype procurement” which involved “maximum contractor tradeoff” and “minimum government involvement.”
- b. A strong motivation was generated “for contractors to submit realistic price proposals.”
- c. A reasonable basis was established for “realistic firm pricing based on each contractor’s proposed effort.”
- d. The “level of effort feature” provided the contractor’s “latitude to limit cost risk” and encouraged “trade-off analysis.”
- e. The prior agreement on price would aid in avoiding charges of “favoritism” that could be made if other contract types were used.
- f. Fixed price contracts would encourage contractors “to design for simplicity” and to “exercise some degree of cost discretion.”
- g. A fixed price agreement placed a “firm limit on the Government’s financial obligation for the prototype phase.”²⁴



North American A-X concept art

The Air Force position was in agreement with Secretary Packard’s policy of tailoring the contract to the risks involved and “when the risks have been reduced to the extent that realistic pricing can take pace, fixed-price type contracts should be used.”²⁵

Source Selection

On 7 August 1970 six companies responded to the Request for Proposal. These companies were:

- a. Fairchild Hiller Corporation
- b. The Boeing Company
- c. Northrop Corporation
- d. Cessna Aircraft Company
- e. General Dynamics Corporation
- f. Lockheed Aircraft Corporation

The A-X Source Selection Evaluation Board, chaired by Colonel James E. Hildebrandt, began evaluation of the six proposals the following day. In order to accomplish the effort in the short period of two months the Directorate of Airframe Subsystems Engineering, Deputy for Engineering, ASD, increased its support to the A-X program from 5 men to 27 men. The Board completed its report on 8 October and on 13 October the Source Selection Advisory Council, chaired by Major General James T. Steward, ASD Commander was briefed. The Council's findings were presented to the

AFSC, AFLC, and TAC Commanders on 21 October; to the Air Council on 22 October; and to the Source Selection Authority, Secretary Seamans, on 23 October 1970.²⁶

On 17 December 1970 Colonel Hildebrandt presented a source selection information briefing to the Defense Systems Acquisition Review Council (DSARC) at the Pentagon. The DSARC review related only to approval of the Competitive Prototype Phase of the A-X Program. A major concern to the DSARC was that both winning proposals exceeded the DCP cost baselines for RDT&E and production. To reduce costs the Air Force would provide additional guidance that stressed simplicity of design, ease of maintenance, and the need to keep the initial and operating costs of the A-X to a minimum. Contractors could consider cost tradeoffs on the performance requirements. The guidance would emphasize that unless production costs were close to the \$1.4 million goal, the A-X program might not be approved for the follow-on acquisition phase. There was considerable discussion about the possible risks in several areas, including: engine development, costs, and schedule; gun recoil and gun testing; and vulnerability. Dr. Seamans reemphasized the guidance to be issued to the winners encouraging tradeoffs between cost and performance. Cost would be a crucial consideration in the final selection.²⁷ On 18 December it was announced publicly that the two winning contractors were the Fairchild Hiller Corporation and the Northrop Corporation.

On 22 December 1970 Secretary Seamans authorized and directed the ASD Commander to award contracts to the winners and to provide them with the following guidance:



Northrop A-X concept art

- a. The Air Force objective was a “relatively simple, easy-to-maintain aircraft.”
- b. The initial and operating costs were to be kept to a minimum for the production aircraft.
- c. The Air Force emphasized a unit flyaway cost “close to \$1.4 million,” or the program might “not be approved for the acquisition phase.”
- d. The specified performance requirements were not firm specifications, but goals “to the extent they are economically feasible.”²⁸

The Competitive Prototype Phase was about to begin. Secretary Seamans’ instructions to General Stewart came exactly four years to the day from the issuance of the original Requirements Action Directive that initiated the A-X program. Originally, it was thought that the initial operational capability (IOC) for the A-X would occur in December 1970. As has been seen in the discussion of the events that occurred during those four years, the A-X program underwent a considerable amount of evolution because of changes in technology, concept of operations, and procurement philosophy. This was to be the first attempt at dual prototyping and Secretary of the Air Force Seamans viewed “it as an experiment in technology and procurement.”²⁹

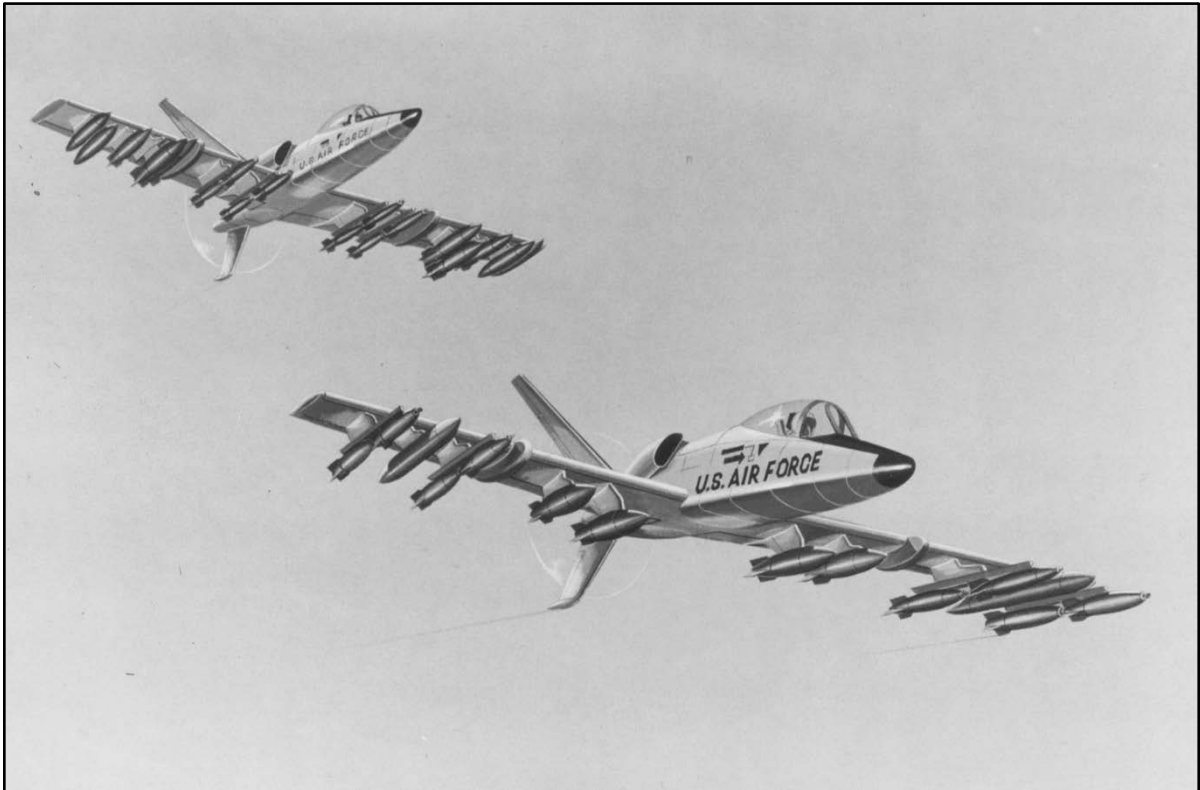


Republic A-X concept art

NOTES

1. Msg, CSAF to AFSC, subj: A-X System Management Directive, 1015192 Apr 70, in files, Ofc of Hist, Hq AFSC; SMD, SMD-0-379-329A(1), 10 Apr 70 (Doc 24).
2. SMD, SMD-0-379-329A(1), 10 Apr 70 (Doc 24).
3. *Ibid.*
4. See Chap 2.
5. Lt, Maj Gen Harry E. Goldsworthy, Comdr, ASD, to AFSC (SCL) [DCS/DevPlans], subj: AFSC Program Direction, AFSC Form 56, Specialized Close Air Support Aircraft (A-X), 24 Jun 68 (Doc 25); Semi-Annual Hist Rept, A-X Close Spt Acft SPO (ASZX), Jan-Jun 68 (Doc 26).
6. Semi-Annual His Rept, A-X CAS Acft SPO (ASZX), Jun 68 - Jan 69 (Doc 27); Hist, Hist of ASD, FY 69, pp I, 5-6, and II, (Doc 15).
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10. ASD News Release 70-172, 18 May 70 (Doc 30).
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12. For additional information on Parallel Undocumented Development see Management Techniques Application Plan (MTAP), Program No. WS-329A, Program Element 64211F, A-X Specialized Close Air Support Aircraft (Competitive Prototype Phase), 15 Aug 70, in files, Ofc of Hist, Hq AFSC. The above discussion was taken from the MTAP, Sec II, pp 3-4.
13. Prog Hist, 1 Jan – 30 Jun 70, A-X Specialized CAS Aircraft (Doc 22).
14. Ltr, Gen William M. Moyer, Comdr TAC, to Gen John D. Ryan, CSAF, undated, ca. Mar-Apr 70, in files, Ofc of Hist, HQ AFSC.
15. Memo, Memorandum for Record by Col Edgar M. Munyon, Dir of Gen Purpose & Alft Sys Plng, DCS/Dec Plans, Hq AFSC, subj: A-X, 25 Apr 70, in files, Ofc of Hist, HQ AFSC.
16. Ltr, Maj Gen Donavon F. Smith, Dir of Opnl Regs & Dev Plans (AFRDQ), DCS/R&D, USAF, to AFSC/SCL, subj: A-X Request for Proposal Revision, 2 May 70.
17. Ltr, Maj Gen Henry B. Kucheman, Jr., Asst DCS/R&D, USAF, to AFSC (SCGC, [Maj] Gen Cooper), subj: Appointment of the Chairman, A-X Source Selection Advisory Council, 5 May 70, w/atch: Memo for CSAF from Secy Seamans, same subj, 2 May 70 (Doc 32). The model contract and an Amendment 1 to the A-X RFP were released at a Bidder's Conference on 22 May 70. (Memorandum for Gen Rogers from Col Munyon, subj: A-X RFP, Amendment No. 1, 22 May 70, w/3 atch: (1) AFRDQ ltr, subj: Amend No. 1 to A-X Req for Proposals, 20 May 70, w/atch: Amend No. 1 to A-X RFP (2) AFSC (SCLT) ltr, subj: A-X Model Contract, 19 May 70, (3) Sum AFSC Staff Positions Unresolved Items.) (Doc 33)
18. RFP, A-X Specialized Close Air Support Aircraft, Request for Proposal, F3365770-R0896, Competitive Prototype Development Program, 7 May 70, in files, A-10 SPO, ASD; Prog Hist, 1 Jan – 30 Jun 70, A-X Specialized Close Air Support Aircraft (Doc 22).
19. Memorandum for the Secretary of the Air Force from DEPSECDEF Packard, subj: RFP for A-X Aircraft, 27 May 70 (Doc 34). An attempt was made to determine the average length of the usual RFP and of the contractor's response in 1970. The author contacted the Sys Proc Div, Dir of Proc, DCS/Procurement and Manufacturing, Hq AFSC, and was informed that such a determination was not possible because of the variation for each system. In the case of the A-X RFP and the required contractor's responses, a considerable reduction in length was achieved as noted by Secretary Packard.
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21. RFP, A-X Specialized CAS Aircraft, 7 May 70, p 2 (Doc 35).
22. *Ibid.*, pp 1-2.
23. *Ibid.*, p 2.
24. Ltr, Brig Gen Louis O. Alder, Asst DCS/P&P, to CV (Lt Gen O'Neill), subj: Contract Type for A-X Prototype Phase, 13 Jul 70, w/atch 2: Discussion Paper (Doc 36).
25. Memorandum for Secretaries of the Military Departments, et al., from DEPSECDEF David Packard, subj: Policy

- Guidance on Major Weapon System Acquisition, 28 May 70 (Doc 37)
26. The above was extracted from Semi-Annual Historical Report, 1 Jul – 31 Dec 70, ASD/SDX (Doc 38).
 27. Minutes, DSARC Review, A-X Aircraft Program 17 Dec 70, 13 Jan 71 (Doc 39).
 28. Memo, Memorandum for Commander, Aeronautical Systems Division, Air Force Systems Command, from SECAF Seamans, subj: Source Selection Division for the Competitive Prototype Phase of the A-X Program, 22 Dec 70 (Doc 1).
 29. Minutes, DSARC Review, A-X Aircraft Program 17 Dec 70, 13 Jan 71 (Doc 39).





**Part II:
A-10 Close Air Support Aircraft, 1970-1976**



**The A-10 Close Air Support Aircraft
1970 - 1976**

By:
Dr. George M. Watson, Jr

FOREWORD

This monograph is the second of a two-volume series dealing with the history of the A-10 Close Air Support aircraft. It tracks the airplane from contract award in 1970 to formal acceptance by the Tactical Air Command in March 1976. Of particular interest is the fly-off between the Northrop and the Fairchild prototypes as well as the fly-off between the A-7D and the A-10. Also noteworthy is the Air Force's investigation of Fairchild's ability to attain full production goals because such a study points out some of the many entangling implications involved in the weapon systems acquisition process.

This volume complements a goal of the History Office at HQ AFSC to document the history of major weapon systems while recording information and assessments of a "lessons learned" nature.

WALTER L. KRAUS
Command Historian Chief, Office of History

CHRONOLOGY

1970

- 27 Apr The Air Force Systems Command established the A-X Systems Program Office (SPO) in the Deputy for Systems Management, Aeronautical Systems Division, Wright-Patterson AFB.
- 8 May The Air Force distributed a request for proposal (RFP) for the competitive prototype phase of the A-X aircraft to 12 companies.
- 18 May Col James E. Hildebrandt was appointed Systems Program Director and Chief of the A-X System Program Office.
- 7 Aug Six companies responded to the A-X Request for Proposal: Fairchild Hiller Corporation, the Boeing Company, Northrop Corporation, Cessna Aircraft Company, General Dynamics Corporation, and Lockheed Aircraft Corporation.
- 23 Oct The Source Selection Advisory Council briefed its findings to the Source Selection Authority (Secretary of the Air Force Robert C. Seamans, Jr.).
- 16 Nov The Air Force released requests for proposals for the GAU-8 30mm cannon to industry.
- 17 Dec The A-X System Program Director presented a source selection briefing to the DSARC.
- 18 Dec The Secretary of the Air Force announced the selection of the Fairchild Hiller Corporation and the Northrop Corporation as the contractors for the competitive prototype phase of the A-X program.

1971

- 1 Mar Air Force designated the two A-X prototypes as the Northrop A-9 and the Fairchild A-10.
- Jun The Air Force awarded letter contracts to the General Electric Company and the Philco-Ford Corporation for the competitive development of the GAU-8 gun system and practice ammunition.

1972

- 9 Jan The Air Force negotiated a \$26.5 million cost-plus-incentive-fee contract (F33-657-C-0135) with AVCO Lycoming for development of the F100-LD100 turbofan engine.
- 10 May Fairchild's first flight of A-10 at Air Force Flight Test Center, Edwards AFB, California; competitive flight evaluation began.
- 30 May Northrop A-9 made first flight at Edwards AFB; competitive flight evaluation began.

- 10 Aug The Air Force completed and released Proposal Instructions (PI) containing all the essential requirements for continued development and operation test production.
- 10 Oct Flyoff between the A-9 and A-10 began at Edwards AFB.
- 9 Dec Flyoff between the A-9 and A-10 completed.

1973

- 17 Jan Defense Systems Acquisition Review Council (DSARC) met to review A-X program and was briefed on the Air Force decision to select the Fairchild Republic Company as the winner.
- 18 Jan Deputy Secretary of Defense, Mr. Kenneth M. Rush, authorized the Air Force to make an A-10 source selection announcement and proceed with contract negotiations to include design-to-cost objectives.
- 1 Mar The Air Force awarded Fairchild Industries a \$159,279,888 cost-plus-incentive-fee contract to continue prototype aircraft testing and to develop and build 10 preproduction aircraft.
- 1 Mar The Air Force awarded General Electric a \$27,666,900 contract to develop and deliver 32 TF34 engines.
- 19 Mar A-10 DT&E/IOT&E Phase I flight testing began.
- 18 Apr The A-X System Program Office was redesignated the A-10 System Program Office.
- 21 Jun John L. McLucas, Acting Secretary of the Air Force, announced the award of the development contract for the GAU-8 gun system being development for the A-10 to General Electric. The award consisted of a fixed-price-incentive fee contract of \$23,754,567 for three preproduction systems.
- Jul The Senate Armed Services Committee cut the FY74 request for A-10 preproduction aircraft from 10 to 6. The committee also recommended a flyoff between the A-10 and A-7D.
- 19 Sept The Air Force agreed to the Congressional recommendation to conduct a flyoff between A-7D and A-10.
- 2 Oct Malcom Currie, Director of Defense, Research and Engineering, proposed a plan to complete the flyoff.

1974

- 26 Feb First in-flight tests of A-10 #1 prototype with GAU-8/A gun installed.
- 9 May The flyoff between the A-10 and the A-7D was completed.
- 19 Jun The GAU-8/A 30mm gun was filled for the first time with combat ammunition.
- 9 Jul DSARC IIIA convened to discuss progress of the A-10.
- 31 Jul Deputy Secretary of Defense, William P. Clements, Jr., authorized the Air Force to proceed with initial production of the A-10 using \$39-million for long lead funding.

He granted approval to procure 52 aircraft subject to provision that contract options to procure a smaller quantity be kept open.

- 4 Sept Air Force Vice Chief of Staff, General Richard H. Ellis, ordered a review of the A-10 Program. The review was headed by Lt Gen Robert E. Hails, Vice Commander, Tactical Air Command. The review took place from 4-22 September 1974.
- 11 Sept Compatibility launches of AGM-65A Maverick air-to-ground tactical missile with A-10 aircraft at Edwards AFB were completed.
- 18 Sept The Critical Design Review (CDR) of GAU-8/A 30mm gun was completed.
- 31 Oct Qualification tests of the TF-34-GE-100 engine completed.
- 6 Nov Col Jay R. Brill was appointed A-10 System Program Director, replacing Brig Gen Thomas H. McMullen (June 1973 – November 1974).
- 22 Nov Deputy Secretary of Defense Clements authorized procurement of 52 A-10 aircraft.

1975

- Jan First A-10 development test and evaluation (DT&E) aircraft delivered to Edwards AFB for test purposes.
- Feb Fairchild announced sweeping organizational and managerial changes for A-10 production. Changes were generated by recommendations of an Air Force study team headed by Lt Gen Robert E. Hails, Vice Commander, TAC. Fairchild announced that it planned to move final assembly and flight testing of A-10 to Hagerstown, Maryland.
- 15 Feb First flight of DT&E A-10 aircraft at Edwards AFB.
- 19 Mar A-10 IOT&E Phase II testing began.
- 31 Mar Secretary of the Air Force announced that the Air Force was not adverse to Fairchild Republic Company's plan to move some of the A-10 workload from Farmingdale, Long Island, to Hagerstown, Maryland.
- 13 Jun A-10 IOT&E Phase II flight testing completed.
- 1 Aug Air Force, NASA, DDR&E agreed to drop requirement of 100-percent airload prior to DSARC IIIB.
- 23 Sept With approximately 80 percent of A-10 lifetime testing completed, a crack was observed in the fuselage frame.
- 21 Oct The first flight of a production A-10 was completed at Farmingdale.
- 28 Oct Testing of reinforced cracked fuselage frame completed – 6,000-hour mark attained.
- 13 Nov A-10 successfully demonstrated GAU-8 30mm lethality against tank targets.

1976

- 10 Feb Deputy Secretary of Defense Clements signed Development Concept Paper 23 B authorizing the Air Force to proceed with full production of the A-10 at a rate of 15 aircraft per month.
- 30 Mar The A-10 formally accepted by the Commander, Tactical Air Command, General Robert J. Dixon, from Commander of Air Force Systems Command, General William J. Evans.



Ground aerial refueling testing at Edwards AFB

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Chapter 1: CLOSE AIR SUPPORT AIRCRAFT BECOMES REALITY

The 18 December 1970 decision of the Secretary of the Air Force, Robert C. Seamans, Jr., to award contracts for construction of two prototype A-X Specialized Close Air Support (CAS) Aircraft represented the first Air Force attempt to acquire for the operational inventory an airplane specifically designed for CAS missions. Prior to the Secretary's decision, the Air Force had conducted a number of studies covering the complete spectrum of close air support tasks. These studies contended that close supporting fire against targets near friendly ground forces dominated close air support functions. In addition, the Air Force determined that a highly maneuverable aircraft capable of operating at lower speeds could outperform high speed jets on close air support missions in weather conditions featuring a 1,000-foot ceiling and one-mile visibility. Further, it was determined that the type of predicted enemy resistance to be encountered on a CAS mission would be automatic weapons, 23mm and 57mm mobile anti-aircraft artillery, heat-seeking missiles, and advanced strategic air missiles. Taking these findings into consideration, the Air Force realized that it did not possess an aircraft that could perform CAS missions against all these defenses.¹

As a result of these studies, the Air Force submitted design requirements for a specialized close air support aircraft designated the A-X, and identified "responsiveness, lethality, survivability, and simplicity" as essential characteristics for this new aircraft system. The Air Force wanted a system that would respond at all times in all types of weather and possess the capability to interface with Army and Air Force command and control communication systems. Also specified was a highly lethal system capable of carrying heavier payloads and possessing more firepower than present systems. The third critical requirement, survivability, called for a plane that could carry these payloads and still be less vulnerable to enemy ground fire than existing aircraft. As planned the system would deliver its ordnance, survive punishing ground fire, and return to base. Finally, the fourth criterion, simplicity, called for a minimum level of support required to keep the aircraft flying. A low number of maintenance hours per flight hour on the CAS aircraft would serve to shorten the mission turnaround time.²

In summary the ideal goal was:

A close support manned aircraft system (which) must be quickly available for employment and responsive to the needs of the army commander. The system must have the capability of identifying, attacking and destroying targets of a fixed or fleeting nature in very close proximity of friendly ground troops. The system should have a high degree of survivability on the modern battlefield and should operate effectively in the attack of ground targets. The system should possess an all-weather navigation capability and simple target acquisition equipment. The system must possess its own strategical and tactical mobility and be free of the requirements for elaborate and vulnerable fixed facilities. Effective command and control equipment is essential.³

A review of Air Force attack aircraft further sustained the rationale for the need of a close

air support airplane. Included within the attack inventory were the A-1, A-26, F-100, B-57,* and the T-28 – all of which by 1971 had been in the Air Force inventory for more than 15 years. In addition, the Air Force possessed the A-7D, a multipurpose aircraft procured for dual purpose of CAS and interdiction mission, and the F-105 and the F-111, both high speed attack aircraft with design characteristics that limited their capabilities for CAS.⁴ (See Table 1).



Martin B-57B Canberra at the National Museum of the United States Air Force.

Development
 Concept Paper (DCP) 23A, 6 April 1970, identified the following design requirements for the A-X systems:

Table 1: MINIMUM A-X PERFORMANCE/CAPBILITY⁵	
<u>Performance</u>	
Instantaneous g (300 kt, BFDW) <u>1/</u>	5.0
Sustained g (150 kt, BFDW) <u>2/</u> (150 kt, 19 MK 82's) (275 kt, BFDW)	1.65 (1/4 NM radius turn) 1.2 (1/2 NM radius turn) 3.2 (1/3 NM radius turn)
Rate of Climb (274 kt, BFDW)	6,000 ft/min
Radius/Loiter (18 MK-82's) (N.3./hours)	250/2
Useful Load, Fuel and Ordnance <u>3/</u>	6,500 lb
<u>Strength</u>	
Limit Load Factor (BFDW)	7.3
Limit Load Factor (Maximum Weight)	5.0
^{1/} Established by aerodynamic pull-out requirement for dive attacks; basic flight design weight (BFDW) includes 6 MK 82 (500-lb bombs), 750 rds 30mm ammo and about 2,000-lb fuel. ^{2/} Established by low altitude level turn maneuver requirement. ^{3/} 1,000 foot ground run, takeoff and land.	

DCP23A provided for the Competitive Prototype Development (CPD)* of the A-X system.

* The B-57B was built for use as a tactical night intruder.
 * For a detailed account and analysis of the background of the decision to go to the Competitive Prototype Development route, see Dr. Edward C. Mishler, "The A-X Specialized Close Air Support Aircraft: Origins and Concept Phase, 1961-1970," Part I of this volume.

This phase consisted of the two contractors competing on a prototype development program and 16 months later receiving instructions for full-scale development production phase proposals. After the proposals were evaluated, a flyoff between prototypes was planned and a single contractor would then be selected. In short, this approach placed heavy emphasis on extensive testing of competing aircraft systems.⁶

In May 1970 the request for proposal (RFP) was issued and by August 1970 six companies had responded: the Boeing Company, Cessna Aircraft Company, Fairchild Hiller Corporation, General Dynamics Corporation, Lockheed Aircraft Corporation, and the Northrop Corporation. These proposals were evaluated by a board headed by Colonel J.E. Hildebrandt, the A-X System Program Director. In October Colonel Hildebrandt briefed the Source Selection Advisory Committee and subsequently the Commander of the Air Force Systems Command, Air Force Logistics Command, and Tactical Air Command; the Air Council; and the Secretary of the Air Force.⁷

The Defense Systems Acquisition Review Council (DSARC) review of the program on 17 December 1970 recognized the need for the A-X and granted approval for Competitive Prototype Phase of development. The following day, 18 December, Secretary Seamans announced the selection of two contractors: Fairchild Hiller Corporation, Republic Aviation, Farmingdale, New York; and Northrop Corporation, Aircraft Division, Hawthorne, California.⁸

Under the terms of the contracts each contractor was to provide two prototypes. In order to accomplish this, Fairchild Hiller's Republic Division was contracted for \$41.2 million (Contract #F33657-71-F-306) while the Northrop Corporation was allowed \$28.8 million (Contract #F33657-71-C-308). Part of the reason for the price differential was that Fairchild had proposed a larger aircraft, as well as a more expensive engine.⁹

The Air Force placed a spending limitation of \$85.4 million on the A-X Competitive Prototype Phase (CPP), with yearly requirements extended as follows:¹⁰

in millions			
FY70	FY71	FY72	FY73
\$2.0	\$27.9	\$47.9	\$7.6

Also planned was a unit recurring flyaway cost of \$1.4 million in Calendar Year (CY) 1970 dollars for production aircraft based upon a total of 600 units, at the rate of 20 aircraft per month. Four program objectives specified in order of priority were:¹¹

- a. Development of a Close Air Support System capable of performing the mission within established cost goals.
- b. Maintenance of a healthy and fair competition between the two CPP contractors.
- c. Assurance of visibility by the Air Force of the contractor's progress and by the contractors of the Air Force's program goals.
- d. Definition of procedures used in conduct of CPP effort for the benefit of other

programs using a similar management approach.

The A-X program was the first Air Force weapon development governed by Design-to-Cost (DTC) principles.* Earlier studies provided the information that all the desired CAS capabilities goals could be achieved with a low cost aircraft. In furtherance of this objective, the Air Force Program Manager, during the Competitive Prototype Phase, gave the two contractors wide latitude in making cost/performance trade-offs to meet the DTC goal.¹²

The Specialized Close Air Support Aircraft (A-X) program was identified in the USAF Force and Financial Program (F&FP) under Program Elements 63233F (Advanced Development, 27131F (A-X Squadrons-Active), 52519F (A-X Squadrons-ANG), and Weapon System 329A*.¹³

The Air Force initiated specific development and competition ground rules for the prototype phase. Under development rules all performance goals were established by Air Force Headquarters with revisions derived only from joint contractor- and Secretary of the Air Force-appointed panel discussions. The system program office (SPO), along with the contractors, was expected to do its best to meet these goals within the resources provided. In addition, the program office was responsible for other development efforts associated with the primary aircraft system. One of these efforts was the 30mm gun which was developed by the

Armament Development and Test Center (ADTC) for the A-X, with the program office responsible for proper dissemination of data between the A-X and gun



Northrop A-9A under construction

contractors. In another effort, the SPO was accountable for monitoring parallel avionics system development providing improved clear-air and all-weather capabilities for the operational A-X.¹⁴

Competitive ground rules were formulated to insure that no undue advantage would accrue to one contractor through either Government action or contractor misinterpretation of

* Design-to-Cost was a concept that required program to have only a single monetary DTC goal which was an average unit flyaway cost target established by the Secretary of Defense for major programs. This goal was an "in-house government" target, "almost contractual in nature," between the Service and the Secretary of Defense. It was the intent of the DTC goal that the Service be allowed the authority to divide it into cost elements, controlled by the Service, to suit the structure of the Service's specific program. Further the Service could make trade-offs between these cost elements without approval from OSD. *Joint Design-to-Cost Guide-Life Cycle Cost As A Design Parameter*, 15 October 1977, DARCOM P700-5, NAVMAT P5242, AFLCP/AFSCP 800-19, pp 5-6.

* It should be noted that Program Management Directive (PMD) R-P 3034(1) 127131F of 17 May 1973 introduced PE 64225, full scale development of the A-10.

the ground rules. One of the tenets was that there would be no communication between contractors. Instead, the Air Force, through the SPO, would provide an equal distribution of information to the contractors. In addition, while all changes in contracts were to be negotiated and incorporated in the respective contracts, the contractors were authorized to initiate design changes they deemed necessary as long as these changes were in the context of the specifics of these contracts.¹⁵

The Air Force designation for the Northrop prototype was A-9A, and for the Fairchild design, A-10A. Northrop began economizing early by opting for the Lycoming F102 turbofan engine while Fairchild selected the higher thrust General Electric TF-34 model. Since the production aircraft engines were to be Government furnished equipment, the Air Force negotiated a \$26.5 million cost-plus-incentive-fee contract (F33-657-C-0135) with AVCO Lycoming for development of the F102-LD-100 turbofan engine through full qualification testing. The effective date of that contract was 9 January 1972. Ten months later, on 3 November 1972, the Air Force awarded the General Electric Company of Lynn Massachusetts a fixed-priced-incentive-fee contract (F33-657 73-C-0073) for Qualification testing of the TF-34 engine. Then the following March the Air Force revamped this contract to include development and delivery of 32 engines for \$27.67 million.¹⁶

Significant planned milestone dates for the A-X program included: Award development contracts, December 1970; Engineering design complete, October 1971; Full-scale development/production RFP released to prototype contractors, April 1972; First flight, June 1972; RFP response due back from contractor, August 1972; Air Force flight evaluation began, October 1972; Air Force flight evaluation end, December 1972.¹⁷

GAU-8 30mm Gun

The development and testing of the GAU-8 30mm cannon strongly influenced the projected production schedule of the A-X. The Air Force had determined that since the GAU-8 would not be ready for installation for initial flight of the prototypes, the General Electric M61 20mm cannon would be substituted during the competitive prototype phase testing. On 16 November 1970 requests for proposals for the gun were released to industry and competitive contract awards were made with letter contracts the following June 1971 to the General Electric Company and the Philco Ford Corporation for development of the gun system and four types of ammunition: Target Practice (TP), High Explosive Incendiary (HEI), Semi-Armor Piercing High Explosive (SAPHE), and Armor Piercing Incendiary (API) with steel penetrator.¹⁸

The Air Force's need for a heavier caliber aircraft gun was expressed in DCP 103 which indicated that studies had demonstrated that a 30mm gun could best cover the target spectrum of a close air support mission. Close air support targets included personnel in foliage and foxholes; moving and fixed armored vehicles including armored trucks and medium and heavy tanks such as the Russian PT-76 light tank, T-54 medium tank, and JS-III heavy tank; the BTR-50P armored personnel carrier; and blast sensitive, hard point targets such as junks, bunkers, and reveted guns.¹⁹

A memorandum of agreement signed on 15 October 1971 by the Commanders of the Aeronautical Systems Division and the Armament Development and Test Center designated the

A-X System Program Office and the Air Force Armament Laboratory as responsible for both the management and development of the GAU-8/A CAS gun. The agreement assigned overall management responsibility to the program office's Project Division and listed its responsibilities which included Phase I (the competitive phase, "except for procurement responsibility upon award of the production contract." Other responsibilities were interface engineering, flight test, and reporting to higher headquarters.²⁰

The Armament Development and Test Center was responsible to the A-10 System Program Director (SPD) for technical/engineering support of the GAU-8 gun system. In turn, the ADTC designated a GAU-8 program manager, located in the Air Force Armament Laboratory, as the focal point. He was responsible for identifying technical/engineering aspects of the gun system and for providing maximum flexibility in cost and performance for the A-10.²¹

When the Air Force awarded the contracts for the GAU-8A gun to General Electric and Philco-Ford in June 1971, it also contracted for a backup system with the Hughes Tool Company, which operated as licensee for the Swiss-made Oerlikon 304RF-30 millimeter gun. The Air Force intended to test and evaluate this gun, which was designated as the GAU-9, against the GAU-8. Testing of the GAU-9, completed in April 1973, proved it to be inferior to the GAU-8, and thus the GAU-9 was dropped from further competition.²²

The gun program was funded according to the following schedule:

Funding in Millions		
FY70	FY71	FY72
\$3.0	\$9.62	\$6.30



A-X prototype assembly at Fairchild

NOTES

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2. *Ibid*; also article, Philip J. Geddes, "USAF Choice for the Close Air Support Role," *International Defense Review*, Feb 74, p 71.
3. DCP 23A, 6 Apr 70, p 4.
4. AFSC Fact Sheet, "A-X Specialized Close Air Support Aircraft," Jun 71, p 2.
5. DCP 23A, A-10 Specialized Close Air Support Aircraft, 19 Feb 75, p 2; DCP 23A, 6 Apr 70.
6. System Management Directive, SMD-1-453-329A(3), 5 May 71 (Doc 1).
7. Draft DCP 23, Rev B, A-X Specialized Close Air Support Aircraft, 9 Jan 73; AFSC Fact Sheet, "A-X Specialized Close Air Support Aircraft," Jun 71.
8. Draft DCP 23, Rev B, 9 Jan 73.
9. Article, "Fairchild-Hiller, Northrop to Build A-X Prototypes," *Armed Forces Journal*, 4 Jan 71, p 17.
10. System Management Directive, SDM-1-453-329A(3), 5 May 71, (Doc 1).
11. Memorandum for the Record, Col James E Hildebrandt, Dir, A-X SPO, Dep Sys Mgt, ASD, subj: Air Force SPO/Contractor Relationships During the A-X Competitive Prototype Program, Apr 71.
12. DCP 23A, 19 Feb 75, p 3 (Doc 2).
13. System Management Directive, SMD-1-453-329A(3), 5 May 71 (Doc 1).
14. Memorandum for the Record, Col Hildebrandt, subj: Air Force SPO/Contractor Relationships during the A-X Competitive Prototype Program, Apr 71.
15. *Ibid*.
16. Article, "Northrop Streamlines A-9A Management," *Aviation Week and Space Technology*, 26 Jun 72, p 109.
17. History of Aeronautical Systems Division, FY72, I, 161, [Hereinafter cited as Hist of ASD]; System Management Directive, SMD-1-453-329A(3), 5 May 71.
18. History of Air Force Systems Command, FY71/72, I, 201; Program Management Plan, 30mm CAS Gun System GAU-8A, PE 63605F, PMD 100-2, 10 Jun 73.
19. Requirement Action Directive (RAD), subj: Air-to-Ground Gun Systems for Close Air Support Aircraft, RAD-8-218-(1), 5 Jan 68; DCP 103, Development Concept Paper, Close Air Support Gun, 5 Jun 70, revised 23 Jun 70.
20. Hist of ASD, FY72, I, 162.
21. Memorandum of Agreement for the 30mm Close Air Support Aircraft GAU-8 Gun Program, 1 Sep 73, signed by Brig Gen Thomas H. McMullen, Dep for A-10, and Brig Gen Gerald K. Hendricks, Comdr. AFATL, (Doc 3).
22. Briefing, GAU-8/A, DSARC II, May 73.

Chapter 2: THE PROTOTYPES*

Northrop's A-9A

The A-9A was a single-place, subsonic, twin turboprop-powered aircraft designed to deliver up to 16,000 pounds of munitions. Its YF102-ID-100 non-afterburning engines rated at 7,500 pounds of thrust were located under each wing root adjacent to the fuselage. The engines were mounted as close as possible to the aircraft center of gravity to minimize pitch trim changes required by changes in power. This proximity to the centerline resulted in limited yawing under engine out conditions.¹ (Major specifications of the A-9A can be found in Appendix 1.)

As mentioned above, one of the reasons Northrop chose a lower thrust engine was that it cost less. But this selection had certain repercussions, since the smaller engine required a trade-off of a number of performance objectives. However, by increasing the wing span seven feet, Northrop hoped to meet the Air Force's low-speed maneuvering and takeoff distance requirements, including a sustained 3.5g turn at low speeds.²

Northrop further expanded its austerity effect by using other off-the-shelf equipment such as main landing gear struts from the McDonnell Douglas A-4, wheels and brakes from the Grumman Gulfstream 2, nose landing gear and strut from the Northrop F-5, and McDonnell Douglas Escape 2 ejection seat developed from the Lockheed S-3A.³

During the prototype phase Northrop was also constantly attentive to future production costs. Interchangeable left and right side parts were developed for the engines as well as for



A-9, A-X Prototype Aircraft

main landing gear flaps, speed brakes, ailerons, elevators, spoilers, and a number of other parts needed to be produced for both sides of the aircraft.⁴

Since survivability was stressed by the Air Force as a key performance goal, Northrop designed the A-9A with several such features in mind.

The A-9A airframe was constructed "with redundant critical structural members" so that an aircraft could return

* The characteristics of the prototypes were current as of June 1972.

safely after loss of a major structural member.⁵ The A-9A access doors were designed to blow out quickly in event of an internal explosion, thus preventing a pressure buildup for more serious damage. The prototype aircraft also had “redundant hydraulic systems and flight controls,” with a manual back-up mode for the controls. Control cables were distributed throughout the aircraft to minimize the chances of a single shot knockout. In addition, there were three independent



A-9 ejection test sled

foam-filled fuel tanks in each wing to thwart massive fuel loss, with one of the tanks self-sealing. A “bathtub” armor plate arrangement provided for pilot protection. The bubble-shaped canopy provided 360-degree vision at eye level and above and forward over-the-nose visibility 20 degrees downward from the centerline.⁶

Northrop maintained that with these and other features the A-9A would sustain fewer losses than conventional operational aircraft that were being employed in Vietnam. The maintenance features also appeared attractive. The engines were located chest high to allow ground-level service, and Northrop engineers speculated that an entire engine could be replaced within 30 minutes.⁷

Fairchild's A-10A*

The A-10A was a single-pace, twin engine close support attack aircraft designed to deliver up to approximately 16,000 pounds of munitions. The TF34 non-afterburning turbofan engines were rated at 9,275 pounds of thrust (static sea level). In addition, the empty and maximum takeoff gross weights of the A-10 prototype aircraft were about 23,800 and 45,600 pounds, respectively.

Like Northrop, the Fairchild Corporation sought to economize by selecting off-the-shelf equipment. Fairchild chose the General Electric TF34 turbofan engine which was originally designed for the Navy/Lockheed S-3A carrier-based, antisubmarine warfare aircraft. Also like Northrop, Fairchild was preparing for final assembly production by developing production

* Fairchild's two prototypes were also referred to as YA-10s. These prototypes competed in a flyoff against Northrop's A-9 prototypes. After winning the flyoff and subsequent contract award, the YA-10s were used in the Development Test and Evaluation program. For purpose of clarity and prevention of confusion, this writer has opted to drop the 'Y' designation and use the A-10, A-10A in reference to both the prototype and preproduction aircraft. (Major specifications of the A-10A can be found in Appendix 2.)

concepts and doing design layouts on tooling.⁸

One significant A-10A development scheme was the selection and positioning of the engines. The engine position of the fuselage above and behind the wing offered definite advantages for the aircraft. It permitted a clear underwing and fuselage for loading up to 11 pylons. The engines' positions made them less vulnerable to foreign object damage which was an important consideration since the aircraft would have to operate from rough, unsurfaced forward-area airstrips. In addition, maintenance work and reloading of ordnance could be performed while the engines were still running with minimum hazard to the ground crews, thus speeding up turnaround time. Also, mounting the engines on separate sides of the fuselage reduced the possibility of one engine knocking out the other in the event of structural failure of the first.⁹

An additional advantage which resulted from the positioning of the engine was a low wing position which allowed the landing gear to be hung from the wing, and in turn permitted wide landing tracts that offered maximum stability in operating from rough forward area landing strips.¹⁰ Like its A-9 competitor the A-10A also had various



Low angle left side view of an YA-10A during first flight on 10 May 1972 at Edwards AFB, Calif.

interchangeable parts between the left and right sides that included the landing gear, ailerons, rudders, elevators, control activators, and engines. (For major specifications of the A-10A see Appendix 1A.)

Other features of the aircraft included a nose gear which retracted fully into the fuselage and was installed to the right of the aircraft centerline to allow centerline mounting of the M6-1A1 gun. The main gear retracted into streamlined pods on the wings, exposing about one third of the tire below the wing when fully retracted. Like its competitor, the A-10A flight controls contained provisions for manual mechanical operation in the event of hydraulic failure. Armament could be carried on 11 external pylon stations located on the wings and fuselage. A self-starting auxiliary-power unit was provided to supply compressed air for engine starting.¹¹

The Air Force expected both contractors to have their prototypes ready for competitive evaluation scheduled for May 1972. Following this, the prototypes would compete in a flyoff planned for October 1972 after which one contractor would be awarded the production contract.



YA-10 prototype first flight, 10 May 1972. USAF Photo by SSgt Joseph M Carey

NOTES

1. Rept, Air Force Flight Evaluation (Systems) of the A-9A Prototype Aircraft, Tech Rept 73-2, Mar 73, pp 3, 16, prepared by AFFTC, Edwards AFB CA [hereinafter cited as Tech Rept 73-2]; Article, "Northrop Streamlines A-9A Management," *Aviation Week and Space Technology*, 26 Jun 73, pp 107-110.
2. Article, "Northrop Streamlines A-9A Management," *Aviation Week and Space Technology*, 26 June 73, p 109.
3. *Ibid.*
4. *Ibid.*
5. *Ibid.*
6. Tech Rept 73-2, Mar 73, p 3.
7. Article, Northrop Streamlines A-9A Management," *Aviation Week and Space Technology*, 26 Jun 73, pp 107-110.
8. Rept, Air Force Flight Evaluation (Systems) of the A-10A Prototype Aircraft, Tech Rept 73-3, Mar 73, p. 3, by Frank N. Lucero, Thomas R. Yechout, and Roy Bridges, Jr., AFFTC, Edwards AFB, CA [hereinafter cited as Tech Rept 73-3].
9. Article, Woods Hansen, "A-10 Prototype Designed for Production," *Aviation Week and Space Technology*, 26 Jun 72, pp 117-118.
10. *Ibid.*, p 118.
11. Tech Rept 73-3, Mar 73, p 3.

Chapter 3: COMPETITIVE PROTOTYPE PHASE AND A-9/A-10 FLYOFF

Competition between Northrop Corporation and Fairchild Industries, Incorporated for selection as system contractor included a “flyoff,” competitive criteria for the technical evaluation, operational suitability, detailed cost analysis, and negotiation of competing proposals. The competitive flight evaluation took place between May and October 1972. During this period the contractors’ flight tested their respective prototype designs. From 30 May to 24 October Northrop’s A-9A accumulated 161.6 flight hours and 125 sorties, while Fairchild’s A-10A completed 189.6 flight hours and 148 sorties from 10 May through 24 October.¹



By 10 August 1972 the Air Force had

completed and released Proposal Instructions (PI) containing all the essential requirements for continued development and testing. In compliance with these instructions the contractors met the deadline requirements and submitted technical proposals by 10 October and price proposals by 24 October 1972; these, along with the results of the “flyoff,” were used in the evaluation of each contractor’s aircraft.²

A-9/A-10 Flyoff

The actual flyoff of the A-9/A-10 began on 10 October at Air Force Flight Test Center (AFFTC), Edwards AFB, CA, with the delivery of each contractor’s first prototype aircraft and terminated on 9 December 1972. Test authority for the program was provided under Program Introduction Document P-71-7-0, submitted by the A-X System Program Office, and AFFTC Project Directive F-72-4-9. During this period the A-9 crew flew 123 sorties for a total of 146 flight hours and the A-10A was flown 87 sorties for a total of 128.5 flight hours.³

The flyoff was not conducted to determine the best A-X weapons delivery accuracies but rather to severely task the aircraft with difficult flying profiles “in attempt to severely task the aircraft with different flying profiles” in an attempt to identify and magnify differences between the aircraft.” Basically, the trails indicated that there was no significant difference in weapons delivery accuracy between the A-9 and A-10 although the A-10 held a slight edge in strafing on the 15-degree profile.⁴ The analysis of this strafing data provided the following conclusions:⁵

- a. The A-10 performs better on the 15° profile and the A-9 is slightly better on the 45° profile.

- b. When only first pass strafing accuracies are considered both aircraft are essentially the same for the 15° profile while the A-9 is slightly better than the A-10 on the 45° profile.
- c. For both the A-9 and the A-10 the first pass strafing accuracies are lower than that achieved for all passes.
- d. All four pilots perform slightly better with the A-10 in the 15° profile strafing.
- e. There are differences between the A-9 and the A-10 in individual pilot performance in the 45° profile strafing, but these differences tend to cancel each other out.

The analysis of the flyoff bombing data yielded the following findings:⁶

- a. There is no difference between the A-9 and the A-10 regardless of the bombing profile selected.
- b. There is no difference between the A-9 and the A-10 in the overall BDU-33 bombing results and both seem to be affected equally by external factors.
- c. There is a learning trend resulting in gradual improvement in BDU-33 bombing accuracy in both the A-9 and A-10 with no significant difference between the two.
- d. There is a difference in individual pilot performance between the A-9 and A-10 in BDU-33 bombing results, however, these individual differences tend to cancel each other out.

The analysis of the bombing tests flown after the competitive flyoff to establish the accuracy of each aircraft on an optimum profile found that a significant improvement was achieved in bombing accuracy by both the A-9 and A-10. But there did not appear to be a significant difference in accuracy between the two aircraft. Thus, in the absence of significant differences in delivery accuracies survivability factors assumed added importance “in the source selection process as well as in the follow-on development.”⁷



A-9 in flight with weapons load out

A-9A/A-10A CONCLUSIONS AND RECOMMENDATIONS

The overall evaluation of the A-9A was that this system could acceptably perform a close air support mission. In addition to its bombing and strafing accuracy, the aircraft exhibited other features such as armament control, visibility, pressurization, ground cockpit cooling, and maintainability, all of which complemented its capability to accomplish its mission design. However, there were some important deficiencies that unless corrected, would have hampered mission performance as well as affected pilot safety. The most notable of these included "high rudder forces upon loss of hydraulic power, unacceptable operation of the heading and reference system, and pilot discomfort caused by the ejection seat."⁸

The A-10, as well as the A-9, exhibited outstanding features such as strafing and bombing accuracy armament control, cockpit visibility, auxiliary power unit, and maintainability that enabled it to perform its mission. Also like the A-9A, the A-10A had demonstrated similar deficiencies, including engine/airframe incompatibility, general cockpit reach, unacceptable operation of the heading and reference system, pilot discomfort caused by the ejection seat and unacceptable manual reversion control in pitch.⁹ (For a detailed list of problems found in both types of aircraft, see Appendix 3.)

On 17 January 1973, the DSARC met at the close of competition to review the A-X program and to select the winning aircraft. The A-10 was chosen. Several reasons for the selection were expressed by the Secretary of the Air Force, Robert C. Seamans, Jr., at that time. The Secretary said that the A-10 had better ground handling capability, the underside of the wing had easy access, and the larger wing size provided more space for ordnance. He maintained the A-10 was closer to production than the A-9, thus the test program could progress faster with minor modification to the prototype. Secretary Seamans further added the A-10's simpler design could keep its unit recurring flyaway cost closer to \$1.4 million per unit although there was no guarantee of this. Dr. Johns Foster, Jr., Director of Defense Research and Engineering (DDR&E), commented that the pilots who had flown both prototypes preferred the A-10 for combat operations.¹⁰

On 18 January 1973 after review of the DSARC recommendation, Mr. Kenneth M. Rush (Deputy Secretary of Defense), authorized the air Force to make a source selection announcement and proceed with control negotiations to include design-to-cost objective. In the meantime, the Office of the Secretary of Defense (OSD) Cost Analysis Improvement Group (CAIG) was directed to continue its program review in order to estimate the cost of the entire program. The Air Force, however, was not authorized to sign a control for full-scale development of the A-10 until after the results of the CAIG view were presented to the DSARC.¹¹

On 8 February 1973 the CAIG presented the results of its review to the DSARC. The CAIG's estimate for 15-year life cycle operating cost in Fiscal Year (FY) 1973 dollars of a 600-plane force was estimated at \$3.158 billion as compared to a \$3.134 billion estimate by the Air Force. Further, total using flyaway costs (in FY70 dollars) of the A-10 were estimated by the CAIG at \$1.7 million with a \$1.5 million to \$2.0 million uncertainty range. The Air Force estimated the total unit flyaway cost at \$1.5 million and the contractor's estimate was \$1.4 million. The CAIG though the probability of procuring the aircraft at \$1.4 million was minimal.¹²

After reviewing the CAIG assessment the DSARC recommended that the Secretary of Defense authorize the Air Force to award the definitive engineering contract for the A-10, provided the engine contract contained provisions for:¹³

- a. Successful accomplishment of the complete QT (Qualification Test) as a demonstration milestone.
- b. Date of exercise of Option II, which commits the first substantial amount of production funds, not to precede QT completion.
- c. A “delay options” clause keyed to Option II.

The DSARC further advised that airframe and engine contracts should be cost-orientation* and both should contain provisions for extending long lead time obligations. In addition, the DSARC urged that design-to-cost goal should be \$1.5 million (FY70 dollars) with contractual incentives designed to force costs as far below this figure as possible. All contracts for airframe, engine, and other major subsystems were to be structured for periodic cost reviews. However, the procurement program was based on the CAIG’s most probable cost of \$1.7 million.¹⁴



Northrop A-9 takes off at Edwards AFB

Full Scale Development

After reviewing both the DSARC recommendations and the Air Force A-X program, the Deputy Secretary of Defense approved full-scale development of the A-10.** In his 28 February

* Cost-oriented meant that special attention should be given to keeping within the design-to-cost guidelines.

** Prototype development which occurs prior to full scale development, is the period when the system’s feasibility is demonstrated and validated. Full scale development is the period when the system is designed, fabricated, tested, and evaluated. The intended result is, as a minimum, a reproduction system that closely approximates the final product.

message to the Secretary of the Air Force, he reiterated the recommendations of the DSARC. Special attention was given to cost; engine contract had to include completion of the QT (Qualification Test) as a demonstration milestone; the design-to-cost target was to be based on total flyaway cost, not recurring flyaway costs; and the design-to-cost goal was to be \$1.5 million (FY70 dollars) with incentive to reduce this figure as much as possible. In addition, the Deputy Secretary stated that he expected the Air Force to “thoroughly review the design and eliminate any features which are not absolutely necessary for accomplishment of the close air support mission.”¹⁵

Air Force Systems Command received Air Staff authorization to award airframe and engine contracts on 1 March 1973. That same day Fairchild Industries (A-10) was awarded a \$159,279,988 cost-plus-incentive-fee contract to continue prototype aircraft testing and to develop and build 10 preproduction aircraft. General Electric was awarded a contract (F33657-73-C-0222) amounting to \$27,666,900 to develop and deliver 32 TF34 engines.¹⁶ (See Table 2 for additional information concerning the contracts.)

After reviewing the 10 March 1973 DSARC report recommending that Department of Defense (DOD) programming documents and Selection Acquisition Reports (SARs) be based on a most likely total unit fly-away cost estimate of \$1.7 million (FY70 dollars) for 600 operational aircraft, Deputy Secretary of Defense William P. Clements, Jr. asked the Secretary of the Air Force to modify and resubmit the 31 December 1972 Selected Acquisition Report and FY74 Congressional Data Sheet on the A-10. Accordingly, the Deputy Secretary declared that the new estimate (\$1.7 million) was for reporting purposes, and would not alter the prescribed total unit flyaway design-to-cost target of \$1.5 million (FY70 dollars).¹⁷

As of Date: 30 June 1973							
TABLE 2: A-10 CONTRACT INFORMATION SECTION (THEN-YEAR DOLLARS IN MILLIONS)							
CONTRACTOR COSTS	1. Initial Contract		2. Current Contract Price			Price of Completion	
	Price	Qty	Target	Ceiling	Qty	Contractor Estimate	Govt Estimate
DEVELOPMENT							
1. Fairchild Republic	\$159.3	10	\$159.4	(Ch 1)	10	\$159.4	\$187.0
2. G.E., Lynn, MA (Ch2)	27.7	32	27.3	30.5	32	27.3	30.5
3. G.E., Lynn, MA (Ch2)	14.5	0	14.9	16.3	0	14.9	16.3
4. G.E., Burlington, VT (Ch3)							13.1 A/
PROCUREMENT							
1. Fairchild Republic	110.3	48	110.3	125.3	48	110.3	110.3
2. G.E., Lynn, MA	59.3	124	59.3	65.6	124	59.3	59.3
3. G.E., Burlington, VT (Ch3)	13.2	48	13.2	14.3	48	13.2	13.7

CONTRACT IDENTIFICATION					
1. Fairchild Industries – Contract #F33657-73-C-0500; 1 March 1973	Cost Plus Incentive Fee; Definitized (Development)				
2. G.E., Lynn, MA – Contract #F33657-73-C-0222; 1 March 1973	Fixed Price Incentive Firm; Definitized				
3. G.E., Lynn, MA – Contract #F33657-73-0073; 3 November 1973	Fixed Price Incentive Firm; Definitized				
4. G.E., Burlington, VT – Contract #F33657-73-C-0682; 21 June 1973	Fixed Price Incentive Firm; Definitized (Development and Procurement)				
A/G.E. Contract Target Price is \$23.8 million. \$13.1 million represents that portion of the total contract price properly chargeable to the A-10 program element.					
<i>SOURCE: History of Air Force Systems Command, FY73, I, 199.</i>					



Front view of a YA-10, on the ground with canopy down, Edwards AFB, Calif., 1973.

SCHEDULE MILESTONES	1. PLANNING ESTIMATE	2. APPROVED PROGRAM	3. CURRENT ESTIMATE
1. DSARC II (Full Scale Dev)	Jan 73	Jan 73	Jan 73
2. Contract Award	Feb 73	Feb 73	Mar 73 (Ch1)
3. Complete 30mm Gun/A-10 Prototype Testing	Apr 74	Apr 74	Apr 74
4. DSARC IIIA (48 A/C, Initial Production)	May 74	May 74	May 74
5. Release FY74 Advanced Buy Production Funds	May 74	May 74	May 74
6. Engine MQT	Oct 74	Oct 74	Oct 74
7. Release FY75 Production Funds (26 A/C)	Sept 74	Sept 74	Nov 74 (Ch2)
8. First Flight DT&E Aircraft	Dec 74	Dec 74	Dec 74
9. Deliver First IOT&E Aircraft	Jun 75	Jun 75	Jun 75
10. Release FY76 Production, Run A (22 A/C)	Jul 75	Jul 75	Jul 75
11. DSARC IIIB (Full Production Approval)	Oct 75	Oct 75	Oct 75
12. Release FY76 Production, Run B	Nov 75	Nov 75	Nov 75
13. Deliver First Production Aircraft	Nov 75	Nov 75	Nov 75
14. Provisional Equipage IOC	Oct 76	Oct 76	Oct 76
15. IOC	Jun 77	Jun 77	Jun 77
<i>SOURCE: SAR, A-10, a/o 31 Mar 73.</i>			

A-10 Program Management

Following approval of full-scale development, the A-X System Program Office (SPO) was renamed the A-10 System Program Office on 18 April 1973. Within two months the A-10 SPO was redesignated the Deputy for A-10. Colonel Thomas H. McMullen, who was promoted to brigadier general on 19 July 1973, was named Deputy for A-10. Almost immediately, General McMullen requested Command Headquarters to make additional changes in the organizational structure of his office along with additional manpower slots since there had been a major increase in program workload concurrent with the March 1973 approval of full-scale development.

General McMullen proposed the establishment of a Management Operations Office, the division of procurement and production functions into separate directorates, and the formation of functional divisions within the program directorates. His request for additional manpower slots was eventually approved as evidenced by the following tables.¹⁸

Table 4: PROGRAM OFFICE MANNING		
(As of 30 June 1973)		
	<u>Authorized</u>	<u>Assigned</u>
<u>System Program Office</u>		
Officers	34	36
Airmen	2	2
Civilians	<u>27</u>	<u>23</u>
	63	61
<u>Collocated Personnel</u>		
<u>Engineers</u>		
Officers	8	8
Airmen	-	-
Civilians	<u>28</u>	<u>27</u>
	36	35
<u>Air Force Logistics Command</u>		
Officers	1	1
Airmen	-	-
Civilians	<u>4</u>	<u>4</u>
	5	5
<u>Tactical Air Command/Air Training Command</u>		
Officers	2	2
Airmen	1	1
Civilians	<u>-</u>	<u>-</u>
	3	3
Grand Total	107	104
<i>SOURCE: Historical Report, Dep/A-10, ASD, Jan-Jun 1973.</i>		

Table 5: A-10 MANNING (As of 31 December 1973)		
	<u>Authorized</u>	<u>Assigned</u>
<u>System Program Office</u>		
Officers	48	54
Airmen	6	7
Civilians	<u>38</u>	<u>37</u>
	92	98
<u>Collocated Personnel</u>		
<u>Engineers</u>		
Officers	14	14
Airmen	-	-
Civilians	<u>43</u>	<u>43</u>
	57	57
<u>Air Force Logistics Command</u>		
Officers	1	1
Airmen	-	-
Civilians	<u>5</u>	<u>5</u>
	6	6
<u>Tactical Air Command/Air Training Command</u>		
Officers	2	2
Airmen	1	1
Civilians	<u>-</u>	<u>-</u>
	3	3
Grand Total	158	164
<i>SOURCE: A-10 Historical Report, Dep A-10, ASD, Jul-Dec 1973.</i>		

Table 6: A-10 MANNING		
(As of 30 June 1974)		
	<u>Authorized</u>	<u>Assigned</u>
<u>System Program Office</u>		
Officers	72	65
Airmen	5	6
Civilians	<u>56</u>	<u>54</u>
	133	125
<u>Collocated Personnel</u>		
<u>Engineers</u>		
Officers	14	14
Airmen	-	-
Civilians	<u>48</u>	<u>48</u>
	62	62
<u>Air Force Logistics Command</u>		
Officers	1	1
Airmen	-	-
Civilians	<u>5</u>	<u>5</u>
	6	6
<u>Tactical Air Command/Air Training Command</u>		
Officers	2	2
Airmen	-	-
Civilians	-	-
Grand Total	203	195
<i>SOURCE: Historical Report, Dep A-10, ASD, Jan-Jun 1974.</i>		

NOTES

1. History of Aeronautical Systems Division, FY73, I, 135. [Hereinafter cited as Hist of ASD.]
2. Advanced Procurement Plan 72-1-329A, Update #3, Description of Item: Development, Fabrication, Test and Production of the A-X Close Air Support Aircraft and Related Program Requirements, 10 Oct 72.
3. Rept, Air Force Flight Evaluation (Systems) of A-9A Prototype Aircraft, Tech Rept 73-2, Mar 73, p ii, by Frank N. Jucero, James A. Ford, and Roy D. Bridges, Jr., AFFTC, Edwards AFB, Calif., [Hereinafter cited as Tech Rept 73-2]; Rept, Air Force Flight Evaluation (Systems) of A-10A Prototype Aircraft, Tech Rept 73-3, Mar 73, p ii, by Frank N. Lucero, Thomas R. Yechant, and Roy D. Bridges, Jr., AFFTC, Edwards AFB, Calif. [Hereinafter cited as Tech Rept 73-3].
4. Rept, Analysis of A-X Competitive Flyoff Data, 29 Dec 72, by Capt Ronald L. Kerchner, Study Manager; Richard H. Anderson; Capt Robert F. Couch; Lt Col William H Newhart Jr.; and Kenneth W. Smith, Office of the Asst for Study Support, DCS/Dev Plans, AFSC. (The Study Group was located at Kirtland AFB, NM but assigned to DCS/Dev Plans at HQ AFSC.)
5. *Ibid.*
6. *Ibid.*
7. *Ibid.*
8. Tech Rept 73-2, Mar 73, p 3.
9. Tech Rept 73-2, Mar 73, p 9.
10. Minutes, DSARC Review of A-X Aircraft Program – Milestone II, 17 Jan 73, (Doc 4).
11. Memo, Memorandum for the Secretary of Defense from John S. Foster, Jr., DDR&E, subj: Defense Systems Acquisition Review Council (DSARC) Recommendation on A-10, 16 Feb 73, (Doc 5).
12. *Ibid.*
13. *Ibid.*
14. *Ibid.*
15. Msg, CSAF to AFSC, subj: A-10 Program, 012216Z Mar 73.
16. See History of Air Force Systems Command, FY73, I, 203. (See Table 3, this chapter, for additional contract information.)
17. Memo, Memorandum for the Secretary of the Air Force from Dr. Foster, subj: A-10 SAR, 14 May 73.
18. Hist of ASD, FY74, I, 87.

CHAPTER 4: A-10/A-7A FLYOFF*

As early as 1972 some congressional circles had voiced concern for a comparative analysis of the A-10 and other close air support aircraft such as the A-7D and the AH-56, an Army armed helicopter. In July 1972 Dr. John S. Foster, Jr., Director of Defense Research and Engineering (DDR&E), requested that the Air Force examine the A-10/A-7 comparison issue, and provide supporting analysis in time for the revised A-X Development Concept Paper anticipated for completion by December 1972.¹

When the Congress reviewed the 1974 RDT&E Defense Budget in September 73, several factors prompted its interest for a comparative analysis of the two aircraft: the A-10's high production cost, the A-10's seemingly lack of versatility, and the rivalry of the two manufacturers, Fairchild Republic Company (A-10) and the LTV Corp of Dallas, Texas (A-7D). In addition, in a 12 September 1973 meeting with Secretary of Defense James R. Schlesinger, Senator Howard W. Cannon (Democrat, Nevada) "challenged the survivability of the A-10 in the European environment," and stressed the need for a flyoff between the A-7D and the A-10.²

Both the Office of the Secretary of Defense (OSD) and the Air Force were opposed to such a flyoff. When questioned by the Senate Armed Services Committee on 28 March 1973 as to whether he was aware that the Air Force had not pursued the Committee's earlier

recommendations for an A-10 flyoff, Secretary of Defense Elliott L. Richardson responded that it was "difficult to see how a flyoff would provide meaningful new information." He added that a flyoff would not produce data on survivability in the face of hostile fire "whereas actual test firings against A-X wing specimens have provided real data to use in vulnerability assessment." A flyoff, according to the Secretary's testimony, "would not develop



A-10 dropping a laser-guided bomb

further information on the ability to operate from badly damaged fields, nor was flyoff considered cost effective for the information it would yield."³

Lieutenant General William J. Evans,* "Deputy Chief of Staff/Research and Development at Air Force Headquarters, concurred with Secretary Richardson. When speaking before the House Subcommittee of the Committee on Appropriations on 27 September 1973, General Evans declared that studies on A-10 survivability showed that the airplane was definitely more survivable than the A-7D or "any other aircraft that we could apply to the close support role." General Evans also stated that the A-7D, F-4, and F-100 all "lack in some characteristic the

* For purposes of clarity the A-X will henceforth be referred to as the A-10.

* On 1 September 1975, Lt Gen William J. Evans became Commander of AFSC and was promoted to four-star rank.

optimum in what we are looking for in the close air support mission aircraft.”⁴

The contractor was also skeptical about any practical benefits accruing from a flyoff. On 4 February 1974 Edward G. Uhl, President and Chief Executive Officer of Fairchild Industries, stated that his greater concern about a flyoff was that it “cannot be used to evaluate all the salient characteristics of the A-10 aircraft.” An “evaluation” he said, “must...be a combination of flying characteristics, basic design features and analysis.” He also expressed his concern over the “ability of anyone to convince special interest Congressmen of the need for specific flight handling characteristics for performing the close air support mission, survivability,” and “other close air support performance parameters, especially when they are not directly evaluated through flying.”⁵

However, Air Force acceded to Congressional pressure, and on 19 September 1973 General George S. Brown, Air Force Chief of Staff, informed Senator Cannon that the Air Force would comply with congressional recommendations and conduct a flyoff. According to Senator Cannon, the flyoff would not be long or complex. The main point of this exercise was to take experienced combat pilots and let them fly both the A-7D and A-10 and provide an assessment of which plane they would prefer to fly in combat.⁶ What remained was to develop a concept and guidelines for the flyoff.

On 2 October 1973, Dr. Malcolm R. Currie, Director of Defense Research and Engineering, proposed a flyoff plan which was approved by the Secretary of Defense. In accordance with the Currie proposal, the plan called for the Deputy Director of Defense Research and Engineering for Test and Evaluation (DDT&E) in coordination with the Weapons System Evaluation Group (WSEG) to develop guidance for the test. The Air Force was charged with developing a detailed flyoff plan for submission to OSD by 1 January 1974 as well as conducting the test with DDT&E, assisted by WSEG, the assigned monitor. Later, the Air Force and WSEG were to analyze the test results and present an evaluation of the A-7D versus A-10 effectiveness in CAS mission to DDT&E.⁷



The first production models of the USAF A-7D were delivered to Luke AFB, Arizona, in August 1969 for evaluation testing. Here, we see a side view of one of the aircraft in flight piloted by Maj Charlie W. McClarren, Commander of Det. 1, 4524th Fighter Wing.

Dr. Currie’s plan further directed the Air Force to conduct the flyoff in realistic combat environment including various tactical situations, terrain, and weather. The Army was to provide the realistic ground equipment: targets, simulated Soviet defense, and related support.⁸

A further definition of the Air Force test role was provided by General George S. Brown on 10 December 1973. He designated the Tactical Air Command (TAC) as the lead command, to

exercise overall management responsibility for the effort. In addition, the participation of AFSC and the Air Force Logistics Command (AFLC) was required in all phases of the evaluation and both Commands were to provide the Army with any additional support necessary for the test.⁹

The Air Force decided that the flyoff could commence in the spring of 1974. By that time the A-10 was expected to be qualified for a maximum load factor in a representative configuration gross weight, qualification tests for some ordnance would be completed, and limited communication equipment and the depressed reticle sight would be installed. However, the aircraft would be lacking some key equipment. The GAU-8 30mm gun, head-up display, Maverick system, flare dispenser, infrared (IR) jammer, and electronic countermeasures (ECM) equipment would not be installed. In addition, the aircraft would not be qualified for maximum load factor at all gross weights nor would its external fuel tanks be qualified.¹⁰

With the above equipment and capabilities unavailable for the test, one might wonder why the flyoff was ever undertaken. While the lack of key equipment served to limit the scope of the flyoff criteria, a review of the test objectives would be in order and suffice as an explanation. As expressed in the Program Management Directive the test was undertaken to acquire evaluations by combat-experienced pilots and to assist in determining the relative capability of the A-10/A-7 aircraft in the CAS mission. In addition, the following specific data were to be collected to support the evaluations:¹¹

- The ability of a pilot to acquire targets and carry out valid attacks and reattacks under varying conditions including ceiling and visibility.
- The ability of the aircraft to take evasive maneuvers during the attack phase and the effect of these maneuvers on the defensive unit.
- Tracking of the aircraft by defensive units while carrying out attacks.
- Qualitative assessment of cockpit visibility.
- The flying and handling qualities of the aircraft throughout the entire mission envelope. These data, which were qualitative in nature, included: taxi, heavy gross weight take-off, loiter, maneuvering for and during various ordnance delivery tactics, SAM and AAA evasive maneuvers and landing. (See Table 7 for Flyoff Schedule Milestones.)

Test

The test was conducted between 15 April and 9 May 1974 with aircraft operating from McConnell Air Force Base, Kansas, against ground targets and simulated defenses located at Fort Riley, Kansas. The Fort Riley location was selected as the test site because the area size was adequate and available for maneuvers, terrain characteristics approximated the European Theater environment, favorable weather conditions prevailed, and data collection instrumentation was available (RMS-2) which minimized additional powerline installations.¹²



Close-up view of an A-10 cockpit at McConnell AFB, Kansas during A7/A-10 Flyoff on 14 April 1974. USAF Photograph by SSgt George Hardiman.

The test evaluation was conducted in two phases; Phase I, a limited, qualitative evaluation, was conducted at the respective test sites. Phase II, both qualitative and quantitative, was handled at Fort Riley. The four fighter pilots who were chosen had no prior experience with either aircraft but had extensive close air support combat experience in either the F-100 or the F-4.¹³

Table 7: FLYOFF SCHEDULE MILESTONES	
<u>Schedule Milestones</u>	<u>Date</u>
Air Staff and OSD Review of Plan	7-23 Jan 74
A-7D Training	3 Jan – 15 Mar 74
YA-10 Training	20 Feb – 10 Apr 74
Test Force in Place	8 Apr 74
Aircraft Deployment	8-11 Apr 74
Coordination Meetings/Briefings	10-13 Apr 74
Local Area Flights	12-13 Apr 74
Active Testing	15 Apr – 15 May 74
Redeployment	15-19 May 74
Reports (3) Provided to DDT&E	15 Jun 74
DSARC III Meeting	Mid to Late Jun 74
Report to Congress	Late June 74
<i>SOURCE: Program Management Directive for A-10/A-7 Fly-Off, PMD R-P4022(1), 11 Feb 74.</i>	

Breakdown of Test

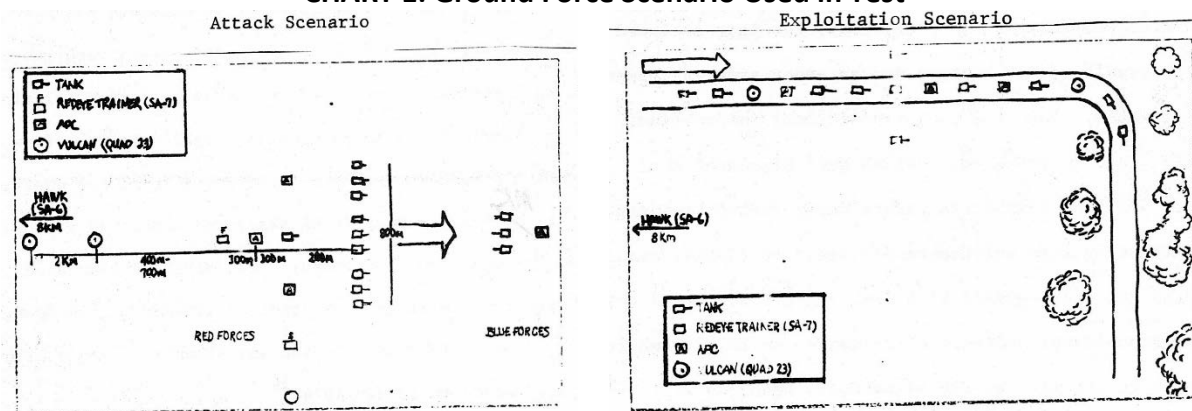
The evaluation consisted of 16 missions and each mission included two sorties, one A-10 and one A-7D. There were two basic scenarios: enemy attacks friendly forces executing delaying action, and enemy breaks through unorganized friendly force. (See Chart 1 for simulated scenarios.) The flyoff entailed three configurations: heavy (12 MK 82s), medium (6 MK 82s), and clean, as well as firings/release of bombs, ROCKEYE, napalm, and MAVERICK simulated: unlimited, 5,000 feet, 3,000 feet, and 1,000 feet. The last mission was flown on 9 May and the flyoff was officially ended on 10 May 1974.¹⁴

The test included various simulated situations including the above listed four ceilings, two types of targets – tank and armored personnel carriers (APC), five weapons types, and three load configurations as well as two scenarios. The last included a simulated frontal assault of U.S. forces and an enemy armored column exploiting a breakthrough. (see charts for additional information.)

In both scenarios, VULCAN guns simulated Soviet QUAD-23-a battery of four 23mm anti-aircraft guns, REDEYE trainers simulated SA-7 infrared-guided surface-to-air missiles (SAMs), and a HAWK battery simulated the radar-guided SA-6 SAM. Each aircraft flew 160 passes. There was no actual delivery of ordnance and MK-82 bomb loads were used primarily to familiarize the pilots with handling of the aircraft.¹⁵

Three sources of information output were used for the test: Range Measuring System II or RMS, the Cooper Harper rating system, and pilot summaries. The Range Measuring System II was an instrumentation system which provided the players position and the telemetry signals for important ground and aircraft events. The Cooper Harper system was used to evaluate aircraft characteristics such as preflight and taxi, takeoff, attack features, and landing.¹⁶

CHART 1: Ground Force Scenario Used in Test



Source: Chart part of briefing on fly-off which was provided to House Armed Services Committee (20 June 1974), Committee on Armed Services, House of Representatives.

The test results garnered by OSD/WSEG and the Air Force generally demonstrated that the A-10 was the more effective aircraft. The Air Force analysis found that the A-10 achieved greater lethality than the A-7D against CAS targets because of its larger payload and the (projected) antitank capability of the GAU-8 gun. In addition, the Air Force maintained that in a

European conflict scenario the A-10 would sustain lower initial losses than the A-7D because of its hardness and superior ability to avoid attrition from air-to-air attacks. Finally, the cost issue was addressed, with the conclusion that the A-10A was less costly than the A-7D both in terms of acquisition cost and in terms of the life cycle cost.¹⁷

The testimony of the pilots sustained the more theoretical findings. Major Willard K. Mincey maintained that when the weather was poor, he preferred the A-10. He stated, “below 2 ½ miles visibility and low ceilings, the turn rate of the A-10 provides the only airplane that will allow you to operate and maintain visual contact with the target and stay in close proximity.” Another pilot participant said that the A-10 was the “only aircraft that can handle the close air support type of mission in a full spectrum of weather operation encountered in the European scenario.”¹⁸

In June 1974, after reviewing the results of the A-7/A-10 flyoff, Secretary Clements was sufficiently satisfied to recommend to the Chairman of the Committee on Appropriations, Senator John L. McClellan, that he approve the FY75 A-10 program. Although he was optimistic about the A-10, Secretary Clements believed that DOD should make no production commitment based on the special flight evaluation results and he further recommended “that Congress afford us the flexibility to proceed as overall testing results warrant.”¹⁹ He added that he had instructed the Air Force and the Defense Systems Acquisition Review Council to schedule its action so that he would “have the opportunity to make the successive production decisions as necessary in FY75.” Secretary Clements urged the Chairman to approve the \$192.7 million for FY75 A-10 procurement and \$81.4 million for research development, test and evaluation (RDT&E).²⁰

Aftermath of Evaluation

DSARC IIIA

The DSARC IIIA that convened on 9 July 1974 remarked on the excellent progress that the Air Force had made with the A-10 program. The main purpose of the review was to assess the Air Force’s plan to initiate low rate production of the A-10 aircraft, GAU-8 gun, and 30mm ammunition. When Dr. Currie asked how the Air Force was faring with the original design-to-cost goal, Brigadier General Thomas H. McMullen, the A-10 Program Manager, responded



¾ right front view of a YA-10 armed with 28 MK-82 bombs, on ground at Edwards AFB, Calif., on 18 December 1974. USAF Photo.

that in January 1973 Secretary Clements had directed the Air Force to manage the program for \$1.5 million (in 1970 dollars, 600 aircraft) but to budget it at \$1.7 million.* General McMullen maintained that using the same ground rules as the original estimates, the SPO unit cost estimate was still within those ground rules at \$1.6 million and an independent Air Force cost estimate was at \$1.7 million.²¹

Then Mr. Arthur I. Mendolia, Assistant Secretary of Defense (Installations and Logistics) and Chairman of the DSARC review, asked Lieutenant General Alfred D. Starbird, Deputy Director of Defense Research and Engineering for Test and Evaluation, to comment about the program. General Starbird expressed the view that the DSARC should keep the Air Force's production (A-10) commitment to a minimum until more testing was done. He recommended that the program proceed with \$39 million long lead funding but retain the option for a minimum quantity (28 aircraft) until November 1974 when another test review would be made.²²

Mr. Milton A. Margolis, Chairman of the Cost Analysis Improvement Group (CAIG), commented that a 1,000-pound increase in aircraft weight since the last DSARC had caused the Air Force independent unit cost estimate to rise to \$1.7 million (1970 dollars). He maintained that almost everyone agreed with this figure; however, he was concerned with the SPO's 15-percent estimated increase in the cost of the first 48 production aircraft. Inflation statistics also worried Mr. Margolis. The System Acquisition Review's 4.9-percent escalation rate was less realistic than the Air Force's 6.8-percent estimate. Mr. Margolis concludes by complimenting the Air Force on its fine analysis of A-10 operating and support cost.²³

On 26 July 1974 Mr. Mendolia submitted a memorandum to the Deputy Secretary of Defense summarizing the DSARC review. He noted that over 400 flight hours of development phase testing of the prototype aircraft had been completed and that the contractor had corrected the deficiencies recorded at an earlier Air Force flight evaluation. The Air Force, he stated, had met the critical test milestone of demonstrating the compatibility of the prototype GAU-8 gun and the A-10 aircraft.

Mr. Mendolia also stated that the DSARC recommended the release of \$39 million for long lead fundings and approval of 52 aircraft keeping the option open for a lesser quantity (28 aircraft). He added that release of full funding slated for November 1974 would not occur until test demonstrations that had been established as program milestones were accomplished. The DSARC approval for using heavy metal production ammunition for the GAU-8 system was also mentioned.^{24*}

On 31 July 1974 Deputy Secretary of Defense Clements authorized the Air Force to proceed with initial production of the A-10 using \$39 million for long lead funding. He also granted approval to procure 52 aircraft subject to the provision that "contract options to procure a smaller quantity (that is, 28 aircraft) be kept open" until the following tests were completed.²⁵

- a. GAU-8 gun and armor piercing ammunition critical design reviews.

* \$1.5 million was the January 1973 SPO estimate and the \$1.7 million was the CAIG estimate.

* The Secretary of Defense had authorized continued development of heavy metal munitions (depleted uranium) but withheld approval to procure for inventory until after developments were completed.

- b. GAU-8 gun testing at depressed angle.
- c. GAU-8 firings, including tests for gun gas concentration, with increased barrow length and Phase II (production) ammunition with plastic rotating band.
- d. Airloads and performance tests with aircraft wing extensions.
- e. Approach to stall, stall and spin avoidance tests.
- f. Completion of engine qualification test.
- g. Egress system sled tests.
- h. Dry in-flight refueling.
- i. Additional stores certification.

Further, the Deputy Secretary of Defense noted that these tasks were scheduled for completion before the November 1974 DSARC, at which time the decision for full production funding would be made.

Colonel Samuel J. Kishline, the A-10 Deputy Director, gave the Air Force presentation. He reported to the DSARC at the November review that all tasks identified as program milestones, except the critical design review (CDR) of the armor piercing incendiary (API) round for the 30mm cannon had been completed. The GAU-8 gun alignment had been corrected by modifying the aircraft to depress the gun two degrees.* He also reported that the secondary gun gas ignition problem was also solved. This phenomenon had produced a fireball in front of the aircraft causing engine disturbances and impaired pilot vision. After several modifications had failed, the problem was finally resolved by adding a double baffled deflector and a flame suppressant to the propellant.²⁶

Engine qualification tests for the TF34-GE-100 had been completed on 31 October 1974. These tests included a high altitude position aboard a B-47 testbed aircraft; a complete environmental series comprising inlet distortion, climatic, water, steam, sand, and rocket gas ingestor testing; low cycle fatigue tests equivalent to 3,000 defined mission hours; and over-temperature and over-speed demonstrations. The engine qualification tests involved a total of 2,181 hours. Tests for stall, post-stall, and spin characteristics had also proved successful.²⁷

In compliance with his 31 July 1974 memorandum for completion of all tests prior to further release of funds, the Deputy Secretary of Defense authorized the Air Force to proceed with production of the FY75 and FY76 quantity of 52 aircraft as well as to purchase the FY75 buy of 30mm ammunition after successful completion of the critical design review. Recognizing the DSARC's concern that a possible slip in the delivery of RDT&E aircraft might cause a delay in completion of the tests required for the October 1975 DSARC IIIB, the Deputy Secretary declared that the Air Force should retain options to maintain aircraft production at a low rate. Thus, the Secretary maintained that lengthening lead times made it necessary to plan for the release of \$20 million in FY76 funds in July 1975 for the next increment of production aircraft beyond the

* When firing the GAU-8 gun on training flight during the A-10/A-7 flyoff, pilots had problems caused by the gun alignment angle. There was a tendency to fly a dangerously low "banana" pattern during low angle strafing runs.

52 authorized.²⁸

A point of concern both for the DSARC and the Deputy Secretary of Defense was the growth of the projected unit cost of the A-10. By December 1974 the Air Force estimate in FY70 dollars had been increased \$.17 million to \$1.77 million. The Deputy Secretary stated that he was disturbed that one of the first design-to-cost efforts was not making a better showing. He urged that every effort be made to avoid additional cost increases, including the use of design trade-offs if necessary.²⁹



Low angle left side view of a YA-10 armed with 28 MK-82 bombs, in flight on 18 Dec 74. USAF Photo.

NOTES

1. Memorandum for the Assistant Secretary of the Air Force (R&D) from John S. Foster, Jr., DDR&E, subj: A-X, 26 Jul 72.
2. Memorandum for Director of Defense Research and Engineering from Brig Gen Raymond B. Furlong, Dep Asst SECDEF (Legislative Affairs), 17 Sept 73, (Doc 6); USAF News Release, "SAF McLucas Speaks to Rotary in Boston," 19 Jun 74.
3. Hearings before the Senate Committee on Armed Services, 93d Cong, 1st Sess, Rept S1263, (Doc 7).
4. Hearings before the House Subcommittee of the Committee on Appropriations, 93r Cong, 1st Sess, *DOD Appropriations for 1974*, pt 7, pp 999-1001.
5. Ltr, Edward G. Uhl, Pres and Chief Exec Off, Fairchild Industries, to Gen George S. Brown, CofS USAF, no subj, 4 Feb 74, (Doc 8).
6. Cong Rec, Senate, 21 Sept 73.
7. Memorandum for Secretary of the Army, Secretary of the Air Force, Director, Weapons Systems Evaluation Group from Malcolm R. Currie, DDR&E, subj: Fly-Off Between the A-7 and A-10 Aircraft, 23 Oct 73, (Doc 9); Memorandum for the Secretary of Defense from Dr Currie, subj: Fly-Off Between the A-10 and A-7 – INFORMATION MEMORANDUM, 2 Oct 73, (Doc 10).
8. *Ibid.*
9. Ltr, Gen George S. Brown, CofS USAF, to TAC/CC, AFSC/CC, AFLC/CC, subj: A-10/A-7 Fly-off Planning, 10 Dec 73, w/atc: Test Concept Paper, (Doc 11).
10. *Ibid.*, Atch., (Doc 11).
11. Program Management Directive for A-10/A-7 Fly-off, PMD R-P4022(1), 11 Feb 74, p 2, (Doc 12).
12. AFSC Fact Sheet, "A-10/A-7 Evaluation," 4 Apr 74.
13. Memorandum for Secretary Stetson from Maj Gen Charles C. Blanton, Dir, Legislative Liaison, subj: A-7/A-10 Flyoff, 28 Jun 74.
14. Point Paper, "A-10/A-7D Evaluation," 20 May 74, (Doc 13).
15. AFSC Fact Sheet, "A-10/A-7 Evaluation," 4 Apr 74, (Doc 14).
16. *Ibid.*, (Doc 14).
17. *Ibid.*
18. Briefing by Department of the Air Force, 20 Jun 74, in Hearings before the House Committee on Armed Services, 93r Cong, 2d Sess, 20 Jun 74, *Fly-off Between the A-7 and A-10 Aircraft*, pp 16-23.
19. Ltr, William P. Clements, Jr., DEPSECDEF, to Hon John L. McClellan, Sen Comm on Approps, 20 Jun 74, (Doc 15).
20. *Ibid.*
21. Minutes, DSARC IIIA Review of A-10 Aircraft Program, 9 Jul 74, (Doc 16).
22. *Ibid.*
23. *Ibid.*, p 5.
24. Memo, Memorandum for the Deputy Secretary of Defense from Arthur I. Mendolia, Asst SECDEF (I&L), subj: A-10 Close Air Support Aircraft Program – ACTION MEMORANDUM, 26 Jul 1974, (Doc 17).
25. Memorandum for the Secretary of the Air Force from DEPSECDEF Clements, subj: A-10 Production Decision, 31 Jul 74, (Doc 18); msg, CSAF to AFSC, subj: A-10 Production Approval, 312150Z Jul 74, (Doc 19).
26. History of Air Force Systems Command, FY75, I, 255-257; History of Aeronautical Systems Division, Jul 74 – Dec 75, I, 136-139; Presentation, Col Samuel J. Kishline, Dep Dir, Dep/A-10, ASD, subj: DSARC Program Review: A-10 Close Air Support Aircraft, n.d. [ca. 19 Nov 74], in files, Dir/Prog Control, Dep/A-10.
27. Appendix, Jacob Neufeld, "Selected USAF Engine Histories," extract from Report of the Procurement Management Review of Aircraft Gas Turbine Engine Acquisition and Logistics Support, Feb 76, HQ USAF, (Doc 20).
28. Memo, Memorandum for the Secretary of the Air Force from DEPSECDEF Clements, subj: A-10 Program, 19 Dec 74.
29. *Ibid.*

CHAPTER 5: CONTRACTOR CAPABILITY ASSESSED

Even though a contract had been awarded for full-scale production, the Air Force had some misgivings about the contractor's ability to produce. This situation prompted the Air Force to send several investigative teams to point out deficiencies as well as to determine the most feasible methods for correction.

Perhaps the primary factor causing Air Force Systems Command (AFSC) executives to question Fairchild Republic Company's (FRC)* competence to move into full production was the fact that the contractor had not produced an aircraft in nine years. Thus in 1973 the Air Force Contract Management Division (AFCMD) ordered an A-10 Procurement Management Review Team (PMRT)** to evaluate FRC's production capability at both the Farmingdale, Long Island, New York and the Hagerstown, Maryland, plants. The PMRT-I report – a result of a 30 April through 11 May 1973 review – contended that while FRC possessed the competence to accomplish the research, development, test and evaluation (RDT&E) program, it did not have the capability to perform in the production program phase. The report contended that FRC's A-10 technical and managerial structure could not meet the Air Force's high rate delivery schedule during production phase. In addition, PMRT-I identified 131 discrepancies within the company's management functions that required correction by the contractor (FRC), and suggested that "continuous monitoring of FRC and corrective action by the Air Force Plan Representative (AF/PR) be coupled with Air Force high level surveillance of FRC's operations."¹ A PMRT-II investigation in February 1974 concluded that FRC had made progress in correcting deficiencies but the contractor was still not considered production ready. The FRC's lack of progress in correcting these deficiencies was being watched by the Air Force Plan Representative Office (AFPRO) at the Farmingdale, New York, plant. When FRC's president refused to provide information to the AFPRO concerning an AFPRO-proposed Farmingdale/Hagerstown plan consolidation, the AFPRO informed both the A-10 System Program Director (SPD) and the Air Force Contract Management Division (AFCMD) Commander of his doubts about the



A-10 construction

* Fairchild Republic Company is a Division of Fairchild Industries. Fairchild Republic Company handled the A-10 project.

** The PMRT acronym is more commonly known as Program Management Responsibility Transfer. Unless otherwise stated, it will be used in this study as Procurement Management Review Team.

contractor's ability to provide the A-10 at rate production.²

These events culminated in the 4 September 1974 decision of the Air Force Vice Chief of Staff General Richard H. Ellis, to conduct a review. The review, which was headed by Lieutenant General Robert E. Hails, Vice Commander of the Tactical Air Command, was conducted during 4-22 September 1974, with a team comprised of experienced technical and professional Air Force military and civilian personnel who had no prior role in the A-10 program. The primary tenet for the study team was total objectivity – to insure that no partiality be shown to findings of previous studies.³ (See Table 8 for team composition.)

Table 8: Review Team Composition	
TEAM CHIEF	Lt Gen R. Hails
TEAM STAFF	Col R.B. Kleiman (Systems Management) TSgt J. Seigler Mrs. E.F. Cook
QUALITY ASSURANCE (QA)	Col L.R. Reed (Contract Administration/ QA) Lt Col R.C. Smith (Management Engineering) Maj R.D. Suelzle (Procurement/QA) Mr. M.F. Vezeau (Procurement/QA)
SUBCONTRACTING	Col E.D. Reinhardt (Air Force Plant Representative) Lt Col W.A. Williams (Contract Administration) Maj N.W. Kuzemka (Procurement Management)
FACILITIES	Col R.E. Lix (Industrial Resources) Maj K.H. Kagiya (Production/QA) Mr. P.A. Melanese (Production)
FINANCE/CONTRACTING	Col B.E. Hunt (Procurement Policy) Lt Col J.D. Zachary (Financial Management) Maj C.T. Kenney (Financial Management/Overhead) Maj A.L. McIntye (Financial Auditing) Maj R.R. Finkbinder (Financial Management/Overhead)
MANUFACTURING	Col J.D. Tanner (Production/QA) Lt Col W.A. Wolfe (Manufacturing) Maj W. Head (Production Management)
MANAGEMENT	Col W.M. Lake (Program Management) Lt Col R.L. Bulmer (Systems Procurement) Lt Col E. Low (R&D Management)

FLIGHT OPERATIONS/SAFETY	Lt Col P.H. Blue (Flight Operations/Systems Safety)
LEGAL	Lt Col J.J. Stirk (Judge Advocate)

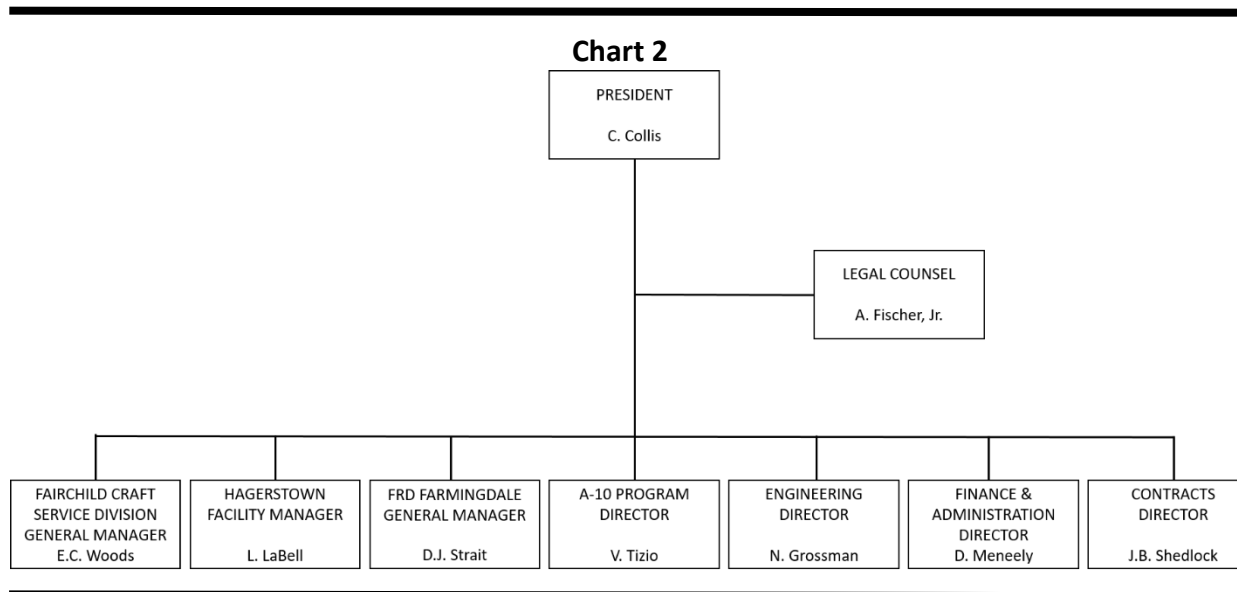
The Hails team report of findings on 30 September 1974 indicated FRC management and organization was deficient. Since its last full assembly line effort (F-105 which terminated in November 1964) the company's primary work was in subcontracting: it built wing control surfaces for the Boeing 747 and F-4 tail assemblies for McDonnell Douglas. Thus, the study team believed that FRC's top-level management organization was market-oriented and that it was neither experienced nor ideally structured to manufacture the A-10 weapon system. In addition, the study team found that the FRC-A10 program director, who was also a company vice president, had not direct control over either the Hagerstown, Maryland, or the Farmingdale, New York, facilities (see Chart 2).⁴

The team found that the two facility managers had little experience in the type of larger scale weapon systems production the A-10 would entail. Further, the integration of these two facilities was dependent upon the company president who resided at neither facility and who also served as executive vice president of the parent corporation, Fairchild Industries, located at Germantown, Maryland. Thus, the conclusion was that FRC's organization, scaled to the active role of a subcontractor, was "too complex and organizationally cumbersome to allow for efficient commitment to the A-10 production program."⁵

The team also criticized the lack of management and coordination as well as organizational relationships between the system program office (SPO) / Air Force Plant Representative Office (AFPRO)/AFCMD. The findings suggested that AFCMD should take more positive "lateral action" with the SPO in support of the AFPRO since it was found that the AFCMD occasionally did not react to the needs of the AFPRO in SPO/AFPRO relationships. This less-than-cooperative relationship between the SPO and the AFPRO had a negative effect upon FRC's responsiveness.⁶



A-10 wing construction



There were other activities targeted as undesirable by the Hails group. In the finance area the FRC was found to have overrun its internal development test and evaluation (DT&E) budget baseline by 16.1 percent at the 54.1 percent completion point and was \$3 million behind schedule. Also, major components had fallen behind schedule causing the contractor to revise his schedule for the first six aircraft which caused the SPO to project a final overrun of nearly \$12 million. The study team recommended close Air Force supervision of FRC's financial condition so as to avoid possible "degradation" of the company's cash flow to the detriment of the A-10 program.⁷

The summary conclusion set forth in the Hails report was that the Air Force should continue its support of the A-10 program and concurrently take corrective action to resolve identified management deficiencies. The Air Force was urged to require FRC to strengthen its top management, and to be more responsive to identifying and resolving problems. More specifically, the team recommended that experience-proven managers should be placed in top A-10 program positions through either immediate internal reassignment or outside recruitment.⁸

The study team also made recommendations for changes in SPO operations. The program office was to become more involved in the production subcontracting and manufacturing aspects of the program. The study team also recommended that:⁹

- The SPO should insist on timely notification of lead time changes and take action to resolve problems resulting from these changes.
- Should insist on timely notification of lead time changes and take action expeditiously to resolve problems resulting from these changes.

- Should establish formal procedures for tasking and follow up on all cited PMRT and PRR* deficiencies and insure that the AFPRO is an active participant in all phases of the project.
- Prior to full production decision, the SPO should determine whether the contractor's restructured proposal [after a November 1973 stop work order\ included all cost related to the stop work order.
- Should renegotiate with appropriate consideration, a more realistic schedule to provide for maximum contractor efficiency.
- Should follow the overall financial condition of Fairchild Industries to assure that adverse financial conditions in other divisions do not degrade the cash position of FRC to the detriment of the A-10 program.

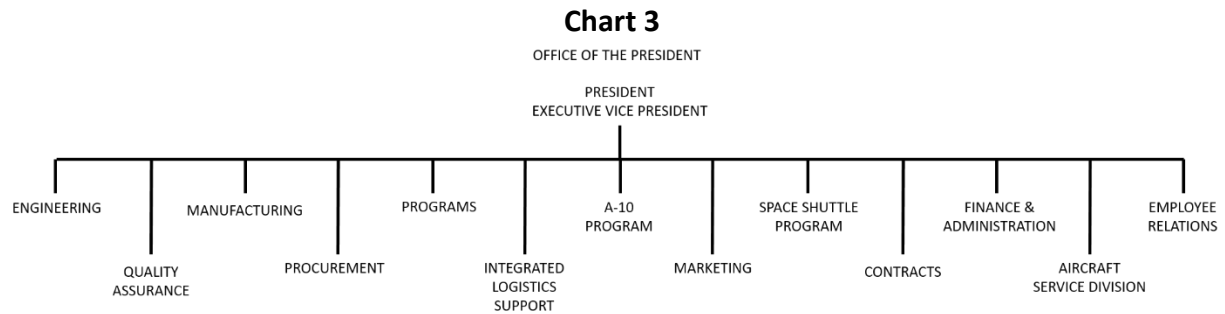
The study team also recommended the Air Force reconfirm the AFPRO role/responsibility to FRC and establish a more effective relationship between AFCMD and ASD. In addition, AFCMD was urged to review AFPRO manning to provide sufficient capability to administer the A-10 Program.¹⁰

The Hails study had definite effects upon both the Fairchild Republic Company and the Air Force. Indeed, in early 1975 FRC made sweeping changes in management, organization, and equipment, and the Air Force ordered specific review procedures to help institute the requirements suggested in the Hails' report.¹¹

For its part the Air Force in the fall of 1974 established two review mechanisms under which the Deputy Chief of Staff for Systems (DCS/S) at Air Force Systems Command would act as the focal point. In coordination with the AFPRO and AFCMD the SPO was to prepare monthly reports for submission to the DCS/S and the AFSC Commander. The second process entailed reporting when appropriate on A-10 status by the DCS/S, System Program Director, or his representative at the scheduled monthly Secretary of the Air Force Reviews. In addition, the AFPR (Air Force Plant Representative) presented a separate progress (status) report at Command Headquarters, a policy that was adopted for all programs.¹²

The Fairchild Company in January 1975 established an Office of the President with responsibility for overseeing the business side of the division while the executive vice president became responsible for all technical and production aspects of the A-10. The separate facilities at Hagerstown, Maryland, and Farmingdale, Long Island, New York, were eliminated and their functions were regrouped, and reported directly to the Office of the President.¹³ (See Chart 3 and compare it to Chart 2.)

* Production Readiness Reviews.



These changes which took place between November 74 and February 75 resulted in a reorganization that paced the Hagerstown plant under the authority of Farmingdale, negating the problem of dual managers heading individual operating centers or autonomous facilities. In addition, the new alignment took both Quality Assurance and Procurement from under Manufacturing, insuring the independence of quality control against any conflicts of interest and allowing Procurement the equality with Manufacturing that its budget size demanded. Perhaps a good assessment of what FRC was attempting to achieve was best expressed by the President, Charles Collis, who declared "These changes in organization are aimed at strengthening our major functional areas such as Procurement and Manufacturing," ... "and to improve our capability of detecting and correcting the root causes of possible deficiencies in our operation."¹⁴

Mr. Collis' statement proved to be a harbinger of his own future, since on 20 March 1975* he was replaced by Dr. Norman Grossman who had been involved with FRC aircraft design, development, and construction for 32 years. Other personnel changes included a new Director of Procurement, Senior Quality Assurance Engineer, Government Property Administrator, Deputy Director/Quality Assurance, Deputy Director/Procurement, Safety Manager, and Manager of Special Projects and Quality Assurance.¹⁵

The Air Force also made manpower changes. Additional manpower was approved for both the AFPRO and the SPO (see Table 10 for SPO manning). That same month AFPRO manning increased from 83 (18 military, 65 civilian) to 112 (18 military, 94 civilian). In addition, organizational changes and new management structures abetted AFPRO capabilities and inter-organizational cooperation. On 6 November 1974, Colonel Jay R. Brill (promoted to brigadier general on 1 June 1975) succeeded Brigadier General Thomas H. McMullen as A-10 System Program Director.¹⁶

* This date furnished by Mr. Roy E. Wendell, Director of Public Relations, Fairchild Republic Company Farmingdale, L.I., New York, 111735, on 3 August 1978.

In compliance with the Hails report recommendation, FRC made considerable progress toward replacing its overaged machinery and increasing its make/buy ratio for “major machined parts for the A-10 from 23:77 to about 55:45.” In early 1975, the FRC determined that the improved ratio would sustain a 20-aircraft-per-month production rate. The contractor hoped that by the time of full A-10 production these improvements would place FRC’s machinery on a par status with all other aerospace companies having major contracts.¹⁷

Fairchild planned to spend about \$20 million on new machine tools, subtracting a portion of the cost by soliciting some equipment from the Defense Industrial Plan Equipment Center (DIPEC) pool. Some of the new equipment included 15 advanced numerically-controlled (N/C) milling machines, 2 or 3 tape-controlled drilling machines, and 3 or 4 machining centers to do a variety of operations on the same piece automatically – “drill, bore, machine and automatically change tool head as required.”¹⁸



Brigadier General Jay Brill looks over the GAU-8 during a visit of the A-10 production factory.

The Air Force’s assessment of FRC’s updating (machinery) program concurred with the contractor. In August 1975 the Air Force considered all of the Fairchild-owned machinery as serviceable. It recognized that extended efforts were being pursued by the contractor to modernize his machinery. In addition, the Air Force identified 28 pieces of industrial plant equipment slated for delivery to the contractor from Government sources and was aware of FRC’s plans to purchase 3 numerically-controlled (N/C) machines and refurbish another 23 pieces.¹⁹

Financial Progress

As a normal procedure, the Air Force kept aware of the financial status of its contractors. But in September 1975 after Senator John L. McClellan, Chairman of the Committee on Appropriations, sent a series of questions about the A-10 program to Secretary of the Air Force, John L. McLucas, the Air Force made a concerted effort to track closely FRC’s financial progress by comparing the contractor’s monthly cost performance report against their resources plan.*

* This resource plan was a quarterly Contract Funds Status Report (CFSR) that provided FRC’s commitments and expenditures at present and to contract completion. This was a normal Air Force procedure.

The program office examined these monthly reports with specific emphasis on evaluating any divergence from previous established policy.²⁰

The Air Force found that FRC's cost performance in relation to target cost on A-10 full-scale development had been marginal, but it had been anticipated and budgeted for by the SPO. As of 29 June 1975 the cost performance data were:²¹

	Dollars in Millions
Budgeted Cost of Work Performed	\$123.8
Actual Cost of Work Performed	158.8
Target Cost	146.9
Estimated Cost at Completion	171.2
Target Price	158.7
Estimated Price**	175.7

At that time Fairchild's costs had exceeded its target cost by \$6.9 million, and the contractor was predicting that cost at completion would exceed target by \$24.3 million, which equated to an FRC estimate of \$17.0 million additional cost to Government over target cost. The SPO concurred with these numbers and maintained that these figures had been consistently reported to the Congress in the Selected Acquisition Reports (SARs) since 1973. In fact, the SPO argued that as the contract neared completion, FRC's estimates were approaching those of the Governments.²² (See Chart 4.)

Table 9: A-10 MANNING		
As of 31 December 1975		
	<u>Authorized</u>	<u>Assigned</u>
<u>System Program Office</u>		
Officers	83	80
Airmen	13	10
Civilians	<u>64</u>	<u>58</u>
	160	148
<u>Collocated Personnel</u>		
<u>Engineers</u>		
Officers	10	10
Airmen	1	1
Civilians	<u>50</u>	<u>50</u>
	61 + 8*	61 + 8*
<u>Air Force Logistics Command</u>		
Officers	2	2

** Price includes profit whereas cost does not include profit.

Airmen	0	0
Civilians	<u>10</u>	<u>8</u>
	12	10
<u>Tactical Air Command/Air Training Command</u>		
Officers	2	2
Airmen	1	1
Civilians	<u>0</u>	<u>0</u>
	3	3
<u>TOTAL</u>	238 + 8*	222 + 8*
* Engineers assigned as needed on a part-time basis.		
SOURCE: A-10 Historical Report, July-December 1975; History of Aeronautical Systems Division, July 1974 – December 1975, I, 129.		

The Air Force also confirmed that the FRC had kept to its predicted DT&E delivery schedule for six aircraft. The original schedule had called for delivery of DT&E aircraft to begin December 1974 with the 6th aircraft delivered June 1975. Fairchild intended to retain this schedule but vendor deliveries and other factors added to the delay, thus a new schedule was agreed upon. The contractor adhered faithfully to this new schedule and by September 1975 all six DT&E aircraft had been delivered.²³

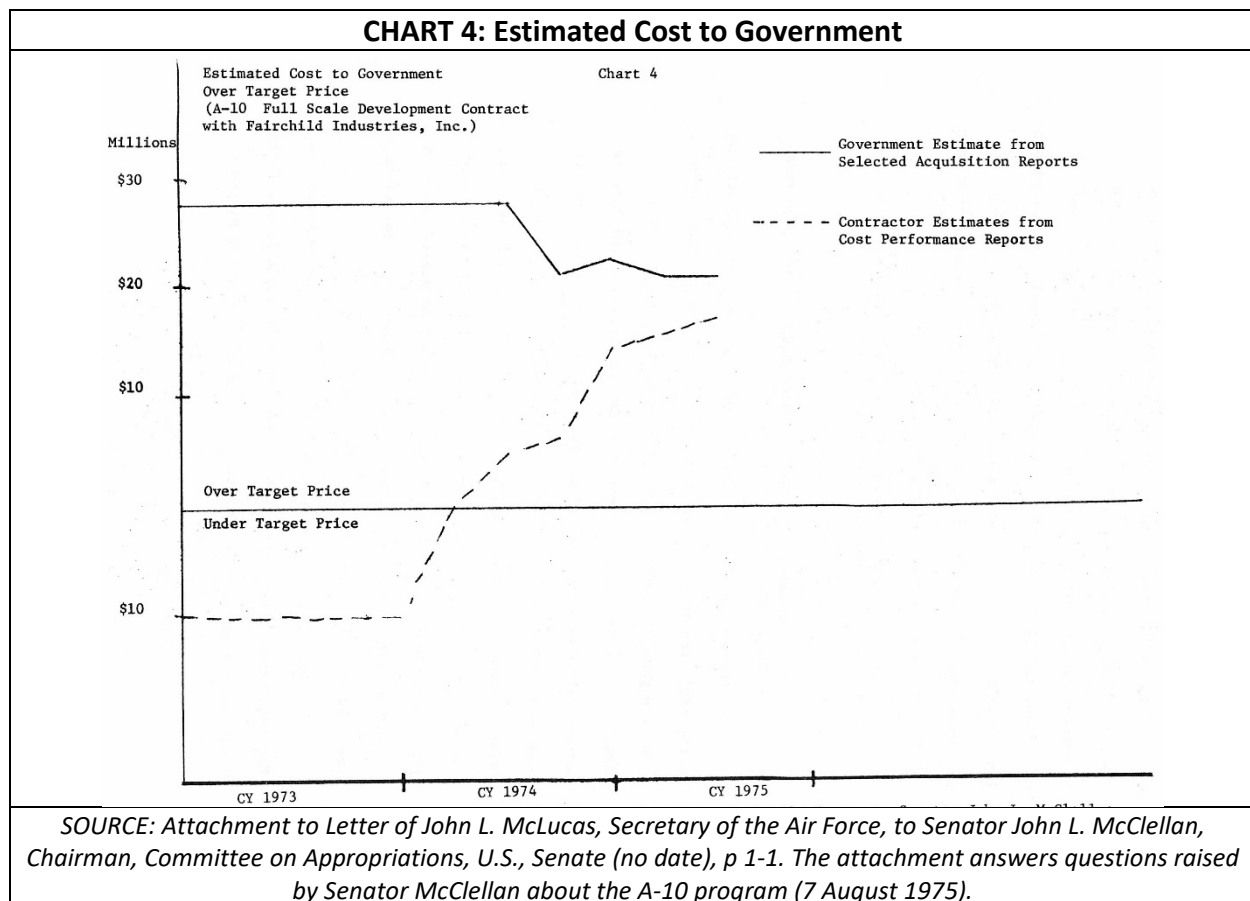
<u>Old Schedule</u>	<u>New Schedule</u>
Aircraft #1 – Dec 74	Aircraft #1 – Feb 75
Aircraft #2 – Feb 75	Aircraft #2 – May 75
Aircraft #3 – Mar 75	Aircraft #3 – Jun 75
Aircraft #4 – Apr 75	Aircraft #4 – Jul 75
Aircraft #5 – May 75	Aircraft #5 – Aug 75
Aircraft #6 – Jun 75	Aircraft #6 – Sep 75

Redistribution of Workload to Hagerstown

One of Hails' study recommendations was that additional Air Force capability be established within the contractor facility to machine critical parts to aid maintenance of schedule during peak production. The increase of machine capability at the Farmingdale plant lessened the area available for assembly.²⁴

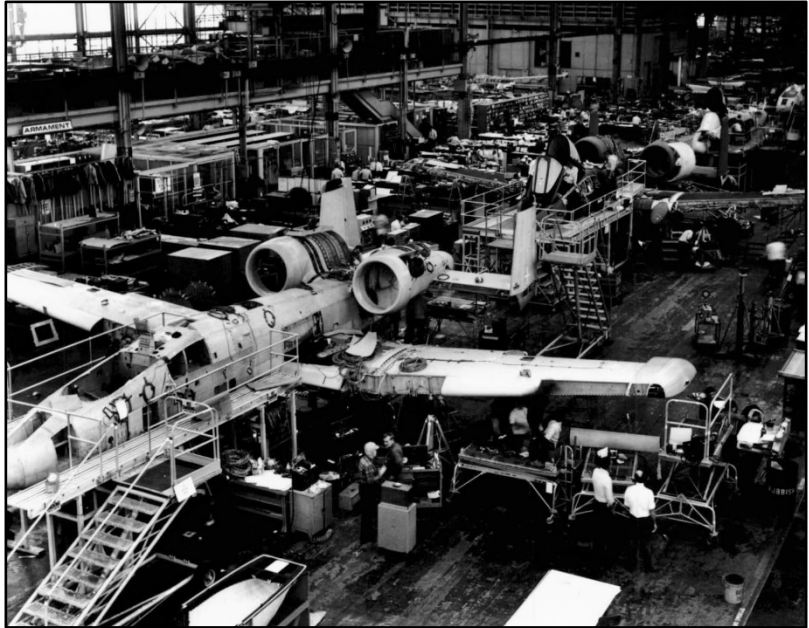
In an attempt to correct this deficiency FRC President Charles Collis in early January 1974 suggested that 20-41* percent of the workload be shifted from New York to the Hagerstown location. One feature of this plan was the transfer of flight testing and acceptance to the Maryland plant on the premise that there would be more favorable flying weather and that the tests would take place over land instead of over water and metropolitan area. Mr. Collis projected that the move would save \$8.5 million over a five-year span and listed several reasons for these savings:²⁵

- Capitalization at Farmingdale would be avoided since facilities existed at the Hagerstown plant.
- Labor rates would be lower at Hagerstown.
- Fixed overhead was lower at Hagerstown primarily because of the much lower property taxes.



* Since winning the contract FRC had planned to build 90 percent of the A-10 at the Farmingdale facility and 10 percent at Hagerstown.

There were also political as well as economic implications in the projected move with the key issue being jobs. After the news about the possible shift became public (January-February 1974) members of the New York Congressional delegation urged the Defense Department to persuade FRC not to go ahead with the move. One New York Representative, Tom J. Downey (Democrat, West Islip, Long Island), informed the Secretary of the Air Force, John L. McLucas, in February 1974, that such a move would entail the loss of 1,000 jobs. Representative Downey considered a shift to Hagerstown as a “breach of faith” because FRC had assured the New York members that the A-10 would be produced entirely on Long Island.²⁶



A-10 production

From 3 to 7 February 1975 an Air Force team examined the FRC recommendation to ascertain whether the move would be beneficial to the Government and detrimental to the A-10 production process. After completing the study, the team concluded that less than \$1 million would be saved.



A-10 production

After several briefings were held between February and March 1975 by Brigadier General Jay R. Brill, A-10 Program Director, before an audience that included Secretary McLucas; the Air Staff; and General Samuel C. Phillips, Commander of the Air Force Systems Command, an Air Force decision was reached. On 31 March 1975 the Secretary of the Air Force announced that the Air Force was not adverse to moving some A-10 workload to Hagerstown. Another reason for the Air Force's willingness to concede to the Hagerstown shift was that Acceptance Flight Testing was more difficult to perform over a highly populated area like New York, a problem other aircraft

manufacturers such as Grumman had already experienced. Also, the Hagerstown facility had a competent labor force available.²⁷

Another recommendation of the Hails group that produced a myriad of Air Force correspondence concerned the AFCMD/AFPRO/SPO organizational structure. The recommendation, made directly by General Hails, urged the elimination of AFCMD's control nearly 30 AFPROs and the placement of them under the direction of the "dominant" SPO or major AFSC division. General Hails believed this realignment would also the AFPRO to be more responsive to the SPO and allow the latter to acquire a greater "sense of responsibility for the attitudes, disposition and responsiveness" of the day-to-day operation of the contractor. He maintained that Air Force's cognizance over the plant could be better sustained if it were placed under the direction of the SPO, and resources assigned to AFCMD could be reduced by cutting it back to a "policy/staff surveillance element of Headquarters AFSC with approximately 50-75 personnel."²⁸

General Hails admitted that his plan did have some disadvantages. For example, he foresaw a difficult situation as to which SPO would be responsible for an AFPRO that was responsible for several major programs. However, he believed that the problem could be resolved by designating the senior resident officer of the AFPRO as the authority who could effectively negotiate issues common to all contractor-involved program such as overhead rates. He also suggested, when conflicts of priorities between programs were involved, the solution would be decided at higher levels (Command Headquarters). General Hails acknowledged that while these recommendations were not solely the product of the A-10 issue, his investigation could have been avoided if the AFPRO had been responsible to the SPO.²⁹

In October 1974 when General R. H. Ellis, Air Force Vice Chief of Staff, queried the AFSC Commander, General Samuel C. Phillips, for his views regarding General Hails' suggestions for the realignment of AFCMD, General Phillips responded in December 1974 and recommended no change in the AFCMD status.³⁰ General Phillips noted that AFCMD served as a vital link in the acquisition process "by providing uniform guidance and procedures to AFPROs to insure consistent application in dealing with contractors." General Phillips agreed that AFPROs do not operate outside the mainstream of weapon system technical direction and at designed AFPROs, deputy Air Force Plan Representatives (AFPRs) "are established for specific programs and assigned people totally dedicated to these programs." In addition he declared that while disestablishment of AFCMD and transfer of functions to AFSC might provide minimal manpower savings, those functions might eventually be dissipated and dispersed "by the primary headquarters' activities and pressures to reduce the size of the headquarters." Listing some of the innovative programs instituted by AFSC such as "establishment of a business management function to focalize [sic] on contractor's overhead management, emphasis on prime contractor management of subcontractors, and reduction of the production function from routine surveillance to involvement with the contractor's manufacturing operation," he maintained that the disestablishment of AFCMD would almost certainly inhibit these important innovation efforts.³¹

General Phillips' arguments settled the question. On 24 December 1974 General Ellis recommended to the Air Force Chief of Staff that any further action on the dissolution of AFCMD

be discontinued since General Phillips had established close ties among AFCMD, ASD, and the AFPROs.³²

Although FRC took positive steps toward correcting the management and organizational ills illuminated by Air Force investigative teams, several deficiencies lingered on. In June 1975 Colonel Merton W. Baker, the AFPR at FRC, maintained that while about 15 Review Team discrepancies still remained uncorrected, several were related to single causes. He stated that individual deficiencies would be righted when a consultant firm completed its study and FRC took appropriate actions. But since some differences were being covered by the Contractor Management System Evaluation Program (CMSEP), he urged that AFCMD take cognizance of the fact that it was duplicating the investigative process. He decided that the CMSEP function was



High angle front view of YA-10 during icing tests at Edwards AFB, Calif. on 4 April 1975. USAF Photo.

doing the job and that it was expected to continually reopen issues covered adequately by the CMSEP. Thus Colonel Baker advised the discontinuance of PMRT to investigate FRC and urged complete reliance on the CMSEP method.³³

The pre-award surveys* of FRC should have identified many of the faults which subsequent Air Force teams revealed in the organizational capabilities at FRC, even though this would not necessarily have prevented FRC from winning the production

contract. This type of survey was an Air Force requirement that was carried out before contracts of this kind were made. It determined a company's capacity, capability, and financial condition. However, the initial Air Force survey team rated FRC as satisfactory in areas where the contractor later proved deficient.

Yet the Air Force wanted FRC's A-10, and FRC not only had successfully competed against six other companies for the best design but also had won a flyoff against Northrop's A-9. Then, too, the Air Force could have shifted from one contractor to another for full-scale development. To change production contractors would introduce divergent conceptual approaches to manufacturing, developing, and producing the aircraft that would be difficult if not impossible to rationalize. So the Air Force stayed with Fairchild; in fact by the time the Air Force had refurbished Fairchild's machines, upgraded its facilities, and aided in correcting its managerial and

* Pre-award surveys took place before the Development Contracts were awarded in December 1970.

organizational defects, the company's posture would have made it a good competitor on several major programs. Thus after the initial erroneous assessment of FRC capabilities the Air Force was able to turn around the manufacturing capability of the contractor so that they could effectively produce the A-10 on a required schedule.³⁴



Low angle ¾ rear view of YA-10A, in slight bank to right, showing three external fuel tanks near center and three stores pylons on each wing at Edwards AFB, Calif. on 22 September 1975. USAF Photo.

Notes

1. Report Relative to Production Readiness Posture of the A-10 Program, 4-30 Sep 74, p 15. (Sometimes called the Hails Report after Lt Gen Robert E. Hails, Vice Comdr TAC, who headed the review team.), (Doc 21).
2. *Ibid.*, pp 3-4.
3. *Ibid.*, p 4.
4. *Ibid.*, pp 22-25.
5. *Ibid.*, pp 25-28.
6. *Ibid.*, pp 29-33.
7. *Ibid.*, pp 36-37.
8. *Ibid.*, pp 69-70.
9. *Ibid.*, pp 70-71.
10. *Ibid.*, p 71.
11. Ltr, John L. McLucas, SECAF, to Sen John L. McClellan, Chmn, Comm on Appropriations, U.S. Senate n.d., w/atrch, p 1-1. The attachment answers questions concerning the A-10 program posed by Senator McClellan on 7 Aug 75, (Doc 22).
12. *Ibid.*, p 1-1, (Doc 22).
13. Article, Warren C. Wetmore, "A-10 Program Approach Reshaped," *Aviation Week and Space Technology*, 10 Feb 75, pp 44-55, (Doc 23).
14. *Ibid.*, p 45, (Doc 23).
15. Ltr, Secretary McLucas to Sen McClellan, n.d., Atch, p 1-1, (Doc 22).
16. *Ibid.*, p 3-1, (Doc 22).
17. Article, Warren C. Wetmore, "A-10 Program Approach Reshape," *Aviation Week and Space Technology*, 10 Feb 75, p 46, (Doc 23).
18. *Ibid.*, (Doc 23).
19. Ltr, Secretary McLucas to Sen McClellan, n.d., Atch, p 6-3.
20. Ltr, Senator John L. McClellan, Chairman of the Community on Appropriations to Honorable John L. McLucas, Secretary of the Air Force, 7 August 1975 with attached questions; Ltr, Secretary McLucas to Senator McClellan, n.d., Atch, p 4-4 (Doc 22).
21. *Ibid.*, p 4-1.
22. *Ibid.*, p 4-1, 4-3.
23. *Ibid.*, p 4-2.
24. *Ibid.*, p 6-1.
25. Ltr, Mr. Charles Collis, Pres, Fairchild Republic Co, to Col Merton W. Baker, Comdr AFPRO, Fairchild Republic Co, 3 Jan 75, (Doc 24).
26. Article, *New York Times*, 27 Feb 78, p 59.
27. History of Air Force Contract Management Division, 1 Jul 74 – 31 Dec 76, I, 66; This information was provided by Major Rodney Sayles, Systems Officer for the A-10 Program at HQ AFSC (September 76 to July 1979), and later Program Element Monitor for the A-10 Program at HQ USAF.
28. Memorandum for General Richard H. Ellis from Lt Gen Robert E. Hails, subj: AFPRO/CMD Organization, 26 Sept 74, (Doc 25).
29. *Ibid.*
30. Ltr, Gen R.H. Ellis, VCS USAF, to Gen Samuel C. Phillips, Comdr AFSC, 3 Oct 74, (Doc 26).
31. Ltr, Gen Phillips to Gen Ellis, 20 Dec 74, (Doc 27).
32. Memorandum for General David C. Jones, CofS USAF, from Gen Ellis, 24 Dec 74, (Doc 28).
33. Ltr, Col baker to AFCMD/CC, 11 Jan 75, (Doc 29).
34. These views were supported by an interview, Dr. George M. Watson, Jr., Ofc of Hist, AFSC, with Brig Gen Merton W. Baker, Comdr, AFCMD, 15 Nov 78.

Chapter 6: TEST PREREQUISITES FOR DSARC IIIB

As previously noted, late receipt of vendor items, tooling, and critical materials caused a two-month delay for the first flight of the development test and evaluation (DT&E) aircraft – 15 February 1975. Consequently, the date for DSARC IIIB was moved from October 1975 to February 1976. However, prior to full production approval (DSARC IIIB) of the A-10 the Air Force still had to complete certain tests.¹

Tests completed with the DT&E aircraft before the end of 1975 included freedom from flutter, initial performance measurements, flying qualities, GAU-8/A-10 accuracy demonstration, aerial refueling, laser spot seeker (PAVE PENNY) integration, bombing accuracy, combat ammunition performance (fired at tanks, trucks, and armored personnel carriers), and Initial Operational Test and Evaluation (IOT&E) (conducted by the Air Force Test and Evaluation Center (AFTEC)). The following were the specific test objectives required prior to full-scale production decision. All objectives established for that stage were completed with the exception of the fatigue failure testing:²

- Investigation of stall/post stall/spin characteristics
- Further verification of operational suitability and military utility, and operational effectiveness to include:
 - An analytical assessment of the A-10 capability in the face of the postulated threat
 - Target acquisition, attack, and reattack
- Further assessment of A-10/GAU-8 compatibility to include strafe safety accuracy
- Bomb weapon delivery accuracy demonstration
- Initial evaluation of reliability, maintainability, and supportability
- Demonstrate critical static loads to ultimate loading conditions
- Complete one lifetime of fatigue testing



Rear view of YA-10 aircraft in slight dive, with one AGM-65 Maverick missile on right wing and left wing equipped with an LAU-8 Launcher but no missiles at Edwards AFB, Calif. on 18 December 1975. USAF Photo.

Stall/Post Stall/Spin Characteristics

The Air Force designed Stall/Post Stall/Spin Characteristics testing to include 40 sorties to ascertain aerodynamic and engine characteristics at high angles of attack, stall warning, susceptibility to depart from controlled flight, and susceptibility to spin. Additional tests were planned to further evaluate the PAVE PENNY and aural stall warning. By September 1975 AFTEC concluded that the test results were excellent.³



YA-10 with spin chute during spin characteristics testing.

Airloads Testing

The Air Force realized that full 100-percent flight airloads testing of the A-10 would not be completed by DSARC IIIB. A 1 August 1975 meeting of Air Force, National Aeronautics and Space Administration, and Director of Defense Research and Engineering (DDR&E) representatives led to a decision by DDR&E to drop the requirements for 100-percent airloads testing prior to DSARC. At this meeting it was agreed that the 80-percent airloads testing performed earlier by the prototype provided sufficient evidence to support a prediction that the DT&E aircraft could carry the additional 20-percent of ordnance. In any case, the Air Force estimated that this 100-percent testing would be completed by June 1976.⁴

A-10/GAU-8 Compatibility

During more than 60 flights with the GAU-8 30mm cannon, 39,000 rounds of ammunition were expended. The gun was fired from 100 feet to 25,000 feet altitude at speeds from 135 to 415 knots, at 0 to 5 g's during slips, banks, and high angles of attack. There were no gun or aircraft malfunctions until 12 November 1975 when the gun jammed causing mission cancellation.

One problem for which a quick solution was found entailed the pilot's loss of vision when gas residue from the gun collected on the canopy. Since the solution was simple – the installation of a wash system to clean the canopy – the Air Force planned to incorporate a standard wash system with the #16 production aircraft and have retrofit kits ready for earlier models by June 1976. The gun gas phenomena also was suspected of compromising engine performance, but engine cleaning solvents successfully dissolved the gas residue.⁵



¼ left front view of YA-10 aircraft as ammunition is loaded into GAU-8/A 30mm gun using munition barrel loader in February 1975 at Edwards AFB, Calif. USAF Photo.

Fatigue Testing

One of the pre-DSARC IIIB test requirements for the A-10 was one lifetime of fatigue testing equaling 6,000 hours. Progress toward this end proceeded without incident with about 80 percent of lifetime testing completed when, on 23 September 1975, a crack appeared on the fuselage frame. Reinforcement of the area corrected the problem and testing resumed with the 6,000-hour mark achieved on 28 October 1975. The Air Force planned to retrofit the reinforcement process on #6 DT&E and #7 production aircraft. The revised production frame was expected to be ready for Aircraft #14 sometime in mid-1976.⁶

In addition to the above tests, the Air Force also planned follow-on testing which would continue after DSARC IIIB. Among these were:⁷

- Flying qualities, performance, and propulsion testing
- Completion of airloads testing
- Stores certification
- Climate Testing
- Systems Evaluation
- Verification of technical data
- Reliability, maintainability, and supportability analyses
- Development of optimum tactics
- Normal and emergency procedures

- Evaluation of cost of ownership
- Identification deficiencies to determine mission areas or systems requiring further testing
- Evaluation of aerospace ground equipment

The Air Force satisfied the requirements of the Defense Systems Acquisition Review Council (DSARC) and on 10 February 1976 the Deputy Secretary of Defense, William P. Clements, signed the Development Concept Paper and authorized the Air Force to proceed with the production of the A-10 at a maximum rate of 15 aircraft per month. The Air Force was now assured of its first specialized close air support aircraft – an airplane that would provide “close supporting fire, armed escort and armed reconnaissance in a battle area involving anti-tank and anti-mechanized vehicle operations in close proximity to friendly ground forces.”⁸ On 30 March 1976 at Langley Air Force Base, Virginia, the Commander of the Tactical Air Command, General Robert J. Dixon, formally accepted the A-10* from the Commander of the Air Force Systems Command, General William J. Evans.⁹



High-angle, front view of several A-10 close support aircraft with various test paint coverings that were flight tested under simulated close air support.

By mid-1976 FRC had made excellent progress at correcting deficiencies pointed out by the various Air Force investigative efforts. However, AFSC was dissatisfied with FRC's approach to quality assurance. General Evans, after a visit to the Farmingdale and Hagerstown facilities, in May 1976, wrote that he hoped this problem could be resolved. The General was particularly pleased with the transition of “the flight assembly and test function” at the Maryland plant as well as with the facility's capacity.¹⁰

* This was a production aircraft.



A-10 with various armament

Table 10

System: A-10 AS OF DATE: 31 March 1976

SCHEDULE SECTION

SCHEDULE MILESTONES	SCHEDULE SECTION		
	1 <u>DEVELOPMENT ESTIMATE</u>	2 <u>APPROVED PROGRAM</u>	3 <u>CURRENT ESTIMATE</u>
1. DSARC II (Full Scale Dev)	Jan 73	Jan 73	Jan 73*
2. Contract Award	Feb 73	Feb 73	Mar 73*
3. Complete 30mm Gun/A-10 Prototype Demo	Apr 74	Apr 74	May 74*
4. DSARC IIIA (Initial Production) (52 A/C)	May 74	May 74	Jul 74*
5. Release FY75 Long Lead Prod Funds	May 74	May 74	Jul 74*
6. Engine Qualification Test Complete	Oct 74	Oct 74	Oct 74*
7. Release FY75 Production (22 A/C)	Sept 74	Sept 74	Dec 74*
8. First Flight DT&E Aircraft	Dec 74	Dec 74	Feb 75*
9. Release FY76 Prod, Run A (30 A/C)	Jul 75	Jul 75	Jul 75*
10. DSARC IIIB (Full Production Approval)	Oct 75	Oct 75	Feb 76* (Ch 1)
11. Release FY76 Prod, Run B (23 A/C)	Nov 75	Nov 75	Feb 76* (Ch 1)
12. Deliver First Production Aircraft	Nov 75	Nov 75	Nov 75*
13. Provisional Equipage IOC	Oct 76	Oct 76	Feb 77
14. IOC	Jun 77	Jun 77	Jan 78

UNITS ACCEPTED TO DATE

Development

CPP

FSD

Procurement

<u>PLAN</u>	<u>ACTUAL</u>
4	4
6	6

SOURCE: SAR, A-10, 31 Mar 76.

A/ includes 2 A-9 Prototypes; * Denotes actual date of completion.

SYSTEM: A-10 AS OF DATE: 31 March 1976

Table 11
TECHNICAL SECTION

OPERATIONAL/TECHNICAL CHARACTERISTICS	1 DEVELOPMENT ESTATE	2 APPROVED PROGRAM	3 DEMONSTRATED PERFORMANCE/A/	4 CURRENT ESTIMATE
<u>Operational</u>				
1. Cruise Speed (k)	300	300	342*	342
2. Forward Airstrip T.O. & Land Roll, 4 MK-82, 750 rds 30mm ammo (ft)	T.O. 1,200 Land 1,200	1,200 1,200	1,900 1,460	1,900 1,460
3. Loiter time at 250NM Radius, 18 MK-82, (hr)	2	2	1.8	1.8
4. Bombing Accuracy, MK-82 (CEP) (ft)	112	112	101*	101
5. Strafing Accuracy, (CEP) (mils)	10	10	4*	4
6. Sustained Load Factor, 6 MK-82 & 750 rds ammo at 275 k (g)	3.5	3.5	3.2	3.2
at 150 K (g)	2.2	2.2	2.0	2.0
<u>Technical</u>				
1. Weight Empty (lb)	19,260	19,260	20,850	20,850
2. Maximum Gross Wt (lb)	45,640	45,640	47,400	47,400
3. Maintainability (Manhours/ft hr)	12	12	12	12

* Meets or exceeds contractual guarantees. Δ/ Mean value
SOURCE: SAR, A-10, 31 Mar 76

Table 12
PROGRAM COST SECTION (Dollars in Millions)
 AS OF DATE: 31 March 1976 BASE YEAR: FY 1970

1	2	3	4	5	6	7	8
PROGRAM COST SECTION	CHANGES	CURRENT ESTIMATE (FY70-81)	CURRENT & PRIOR YRS	BUDGET YEAR	BALANCE FYDP	TO COMPLETE BEYOND FYDP	TOTAL
1. ACQUISITION COST							
DEVELOPMENT			DEVELOPMENT	\$ 12.9	\$ 43.4	\$ -	\$ 442.6
CPP			CPP	-	-	-	84.5
FSD			FSD	12.9	43.4	-	338.1
PROCUREMENT			PROCUREMENT	604.9	2507.3	-	3782.2
Airframe			CONSTRUCTION	-	-	-	-
Engine			Total	\$ 617.8	\$ 2550.7	\$ 0	\$ 4204.8
Avionics							
Armament			<u>QUANTITIES</u>				
Peculiar Support			DEVELOPMENT	-	-	-	10
Initial Spares			PROCUREMENT	100	538	-	733
CONSTRUCTION			Total	100	538	-	743
Total (FY70\$)							
ESCALATION							
TOTAL PROG COST							

Column 1 reflects the estimate of program cost at the time of Development Estimate Approval (FY70) at which time the provision for escalation was \$721.3M based on a rate of 4.6% annually through FY83. The Current Estimate, Column 3, includes adjustments for program changes and economic change greater than initially assumed. For FY77, annual escalation rates of 7.0% for RDT&E and 7.2% for Procurement are assumed, with an average annual escalation rate of 5.7% extending through FY83. The table below indicates the change to the Current Estimate of \$4202.8M which would result from other rate assumptions.

2. QUANTITIES	3	4	5	6
DEVELOPMENT	ESTIMATE (FY70-81)	CHANGES	CURRENT ESTIMATE (FY70-81)	ESCALATION RATE
DEVELOPMENT	14	-4	10	2%
PROCUREMENT	729	+4	733	4%
Total	743	0	743	6%
				8%

3. UNIT COSTS
 PROCUREMENT
 Constant FY70\$ \$ 2.04
 Escalated \$ 2.95
 PROGRAM
 Constant FY70\$ \$ 2.38
 Escalated \$ 3.35

4. APPROVED DESIGN TO COST GOAL: \$1.5M cumulative average unit flyaway cost estimate based on 600 aircraft at a peak rate of 20 per month expressed in FY70 dollars

SOURCE: SAR, A-10, 31 Mar 76.

Notes

1. Decision Coordinating Paper, A-10 Specialized Close Air Support Aircraft, 7 Jan 76 [hereafter cited as DCP 23B], (Doc 30).
2. *Ibid.*, (Doc 30).
3. Draft Study by the Staff of the U.S. General Accounting Office (GAO), A-10 Aircraft Program, Deputy Secretary of the Air Force, Dec 75, pp 23-24. [hereinafter cited as GAO Report.]
4. DCP 23B, 7 Jan 76.
5. GAO Report, Dec 75, pp 25-26; DCP 23B, 7 Jan 76, p 11.
6. DCP 23B, 7 Jan 76, p 11, (Doc 30).
7. *Ibid.*, p 13.
8. Selected Acquisition Report (SAR), A-10, a/o 31 Mar 76, p 1, (Doc 31).
9. Article, *Air Force Times*, 5 Apr 76, p 17.
10. Ltr, Gen William J. Evans, Comdr AFSC, to Mr. Edward G. Uhl, Pres, Fairchild Industries, 5 May 76, (Doc 32).



Close-up view of laser tracker of A-10. The tracker beam signal appears on the pilot's cockpit control panel when he is locked on to the ground target.

APPENDIX I

Major specifications of the A-9A were as follows:*

General

Configuration	Single place, high wing, single conventional tail.
Powerplant	Two Lycoming YF102-LD-100 Turbofans
Thrust	7,500 lb. each
Gearbox	Two – each with hydraulic pump, generator, and engine start turbine
Landing gear	Tricycle gear – single wheel, each with direct acting oleo shock struts

Dimensions (inches)

Length (less boom)	642.0
Overall height	203.0
Horizontal stabilizer height at root	123.5
Wing height at centerline	83.0
Fuselage height (ground to bottom of fuselage)	30.0
Tail height (ground to bottom of tail)	60.0
Engine height – aft centerline	63.0
Wing span	696.0
Horizontal tail span	326.95
Main landing gear span (tire centerline)	122.5
Nose landing gear axle to main landing gear axle	224.4
Nose landing gear off center (left of centerline)	12.0
Engine centerline distance from fuselage centerline	47.0

<u>Weight (pounds)</u>	Prototype I	Prototype II
Empty weight	23,734	23,615
Gross weight (maximum alternate)	41,795	41,795
Useful load	18,719 (Max)	19,219 (Max)
Weight empty (dry, no liquids or guns)	20,754	20,254

Center of Gravity

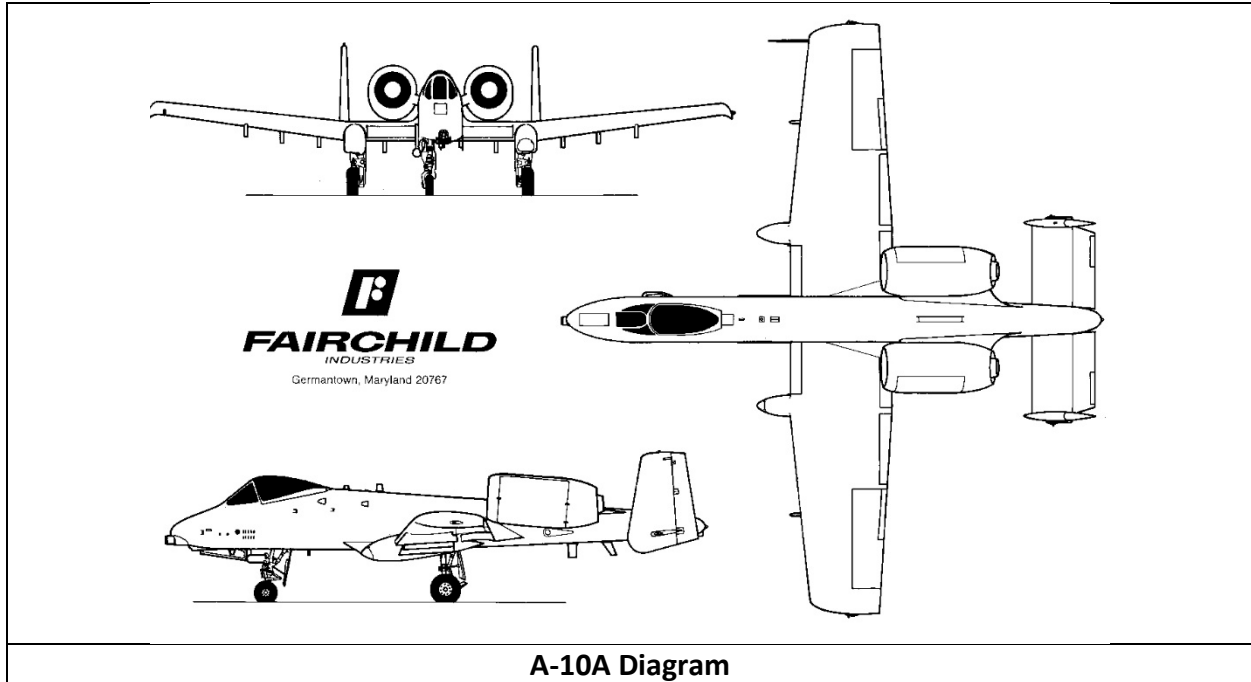
Fuselage <u>Station</u>	<u>pct MAC</u>	<u>Waterline</u>
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* SOURCE: *Air Force Flight Evaluation (Systems) of the A-9A Prototype Aircraft, Technical Report No. 73-2, March 1973, pp 10-13.*

At design weight	382.5	32.6	108.5
Most forward (gear up)	380.6	31.0	109.0
Most aft (gear down)	389.1	38.0	106.5
Most abrupt cg Shift (gear up to gear down)	382.5 to 384.4	32.6 to 32.5	108.5 to 109.2
Landing Gear			
Nose gear steering	30 deg		
Nose gear tire size	18x6.5-8 12-ply rating		
Main gear tire size	32x8.8-16 Type VIII 24-ply rating		
Wing			
Area total	580 sq ft		
Sweepback (at 25 pct chord)	3 deg, 12 min		
Incidence	00.00 deg		
Dihedral	00.00 deg		
Vertical Tail			
Exposed area	98 sq ft		
Sweepback (at 25 pct chord)	30 deg, 29 min		
Horizontal Tail			
Area total	153 sq ft		
Sweepback (at 25 pct chord)	6 deg, 57 min		
Incidence	00.00 deg		
Dihedral	10.00 deg		
Flight Controls			
Flat total area (Fowler area)	88 sq ft		
Flap travel	45 deg		
Aileron area (each, aft of hinge)	22.7 sq ft		
Aileron travel	30 deg (up and down)		
Speed brake (split ailerons) area total (aft of hinge)	102 sq ft		
Speed brake travel	57 deg up, 63 deg down		
Lift dumper (upper flat surface) area total	98 sq ft		
Lift dumper travel	60 deg (up)		
Elevator area (aft of hinge – 70 pct)	42 sq ft		
Elevator travel	12 deg up, 8 deg down		
Rudder area (aft of hinge)	31 sq ft		
Rudder travel	30 deg right or left		
Fuel			
Fuel tank configuration	Internal – 5 each wing		
Fuel volume	Liquid		
	Weight (lb)	Measure (gal)	

	Total capacity	9,750	1,500	
	Left wing	4,875	750	Pylon tank fuel
	Right wing	4,875	750	feed not
	Pylons (2) – total	3,900	600	available on the
	Each	1,950	300	prototype
	Usable fuel – total	9,074	1,396	aircraft. Tanks
Armament				installed (on
	Automatic gun (1), six barrel fuselage mounted, model M61A1,			pylons 4 and 7)
20mm				for aerodynamic
	Total capacity	635 rounds		tests only.
	Rate of fire	4,000 rounds/min		
	Burst shots	60 (burst limiter installed for tests)		
	Overall weight – loaded	1,065 lb		
	Empty	708 lb		
	Gun & Feed drive system	Hydraulic		
	Overall gun width	22 in.		
	Overall gun height	45 in.		
	Overall gun length	72 in.		

	Main gear tire size	26x11 24-Ply
Wing		
	Total area	488 sq ft
	Taper ratio	0.69
	Incidence	-1°
	Dihedral (outboard panel)	7°
Vertical Tails		
	Area (each tail)	52.5 sq ft
	Taper ratio	0.61
Horizontal Tail		
	Total area	118.4 sq ft
	Sweepback (at 25 pct chord)	0
	Incidence	-7°
	Dihedral	0°
Flight Controls		
	Flap total area	82.9 sq ft
	Flap travel	0-40°
	Aileron area (total)	48.79 sq ft
	Aileron travel	25° up, 15° down
	Speed brake total area	92.36 sq ft
	Speed brake travel	±65°
	Elevator area (total)	28.42 sq ft
	Elevator travel	30° up, 10° down
	Rudder area (each tail)	11.2 sq ft
	Rudder travel	±25°
Fuel		
	Fuel tanks configuration	2 internal fuselage tanks 2 internal wing tanks
	Fuel volume (pounds)	
	Total capacity	10,010
	Left main fuselage	2,755
	Right main fuselage	3,055
	Left wing	2,100
	Right wing	2,100
Armament		
	Gunsight	Norsight
	M61A1 gun system	
	Total capacity	660 rounds
	Rate of fire	4,000 rounds/min
	Burst shots	60 (burst limiter installed for tests)
	Gun and feed drive system	hydraulic



APPENDIX III

A-10A System Evaluation Report Summary

<u>Ser No.</u>	<u>Date (72)</u>	<u>Safety Code</u>	<u>Correction Category</u>	<u>Deficiency</u>
<u>AIRFRAME (WUC 11000)</u>				
10-13-9	2 Nov	II	M	Poor access to top of fuselage
10-19-10	10 Nov	II	D	Unacceptable nylon straps retaining lower fuselage access doors.
10-45-32	14 Nov	II	M	Lock in integral cockpit ingress/egress provisions
10-56-45	2 Dec	I	D	Large number of fasteners required for engine nacelle access doors
10-57-46	2 Dec	II	M	Excessive gap at air inlet duck/engine inlet interface
10-55-47	2 Dec	I	D	Potential damage to "coin-slotted" screws during removal
10-55-49	4 Dec	I	D	Difficulty in handling TACAN RT unit (for removal and replacement)
10-59-50	4 Dec	II	M	Crack in structure at F.S. 512 (aft fuel tank bulkhead stiffener)
<u>COCKPIT (WUC 12000)</u>				
10-1-4	2 Nov	II	M	Poor location (too far forward) of throttles
10-21-14	10 Nov	I	D	Poor location and actuation of throttle friction control
10-24-17	14 Nov	I	D	Difficult ingress to cockpit with parachute on
10-36-24	13 Nov	I	M	Lack of labeling of release mode control
10-31-25	14 Nov	II	M	Poor location of external lights control panel
10-32-26	14 Nov	I	M	Poorly designed latching device on ram inlet doors
10-35-27	15 Nov	II	M	Poor grouping of primary flight instruments
10-39-28	14 Nov	I	D	Poor grouping of engine instruments
10-41-29	15 Nov	I	D	Poor actuation of speed brake
10-43-30	15 Nov	I	D	Unsatisfactory grouping of light test buttons/switches
10-44-31	16 Nov	I	D	Uncomfortable parachute

10-40-34	18 Nov	I	M	Unconventional actuation direction of crossfeed and tank gate valve controls
10-38-42	27 Nov	I	D	Poor forward visibility
10-37-43	27 Nov	II	M	Unacceptable location of anti-skid switch
10-28-51	4 Dec	II	M	Poor canopy operation for emergency ground egress
10-66-56	5 Dec	II	M	Engine over-temperature during airstarts with throttles forward of IDLE
10-70-61	14 Dec	II	M	Poor access (beyond reach) of forward cockpit control surface

LANDING GEAR SYSTEM (WUC 13000)

10-7-3	2 Nov	III	M	Poor location of brake components for forward airstrip operations
10-33-33	18 Nov	III	M	Possible hardover of nose gear after electrical component malfunction
10-61-53	4 Dec	II	M	Loss of normal braking system with both electrical systems inoperative
10-69-60	12 Dec	III	M	Loss of normal and emergency braking with anti-skid malfunction

FLIGHT CONTROL SYSTEM (WUC 14000)

10-9-7	2 Nov	I	M	Lack of access to speed brake actuator
10-22-15	14 Nov	II	M	Poor location and mode of flap control
10-16-16	10 Nov	I	D	Poor material utilized in flight control surfaces
10-15-20	14 Nov	II	M	Undesired flap blowback
10-49-38	27 Nov	II	M	Lack of flight controls ground lock in cockpit
10-52-44	2 Dec	I	D	Poor access to aileron trim actuator
10-60-52	4 Dec	III	M	Inadequate switchover to and from manual reversion

PROPULSION SYSTEM (WUC 23000)

10-2-1	2 Nov	III	M	Possible inadvertent double-engine shutdown
10-25-18	9 Nov	I	D	Difficulty in interpreting fan tachometer readings
10-62-54	6 Dec	II	M	Restricted access for fuel control removal/installation

10-65-55	2 Dec	II	M	Excessive carboning of engine carbureting scrolls
<u>AUXILIARY POWER UNIT (WUC 24000)</u>				
10-50-19	24 Nov	II	M	Poor location of APU inlet for unprepared surface operations
<u>ENVIRONMENTAL SYSTEMS (WUC 41000)</u>				
10-10-5	1 Nov	I	D	Lack of disconnect provisions on over-temperature sensor wiring of refrigeration package
10-47-36	27 Nov	II	M	Poor access to ventilation garment blower
<u>LIGHTING SYSTEM (WUC 44000)</u>				
10-27-23	13 Nov	I	M	Incompatibility of interior lighting with task requirements
10-21-62	14 Dec	I	M	Lack of formation lights on forward fuselage
<u>HYDRAULIC SYSTEM (WUC 45000)</u>				
10-6-2	1 Nov	III	M	Unacceptable rapid bleeding at hydraulic pressure after engine shutdown
10-17-12	14 Nov	I	D	Inadequate dumping provisions for hydraulic reservoirs
10-23-22	14 Nov	I	D	Difficulty in reading hydraulic pressure gauges
<u>FUEL SYSTEM (WUC 46000)</u>				
10-4-13	14 Nov	II	D	Inadequate fuel quantity indicating system
10-3-35	18 Nov	III	M	Inadequate fuel shutoff control for APU
10-48-37	24 Nov	II	M	Poor access to fuel cell
10-57-40	24 Nov	II	M	Inability to correct fuel imbalance
<u>OXYGEN SYSTEM (WUC 47000)</u>				
10-12-8	2 Nov	III	M	Unacceptable location of oxygen overflow vent
<u>INSTRUMENTS (WUC 51000)</u>				
10-14-10	6 Nov	II	M	Highly vulnerable location of pilot tube to maintenance activities

10-5-19	10 Nov	III	M	Functional inadequacy of attitude indicating system
10-46-41	30 Nov	I	D	Lack of HARS gyro cutoff circuit during maintenance activities

INTERPHONE (WUC 64000)

10-18-21	10 Nov	II	M	Poor access to intercom headset cordage
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RADIO NAVIGATION (WUC 71000)

10-54-48	4 Dec	I	D	Difficulty in reading TACAN RT unit indicator
10-53-57	14 Dec	II	M	Inadequate marking of TACAN suppressor cables on RT unit

WEAPONS DELIVERY (WUC 75000)

10-67-58	14 Dec	I	M	Inadequate access to electrical connector in pylons 3, 4, 7, 8, and 9
10-68-59	5 Dec	I	M	Lack of access panels on wing pylons 1 and 11

ALL AVIONICS

10-8-6	2 Nov	II	D	Poor type of electrical connectors (solder-on)
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A-9A System Evaluation Report Summary

<u>Ser No.</u>	<u>Date (72)</u>	<u>Safety Code</u>	<u>Correction Category</u>	<u>Deficiency</u>
<u>AIRFRAME (WUC 11000)</u>				
9-21-1	2 Nov	III	M	Possible aircraft damage by blown off gun access door
9-24-13	4 Nov	I	M	Unacceptable operation of aft engine bay lower access door hinge point support rods
9-25-14	6 Nov	I	M	Inadequate engine removal/installation clearance
9-27-17	13 Nov	I	M	Poor material used for avionic bay covers
9-26-20	15 Nov	I	M	Poor material utilized in airframe structure
9-29-22	13 Nov	II	M	Difficulty of maintenance and work hazards in fuselage center equipment bay
9-48-47	21 Nov	II	M	Lack of moisture drains
9-66-51	21 Nov	II	M	Lack of integral cockpit ingress/egress provisions

9-85-59	4 Dec	II	M	Unacceptable canopy operations for emergency ground egress
9-75-60	2 Dec	I	D	Inadequate clearance for standard wing jack
9-84-61	4 Dec	II	M	Lack of AGE to hold canopy open during maintenance
9-79-69	4 Dec	II	M	Damage to "coin-slotted" screws during removal
9-104-96	14 Dec	II	M	Restrictive APU door limit airspeed

COCKPIT (WUC 12000)

9-58-39	18 Dec	II	M	Poor access to console panel mounting fasteners
9-40-41	14 Dec	II	M	Poor location of emergency brake T-handle
9-42-73	13 Dec	I	D	Poor location of UHF radio control
9-58-85	14 Dec	II	M	Poor arrangement of engine strat controls
9-53-83	14 Nov	I	D	Poor location of canopy open/close switch
9-89-86	14 Dec	I	D	Poor location of optical sight control panel
9-90-87	14 Dec	I	D	Poor location of fuel-to-engines control panel
9-91-88	14 Dec	I	M	Poor arrangement of secondary (supportive) flight controls
9-101-92	12 Dec	II	M	Unacceptable location of dc circuit breaker panel
9-102-93	13 Dec	I	D	Unacceptable location of instrument panel side extension controls
9-112-103	14 Dec	II	M	Poor access (beyond reach) to forward areas of cockpit side control
9-116-106	14 Dec	II	M	Uncomfortable ejection seat and restricted pilot movement

LANDING GEAR SYSTEM (WUC 13000)

9-2-24	18 Nov	II	M	Inadequate hydraulic emergency power source for normal braking and brake accumulator
9-57-38	21 Nov	II	M	Poor access to landing gear alternate release handle and reset switch
9-60-48	21 Nov	I	D	Requirement for disconnection of main gear doors for installation of jack adapter

9-65-50	21 Nov	I	D	Inadequate tool access space for maintenance on nose-wheel steering assembly mounting
9-63-55	27 Nov	I	M	Lack of towing provisions for securing nose gear torque arm during towing
9-86-72	5 Dec	III	M	Poor location of brake lines for Forward Airstrip Operations
9-106-98	14 Dec	II	M	Poor design of alternate landing gear release system

FLIGHT CONTROL SYSTEM (WUC 14000)

9-36-29	18 Nov	III	M	Unacceptable flap control mode of actuation
9-45-34	20 Nov	II	M	Lack of flight controls ground lock in cockpit
9-54-35	18 Nov	II	M	Chaffing of speed brake hydraulic line
9-38-44	27 Nov	I	D	Poor wing flap extension/retraction rates (slow)
9-8-45	21 Nov	II	M	Unsatisfactory failure mode of rudder limiter system
9-48-47	21 Nov	II	M	Lack of moisture drains
9-73-65	4 Dec	II	M	Loss of trim capability during double generator failure
9-107-99	14 Dec	III	M	Lack of asymmetry comparator in speed brake extension circuit
9-108-100	14 Dec	I	M	Lack of pitch SAS
9-113-104	14 Dec	II	M	Poor squat switch/lift dumper interconnect design
9-118-108	14 Dec	II	M	Poor location of lift dumper manual override switch
9-115-109	14 Dec	I	D	Weak speed brake detents

TURBOFAN ENGINE (WUC 23000)

9-14-3	3 Nov	II	D	Unnecessary oil filler crossover tube to oil tank
9-13-8	3 Nov	II	D	Inadequate sized mesh screen in oil tank
9-10-9	3 Nov	II	M	Inadequate clamping of engine oil tank supply line
9-34-27	18 Nov	II	M	Chaffing of fuel supply line against accessory gear case

9-37-30	18 Nov	I	D	Difficulty in reading engine oil pressure gauges
9-44-33	21 Nov	I	D	Difficulty in reading engine oil temperature indicator
9-39-71	2 Dec	III	M	Lack of shrouds on engine tail cones
9-77-84	14 Dec	I	D	Inability to adjust throttle
9-98-89	14 Dec	II	M	Burning, buckling, and distorting of second stage turbine nozzle vanes
9-99-90	14 Dec	II	M	Inability of engine hoist to allow longitudinal movement of engine
9-109-101	15 Dec	I	D	Unstable engine operation parameters at high power settings
9-114-105	14 Dec	II	M	Unacceptable requirement to shut down left engine to arm/dearm gun
<u>AUXILIARY POWER UNIT (WUC 24000)</u>				
9-23-16	15 Nov	II	M	Unsatisfactory mode of APU inlet door operation
<u>ENVIRONMENTAL SYSTEMS (WUC 41000)</u>				
9-22-19	9 Nov	II	M	Possible kinking of air outlet flex duct
9-30-53	27 Nov	I	D	Lack of disconnect provisions on over-temperature sensor wiring of refrigeration package
9-49-36	18 Nov	I	D	Poor access to cabin pressure regulator mount bolts
9-50-37	20 Nov	II	D	Lack of adequate drain provisions in ram air ducting
9-47-43	18 Nov	II	M	Lack of adequate provisions to prevent water and moisture from entering avionics equipment compartments
9-46-46	21 Nov	II	D	Lack of means to keep foreign objects out of ram air Inlet duct
<u>LIGHTING SYSTEM (WUC 44000)</u>				
9-61-74	5 Dec	I	M	Inadequate lighting of cockpit circuit breaker panels and canopy switch
9-93-76	4 Dec	II	M	Reflection of landing lights in cockpit and on pylons wing.

9-94-77	14 Dec	I	D	Unacceptable lighting control for fire agent discharge switch
9-95-78	14 Dec	II	M	Bright instrument panel floodlights in emergency dc power mode
9-111-95	14 Dec	II	M	Improper design and placement external lighting
9-110-102	14 Dec	I	D	Undesirable interior lighting functional arrangement

HYDRAULIC SYSTEM (WUC 45000)

9-16-10	3 Nov	I	D	Non-standard hydraulic system service adapters
9-18-11	2 Nov	I	D	Unnecessary AGE required for hydraulic system servicing
9-15-12	3 Nov	I	D	Poor access to right hand hydraulic reservoir
9-43-32	21 Nov	I	D	Inadequate size (too small) of hydraulic pressure gauges
9-11-52	14 Dec	II	M	Inadequate emergency hydraulic power source for rudder.

FUEL SYSTEM (WUC 46000)

9-3-15	16 Nov	III	M	Lack of backup fuel transfer capability after transfer pump failure
9-1-18	13 Nov	II	M	Lack of fuel crossfeed warning
9-59-40	21 Nov	I	D	Poor access to fuel cell probes
9-68-62	4 Dec	III	M	Unacceptable fuel dumping/venting
9-105-97	14 Dec	II	M	Poor positioning/inadequate lighting of fuel quantity indicator
9-117-107	14 Dec	I	M	Inaccurate and inconsistent fuel quantity indicators

OXYGEN SYSTEM (WUC 47000)

9-82-63	4 Dec	I	M	Poor location of oxygen regulator
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MISCELLANEOUS UTILITIES (WUC 49000)

9-70-57	2 Dec	II	M	Unacceptable actuation of APU fire warning test switch
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INSTRUMENTS (WUC 51000)

9-41-31	18 Nov	III	M	Poor location of ABU4A/A accelerometer
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AUTO PILOT (WUC 52000)

9-35-25	18 Nov	I	D	Poor access to forward mounting screws on SAS and SFC system amplifiers
9-67-42	18 Nov	II	M	Unprotected electrical equipment.

UHF COMMUNICATIONS (WUC 63000)

9-19-2	3 Nov	II	M	Possible damage to lower UHF/IFF antenna and chaffing of antenna cables by gun firing vibration
9-12-4	2 Nov	II	M	Poor emergency electrical power source for UHF
9-4-5	2 Nov	I	D	Poor location of remote UHF indicator
9-74-66	4 Dec	II	M	Loss of radio communications during double generator failure
9-87-75	5 Dec	II	M	Poor routing of wiring bundles at UHF transceiver installation
9-88-85	14 Dec	II	M	Complex method of presetting frequencies and poor material for alignment tabs

INTERPHONE SYSTEM (WUC 64000)

9-28-21	13 Nov	II	M	Poor access to intercom head set coverage
9-33-26	20 Nov	II	M	Poor location of inter-communication system circuit breaker
9-25-28	24 Nov	II	M	Poor access to intercommunication system amplifiers

IFF SYSTEM (WUC 650000)

9-19-2	3 Nov	II	M	Possible damage to lower UHF/IFF antenna and chaffing of antenna cables by gun firing vibration
9-5-6	2 Nov	I	D	Poor location of IFF/SIF control panel
9-64-49	21 Nov	II	M	Poor access to upper antennas

NAVIGATION SYSTEM (WUC 71000)

9-51-23	16 Nov	III	M	Unacceptable operation of attitude and heading reference system
9-69-56	2 Dec	I	D	Lack of HARS gyro cutoff circuit during maintenance activities

9-71-58	2 Dec	I	M	Lack of strain relief on electronic control amplifier connector
9-72-64	4 Dec	II	M	Unacceptable installation/routing of TACAN cabling
9-80-70	4 Dec	II	M	Inadequate identification of TACAN suppressor cables and RT unit
9-81-79	14 Dec	I	D	Difficulty in reading TACAN RT unit indicators
9-96-80	14 Dec	I	D	Difficulty in removing/replacing TACAN RT unit
9-97-81	14 Dec	I	D	Difficulty during on-aircraft adjustment of TACAN RT unit
<u>FIRE CONTROL SYSTEM (WUC 74000)</u>				
9-100-91	14 Dec	II	M	Requirement of jack aircraft for gun removal/installation
<u>WEAPONS DELIVERY (WUC 75000)</u>				
9-103-94	12 Dec	I	M	Lack of inspection panels on pylons
ALL AVIONICS				
9-17-7	3 Nov	II	D	Poor type of electrical connectors (solder-on)
<u>AEROSPACE GROUND EQUIPMENT</u>				
9-62-54	27 Nov	I	D	Use of non-universal tow bar
9-78-68	4 Dec	I	D	Requirements for peculiar workstand during maintenance in avionic bays

**Part III:
The Development and Acquisition of the GAU-8/A:
The A-10's "Tank Buster"**



GAU-8/A size comparison next to VW Bug

THE DEVELOPMENT AND ACQUISITION OF THE GAU-8/A:
THE A-10'S "TANK BUSTER"
1966-1976

VOLUME 1 – NARRATIVE

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United States Air Force
12 Mar 1981

SECURITY NOTICE

This study was declassified IAW E.O. 12958 and reviewed on 20 May 1997 and via OO-ALC/LIWCA Letter dated 11 June 1997. It was cleared for Public Release by HQ AFMC/PAX on 19 June 1997.

FOREWORD

This monograph on the GAU-8/A completes AFSC Office of History's three volume series covering the development and acquisition of the A-10 Close Air Support aircraft. The series includes *THE A-X SPECIALIZED CLOSE AIR SUPPORT AIRCRAFT: ORIGINS AND CONCEPT PHASE, 1961-1970* and *THE A-10 CLOSE AIR SUPPORT AIRCRAFT: FROM DEVELOPMENT TO PRODUCTION, 1970-1976*. Early in the planning for this series it was decided that the development of the GAU-8/A was worthy of an individual monograph because of the independent and unique acquisition program established by AFSC to provide Air Force with a weapon capably of providing the A-10 with a "tank busting" punch.

It has long been the contention of the Command Historian that the entire life cycle of the weapon system should be delineated. Air Force Managers should be provided with decision-making information in order to obviate the reinvention of the "wheel," or more specifically, prevent the need to continually redevelop existing procedures and methodology. Then with the series AFSC challenges the operational commands and the Air Force Logistics Command to provide companion volumes to the AFSC series since the A-10 story does not conclude with just system production.

WALTER L. KRAUS
Chief/Command Historian
Office of History
19 February 1981

PREFACE

In January of 1968 the Air Staff concluded that a large bore rapid-firing aircraft cannon was both necessary and feasible. The necessity was a product of several factors: the increasing Russian tank threat in Europe; the need for a versatile weapon system on the close air support (CAS) aircraft being developed to counter that threat; the impotence of existing aircraft guns against tanks; and the fact that missile anti-tank systems could not be used in bad weather or close to friendly troops. Advancing technology made it feasible to develop a rapid firing system with a larger caliber than before with armor piercing projectiles fabricated from exotic high density materials for better penetration.

Though ultimately successful, the program encountered several bureaucratic and technical problems. Both the Secretary of the Army and the Secretary of the Navy objected to the program because the gun would be unsuitable for joint service use (too heavy for Navy planes, too little power for Army personnel carriers), but their objections were overridden by the Deputy Secretary of Defense. A more serious challenge came from congressional and Department of Defense supporters of the 30mm cannon produced by the Swiss firm of Oerlikon. Failing to understand why the Oerlikon gun's low rate of fire and very low reliability made it acceptable for the CAS role, these supporters insisted on and got a "shoot-off" between the Oerlikon and the prototype GAU-8. While this test confirmed that the Oerlikon could not do the job, it ate up a significant portion of the development budget and forced adjustments in the schedule.

Technical problems presented less difficulty, perhaps because of extensive use of previously developed technology. Secondary gun gas ignition which interfered with air flow to the engines was eliminated by changing the propellant mixture. Gun gas residue on the windscreen was controlled by adding a washer system and an awkward firing angle for strafing was corrected by changing the airframe to allow the gun barrel to be depressed two degrees. In meeting the requirements for lightweight, high-powered ammunition with exceptional penetration, the GAU-8 program introduced three advances in state-of-the-art technology: high density penetrators, plastic bands on projectiles and aluminum cases.

By March 1976 when it went into full-scale production, the GAU-8 gun system had demonstrated great destructive power, high reliability, and easy maintenance for a reasonable cost over its projected life cycle. Careful management of the GAU-8 program had given the Air force its first rapid-firing gun able to kill tanks on a strafing pass.

MALCOLM D. WALL

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CHRONOLOGY

<u>Date</u>	<u>Event</u>
1966	Air Force planners began to examine requirements for a future close air support (CAS) aircraft incorporating a large bore rapid-fire cannon.
Late 1967	The desired characteristics of the aircraft and gun were identified.
Jan 1968	Air Staff concluded that a large bore rapid-firing aircraft cannon was both necessary and feasible.
5 Jan 1968	Air Staff issued Requirements Action Directive, "Air to Ground Systems for Close Air Support," instructing AFSC to plan the development and acquisition of an air-to-ground gun system including "associated rounds" as an integral component of the A-X (later A-10) close air support aircraft system.
Feb 1968	As a result of a Requirements Action Directive (RAD), "Air-to-Ground Systems for Close Air Support," issued by the Air Staff in late 1967, a Close Air Support Gun System Study Group was established by AFSC.
9 Jun 1969	A prime/subcontractor strategy to the development of the gun and ammunition was approved.
Sep 1969	The Close Air Support Gun System Study Group's final report recommended development of a 30mm internally-mounted Gatling gun system together with a family of associated rounds which would be developed especially for close air support.
Oct 1970	The Armament Development and Test Center (ADTC) released a Request for Proposal for design, fabrication, and demonstration of a prototype gun.
Dec 1970	The A-X prototype fly-off began.
Jun 1971	General Electric and Philco-Ford were selected as the prototype contractors for the GAU-8/A cannon.
15 Jun 1971	Dr. John S. Foster, Jr., Director of Defense Research and Engineering, announced immediate release of funds for the prototype gun development.
19 Aug 1971	An Ad Hoc Group of the Air Force Scientific Advisory Board concluded that for the AX aircraft the 30mm Gatling type gun was superior to the Oerlikon revolver type.
1 Oct 1971	Dr. McLucas announced a modified acquisition program which would allow flight tests of the winning Gatling gun in the winning AX aircraft prior to the production decision to determine gun/aircraft interaction (vibration, recoil, gun, gas, etc.).

Mid-1972	Contractors completed gun system fabrication and began firing tests in preparation for the competition shoot-off scheduled for January-April 1973.
Dec 1972	The A-X prototype fly-off, which began in December 1970, was completed.
3 Jan – 6 Apr 1973	The Air Force evaluation of the General Electric and Philco-Ford 30mm gun system prototypes was conducted with firing tests at AFSC's Armament Development and Test Center, Eglin AFB, Florida.
18 Jan 1973	The Air Force selected the Fairchild Industries A-10 over the Northrup A-9 close air support aircraft.
5 Jun 1973	The Defense Systems Acquisition Review Council (DSARC) II reviewed the GAU-8A program and recommended that the Air Force proceed with negotiations for the full-scale development of the GAU-8/A gun and ammunition.
21 Jun 1973	The Director of Defense Research and Engineering authorized the Air Force to enter into full-scale ammunition development.
21 Jun 1973	The full-scale development contract for the GAU-8/A gun system was awarded to the General Electric Company as a fixed-price-incentive-firm (FPIF) contract in the amount of \$23,754,567.
22 Feb – 25 Mar 1974	Flight testing of the GAU-8A installed in the YA-10 aircraft was conducted at the Air Force Flight Test Center at Edwards AFB, California.
15 Apr – 9 May 1974	At the direction of the Congress, the Air Force conducted a joint comparative flight evaluation of the YA-10 prototype and the A-7D at Fort Riley Kansas. The data analysis, nicknamed Saber Compare, produced the observation that the YA-10 prototype was overall the more effective aircraft.
11-12 Jun 1974	Flight tests conducted at Edwards AFB, California, demonstrated that a two-degree gun alignment angle would be best for the GAU-8A in the YA-10.
9 Jul 1974	DSARC IIIA review of the A-10 program.
31 Jul 1974	Deputy Secretary of Defense, William P. Clements, Jr., authorized the Air Force to proceed with the initial production of the A-10 aircraft using long-lead funding.
9 Oct 1974	After modifications were made to correct problems identified during the earlier flight tests, evaluations were again begun at Edwards with the GAU-8/A installed in the YA-10.
7 Nov 1974	The secondary gun gas ignition problem was considered solved by the A-10 Systems Office at HQ AFSC.

- 19 Nov 1974 A follow-up DSARC review was held to confirm milestone completions called for in the DSARC IIIA Review held in July 1974.
- May 1975 The Air Force began an evaluation at Eglin AFB, Florida, of the GAU-8/A gun system including ammunition.
- Oct-Nov 1975 The A-10/GAU-8/A weapon system proved its worth as an anti-armor weapon in lethality tests conducted at Nellis AFB.
- 10 Feb 1976 Deputy Secretary of Defense Clements authorized the Air Force to proceed with full production of the A-10 close air support aircraft.



Prototype YA-10 loaded with television-guided Maverick air-to-ground missile

Chapter 1: CONCEPT PHASE

Requirements Action Directive

In 1966 Air Force planners began to examine the requirements for a future close air support (CAS) aircraft incorporating a large bore rapid-firing cannon. Late in 1967 the desired characteristics of the aircraft and the gun had been identified, and on 5 January 1968 the Air Staff issued a Requirements Action Direction (RAD), "Air-to-Ground Systems for Close Air Support." This directive instructed the Air Force Systems Command (AFSC) to plan the development and acquisition of an air-to-ground gun system including "associated rounds" as an integral component of the A-X (later A-10) close air support aircraft system, with other applications possible. Specifically, the Air Staff required that planning include modifications to retrofit the gun on close air support versions of existing aircraft, including the A-1, A-7D, A-37, F-4C/D, F-100, F-105, and OV-10.¹

Scenarios for use of the A-X included Southeast Asia and Europe, as the increasing Soviet armored threat made the need for a more potent air-to-ground gun apparent: "Existing guns and systems do not provide adequate firepower to kill the type of targets developed by enemy forces."²

The directive specified three particular types of targets for the new gun:

- a. Personnel: Troops in foliage and foxholes (10 men prone in a 5 x 10 meter area; probability of kill (P_k) of 0.9 for one firing pass).
- b. Vehicles: Moving or stationary tanks and armored trucks including the Russian PT-76 light tank, T-54 medium tank, JS-III heavy tank, and BRT 152 and BRT-50P armored personnel carriers (P_k of 0.5 for one firing pass).
- c. Hard Targets: Blast sensitive junks of the type used in North Vietnam, bunkers, and reveted guns (P_k of 0.4 for one firing pass).³

Although the services at that time had in development or production several air-to-ground missile systems with exceptional effectiveness against these same targets, each of these systems had limitations in application: their guidance systems required better visibility and greater distance to target than conventional aircraft cannon and their wider collateral damage limited their use in the most critical air-to-ground situation in which friendly troops are engaging the



Armored personnel carriers and trucks utilized during strafing attacks during Nellis evaluations in 1976.

enemy at close range. Fortunately, improving technology made feasible the development of large caliber guns with rates of fire comparable to those previously attainable only with smaller weapons and with an improved projectile offering significant armor penetration.

System Design Studies

Systems Command responded to the Directive by negotiating contracts for gun system design studies with four firms and by establishing a Close Air Support Gun System Study Group. This group, staffed from the Air Force Armament Laboratory (AFATL) and the Cost Analysis Division of the Comptroller, Armament Development and Test Center, began its study in February 1968.

Study Group responsibilities encompassed a three-phase program: (1) the technical direction of the four gun system study contractors and the reevaluation of their reports; (2) the performance of detailed in-house analyses for gun system requirements and characteristics; and (3) submission of recommendations for a close air support gun system development program.⁴

After the initial studies, each contractor recommended a different system design:

- a. Philco-Ford Aeronautics recommended an internally mounted 30mm gun with six fixed barrels. The two types of ammunition recommended with an AP (armor piercing) steel round optimized for heavy materiel targets and an HE (high explosive) round for personnel and light materiel.⁵
- b. The General Electric Company recommend an internally mounted Gatling-type five-barrel 30mm gun with a double-ended linkless feed system using a tungsten carbide AP round and an HE round.⁶
- c. The TRW Ordnance recommendation was for a two-barreled 30mm gun and feeder system for internal use in a twin or triple mounted (for or six barrels) with tungsten carbide and HE rounds.⁷



General Electric GAU-8 Gatling Gun

- d. Harvey engineering Laboratories recommended an external pod mounting for a 57 mm recoilless rifle with four-chamber revolver loaded, using HE and shaped charger rounds. The Study Group rejected Harvey's recommendation because "Current delivery accuracy precludes an effective system which incorporates the inherent low rates of fire of recoilless rifles." Even multiple installations of recoilless rifles could not approach the kill probability of the various rapid-firing systems.⁸

Characteristics of the designs are show in Table 1.

<u>Parameter</u>	<u>Philco Ford</u>	<u>GE</u>	<u>TRW</u>	<u>Harvey</u>
Caliber (mm)	30	30	30	57
Ammunition Type	API/HEI*	API/HEI*	API/HEI*	HEAT/HEI
Muzzle Vel (feet per second)	3350/2500	3200	3600	1800
Rate of Fire (rounds/minute)	4000	Vbl to 4000	3000	180
Gun Wt. (lbs.)	376	367	258x2	70
Number Barrels	6	5	2x2	1
Round Wt. (lbs.)	1.39/1.38	1.59	1.52	8.05.8.07
Penetrator	Steel	Tungsten Carbine	Tungsten Carbine	-
No. Rounds	1333	1000	1000	100
Gun System Wt. (lbs.)	2787/2770	2607	2550	805/807
* API = armor piercing incendiary; HEI = high explosive incendiary; HEAT = high explosive anti-tank (shaped charge)				

Initial Conclusions

The Study Group also considered modifications of existing guns, specifically comparing the cost effectiveness of the existing M61A1 20mm Gatling gun with the proposed heavier gun system. They found it impossible to upgrade smaller caliber weapons for an anti-armor role without greatly degrading reliability and barrel life and determined the proposed 30mm system to be more cost effective than the m61A1 against personnel and light materiel targets.¹⁰

The Study Group favored using depleted uranium in the AP round because its density offered greater penetration and its inherent pyrophoric characteristics increased the probability of igniting fuel and ammunition inside the turrets of target tanks. This recommendation was contingent on state-of-the-art metallurgy being adequate to fabricate the rounds. The group found tungsten carbide an acceptable but less desirable penetrator because of its higher cost, lower mass, and questionable availability. The group considered steel AP rounds the least desirable because they were relatively ineffective at low dive angles and long ranges and because they tended to shatter.¹¹

In its final report, published in September 1969, the Study Group recommended a 30mm internally-mounted Gatling gun system together with a family of associated rounds which would be developed especially for close air support.¹² This gun system, the Study Group concluded, could be produced with existing technology if it had the performance characteristics shown in Table 2.

Table 2: Study Group Recommendations	
<u>Gun System Parameters</u>	<u>Description</u>
Ammunition Types	API/HEI
Caliber (mm)	30
Muzzle Velocity (ft./sec)	3200-3500
Rate of Fire (rounds/min)	Variable to 4000
Projectile Weight (grains)	5500-6000
Gun Weight (lbs.)	360
Overall Gun Length (inches)	100-115
Barrel Length (inches)	80-95
Number of Barrels	4-6
Total System Volume (ft ³)	55-60
Total Impulse per round (lb.-sec)	100-110
Maximum Recoil Force (lbs.)	11000-12000
Average Recoil Force (lbs.)	5000-6000
Total Round Weight (lbs. – based on aluminum case)*	1.52-1.59
Total Round Length (inches)	10-11
Peak Chamber Pressure (psi)	50,000
Maximum Number of Rounds	1350
Normal System Weight (lbs.)	2295
Maximum System Weight (lbs.)	3231
* In view of the potential risks of an aluminum case, a back-up steel case design should be retained.	
SOURCE: Final Report, CAS Gun System Study, 15 Aug 69.	

On 9 June 1969 Colonel Robert W. Dillon, the Chief of the Munitions Division under AFSC's Deputy Chief of Staff/Systems, directed a prime/subcontractor approach to the development of the gun and ammunition. While Colonel Dillon recognized the apparent cost advantages of separate gun and ammunition contractors, he was convinced that the need for "positive assurance of system integration with minimum problems..." outweighed the possibility of additional cost and "not having the most knowledgeable" ammunition contractor due to contractor teaming agreements.¹³

Development Concept Paper

Since the Study Group favored the development of a new 30mm CAS gun as a feasible and necessary weapon system, AFSC forwarded the recommendations to the Director of Defense Research and Engineering (DDR&E). After a lengthy review, DDR&E issued the first version of Development Concept Paper (DCP) number 103, *Close Air Support Gun*, dated 5 June 1970. This paper, based heavily on the Gun System Study Group's Final Report, generally confirmed the Group's findings regarding the threat, the capabilities of existing guns, and the characteristics of

the proposed new design, but raised significant new questions in the broader context of defense policy.¹⁴

The essential connection between the proposed gun system and the AX aircraft was stressed on DCP #103 with the statement that: "The proposed program would provide a gun system concurrent with and complementary to the AX aircraft program..." The paper also confirmed Air Force criteria for the 30mm CAS Gatling gun: (1) a nominal design mission of 10 passes with at least 2 seconds firing time per pass; (2) externally powered gun mechanism and linkless feed for maximum reliability; and (3) modular design adaptable for palletized installation, simple maintenance, and minimum turnaround time.¹⁵

The interrelated issues which concerned DDR&E, but not the Air Force Study Group, were the substitution of another foreign or domestic 30mm gun, the question of joint service use, and the possibility of delaying development to await advanced technology. However, both of the principal competing guns failed to match the capabilities of the proposed CAS gun in some critical area:

- a. The Swiss-made Oerlikon 304RK 30mm had a low rate of fire (1350 rpm) requiring a three gun mount to attain the required 4000 rpm, very low reliability (600 rounds/stoppage), and an unacceptably large pod for external mounting.¹⁶
- b. The Vehicle Rapid Fire Weapon System-Successor (VRFWS-S) proposed by the Army appeared unacceptable for air firing because its design depended on a sabot round and previous efforts to prevent sabot ingestion by turbine engines had failed.¹⁷

Joint Service use proved equally hard to achieve. The proposed CAS gun was too heavy for use on Navy aircraft, but prolonged development using advanced technology (liquid propellants) while allowing reduced weight would increase the risk and delay AX production 3-5 years. Neither could the CAS gun be adopted as the VRFWS-S because the heavier armor on the sides of targets (as compared to the tops) required a heavier payload than attainable with the proposed CAS gun.¹⁸

The final recommendation of DDR&E was to proceed with a 33 month competitive prototype development. Both the Secretary of the Navy and the Secretary of the Army dissented; Navy proposed additional research on liquid propellants for a future gun, but Army insisted Air Force estimates of the proposed gun's effectiveness were unrealistic. Deputy Secretary of Defense David Packard approved the proposed prototype development pending confirmation by the Joint Technical Coordinating Group (JTCG) of Air Force estimates of the new gun's effectiveness against armored targets.¹⁹

The Joint Technical Coordinating Group for Munition Effectiveness provided this validation in its Summary Report of 3 December 1970, confirming that the proposed 30mm gun and ammunition did "equal or exceed the performance estimates contained in DCP #103 for T-54/T-55 [Soviet medium] tanks." The study also agreed with the Air Force that both depleted uranium (DU) and tungsten carbide were "good penetrator materials," but urged that optimum

penetrator design should be sought through the “choice of the best nose shapes, penetrator geometry, and penetration composition.”²⁰



Tank target engaged during strafing attacks by A-10 30mm gun during Nellis evaluations in 1976.

NOTES

1. See RAND Rept, Alfred Goldberg and Lt Col Donald Smith, "Army-Air Force Relations: The Close Air Support Issue," R-906-PR, Oct 71; in 1967 an analysis performed at the Armament Development and Test Center had recommended a 30mm multi-barrel cannon as the most effective gun for a close air support aircraft system. Requirements Action Directive (RAD), subj: Air-to-Ground Gun Systems for Close Support Aircraft, RAD-8-218-(1), 5 Jan 68 (Doc 1). Hereinafter cited as RAD, CAS Gun System, 5 Jan 68.
2. RAD, CAS Gun System, 5 Jan 68, (Doc 1).
3. *Ibid.*, p. 16.
4. Ltr, Lt Col J.S. McCrea, Dir of Mun, HQ ADTC, to AFSC, subj: 30mm Air-to-Surface Gun System, 17 Sep 69, w/1 atch; Final Report, Close Air Support Gun System Study, Vol. 1, Summary and Recommendations, AFATL 69-4125, undated, p. 3 (Doc 2). Hereinafter cited as Rpt, CAS Gun System Study, AFATL 69-4125.
5. *Ibid.*, p. 8.
6. *Ibid.*, p. 9.
7. *Ibid.*
8. *Ibid.*, pp. 9-10, 18.
9. *Ibid.*; Plan, Program Management Plan 100-2, 30mm CAS Gun System GAU-8/A, 10 Jan 73, p. 5 (Doc 3). Hereinafter cited as PMP 100-2, 10 Jan 73.
10. Rpt, CAS Gun System Study, (AFATL 69-4125), pp. 10-11, 13-14 (Doc 2).
11. *Ibid.*, pp. 17-18.
12. *Ibid.*, pp. 14-20.
13. Msg, AFSC to ADTC/ADDHF/ADAP/ADAMG, subj: 30mm AX Gun System, 091743Z Jun 69 (Doc 4); Ltr, Col John D. Coke, Dir of Armament, DCS/Systems, to SD (DCS/Systems), subj: 30mm Gun Program, 9 Mar 71 (Doc 5).
14. Development Concept Paper, DCP 103, Subj: Close Air Support Gun, 5 Jun 70, revised 23 Jun 70 (Doc 6).
15. *Ibid.*, pp. 7, 11, 13.
16. *Ibid.*, p. 9.
17. *Ibid.*, p. 9.
18. *Ibid.*, pp. 9, 13, 18.
19. *Ibid.*, p. 18.
20. Summary Rprt, Evaluation of the Effectiveness of the 30mm CAS Gun, 3 Dec 70, prepared by Joint AMC/NMC/AFLC/AFSC Commanders, Joint Technical Coordinating Group for Munitions Effectiveness, Aberdeen Proving Ground.

Chapter 2: VALIDATION PHASE

Competitive Prototypes

Selection of Contractors

While awaiting the munitions effectiveness evaluation, the Armament Development and Test Center (ADTC) began actions leading to the award of a development contract. The Center released a request for proposal (RFP) in October 1970 and by January 1971 had received technical and cost proposals from four contractors, but none of the proposals was amendable to a comprehensive evaluation. The best gun design had the worst ammunition, but the prime-subcontractor approach prevented a separate contract with an ammunition contractor having a better design. One contractor submitted a firm fixed-price* bid; two had fixed price best effort bids, and one a cost-plus-incentive-fee—preventing** any meaningful comparison. To compound the problem, the proposed development schedule appeared incompatible with the AX aircraft program. The Armament Center responded to this impasse by releasing a revised RFP in April, which resulted in the June 1971 selection of General Electric and Philco-Ford as the prototype contractors.¹



Vulcan installed in YA-10

The Oerlikon 304RK Challenge

Although the two competitive contractors were selected, the Office of the Secretary of Defense delayed releasing the necessary funds. This delay prompted the Acting Secretary of the Air Force, Dr. John L. McLucas, in an 8 June 1971 memorandum, to inform the Deputy Secretary of Defense of the source selection completion and request the release of funds for the competitive contract awards. Dr. McLucas believed that this delay was generated by the DDR&E request for consideration of the Oerlikon 304RK as a third option.²

Dr. McLucas supported the 30mm Gatling gun for the AX, while accepting the DDR&E position that the Air Force should evaluate the Oerlikon gun in order to provide a “direct comparison” of the Oerlikon revolver gun system with the 30mm Gatling gun system. The Secretary concluded with a request for the release of funds, to maintain a gun development schedule compatible with the AX prototype schedule.³

On 15 June, Dr. John S. Foster, Jr., Director of Defense Research and Engineering, responded to the McLucas memorandum with the assurance that funds would be immediately

* A contract whereby a contractor is paid a stated price for fulfilling the terms of the contract.

** A contract in which the government agrees to reimburse a contractor for costs incurred in producing the articles or performing the contract and to also pay an incentive fee.

released for the prototype gun development. At the same time he expressed reservations about the CAS gun development schedule. While the approved schedule allowed time to test the candidate guns and the proposed ammunition, it did not ensure a test of the winning gun in the prototype airframe, and Dr. Foster doubted that 20mm gun/aircraft interaction (vibration, recoil, gun gas, etc.) could be realistically extrapolated to predict 30mm reactions.⁴

Dr. McLucas responded to Dr. Foster's concerns on 1 October 1971 with a modified gun system program allowing flight tests of the winning Gatling gun in the winning AX aircraft prior to the production decision (see Table 3). In addition, McLucas agreed a test of the Oerlikon 304RK would be conducted by the Air Force at an estimated cost of \$3.6 million despite the constraints that expense would impose on the rest of the program.⁵

<u>Milestones</u>	<u>Date</u>
Contract Award (Phase I)	Jun 71
Competitive Evaluation (Gun System)	Jan 73 – Apr 73
DSARC II Review	Apr 73
Contract Award (Phase II)	May 73
Gun System Preliminary Design Review (PDR)	Oct 73
Combat Ammo Preliminary Design Review	Jan 74
Flight Demonstration of Gun System in AX	Mar 74 – Apr 74
IOT&E of Gun System	Mar 74 – Jul 75
Critical Design/Production Readiness Review	Jun 74
DSARC III Review/Production Approval	Jul 74
Ground Qualification Test – Gun and Ammo	Jul 74 – Feb 75
Production Delivery – Gun System	Jul 75
Production Delivery – Ammo	May 75
Production Release – Pod	May 75
Pod Delivery	May 76
<i>SOURCE: PMD, P-2P006(2), 3 Jun 72.</i>	

The seeming reluctance of the Air Force to evaluate the Oerlikon 30mm gun on the same basis as the 30mm Gatling gun type was based to a large degree on the results of previous gun system studies which had dealt with the capabilities, reliability, and cost effectiveness of this gun system, among others, for the close air support mission. An evaluation of the gun was also provided in Development Concept Paper #103 which identified the 304RK 30mm Oerlikon “as the only existing gun system that approximates the required caliber and muzzle energy.” However, this same evaluation continued with the assertion that a low rate of fire together with a low reliability provided an unfavorable comparison with the minimum requirements specified for the 30mm CAS gun.⁶

In 1971 a comparative 10-year life cycle cost study of 30mm CAS guns, including the Oerlikon 304RK, had started that the initial cost of a 30mm revolver gun system such as the Oerlikon was less than a 30mm Gatling gun system. Despite this initial cost difference, the 10-year life cycle cost for 600 revolver systems, firing 84 million rounds, was estimated to exceed the cost of the same number of Gatling gun systems “by 8 to 52 million dollars,” because of reliability problems, depending on the particular gun system chosen.⁷

A further evaluation was provided by an Ad Hoc Group of the Air Force Scientific Advisory Board, which had been asked to review the “CAS gun development program and test criteria and interface between gun and aircraft.” This group delivered its summary conclusions on 19 August 1971 to an Air Staff audience which included both the Secretary of the Air Force and the Chief of Staff. The ground concluded:⁸

- a. Utility of the Oerlikon gun for AX [was] inferior to 30mm Gatling.
- b. Oerlikon might have other applications that should be pursued.
- c. [The air Force should] continue with current program and look at ways to get prototype gun in prototype aircraft and fly and fire.

There were also some cogent arguments advanced in support of an in-depth test and evaluation of the Oerlikon 30mm gun. The fact that the Oerlikon gun had been in existence for 10 years decreased the development risks inherent in a new system and the initial research and development costs. Another advantage advanced by Oerlikon proponents was the near certainty that the already-developed Oerlikon would be ready for testing in the prototype AX aircraft well ahead of any production decision. The Oerlikon gun also offered substantial weight savings over the larger and heavier 30mm Gatling gun system proposal. This size and weight advantage made the 30mm Oerlikon a particularly attractive candidate for gun pod applications and thus for retrofit is operational aircraft.⁹

The Air Force eventually acceded to the concurrent test and evaluation fo the Oerlikon with the other competing gun systems. However, the introduction of an additional and major test program into the competitive prototype phase would place a severe strain on the test capabilities of the Armament Development and Test Center. Another immediate problem was the additional cost for the overall development of a 30mm gun system which would be generated by the requirement for an Oerlikon evaluation.¹⁰

The program changes which were made in the last six months of 1971 to accommodate the Oerlikon gun did not diminish the status of the 30mm Gatling-type (GAU-8/A) gun system as the Air Force’s first priority in close air support gun development. In early November 1971 Maj Gen William J. Evans, Director of Development and Acquisition, Deputy Chief of Staff/Research and Development at Air Force Headquarters, summarized the changes in the competitive prototype program and confirmed the Oerlikon test program scope.¹¹ The principal points made in this summary were:

- a. The Oerlikon 304RK evaluation would be conducted to provide by April 1973 the basis for determining the “utility of the weapon” in meeting Air Force

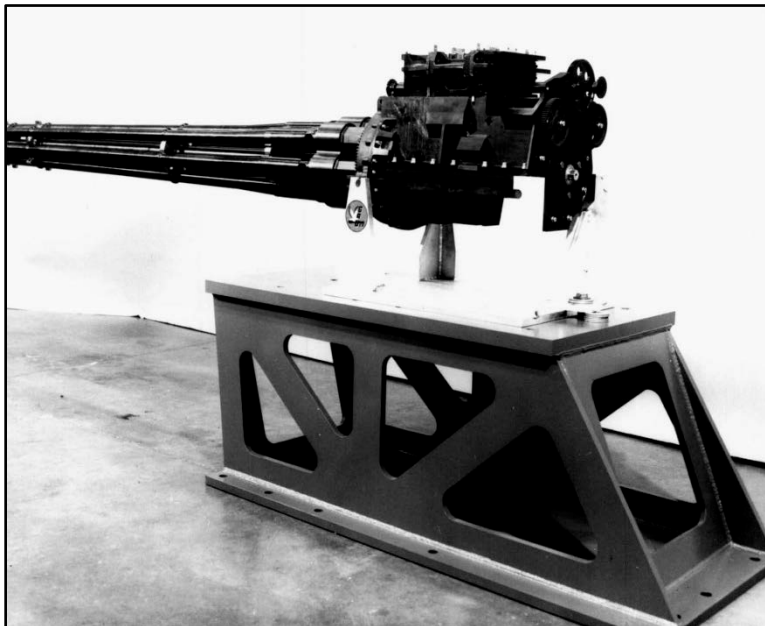
requirements as well as serving as an alternate in case neither of the Gatling gun candidates proved acquate.¹²

- b. The Hughes Tool Company, as the licensee for the Oerlikon gun in the United States, would be required to submit cost proposals for a Phase II Oerlikon gun system development should the need arise for a “follow-on Oerlikon gun development program.”¹³

One effect of General Evans’ letter was to remove the Oerlikon 304RK gun, which the Air Force designated as the GAU-9/A, from the competitive evaluation program conducted with the Gatling gun system, although the Oerlikon gun evaluation would be performed during the same time frame and using the same evaluation criteria as the Gatling gun competition. General Evans directed that the GAU-8/A and AX prototype program schedules would be maintained without dependence upon the progress of the Oerlikon gun tests.¹⁴

Prototype Contracts

Each of the two prototype contractors signed a firm fixed price contract which called for prime contractor responsibility for gun system integration. The contracts called for the design, fabrication, test, and delivery of three copies of the prototype gun system to the Air Force for performance evaluation. The contracts included the gun itself, as well as a linkless feed and storage system with hydraulic drive, an electronic control unit (ECU), and a family of “appropriate aluminum cased” combat and target practice ammunition. Air Force contract number F08635-71-C-0712 was awarded to the General Electric Company, Armament Systems Development Department, Burlington, Vermont, and contract number F08635-71-C-0713 to the Philco-Ford Corporation, Aeronutronic Division, Newport Beach, CA.¹⁵



Philco-Ford Prototype Entry

General Electric subcontracted for ammunition development with the Aerojet Ordnance and Manufacturing Company (AOMC) while Philco-Ford subcontracted ammunition development to Honeywell, Inc., Minneapolis, MN, and ammunition feed and storage subsystem development to the Emerson Electric Company, St. Louis, MO.¹⁶

The ammunition family initially included four rounds: Target Practice (TP), High Explosive Incendiary (HEI), Semi-Armor Piercing High Explosive (SAPHE), and Armor Piercing Incendiary with steel penetrator. Concurrently, the Los Alamos Scientific Laboratories and AAI Corporation

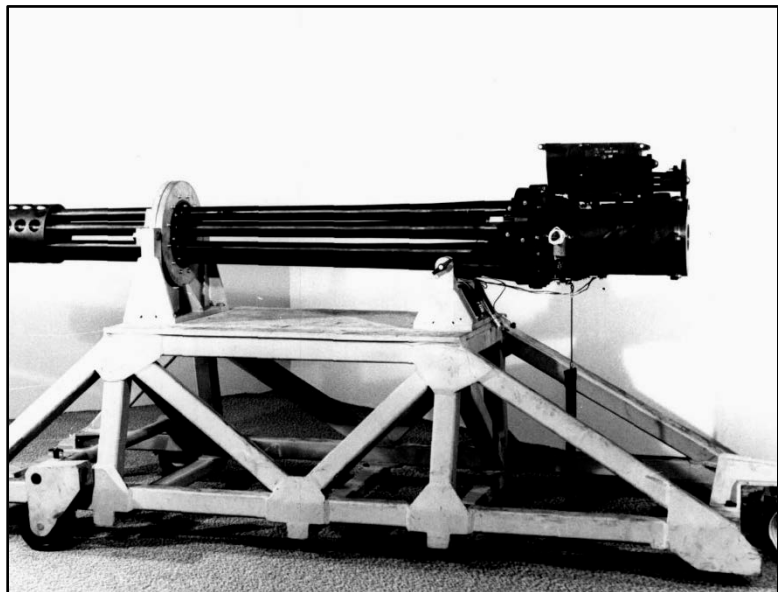
began joint development of an Armor Piercing Incendiary (API) round which would use a plastic bonded depleted uranium (DU) penetrator.¹⁷

By mid-1972, each of the contractors had completed gun system fabrication and began firing tests in preparation for the competition shoot-off which the Air Force had scheduled for January-April 1973.

Tests of A-X Competitive Prototypes

The competitive fly-off of the A-X prototype aircraft (the Northrup A-9 and the Fairchild A-10) was completed shortly before the GAU-8/A test competition began.

The revised CAS gun development program had been aligned with the A-X aircraft development program to insure flight demonstration of the winning CAS GAU-8/A design on the winning prototype A-X aircraft prior to an A-X production decision date. However, the development schedules did not permit the CAS prototype guns to be flight tested during the competitive fly-offs in Northrup A-9 and the Fairchild A-10 prototypes. Air Force evaluation of the 30mm gun system prototypes in firing tests began on 3 January 1973 while the A-X prototype fly-off, which began in December 1970, was completed in December 1972. When the announcement was made on 18 January 1973 that the Fairchild A-10 had won the A-X competition, the CAS/GAU-8/A competition had just begun.¹⁸



General Electric Prototype Entry

Instead of the GAU-8/A, the Air Force M61 20mm aircraft gun, which was an internally-mounted Gatling gun similar to the GAU-8/A in many respects, was used in the A-X prototype flight demonstrations of the Northrup A-9 and the Fairchild A-10A. The M61 gun system included a Gatling gun, a rotary gun storage drum, and a double-ended linkless feed system, all characteristics of the 30mm prototype. For the A-9/A-10 tests, the M61 gun system was pallet-mounted in the test aircraft. In both the A-9 and the A-10 installation, the muzzle of the firing barrel was located slightly aft and beneath the cockpit near the fuselage centerline.¹⁹

The flight tests, which were conducted with the M61 installed in the A-9 and A-10, showed that this gun system was compatible with both airframe and engine and also that the centerline installation provided good strafing accuracy. The results of the testing, when extrapolated, were advanced as corroborative evidence that the 30mm GAU-8/A would be compatible with the

prototype competition winner, qualified only be a “reasonable acceptable risk.” However, the compatibility of the GAU-8/A with the A-10 was still to be demonstrated.²⁰

Competitive Test Firings

The Air Force evaluated the General Electric and the Philco-Ford gun systems in a series of test firings conducted at AFSC’s Armament Development and Test Center, Eglin AFB from 3 January to 6 April 1973.²¹



GAU-8 testing at Edwards AFB.

Each contractor supplied three gun system copies, two to be used for firing tests and the third to be held in reserve as a backup or for spare parts. In addition to the three gun assemblies, each contractor provided the 30mm ammunition required for the test firings: 100,000 TP rounds, and 1,000 rounds each of HEI, SAPHE, and API (steel core). Each contractor also provided 12 Mann barrels* for test firing ammunition under

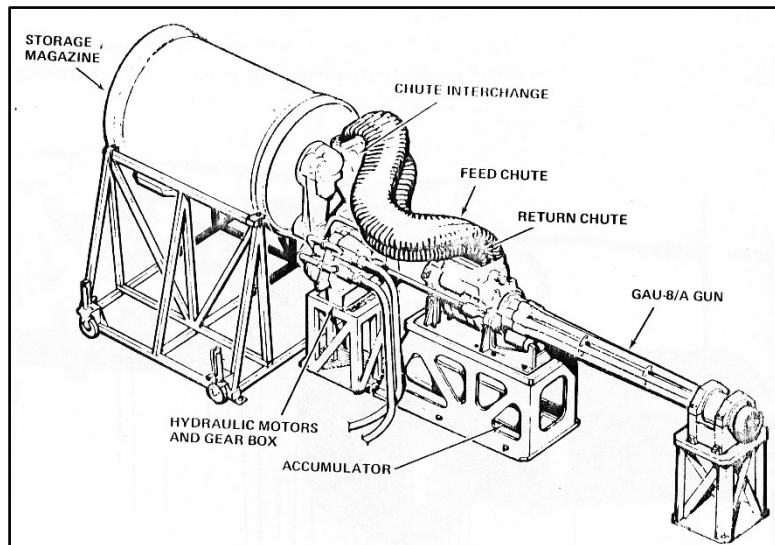
various simulated combat conditions as well as various pieces of support equipment needed for the gun system operation.²²

The testing was directed by personnel from the Air Force Armament Laboratory (AFATL) with maintenance of the prototypes performed by Air Force engineers and technicians divided into two separate teams, one for each contractor system. Strict industrial security was maintained because of the competition-sensitive nature of the data being gathered, and each contractor had access only to his own hardware and data. Air Force evaluation teams fired and maintained the candidate guns with contractor personnel used only in an advisory capacity or to assist in the analysis of stoppages. Each firing gun was manned by one Air Force test engineer and three Air Force technicians, usually “retired Air Force weapons mechanics with a wealth of experience derived from earlier gun systems.”²³

* Mann barrels: single shot gun barrels instrumented to make ballistic measurements.

General Electric Gun System

The General Electric (GE) CAS 30mm gun system included the gun, a linkless, double-ended ammunition handling and storage system, a hydraulic drive system, and an electronic control assembly. The GE gun was a seven-barrel, Gatling-type in which the barrels and a rotor assembly rotated as a single unit within an outer housing. The gun itself had an overall length of 105 inches and weighed 641.5 pounds. The gun and ammunition systems were configured in tandem assembly approximately 254 inches long by 47 inches wide by 42 inches high. The Aerojet Ordnance and Manufacturing Company (AOMC) provided 100,000 rounds of 30mm Target Practice (TP) ammunition for the General Electric guns.²⁴



Philco-Ford GAU-8/A gun system in test configuration

The gun and ammunition systems were configured in tandem assembly approximately 254 inches long by 47 inches wide by 42 inches high. The Aerojet Ordnance and Manufacturing Company (AOMC) provided 100,000 rounds of 30mm Target Practice (TP) ammunition for the General Electric guns.²⁴

Philco-Ford Gun System

Philco-Ford provided a GAU-8/A 30mm CAS gun system which closely resembled the specifications of the General

Electric system: a six-barrel, Gatling-type gun which used linkless ammunition feed, and an ammunition storage subsystem powered by dual hydraulic motors and operated and controlled by ECU. Honeywell supplied 100,000 rounds of TP ammunition.²⁵

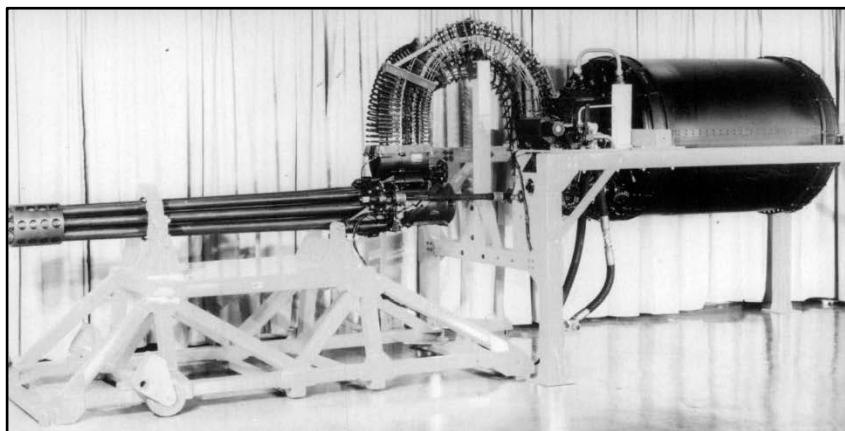
Table 4: General Electric GAU-8/A Gun System Characteristics	
System weight (loaded)	3,818.3 lb.
System weight (empty)	1,818.3 lb.
Gun weight	641 lb.
Ammunition capacity	
Drum	1,200 rounds
Total system	1,386 rounds
Firing rate	2,000/4,250 spm
Drive system	Hydraulic
Reliability goal in production	10,000 MRBF*
Barrel life (per set of seven)	14,000 rounds
Storage drum size	
Diameter	41 inches
Length	59 inches
Gun length	105 inches
Barrel length	86 inches
Ammunition	30mm, HEI, TP, SAPHE, API

Gun type	Seven-barrel Gatling
Feed system type	Linkless, double-ended
Clearing	Reverse rotation
Bolt	Rotary head bolt
* Mean rounds between failures	
SOURCE: ADTC-TR-73-66.	

Results

AFATL programmed the test for 70,000 rounds for each design (35,000 for each of the two copies supplied by the contractor). During the test period, the General Electric guns actually fired 70,407 rounds but the Philco-Ford system fired only 15,969 rounds due to repeated jamming. While the General Electric prototype averaged 8,800 rounds for each failure, the Philco-

Ford design's mean failure rate was only 728 rounds, leading the evaluators to judge it "inadequate" for the GAU-8/A mission. However, they considered the GE gun "operationally suitable and capable of performing the GAU-8/A mission" and declared General Electric winner of the prototype competition and candidate for the award of a contract for full-scale development of the GAU-8/A gun system.^{25A}



Overall view of the General Electric GAU-8/A gun system. USAF Photograph.

for full-scale development of the GAU-8/A gun system.^{25A}

The Oerlikon 304RK Evaluation

Concurrent with the test on the Philco-Ford and GE prototypes, AFATL began evaluating the Oerlikon 304RK 30mm gun as directed by Secretary McLucas. The 304RK Oerlikon was a single-barrel, gas-driven revolver gun which fired linked ammunition approximately 1,350 rounds per minute. This gun had been developed by the Machine-Tool Works Oerlikon Buehrle and Company, Zurich, Switzerland.²⁶

Procurement of the Oerlikon gun was made through the Hughes Tool Company, Culver City, CA. In addition to modification to the gun system to adapt it to the Air Force requirements, Hughes also fabricated the necessary associated equipment for the test and evaluation program. The contract with Hughes called for a gun assembly mounted in a test stand and consisting of two 30mm Oerlikon 304RK guns, ammunition, ammunition feed and storage system for a minimum of 750 rounds, recoil adapters, and other necessary controls. Ammunition included aluminum-cased TP, aluminum-cased HE, armor piercing high explosive (APHE), and tungsten-alloy-penetrator AP ammunition. In addition, the contract called for a podden gun system design "compatible with the A-X, A-7, and F-4 aircraft." Design criteria for this pod included a diameter

of 30 inches, a minimum capacity of 450 rounds, and a maximum weight of 1900 pounds when loaded with 450 rounds of aluminum-cased ammunition.²⁷

As shown in Tables 5 and 6, test data accumulated at Eglin AFB clearly indicated that the General Electric GAU-8 gun's technical performance was considerably better than that demonstrated by the Oerlikon GAU-9/A.

Characteristics	GAU-8	GAU-9
Major maintenance interval	15,000 rounds	3,000 rounds
Mean rounds between failure	8,800	846
Maintenance man-hours/1,000 rounds	5.9	24.3
Barrel life (rounds)	2,373 (copper bands) 6,000* (plastic bands)	748 (sintered iron bands)
Rounds on system before barrel change	16,000 (copper bands) 42,000 (plastic bands)	1,500
* Estimated barrel life		
<i>SOURCE: GAU-8/A, DSARC II Briefing, May 73.</i>		

Characteristics	GAU-8/A General Electric	GAU-9/A Twin Oerlikon
Design	3	12
Workmanship	0	0
Ammunition	1	1
Purchased parts	2	1
Other	<u>2</u>	<u>1</u>
Total	8	15
Rounds fired	70,400	12,687
Rounds/failure	8,800	864
<i>SOURCE: GAU-8/A DSARC II Briefing, May 73.</i>		

Gun Pod Design

One facet of the 30mm CAS gun program which did not continue beyond the Phase I period was the gun pod development. In the early stages the 30mm CAS gun program plan, in addition to the internally-mounted gun system, had encompassed an external gun pod system for retrofit on existing aircraft. The Requirements Action Directive of January 1968, in addition to an internally-mounted 30mm gun system, had also directed a study of the feasibility of an

“externally-mounted forward firing large bore anti-tank gun or recoilless rifle.”²⁸ The Close Air Support Study Group, after reviewing concept studies by selected contractors, recommended an external gun system which was a “podded configuration of the internal gun system.” The gun pod, in other words a 30mm Gatling-type gun pod system, would be the gun system for retrofit to existing aircraft which could not accommodate the internal gun installation used in the A-X.

The basic technical and management orientation of the 30mm CAS gun pod effort limited development activity to preliminary design by the competing prototype gun contractors with ADTC keeping responsibility for the engineering design of the pod.²⁹ However, the contracts, which were awarded General Electric and Philco-Ford in mid-1971 for Phase I prototype gun systems included a provision for a gun pod design which would satisfy a requirement as follows:³⁰

A podded gun system design compatible with the A-X, A-7 and F-4 shall also be submitted during Phase I. The maximum pod diameter shall be 30 inches. The pod should have a minimum capacity of 750 rounds and shall be designed to weigh not more than 2500 pounds when loaded with 750 rounds of aluminum-cased ammunition. Full rate of fire is desired but not required for the podded system. This design effort shall include coordination with the airframe contractors to assure gun pod interface.

The characteristics of the gun pod concept were reflected in the design proposed by the General Electric Company. This gun pod was designed to fire at rates of up to 4200 rounds per minute and the gun would weigh an estimated 2800 pounds when fully loaded with 750 rounds of ammunition. The pod, which had a maximum diameter of 30 inches and was approximately 18 feet long, was designed so as to make its external installation compatible with the centerline station of the F-4 and the inboard wing stations at the A-7D aircraft.³¹

Gun pod development associated with the 30mm GAU-8/A was abruptly halted when the DSARC II,* which recommended full-scale development of the GAU-8/A 30mm internally-mounted gun system at the same time, deleted the requirement for a gun pod application. A Program Management Directive of 30 July 1973 from the Air Staff confirmed this action and directed the cancellation of any further 30mm gun pod effort. Considerations which entered into this decision included both the technical aspects of the pod's size and weight, as well as the costs inherent in a full development program for the 30mm gun pod. Those represented substantial increases to the overall 30mm CAS gun program, which has already been strained by the costs of the Oerlikon tests. While some gun pod concept and design activity concerned with possible retrofit to inventory aircraft such as the A-7 and F-4 would continue, this application was no longer conducted with the GAU-8/A program.³²

* Defense Systems Acquisition Review Council. DSARC membership included the Director of Defense Research and Engineering (DDR&E), the Assistant Secretaries of Defense for Installations and Logistics (IL) and Systems Analysis (SA), and the Comptroller. The acronym DSARC was commonly pronounced DEESARK.

Performance Achievements

While the Oerlikon gun tests as well as the gun pod design efforts did not call for a full-scale development effort, the results of the test and evaluation of the 30mm Gatling-type gun system fully supported Air Force recommendations for authority to proceed with full-scale development of the winning prototype system. In the briefing prepared for the DSARC II review, the Air Force provided the results of the Phase I prototype development demonstrations as the basis for its recommendation that the GAU-8/A program be approved for full-scale development using the GE design. The 86,370 rounds fired by the competing guns in the “shoot-off” demonstration had also demonstrated the compatibility and high reliability of aluminum cases with the Gatling gun. Table 7 compares the Phase I production goals to the achievements of the GE prototype design.³³



30mm GAU-8/A Ammunition

The results actually achieved by the GE prototype met or exceeded performance promised by their initial design (Table 7) in all areas except weight. Gun weight had increased from 367 to 591 pounds and system weight from 2607 to 3885.³⁴

Table 7: Performance Achievements 30mm GAU-8 (Phase I)		
<u>Characteristic</u>	<u>Production Goal</u>	<u>Achieved Prototype</u>
Caliber	30mm	30mm
Muzzle velocity (fps) (API/TP)	3200/3500*	3250/3550
Rate-of-fire	4000	4200
Selectable alternate rate-of-fire	2000	2000
Rounds fired 1 st sec	60	60
Weight of gun (lbs.)	600	591
Gun dispersion, ground mount (1 sec burst)	80% in 5 mil diam circle	80% in 4.76 mil diam circle
Weight of round (lbs.)	1.5 approx.	1.42-1.54
System capacity	1350 rounds	1368 rounds
Weight of loaded gun system (1350 rounds/1.5 lb./round)	3500	3885

Armor penetration Steel penetrator HD penetrator	1.5 inches **	1.5 inches# 2.35
Reliability (rounds/stoppage)	10000	8800
Barrel life (rounds)	3000	2373 (copper bands) 6000 (plastic bands)##
* API-HD heavier than API-steel; ** Not specified; # 250K, A/C slat range 4000 ft., 30° obliquity; ## Estimated – no measurable wear after 2700 rounds.		
<i>SOURCE: DCP 103A, 28 Aug 73.</i>		

NOTES

1. Development Concept Paper, DCP 103, subj: Close Air Support Gun, 5 Jun 70, revised 23 Jun 70 (Doc 6); Summary Rept, Evaluation of the Effectiveness of the 30mm CAS Gun, 3 Dec 70, prepared by Joint AMC/NMC/AFLC/AFSC Cmdrs, Joint Technical Coordinating Group for Munitions Effectiveness, Aberdeen Proving Ground (Doc 7); Ltr, Col John D. Coke, Dir of Armament, DCS/Systems, to SD (DCS/Systems), subj: 30mm Gun Program, 9 Mar 71 (Doc 5).
2. Memo, Memorandum for the Deputy Secretary of Defense from John L. McLucas, Acting SAF, subj: Request for Fund Release, 30mm Gun Program, 8 Jun 71 (Doc 8).
3. *Ibid.* See also Directive, Program Management Directive for the 30mm Close Air Support Gun System, PMD No. P-2P006(1), 30 Jul 71 (Doc 23). Hereinafter cited as PMD No. P-2P006(1), 30 Jul 71.
4. Memo, Memorandum for Secretary of the Air Force from John S. Foster, Jr., DDR&E, subj: A-X Gun Development Program, 15 Jun 71 (Doc 9); Msg, CSAF to AFSC/SD, subj: 30mm Gun Program, 181334Z Jun 71 (Doc 10).
5. Memo, Memorandum for the Assistant Secretary of the Air Force (Research and Development) from John L. McLucas, Under Secretary of the Air Force, subj: 30mm Gun Development Program, 1 Oct 71 (Doc 11).
6. Development Concept Paper, DCP 103, subj: Close Air Support Gun, 5 Jun 70, revised 23 Jun 70 (Doc 6).
7. Report, Comparative 10 Year Life Cycle Costs, 30mm CAS Guns, 8 Sept 71 (Doc 12).
8. Memo, Memorandum for Record, Maj Gen Henry B. Kucheman, Jr., Asst DCS/R&D, HQ USAF, subj: A-X CAS Gun Options Briefing, 20 Aug 71 (Doc 13); Ltr, Maj Gen Henry B. Kucheman, Jr., Asst DCS/R&D to AF/RDP, subj: A-X/30mm Gun Meeting, 19 August 1971, 20 Aug 71 (Doc 14).
9. Memo, Memorandum for Dr. McLucas from Pierre M. Sprey, Asst for Spec Projs, OASD(SA), subj: A-X, 12 Nov 70 (Doc 15).
10. Msg, CSAF to AFSC/SD subj: 30mm Gun Program, 181334Z Jun 71 (Doc 10).
11. Ltr, Maj Gen William J. Evans, Dir of Dev & Acq, DCS/R&D, HQ USAF, to AFSC/SD, subj: 30mm Gun Program, 5 Nov 71 (Doc 16); Ltr, Col John W. Hepfer, Asst DCS/Systems, HQ AFSC, to ASD/SD, subj: Project 2583, 30mm Close Air Support Gun System, 16 Nov 71 (Doc 18); Ltr, Col James D. Hildebrandt, A-X Sys Prog Dir, Dep for Sys, ASD, to AFSC/SDNS, subj: Request for Change to Program Management Directive P-2P006(1), 4 Nov 71.
12. Ltr, Maj Gen William J. Evans, Dir of Dev & Acq, DCS/R&D, HQ USAF, to AFSC/SD, subj: 30mm Gun Program, 5 Nov 71 (Doc 16).
13. *Ibid.*
14. *Ibid.*; Ltr, Col John Hepfer, Asst DCS/Systems, HQ AFSC to ASD/SD, subj: Project 2583, 30mm Close Air Support Gun Systems, 16 Nov 71 (Doc 17).
15. Letter contracts with the General Electric Company and the Philco-Ford Corporation were awarded 30 Jun 70. See Development Concept Paper, DCP 103A, subj: 30mm Close Air Support Gun (GAU/8), 28 Aug 73 (Doc 18). The DCP was approved by the Secretary of Defense on 2 Nov 73. Hereinafter cited as DCP 103A, 28 Aug 73.
16. Development Concept Paper, DCP 103A, subj: 30mm Close Air Support Gun (GAU-8), 28 Aug 73 (Doc 18).
17. *Ibid.*
18. Rept, Air Force Flight Evaluation (Systems) of the A-9A Prototype Aircraft, AFFTC TR-73-2, Mar 73, prepared by Air Force Flight Test Center, Edwards AFB (hereinafter cited as AFFTC TR-73-2); Rpt, Air Force Flight Evaluation (Systems) of the A-10A Prototype Aircraft, AFFTC TR-73-3, Mar 73, prepared by Air Force Flight Test Center, Edwards AFB (hereinafter cited as AFFTC TR-73-3, Mar 73); Development Concept Paper, A-10 Specialized Close Air Support Aircraft, Rev B, DCP-23, For Comment Draft, 14 Sep 73.
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20. See note above.
21. Plan, Program Management Plan, 30mm CAS Gun System GAU-8A, 10 Jan 73 (Doc 3); Rept, Comparative Evaluation of Two GAU-8/A Gun System Candidates, ADTC-TR-73-66, Sep 73, prepared by 3246 Test Wing,

- ADTC. Hereinafter cited as ADTC-TR-73-66, Sep 73.
22. ADTC-TR-73-66, Sep 73.
 23. *Ibid.*
 24. *Ibid.*
 25. *Ibid.*
 - 25A. *Ibid.*
 26. *Ibid.*, pp. 16ff.
 27. Planning Summary, Research and Development Planning Summary, Title: Evaluation of 30mm 304RK Oerlikon Gun System, Oct 71; Ltr, Col R.H. Lengnick, Dep for Sys, ASD, to AFSC/SD, subj: Project 2583, 30mm CAS Gun System, 27 Dec 71 (Doc 19); Statement of Work DLDG, 30mm Oerlikon 304RK Gun System, 29 Oct 71, prepared by Guns and Rocket Br, AFATL, Eglin AFB (annexes not included) (Doc 20). Hereinafter cited as Oerlikon Statement of Work DLDG, 29 Oct 71.
 28. RAD, CAS Gun System, 5 Jan 68 (Doc 1).
 29. Rpt, CAS Gun System Study, AFATL 69-4125 (Doc 2).
 30. Rept, GAU-8/A Gun System Development, Phase I, Vol. I, Gun System Program, AFATL-TR-73-131, Jun 73, p. 193, prepared by Armament Sys Dept, General Electric Co. Hereinafter cited as AFATL-TR-73-131, Jun 73.
 31. *Ibid.*
 32. DCP 103A, 28 Aug 73 (Doc 18); Directive, Program Management Directive, 30mm Gun System GAU-8/A, R-P20006(4)/64605F/GAU-8/A, 30 Jul 73 (Doc 21). Hereinafter cited as PMD R-P20006(4), 30 Jul 73.
 33. Briefing, DSARC II, May 73.
 34. *Ibid.*

Chapter 3: FULL-SCALE DEVELOPMENT

Ratification Decision

The Defense Systems Acquisition Review Council (DSARC) reviewed the GAU-8/A program on 5 June 1973 and recommended that the Air Force proceed with negotiations for the full-scale development of the GAU-8/A gun and ammunition. However, the DSARC also directed that the Air Force defer the award of the full-scale development contract until ammunition development and production options could be reviewed. This latter direction was generated by DSARC concern as to whether ammunition costs, particularly for the armor piercing incendiary (API) round, could be held to current Air Force estimates.¹

Following DSARC approval of the options presented by the Air Force, the Director of Defense Research and Engineering, on 21 June, authorized the Air Force to enter into full-scale ammunition development with these provisions:²

1. Initiate competition by introducing a second ammunition developer under contract to the gun developer.
2. Immediate start by the first ammunition contractor on combat round development.
3. Component competition by ammunition subcontractors.
4. Trade-off analyses that consider cost and effectiveness implications of various high density penetrator (HDP) designs.
5. Development of alternative methods for manufacturing HDPs.

Full-Scale Development Contract

The full-scale development contract award, made to the General Electric Company, Armament Division, Burlington, VT, 21 June 1973, was a fixed-price-incentive-firm contract in the amount of \$23,754,567,000.³

The contract called for GE to deliver seven preproduction 30mm gun assemblies and to refurbish the three Phase I gun systems which GE provided for the prototype competition. General Electric, as the prime contractor, was also responsible for the development and design of the 30mm family of ammunition with the ammunition development and limited production subcontracted to the Aerojet Ordnance and Manufacturing Company. The contract with GE further provided for a full-scale development option for four additional gun system copies and for two fiscal year production options of 48 gun system copies and 3.3 million rounds of 30mm ammunition.⁴

In accordance with the approved plan for ammunition development and procurement, a second ammunition contractor was selected. GE subcontracted with Honeywell Inc., Government and Aeronautical Products Division, Minneapolis, MN, in March 1974. Honeywell was not new to 30mm ammunition development since this company had been ammunition subcontractor to Philco-Ford during the competition prototype development phase of the GAU-8/A. however, the

introduction of this second source for competitive development of ammunition did increase the RDT&E costs by an estimated \$17 million.⁵

Schedule of Program Milestones

The full-scale development period encompassed two closely coordinated and integrated efforts. One of these was the testing that would assure that the gun system itself satisfied all performance criteria, including reliability, maintenance, and compatibility with the A-10 aircraft. The other major effort was concerned with the development, testing, and milestone demonstrations of 30mm combat ammunition, with the development of the high density penetrators for the armor piercing incendiary (API) round the cost critical task in this program. This round was integral to the “tank killing” mission of the GAU-8/A, which was one of the primary objectives in the establishment of the A-10 program. Table 8 gives the full schedule of milestones prepared for the full production decision in February 1976.⁶

Table 8: Program Milestones	
<u>Milestone</u>	<u>Date</u>
Phase II Full-Scale Development Contract Award	Jun 73
<u>Gun System</u>	
*Refurbish Phase I Gun Systems	Jun 73 – Dec 73
*Preliminary Design Review	Aug 73
*DT&E/IOT&E Flight Demonstration (Prototype Gun/Prototype A-10)	Feb 74 – Jun 74
*Logistic Support Plan Summary	May 74
*Production Approval (A-10 DSARC IIIA) of 52 A/C and Equal Quantity of Gun Plus Ammo to Support 52 A/C	Jul 74
*Release Long Lead Funding for 22 A/C	Jul 74
*Critical Design Review (Gun)	Oct 74
*Deliver Three Phase II guns	Oct 74 – Dec 74
*Release of Production Funds for 22 A/C Guns	Dec 74
*Release Long Lead Funding for 30 A/C	Jan 75
DT&E/IOT&E Flight Demo of Preprod Guns/Ammo in Preproduction A-10	May 75 – Dec 75
*Release of Production Funds for 30 A/C, Guns/Ammo	Jul 75
*Delivery of First Production Gun (52 guns)	Aug 75
*Final Ground Qualification	Oct 75
DSARC IIIB – Full Production Approval – A/C Guns, Ammo	Feb 76
<u>Ammunition (Aerojet)</u>	
*Preliminary Design Review TP Rounds	Dec 73
HEI Rounds	Dec 73
APIT Rounds	Jun 74
*Prequalification	Jun 74 – Oct 74

*Critical Design Review (TP and HEI rounds)	Aug 74
*Production Approval and Release of Long Lead Items (A-10 DSARC IIIA)	Jul 74
*Critical Design Review (APIT round)	Dec 74
*Final Qualification	Oct 75
DSARC IIIB – Full Production Approval – A/C, Guns, Ammo	Feb 76
*Delivery of Production TP Ammo	Sept 75
Delivery of Production Combat Ammunition (HEI)	Feb 76
<u>Ammunition (Honeywell)</u>	
*Preliminary Review (TP, HEI, APIT rounds)	Apr 75
*Critical Design Review (TP, HEI, and APIT rounds)	Oct 75
Completion of Qualification Testing of TP, HEI, APIT rounds	Jul 76
Complete Flight Qualification of Ammo	Jun 76
<u>DT&E Flight Demonstrations</u>	
*A-10 Prototype with Phase I Refurbished GAU-8	Feb 74 – Jun 74
*Report of the Prototype A-10 Flight Demonstration	Jun 74
*DT&E/IOT&E Flight Demonstration of Preprod Gun/Ammo	Mar 75- Dec 75
*Complete Flight Qualification of Gun/Ammo (Aerojet Rds)	Nov 75
* Completed milestones as of Feb 76. SOURCE: Program Memorandum 121, 29 Oct 75; updated to 22 Mar 76.	

The integration of the GAU-8/A gun system into the A-10 CAS weapon system involved both gun system development/testing and aircraft-gun integration testing. This testing, conducted throughout the Phase II full-scale development period, was organized into three parts:⁷

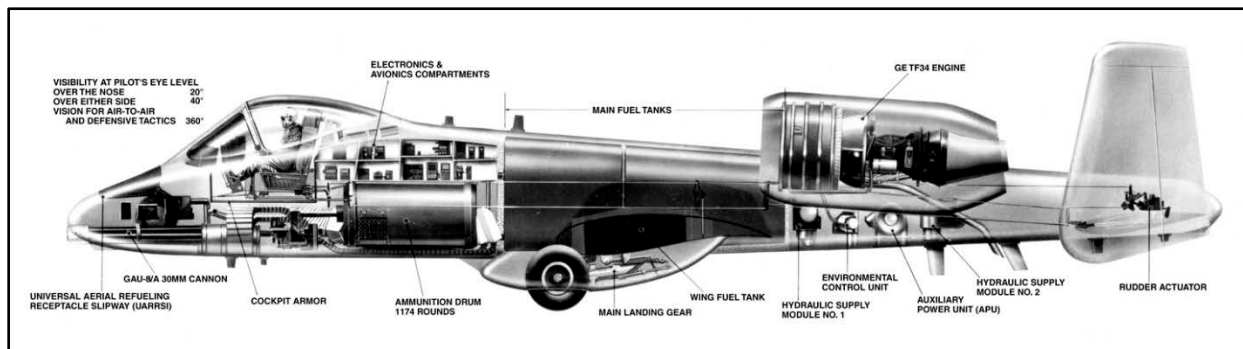
1. A/10/GAU-8/A prototype ground and flight testing
2. Gun system development testing
3. Gun system/aircraft ground and flight testing.

Major development milestone events were established for each of these parts. Part I included the compatibility demonstration of the GAU-8/A prototype gun in the A-10 prototype aircraft prior to the production decision, using two refurbished Phase I guns. Part II included the full-scale development of the GAU-8 gun system and ammunition leading to the final ground qualification of preproduction systems. In addition, Part II testing included engineering, acceptance, pre-qualification, and qualification testing using one refurbished Phase I prototype, three preproduction gun system copies, and the complete family of combat and target practice ammunition. After development testing, a preproduction Critical Design Review (CDR) would identify those changes required to improve the gun system and make it fully compatible with the “production design A-10.” Part III included GAU-8/A gun system support for the A-10 DT&E (development, test, and evaluation) and IOT&E (initial operational test and evaluation). Part III testing was conducted in the A-10 DT&E aircraft with eight preproduction gun system copies

scheduled to be used in this part of the test program leading to final flight qualification of the gun system ammunition and supporting ground equipment.⁸

GAU-8/A-10 Compatibility Tests

Two Phase I prototype 30mm gun systems were refurbished in order to demonstrate compatibility with the prototype YA-10. Ground firing with one of these refurbished Phase I guns was conducted at the Underhill, VT, range of the General Electric Company from December 1973 through January 1974. These gun firings were made with the gun installed in a highly instrumented nose section of the YA-10 built specifically for this test, but structurally identical to the YA-10. A total of 7,833 rounds were fired with four-second bursts at a rate of 4,200 rounds per minute and six-second bursts at a rate of 2,100 rounds per minute, with these rates presenting the low and high rates of fire which could be controlled by the A-10 pilot. Major Robert Riggs, GAU-8/A program manager in the A-10 System Program Office, participated in several of the test firings. He reported no “excessive flash or vibration,” and a cockpit environment which was similar to that when firing the 20mm cannon installed in the F-100 aircraft. Ground firings were also conducted with a second prototype gun system installed in a YA-10 at the Air Force Flight Test Center, Edwards AFB, CA. While some minor modifications were necessary for this particular gun installation, 1,700 rounds were fired in this contractor-conducted ground test with no problem.⁹



After the successful ground testing, the Flight Test Center began evaluations on 22 February 1974 using two of the refurbished GAU-8/As installed in YA-10s. This test used the same method as the A-9/A-10 flyoff where strafing hit percentages were determined on separate hits on 20x20 foot strafe panels placed on the ground. Flight testing was accomplished by Air Force Systems Command personnel and Tactical Air Command personnel with “full participation” of the Air Force Logistics Command and the Air Training Command.¹⁰

The flight tests, completed on 25 March 1974, supported the conclusion that there were no major problems of compatibility between the gun system and the aircraft, which would delay an initial production decision. However, a secondary gun gas ignition phenomena, which had been observed during these tests, did require a remedy prior to the final production decision.¹¹

Problems and Solutions

Secondary Gun Gas Ignition

During the first phase of in-flight firing of the prototype GAU-8/A gun in the YA-10 prototype aircraft, which extended from 26 February to 25 March 1974, pilots reported

secondary gun gas ignition that caused a flame area ahead of the nose of the aircraft. While the major problems caused by this phenomenon were perturbations in the internal pressure of the engines, there was also some obstruction of pilot vision.¹²

The GAU-8/A prototype gun was modified to correct several problems and flight tested again beginning on 9 October 1974. The modifications included gun barrels which were six inches longer than the prototype model, and the use of plastic bonded ammunition. The lengthening of the gun barrel, which would provide for a more complete burning of propellants in the barrel of the gun, was expected to contribute to a decrease in secondary gas ignition. The replacement of copper bands on the 30mm ammunition with plastic bands was expected to reduce the secondary ignition by reducing blowby,* thus encouraging more complete burning of propellants in the gun barrel. At the same time barrel life would be extended by cutting friction and corrosive blowby. In addition to the gun and ammunition modifications, the aircraft was modified by adding a double-baffled deflector to redirect air flow at the muzzle.¹³

These Phase II tests were less successful than expected. The gun modifications failed to meet the "no engine perturbation" criteria since they failed to prevent secondary gas gun ignition "directly off the aircraft nose." Even the double-baffled deflector, which was the "highest confidence device," failed to correct the engine perturbation problem: engine perturbation occurred during a 2g, 200 kts, 10° angle of attack maneuver.¹⁴

While the reduction or elimination of secondary gun gas ignition by an "improved" double-baffled reflector would be pursued, evidence indicated that the principal difference between Phase I prototype testing and Phase II production gun testing contributing to secondary gun gas ignition was a difference in propellant. The long term solution, therefore, was to "modify propellant formulation so as to depress secondary ignition."¹⁵

The initial determination was that the secondary gun gas ignition in the GAU-8/A/A-10 tests could be controlled by the addition of potassium salts to the basic GAU-8/A ammunition propellant. One of the techniques evaluated was the adding of a potassium nitrate "suppressant" to the propellant in pellet form. Since these pellets were the same size and shape as the grains of the basic propellant, they would remain uniformly distributed even under severe vibration conditions.¹⁶

Six thousand rounds of Phase II ammunition, a heavier projectile with plastic rotating bands, using the same propellant formulation used in Phase I tests, were fired in flight tests at Edwards AFB in October and November 1974 with the double-baffled deflector installed. No secondary gun gas ignition was experienced. This fully confirmed the tentative conclusion that differences in Phase I and Phase II propellant was causing the secondary ignition in the Phase II tests. Further, small lots of propellant with additional suppressant were also tested in flight with no secondary gun gas ignition experienced. The problem had been solved with only the precise formula of deterrent and propellant mixture to be determined. On 7 November 1974 the A-10 System Office at AFSC Headquarters referred to the gun gas problem with a notation: "Action Closed."¹⁷

* The escape of gun gases past the projectile while it is still in the gun barrel.

Additional in-flight firing tests of the new propellant mixture with potassium pellets on 5 February 1975 confirmed the success of the suppressant. One day and one night sortie were flown with 985 rounds fired under conditions considered conducive to the secondary ignition; however, no ignition or engine perturbation were recorded.¹⁸

Gun Gas Residue

Although the addition of the nitrate suppressant had solved one problem, there was evidence that this solution had created another. The A-10 Program Director described the probable permanent solution to the secondary ignition problem, and at the same time asserted that following a night sortie, the A-10 pilot reported unacceptable performance because “excessive residue” from the gun firing covered the canopy and “impaired vision.”¹⁹

The excessive residue deposits not only impaired pilot vision but also degraded engine thrust. There was, however, no evidence that this residue caused corrosion. A windshield washer system, which proved to be operationally acceptable, was developed for cleaning the residue from the windscreen. Washing the engine with water was also found to be effective in removing the gun gas residue (which was potassium bicarbonate and therefore water soluble) and keeping the engine clean.²⁰

Gun Angle

An unsatisfactory angle of gunfire also emerged as a problem. Pilots who had taken part in the GAU-8/A/YA-10 flyoff reported that the angle of gunfire was not correct for low dive-angle and low slant-range strafing profiles, and test pilots who flew GAU-8/A gun firing sorties at the Air Force Flight Test Center confirmed the problem. Although strafing at larger slant ranges, high angles, or with flaps down at low speed had been satisfactory, the set angle of gunfire required the pilot, under other firing conditions, to aim the aircraft velocity vector short of the target in



Firing the GAU-8 during testing

order to make a hit. The normal method could not be used to concentrate bursts because a positive pitch rotation was needed to keep the gun on the target. Flight tests conducted on 11 and 12 June 1974 demonstrated that a two degree gun angle alignment would be best.²¹

The unsatisfactory gun alignment was briefed at the DSARC IIIA meeting in early July 1974. Following this review, the A-10 was modified to depress the GAU-8 gun two degrees.

Subsequent flight evaluation indicated that all deficiencies related to this problem had been eliminated and that this gun alignment was optimum for the A-10 attack profile.²²

A-7D/A-10 Flyoff

The Air Force's selection of the A-10 for the close air support mission prompted Congressional criticism, which for a time seemed to threaten the continuation of the A-10 program. In July 1973 the Tactical Air Power Subcommittee of the Senate Armed Services Committee slashed \$50 million from the Air Force's FY74 A-10 budget and tacked on \$72 million to a budget request for 24 A-7Ds. At the same time, it recommended that the Air Force conduct a flyoff between the two aircraft to determine which was better suited for the close air support and interdiction missions.²³

The GAU-8/A 30mm was squarely in the middle of the aircraft controversy. Without the big cannon the A-10 was neither cost-effective nor technologically superior in combating heavy enemy targets. The importance of this gun was further confirmed when the A-7D producer, LTV, approached both General Electric and Philco-Ford in an effort to obtain a gun pod design for a 30mm gun that would fit the A-7 aircraft. The best that General Electric could do for LTV was to submit a design concept for an internally-mounted 30mm gun that carried about 500 rounds (compared to the A-10's 1,350 rounds). In addition, the total package price for the A-7 and the General Electric Gatling gun was higher than the cost of the A-10 with its GAU-8/A.²⁴

The Air Force, however, continued its unwavering support of the A-10 close air support system and forwarded to Representative George H. Mahon, Chairman, House Armed Services Committee, a complete study that appeared to verify the Fairchild A-10 prototype's superiority over the A-7D and other attack aircraft.²⁵

Labeled "Saber Armor Charlie," the study was a computerized war game in which various planes in the Air Force's inventory encountered a major tank offensive. These analytical results showed that the 30mm gun system doubled the tanks killed per sortie in a scenario in which A-10 or A-7 aircraft were employed against a massive Soviet armored attack in central Europe. The Air Force believed that the statistics in this study, which reaffirmed the A-10's effectiveness, obviated the need for a flyoff which, at best, would be difficult to evaluate.²⁶

Political pressure was still sufficient to force a flight test showdown between the A-7D and the A-10. In September 1973 the Senate Armed Services Committee insisted that "the Air Force conduct a flyoff between the A-7D and A-10 to obtain the opinion of operational pilots on their relative suitability for close air support." Dubbed "Saber Compare," the flyoff, conducted at Fort Riley, KS, from 15 April through 9 May 1974, confirmed the Air Force's earlier date on the overall effectiveness of the A-10 in the close air support mission.²⁷

The GAU-8/A aboard the A-10 destroyed tanks at the rate of a 0.21 single pass probability of kill, while the M-61 cannon installed on the A-7D was virtually useless against hard targets. Again, there was a significant difference when the two planes directed their fire on armored personnel carriers. Against those targets, the A-10's big cannon was approximately four times as destructive as the smaller M-61 20mm gun. During the first part of the flyoff, pilots expressed some concern over the effectiveness of GAU-8/as when fixed from low altitudes and at slow speeds. Keeping the gun on the target under those conditions resulted in aircraft sink rates that some pilots believed were unsafe (the same gun angle problem discussed earlier). Further flight

testing, however, revealed that the A-10's maneuver flaps corrected the aircraft sink rate during low speed strafing runs and depressing the gun angle corrected the problem entirely.²⁸

More particularly, the flyoff highlighted the GAU-8 system as a major contributor to the close air support capability. "The A-10 achieves greater lethality against close air support targets than the A-7D by virtue of its larger payload and the anti-tank capability of the GAU-8 cannon, which produced higher average per sortie and per pass kill capability."²⁹

In short, the comparative flight evaluation of the YA-10 and the A-7D provided an emphatic endorsement of the effectiveness of the YA-10/GAU-8/A combination as a close air support system.

Ammunition Development

The development of a suitable penetrator for the armor piercing (AP) round had been in the forefront of development problems and objectives from the earliest concept studies concerned with the 30mm CAS gun system. A particular concern was the technology needed for the design, development, and production of the AP round. One was an AP projectile which would be a "depleted uranium (DU) sub-caliber aluminum-jacketed projectile of 5500-6000 grain."³⁰

One advantage of depleted uranium was that the density of this material offered the "greatest penetration for a given penetrator mass." A second advantage was that the "inherent pyrophoric effects" of this material would provide for "considerable exposed fuel/fire potential, after-armor ignition of fuel and ammunition, and after-armor burning of interior contents." However, the Close Air Support Study Group, which had expressed a preference for a depleted uranium penetrator development might not permit the timely development of the desired API projectile, and, therefore, recommended a tungsten carbide or an appropriately designed steel case projectile as a backup round through the period of development.³¹

All three Services had development programs for munitions using depleted uranium, and the Air Force had been successful in the development of a 20mm flechette projectile which was designed for air-to-ground applications in order to enhance vehicle kills. However, the Secretary of Defense had, on 7 November 1970, disapproved a request for the authority to proceed with quantity production of this projectile.³²

On 4 April 1972 the Secretary of Defense approved the selective use of depleted uranium for munitions when he signed Program Memorandum #40, titled "Selective Use of Depleted Uranium (DU) in Munitions." This program memorandum offered several alternatives ranging from approval of DU for the Service inventories and for Southeast Asia to the discontinuance of "developments leading to the use of DU in conventional munitions." The Secretary approved Alternative I which provided for the "continued development of DU munitions" but delayed any approval for production until development had been completed. The memorandum confirmed the availability of depleted uranium materials with the evidence that stocks of this material were well above any expected requirements which might be imposed by the total requirements of the military services.³³

The types of rounds which were competitively developed for the family of 30mm ammunition for the GAU-8/A gun system included: HEI (high explosive incendiary), SAPHE (semi-

armor piercing high explosive), and API (armor piercing incendiary) with a steel or high density penetrator. The status of this ammunition program at the end of Phase I competitive prototype period in 1973 was reported in DCP-103A:³⁴

HEI. The Phase I projectile achieved all of its goals and is effective against trucks, personnel, and other soft/semi-hard targets.

SAPHE. The production design goal to defeat .5 inch 450 BHN armor at 60° obliquity (250 KTAS aircraft at 4000 ft. slant range) was achieved. However, the fuse function to optimize after-armor effects was unsatisfactory. The complexity, high cost, and marginal effectiveness of this warhead make it undesirable for further development.

API-Steel. This projectile achieved its production penetration goals but lacks sufficient effectiveness against the tank target. Therefore, this round was eliminated from the combat family.

API-High Density Penetrator. Phase I tests yielded 2.35 inches penetration of rolled homogeneous BHN armor (30° obliquity, 250 KTAS, 4000 ft. slant range) with DU penetrators. An alternative high density penetrator material is a tungsten alloy.

Aluminum Case. Aluminum case development is going well. Phase I indicated that gun/ammunition case design, manufacturing processes, and alloy quality control were keys to 30mm Gatling gun compatibility.

After elimination of the API-Steel projectile, development effort was then concentrated on a penetrator for the API fabricated from depleted uranium (DU) or, as an alternative, a tungsten alloy. The choice would be made on the basis of “performance, availability of material, and cost of the penetrator.” The Air Force ultimately proposed a penetrator 290-300 grains composed of DU alloyed with 0.75 percent titanium.³⁵

The Air Force recommendation that development be concentrated on the high density metals, preferably depleted uranium, as the penetrator material for the armor piercing incendiary (API) round was based squarely on the results of firing tests which showed the dominant effectiveness of the high density metals for armor piercing “tank killing” requirements, but this decision compounded manufacturing and cost problems. While this recommendation was approved by the Deputy Secretary of Defense following the Air Force presentation to the DSARC II principals, they identified ammunition development uncertainties and production costs



GAU-8 gun ammunition

as problems which could have significant adverse effects on the A-10 close air support program.³⁶ This concern was iterated by the Deputy Secretary of Defense who requested the Air Force to submit alternatives which would address the achievement of the lowest possible ammunition production costs. The crux of this concern was the high density penetrator for the API round. Of the four options presented by the Air Force to the DSARC principals on 20 June 1973, one was approved unanimously. This option featured the following provisions:³⁷

- a. There would be two competitive ammunition subcontractors.
- b. Both contractors would be required to develop an armor piercing penetrator.
- c. Both of these subcontractors would obtain at least two supply sources for case, propellant, and penetrator.
- d. Both contractors would design target practice (TP), high explosive incendiary (HEI), and armor piercing (AP) projectiles.
- e. Both ammunition contractors would develop processes to manufacture depleted uranium (UD) penetrators.

These recommendations were interpreted by the Air Staff to mean that the second ammunition contractor would also carry out penetrator design and development, an added factor which would increase estimated cost of ammunition development under the approved plan from approximately \$9.2 to \$15 million. The Air Staff also revised the proposal by DSARC II in consonance with AFSC advice so that requests for proposal (RFP) to the potential ammunition contractors required two separate programs, one in which each contractor would utilize only an Air Force design penetrator and one in which the contractor would do its own penetrator development.³⁸

Lt Gen James T. Stewart, Commander of the Aeronautical Systems Division, also described the advanced development programs which would be carried out concurrently by the Armament Laboratory at Eglin AFB, FL, to "further reduce (unit) round cost."³⁹ This program, which would be conducted parallel with the full-scale development effort by contractors, was directed toward attaining three objectives from ammunition development:⁴⁰

- a. Compatibility with the GAU-8/A gun.
- b. Credible cost data to make production tradeoff decisions.
- c. Integration of efforts and exchange of data among AFATL, the Air Force Materials Laboratory, the A-10 Program Office, and the contractor.

General Stewart identified four advanced development tasks and technical objectives:

1. High density API penetrators: to determine the most cost effective high density penetrator with testing of several shapes of each candidate penetrator.
2. Improved propellants: to develop a propellant which would provide a higher muzzle velocity.

3. Alternate cartridge case: to provide the most cost effective case for the GAU-8/A 30mm ammunition. Plastic/aluminum cases and two-piece magneformed aluminum cases had been identified as having a potential for reducing the cost of the currently used aluminum cases.
4. Each ammunition contractor would undertake manufacturing technology studies to find out the most cost effective method of producing high density penetrators through a pilot production and testing program. Paralleling this effort would be an Air Force Materials Laboratory and Air Force Armament Laboratory team effort with the United States Army to optimize "present manufacturing technology for lowering the cost of the penetrators."⁴¹

Air Force efforts to gain approval of depleted uranium (DU) as the material for a high density penetrator for the API round received further support in an evaluation of the "medical and environmental implications of the use of depleted uranium (UD)..." This evaluation, which the Director of DDR&E requested in October 1973, was conducted by an ad hoc working group established by the Joint Technical Coordinating Group for Munitions Effectiveness (JTCEG/ME).⁴²

The objective of the evaluation was "to foresee and be prepared to answer the many questions that may be raised within the DoD, the Public Health Service, Congress, and the public with regard to DU use in munitions." The Air Force GAU-8/A was included with the Navy Phalanx and the Army Bushmaster guns.⁴³

The scope of the evaluation encompassed not only the environmental effects of the combat use of depleted uranium in selected scenarios but also the environmental and medical considerations associated with the manufacture, storage, use, and disposal of depleted uranium munitions. The Munitions Effectiveness Working Group reported the use of depleted uranium ammunition under normal conditions was "expected to have no significant medial and environmental impact." But in the event of an accident: "Depending upon conditions locally, significant impact can occur in the event of uncontrolled release of DU."⁴⁴

During the period of the Phase II full-scale development from June 1973 to the July 1974 DSARC IIIA decision point for long lead funding of initial production, ammunition development had produced a number of changes from the designs developed during Phase I. One major difference was the replacement of the copper rotating band with a plastic rotating band which reduced round costs, reduced blowby (and attendant secondary gun gas ignition), and most importantly showed clear promise of a major increase in gun barrel life. An increase of 0.016 inch was made in the base diameter of the Phase II round as compared with the Phase I and the propellant mixture was altered as noted in the discussion of secondary ignition. For the high explosive incendiary (HEI) round, the Phase II design incorporated the standard M505 fuze.⁴⁵

The manufacturing technology programs aimed at the reduction of costs for the fabrication of depleted uranium materials for the API penetrator continued to be the focus of a primary development effort. In an Air Force briefing to the DSARC IIA principals in July 1974, an on-going joint Air Force/Army program was described in which high density penetrators were fabricated by machining them from bar stock using production equipment. One objective of this

program was the analysis of penetrator fabrication costs; another was the evaluation of alternate fabrication processes which might reduce costs.⁴⁶

The Battelle Institute was also examining casting and forging as cheaper alternate processes for penetrator fabrication using depleted uranium. In all cases, the data derived from these manufacturing technology investigations were shared with the ammunition contractors, AOMC and Honeywell.⁴⁷

While the Air Force was directed to insure accomplishment of specified ammunition program milestones prior to full-scale production approval, the Deputy Secretary of Defense approved Air Force use of DU API rounds for testing following the DSARC IIIA review of the A-10 CAS program on 19 July 1974.⁴⁸

In October 1975 ammunition testing, which encompassed the firing of more than 100,000 TP (target practice) projectiles, substantiated not only the compatibility of the TP round but also the aluminum cartridge case and propellant ignition system. At this date, only limited tests of the HEI projectile employing a standard fuze and HE loading technique had been conducted. However, since the HEI projectile used the same cartridge case and propellant-ignition system and ballistically matched the TP projectile, no serious problems affecting the design of this projectile were anticipated.⁴⁹

As Table 9 shows, during 1975 major ammunition development milestones were achieved by Aerojet and partially by Honeywell. In September Aerojet began delivery of production TP rounds with 15,000 rounds. The final qualification of the Aerojet ammunition was formally achieved when the Aerojet rounds passed all qualification tests in October and flight qualification in November. Honeywell would not pass the same milestone until July 1976.⁵⁰



Ground crew personnel reload an aircraft for another flight during Red Flag 77-6/Task Force Irwin II conducted in April 1977

Table 9: Gun/Ammunition Milestone Dates			
<u>Milestone</u>	<u>GE</u>	<u>AQMC</u>	<u>H W</u>
CDR			
Gun System	*Oct 74		
Ammo HEI		*Aug 74	*Oct 75
Ammo HEI		*Aug 74	*Oct 75
Ammo APIT		*Dec 74	*Oct 75
Qual Testing (Completion)			
Gun System		*Oct 75	Jul 76
Ammo TP/HEI		*Oct 75	Jul 76
Ammo APIT		*Oct 75	Jul 76
Production Deliveries			
Start			
Gun Systems	*Aug 75		
Ammo TP		*Sep 75	N/A
Ammo (Combat) HEI		Feb 76	N/A
APIT		Oct 76	N/A
Flight Qualification Gun/Ammo		*Nov 75	Jul 76
* Completed milestones.			
SOURCE: Program Memorandum 121, 29 Oct 75.			

NOTES

1. DCP 103A, 28 Aug 73 (Doc 18).
2. *Ibid.*
3. *Ibid.*; PMD R-P2006(4), 30 Jul 73 (Doc 21).
4. Plan, Program Management Plan, 30mm Close Air Support Gun System (PMP 100-3), 1 May 74 (Doc 22).
Hereinafter cited as PMP 100-3, 1 May 74.
5. *Ibid.*
6. DCP 103A, 28 Aug 73 (Doc 18).
7. PMP 100-3, 1 May 74, pp. 2-2, 2-3 (Doc 22).
8. *Ibid.*, pp. 4-1, 2-2.
9. DCP 103A, 28 Aug 73 (Doc 18); Article, "GAU-8 Gun Completes Ground Firing Tests at GE's Burlington Facility," *Aerospace Daily*, 13 Feb 74.
10. Hist, History of the Air Force Flight Test Center, FY 74, Vol I, pp. 41-43.
11. Summary of GAU-8/A Qualification Testing, DCS/Systems, 14 Nov 74; Ltr, Maj Gen R. T. Marsh, DCS/Systems, to AFSC/CC, subj: Secondary Gun Gas Ignition Problem on the A-10 Weapon System, 7 Nov 74 (Doc 24).
12. See note above.
13. Memo, Memorandum for General Stewart from Brill (Brig Gen Jay Brill, A-10 SPD), subj: Secondary Gun Gas Ignition, Feb 75 (Doc 25). Hereinafter cited as Brill Memo, Feb 75.
14. *Ibid.*; Memo, Memorandum, Maj Gen R. T. Marsh, DCS/Systems, to AFSC/CC, subj: Secondary Gas Ignition/Status of 30mm Flight Tests,
23 Oct 74 (Doc 26). Hereinafter cited as Marsh Memo, 23 Oct 74.
15. Marsh Memo, 23 Oct 74 (Doc 26); Brill Memo, Feb 75 (Doc 25).
16. Brill Memo, Feb 75, (Doc 25).
17. Ltr, Maj Gen R. T. Marsh, DCS/Systems, to AFSC/CC, subj: Secondary Gun Gas Ignition Problem on the A-10 Weapon System, 7 Nov 74,(Doc 24).
18. Brill Memo, Feb 75 (Dco 25).
19. *Ibid.*
20. Ltr, Asst DCS/Research and Development (USAF) to DDR&E (T&E), subj: A-10 Report, 27 Sep 76, Atch 4, Gun Gas Residue Testing.
21. Hist, History of the Air Force Flight Test Center, FY 74, Vol I, p. 44.
22. Briefing, DSARC Program Review, A-10, Close Air Support Air-craft, Nov 74 (Doc 27).
23. Article, "Senate Unit Cuts A-10 Funds; Recommends Flyoff with A-7D," *Aviation Week & Space Technology*, 16 Jul 73; Article, "Air Force Battles Political Pressure to Proceed with A-X Program," *Aerospace Daily*, 23 Jan 73; Article, "ASD Chief Says He's Not Aware of Pressure for A-7 Over A-X," *Aerospace Daily*, 24 Jan 73.
24. Article, Clarence A. Robinson, Jr., "USAF Unveils War Game Study to Blunt A-10 Contract Attacks," *Aviation Week & Space Technology*, 5 Mar 73.
25. *Ibid.*
26. *Ibid.*, DCP 103A, 28 Aug 73 (Doc 18).
27. Executive Summary, A Comparative Flight Evaluation of the YA-10 and A-7D (SABER Compare), 15 Jun 74, pp. iv-vii, 7, 12, 29-30. Prepared by Dir of Gen Purpose and Alft Studies, Asst Chief of Staff, Studies and Anal, HQ USAF (Doc 28).
28. *Ibid.*, p. 12.
29. *Ibid.*, p. 29.
30. Rpt, CAS Gun System Study, AFATL 69-4125, p. 18 (Doc 2).
31. *Ibid.*, pp. 17-18.

32. Memo, Memorandum for the Secretaries of the Military Departments, Chairman of the Joint Chiefs of Staff (J-5), Asst Secretary of Defense (Compt), Asst Secretary of Defense (I&L), Asst Secretary of Defense (SA), from John S. Foster, Jr., DDR&E, subj: Program Memorandum 40 "Selective Use of Depleted Uranium (DU) in Munitions," 2 May 72, w/1 Atch; Program Memorandum 40, subj: Selective Use of Depleted Uranium (DU) in Munitions, 3 Dec 71 (Doc 29).
33. *Ibid.*
34. DCP 103A, 28 Aug 73 (Doc 18).
35. Special Report, Medical and Environmental Evaluation of Depleted Uranium, Vol I, Apr 74, prepared by JTCG/ME Ad Hoc Working Group for Depleted Uranium; DCP 103A, 28 Aug 73 (Doc 18).
36. Memo, Memorandum for the Acting Secretary of the Air Force from Deputy Secretary of Defense W.P. Clements, Jr., subj: 30mm Close Air Support Gun (GAU-8) Program, 13 Jun 73 (Doc 30); Memo For the Acting Secretary of the Air Force from the Director of Defense Research and Engineering, John S. Foster, Jr., subj: 30mm Close Air Support Gun (GAU-8) Program, 21 Jun 73 (Doc 31).
37. Memo, For the Acting Secretary of the Air Force from the Director of Defense Research and Engineering, John S. Foster, Jr., subj: 30mm Close Air Support Gun (GAU-8) Program, 21 Jun 73 (Doc 31).
38. Talking Paper, subj: DSARC Trends-GAU-8, a/o 7 Nov 73, pre-pared by SDWM/Maj Ripley; Ltr, Lt Gen James T. Stewart, ASD/CC, to AFSC/CV (Lt Gen Edmund F. O'Connor), subj: GAU Ammunition Program (Your Ltr, 2 Aug 73), 13 Aug 73, w/2 Atchs: (1) GAU-8 Competitive Ammunition Development: (2) Annex I, 30mm CAS Gun Program Parallel Development Tasks (Doc 32).
39. Ltr, Lt Gen James T. Stewart, ASD/CC to AFSC/CC (Lt Gen Edmund F. O'Connor), subj: GAU-8 Ammunition Program (Your Ltr, 2 Aug 73), 13 Aug 73, w/2 Atchs: (1) GAU-8 Competitive Ammunition Development (2) Annex I, 30mm CAS Gun Program Parallel Development Tasks (Doc 32).
40. *Ibid.*
41. *Ibid.*
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44. *Ibid.*
45. Briefing, DSARC Program Review, A-10 Close Air Support Air-craft, Nov 74 (Doc 27).
46. Briefing, Questions & Issues for A-10 DSARC IIIA on Gun Ammunition, Jun/Jul 74 (Doc 33).
47. *Ibid.*
48. Memo, Memorandum for the DSARC Principals, subj: PM 121, GAU-8 Gun/Ammunition System, 20 Aug 75, w/1 Atch: PM 121 (previously DCP #103), 30mm Close Air Support Gun (GAU-8), 20 Aug 75 (Doc 34). Hereinafter cited as PM 121, 20 Aug 75.
49. Program Memorandum, Program Memorandum 121 (previously DCP 103), 30mm Close Air Support Gun (GAU-8), 29 Oct 75, revised 8 Dec 75, updated 22 Mar 76 (Doc 35).
50. *Ibid.*

Chapter 4: PRODUCTION PHASE

Limited Production Decision

At the DSARC IIIA Review of the A-10 program on 9 July 1974, the DSARC principals noted the excellent progress of the A-10 system prototype and development program; on their recommendation, Deputy Secretary of Defense, William P. Clements, Jr., on 31 July authorized the Air Force to proceed with the initial production of A-10 aircraft using long-lead funding. The approval was for the procurement of 52 A-10s, but with the qualification that contract options would be kept open for a smaller number (28) of aircraft until specified milestones had been achieved. The milestones that were specified included three items directly concerned with the GAU-8/A gun program:¹

- a. GAU-8 Gun and Armor Piercing Ammunition Critical Design Reviews.
- b. GAU-8 gun testing at depressed angle.
- c. GAU-8 firings, including tests for gun gas concentration, with increased barrel length and Phase II (production) ammunition with plastic rotating band.

Secretary Clements also authorized the Air Force to proceed with the initial options for GAU-8/A ammunition production. At the same time he reminded the Air Force managers that both the gun and ammunition programs would be subjects for DSARC review prior to full funding release. Ammunition costs continued to be singled out as a major concern with the Deputy Secretary of Defense identifying competition between potential ammunition suppliers as a primary means of reducing the cost per round. A major Air Force objective as attained, however, when the Deputy Secretary of Defense approved Air Force use of depleted uranium (DU) for the penetrator of the armor piercing incendiary (API) round of the GAU-8/A family of ammunition "subject to the licensing requirements of the Atomic Energy Act of 1954."²

A follow-up DSARC review was held on 19 November 1974. At that time, all residual milestones concerned with the GAU-8/A gun and ammunition, with the exception of the Critical Design Review for the Armor Piercing Incendiary (API) round, had been completed as required by Secretary Clements following the July DSARC IIIA Review. Milestone completions included the correction of the gun alignment problem and the essential solution of the secondary gun gas ignition problem.³

Qualification Tests

The GAU-8 Qualification Program was begun in October 1974 with the acceptance of the first of the three preproduction gun system copies. This testing, which encompassed a variety of test environments and test objectives, has been summarized below:⁴

- a. Endurance Qualification Test: a 50,000 round automatic gun firing test conducted at the General Electric Company facility range at Underhill, VT.
- b. Environmental Qualification Testing
 1. Salt Fog Exposure: to evaluate performance degradation due to corrosion.

2. Dust Exposure: the accelerated exposure of the gun system and ammunition to a spectrum of dust particles to reveal performance degradation.
 3. Temperature Altitude Humidity Exposure: testing to verify system performance at extremes of temperature, altitude, and humidity.
 4. Shock and Vibration: exposure to a shock and vibration spectrum which simulated the aircraft flight environment.
 5. Electromagnetic Interference (EMI): electrical subsystem EMI testing.
 6. Humidity: electrical subsystem humidity exposure testing.
 7. Hydraulic Drive Qualification.
 8. Exposure Atmosphere.
 9. Temperature Altitude Humidity (TAH) Test of Electrical Subsystem: a separate test was made of the electrical subsystem with the exception of the electronic control unit (ECU).
- c. Static Loads Test: Testing scheduled to begin in September 1975 for a duration of 45 days.
- d. Air Force Independent Evaluation: In May 1975, the Air Force began an evaluation of the GAU-8/A gun system including ammunition. The testing, which was conducted at Eglin AFB, consisted of automatic gun firing of approximately 8,500 rounds of target practice ammunition. The armor piercing incendiary (API) rounds were also fired against suitable armored targets. Measurement of HEI and API round capability was a prime test objective to be completed prior to the inflight firings of combat ammunition. Data taken during this evaluation was specifically directed to the "critical issues" addressed in the GAU-8 Management Directive.

Reliability

The reliability of the GAU-8/A gun system was fully demonstrated by actual gun firings before the completion of the development flight test program which was scheduled for completion in December 1975. By August 1975 firing tests of the prototype gun system had been accomplished with more than 90,000 rounds fired. This total included the 70,400 rounds fired in the competitive shoot-off. It also included 21,000 rounds fired in the YA-10/GAU-8/A compatibility test of which 11,265 rounds had been fired in flight. On the basis of these firings, the mean time before failure of 10,000 rounds had been almost achieved.

Lethality Test

In the operational environment of Central Europe would probably provide the most difficult armored targets that the A-10 would likely encounter through the 1985 time period, in the form of T-55 and T-62 Soviet tanks. The A-10/GAU-8/A weapon system proved its worth as

an anti-armor weapon in lethality tests conducted at Nellis AFB in October and November 1975. This live-gun lethality test, which was a part of the overall development test and evaluation (DT&E) program, used combat configured Soviet T-62 and American M-46 and M-48 tanks containing diesel fuel and tank ammunition as the targets. Twenty-two passes were made, which resulted in all of the 15 tanks used in the test being immobilized, with eight catastrophic kills. (A catastrophic kill destroyed a tank or rendered it unrepairable.)⁶



Aftermath of the lethality of the GAU-8/A gun system visible on the post-attack photograph of a T-62 tank target, May 1976.

Full Production Decision

A formal DSARC IIIB Review which signaled the decision point for the full-scale production of the A-10 and the GAU-8/A had been scheduled initially for October 1975. The review, which was first rescheduled to December 1975 awaiting the completion of specified test milestones, was not held. Instead, members of the council expressed preference for a more informal approach with the result that a series of pre-DSARC briefings were made by Air Force officials with evidence that the DSARC III test objectives had been accomplished.⁷

Although the secondary gas gun ignition problem had been solved, there were still some questions as to the potential corrosive effects of the large quantities of gas produced by the firings of the GAU-8/A. However, December 1975 DSARC briefings identified no corrosive problem affecting the aircraft or the engines.⁸

In January and February 1976, DSARC principals reviewed Decision Coordinating Paper (DCP) 23B, "A-10 Specialized Close Air Support Aircraft," dated 7 January 1976. The stated purpose of this DCP was to "support a DSARC IIIB decision to allow the A-10/GAU-8 program to proceed from low-rate production to full-rate production." The DSARC principals approved this DCP without dissent.⁹

The January 1976 DCP supplied the Air Force response to two "issues" concerning the GAU-8/A gun and ammunition: (1) Had the gun contractor adequately demonstrated an ability to perform his contract "in accordance with budgets and schedules?" (2) "Can the 30mm ammunition be produced for [sic] an acceptable cost?" The Air Force's response was that "Production readiness reviews of the...gun contractor, General Electric, Burlington, VT (GEB) conducted since July 1973" indicated that this contractor was "capable of achieving the planned production rates on schedule and within budget."¹⁰

While the Air Force could not answer the second issue with a particular cost figure, it did summarize the progressive advance toward more economical fabrication processes:

Through FY76, the API penetrator will be produced by machining, swaging, and forging. Both FY75 and FY76 buys will be nearly equally divided between the three processes. Consequently, FY77 and beyond buys will be produced by the most economical process for the individual contractors involved in the manufacture based on their experience.¹¹

The Air Force response also noted that the uranium salts which was “reduced to form the DU metal” were in “abundant supply.”¹²

Deputy Secretary of Defense Clements gave full production approval on 10 February 1976, authorizing the Air Force to “proceed with production of the A-10 in accordance with Alternative I described in this DCP.” Alternative I was characterized by the Deputy Secretary as a “good compromise” which considered “anticipated funding” and expressed concern for the “contractor’s ability to finance and produce efficiently.” This same schedule would also provide time for the resolution of problems and the incorporation of fixes into earlier production aircraft.¹³

To gain the needed time for problem-solving, Alternative I would reduce the baseline or full rate production from the 20 aircraft/month proposed by the Air Force for its FY77 budget:

The production rate will build to reach a maximum rate of 15 aircraft per month in September 1970 with the FY77 buy being 100 aircraft. This alternative then would continue at that rate until completion of the program. The lower maximum rate (15 aircraft/month) would provide higher confidence that the contractor can finance and effectively manage this production program without major difficulty. The program would be extended with a resultant program cost increase of approximately \$500M. This alternative would reduce active A-10 squadrons by four squadrons in FY80 and defers modernization of four reserve squadrons in FY80. This alternative would also provide a slower build-up in production more consistent with the anticipated schedule for resolving reliability difficulties which have been encountered in early flight testing.¹⁴

In March 1976, the DSARC principals followed up on the full-scale production approval for the GAU-8/A gun systems and associated ammunition to support the A-10 aircraft force with explicit approval for a full competitive program for the production of 30mm ammunition in “the rates and quantities recommended by the Air Force to support the total A-10 force.”¹⁵

There were three principal features of the “Plan C” for 30mm ammunition procurement. First, a full competitive program between the two ammunition contractors, Aerojet Ordnance Manufacturing Company and Honeywell, Inc., would be continued. Secondly, the Aerojet Company, which had already qualified its ammunition, would be the sole source for the FY75 ammunition buy. Finally, there would be a split in each of the subsequent fiscal year buys between Aerojet and Honeywell.¹⁶

The split between the two contractors recommended by the Air Force was approximately 60 percent to 40 percent for the FY76 and FY77 procurements in order to obtain about the same experience factors in terms of rounds produced by each contractor to support preparation of bids for the large FY78 buy. The FY75-FY76 and FY77 ammunition buys would be procured by the General Electric Company on subcontract with Aerojet and Honeywell. In FY78 and subsequent years Air Force would buy through direct contracts with the two ammunition suppliers.¹⁷



NOTES

1. Memo, Memorandum for the Secretary of the Air Force from W.P. Clements, Jr., DEPSECDEF, subj: A-10 Production Decision, 31 Jul 74 (Doc 36).
2. *Ibid.*
3. Memo, Memorandum for the Secretary of the Air Force from W.P. Clements, Jr., DEPSECDEF, subj: A-10 Program, 19 Dec 74 (Doc 37).
4. Talking Paper, GAU-8/A Gun Test Status, 27 Jun 75 (Doc 38); Talking Paper, GAU-8/A Ammunition Test Status, 15 Jun 75 (Doc 39).
5. PM 121, 20 Aug 75 (Doc 34).
6. Ltr, Grig Gen Jay R. Brill, Dep for A-10, to AFSC/SD, subj: Status of the A-10 GAU-8 Lethality Tests, 13 Nov 75 (Doc 40). See also Ltr, Joint Technical Coordinating Group for Munitions Effectiveness to Commander, US Army Air Materiel Command, subj: Evaluation of the GAU-8 Projectile, 5 Dec 75, w/Atch: Ltr, William Kokinakis, Actg Ch, Vulnerability Lab, to Dir, US Army Materiel Systems Analysis Agency, subj: Lethality Evaluation of GAU-8 Projectiles in the DT&E and IDT&E Tests of A-10, 28 Nov 75 (Doc 41).
7. Hist, Air Force Systems Command, 1 Jul-31 Dec 75, Vol I, pp. 77, 79, Msg, CSAF/RD/XO to AFSC/CV and AFTEC/CC, subj: A-10 DSARC IIIB and Test and Evaluation Briefings, 0300452 Dec 75; Msg, AFSC/CV to ASD/CCYK, subj: A-10 DSARC IIIB and Test and Evaluation Briefing, 0400332 Dec 75. See also Briefing, A-10 CAS Aircraft DSARC IIIB Program Review, 11 Dec 75, in files of Office of History, HQ AFSC.
8. Hist, Air Force Systems Command, 1 Jul-31 Dec 75, Vol I, pp. 77, 79.
9. Paper, Decision Coordinating Paper, DCP 23B, subj: A-10 Specialized Close Air Support Aircraft, 7 Jan 76 (Doc 42).
10. *Ibid.*
11. *Ibid.*
12. *Ibid.*
13. *Ibid.*
14. *Ibid.*
15. Program Memo (C/DECL 31 Dec 81), Program Memorandum 121 (previously DCP 103), 30mm Close Air Support Gun (GAU-8), 29 Oct 75, revised 8 Dec 75, updated 22 Mar 76 (Doc 35).
16. *Ibid.*
17. *Ibid.*

Chapter 5: MANAGEMENT HIGHLIGHTS

Program Management Structure

The acquisition of the GAU-8/A gun system was conducted in accordance with a management structure which reflected the fact that it was a major system acquisition program as defined by Department of Defense Directive 5000.1, 13 July 1971 (53), and Air Force Regulation 800-2, 16 March 1972.¹

In consonance with these directives the GAU-8/A gun system acquisition program was divided into three basic phases. Phase I encompassed the competitive evaluation of the two candidate gun systems and ammunition “designed to satisfy the requirements for a 30mm Close Air Support Gun in the A-X aircraft.” The Phase II effort involved the redesign of the selected gun system following the competitive evaluation, and the “extensive testing” necessary to the qualification of the design for production and the installation in the A-X aircraft. Phase II also called for the inclusion of the “fabrication and test of podded GAU-8/A gun systems, the development of a high-performance AP round containing a high density core, and ground support equipment.” Phase III was the production phase during which sufficient GAU-8/A gun systems would be procured to match A-X aircraft production.²



Evaluating the GAU-8/A.

During each phase the achievement of scheduled milestones through demonstrated performance was required in order to move into the succeeding phase. The major decision points for progress into Phases II and III were those points in the development and acquisition process at which the Secretary of Defense decided whether or not a program should be continued into the next phase. This decision was based in part on the information contained in the updated Development Concept Paper (DCP) and in part on the approval/recommendations of the Defense Systems Acquisition Review Council (DSARC).³

The DSARC reviewed proposed programs at the specified decision points and made recommendations to the Secretary of Defense. This recommendation/evaluation, combined with the content of the Development Concept Paper, provided the major body or reference for program decision. The system program manager made direct inputs into this procedure, not only through his major responsibility for preparation of the DCP, but also in briefing the DSARC on program matters with which this group was concerned.⁴

Prior to the start of the Phase I competition prototype period, the Armament Development and Test Center/Air Force Armament Laboratory had been responsible for management of the 30mm gun system development with the A-X System Program Office (SPO) responsible for aircraft/gun interface. On 12 September 1971 the executive management responsibility for what was now designated the GAU-8/A 30mm gun program had been vested in the A-X, later the A-10 System Program Office, by Headquarters AFSC. However, since the Armament Development and Test Center had contracted for the Phase I effort, the Center retained contact administration responsibility and provided technical engineering support and test services to the A-X System Program Office.⁵

A 15 October 1971 Memorandum of Agreement (MOA) between the Aeronautical Systems Division (ASD) and the Armament Development and Test Center (ADTC) was superseded on 1 September 1973 with an agreement signed by Brig Gen Thomas H. McMullen, A-10 Systems Program Director, and Brig Gen Gerald K. Hendricks, Air Force Armament Laboratory Commander. This MOA expanded the earlier agreement to include an advanced development program for 30mm ammunition. The various ammunition programs would parallel and support the GAU-8/A full-scale development. These programs were concerned with (1) High Density API Penetrators; (2) Improved Propellants; (3) Alternate Cartridge Cases; and (4) Frangible Target Practice Projectile.⁶

Funding

The GAU-8/A was procured using the design-to-cost concept. The contractual design-to-cost goal for the gun system was a cost not-to-exceed \$85,000/unit (FY70 dollars) for a 600 gun system buy at a maximum production rate of 20 systems per month. Funds for the RDT&E portion of the development and acquisition program were provided under program element (PE) 64603F; funds for the production gun system were provided from the A-10 program element (PE 64211F).⁷

The Research, Development, Test and Evaluation (RDT&E) funds which were required to design, develop, fabricate, test, and qualify the GAU-8/A gun system, ammunition, and ground support equipment are shown in Table 10. The total unit flyaway cost of 773 gun/feed systems was estimated \$238,000 in then-year dollars for a total flyaway cost of \$174,400,000. However, the initial GAU-8/A production award was for 52 gun systems.⁸ The status of the full-scale development contract with the General Electric Company in 1976 was as shown in Table 11.

<u>(\$ in Millions)</u>	<u>FY72 & Prior</u>	<u>FY73</u>	<u>FY74</u>	<u>FY75</u>	<u>FY76</u>	<u>Total</u>
Phase I	17.4	7.4	–	–	–	24.8
Phase II (reqd)	–	0.9	13.0	10.0	8.0	31.9
	—	—	—	—	—	—
Total	17.4	8.3	130	10.0	8.0	56.7
Appr. Prog	17.4	9.0	12.3	10.0	8.0	56.7

SOURCE: PM 121, 29 Oct 75 (updated to 22 Mar 76).

<u>Contract Data (FPIF)</u>	<u>Current (2 May 76)</u>	<u>Last Spr (4 Jan 76)</u>
Ceiling Price	\$42.1M	\$42.0M
Estimated Price	\$40.1M	\$40.4M
Target Cost (TC)	\$35.3M	\$35.3M
Contractor Estimate		
Budget at Completion (BAC)	\$35.3M	\$35.3M
Estimated Cost at Completion (EAC)	\$30.4M	\$38.7M
EAC as a Percentage of Target Cost (EAC/TC x100)	100.6%	109.8%
Cost Performance to Date		
Percent Complete (Earned/BAC x 100)	85.5%	82.8%
Planned	\$32.8M	\$30.8M
Earned (Accomplished)	\$30.2M	\$29.2M
Actual	\$32.7M	\$38.8M
Total Cost Variance (TCV)	\$(2.5)M	\$(1.6)M
Current	\$(2.5)M	\$(1.6)M
At Baseline Adjustment	N/A	N/A
As a Percent of Earned (TCV/Earned x 100)	(8.4)%	(5.6)%
Program Office		
Contract Funding	\$40.4M	\$40.4M
Estimated Price at Completion	\$40.4M	\$40.4M

SOURCE: SPR, "A-10," 10 Jun 76.

Development of the 30mm GAU-8/A gun system was initiated with funding provided from program element PE64603F, Improved Aircraft Gun Systems. Until January 1973 both the 25mm

GAU-7/A gun which was being developed for the F-15 fighter aircraft and the 30mm GAU-8/A gun system were included in a single program element. At that time the Air Force set up a new program element (PE64605F) in consonance with the desire of the Senate Armed Services Committee.⁹

There was also a protracted albeit unsuccessful effort by the Air Force Systems Command to gain Air Staff approval for changing the GAU-8/A program from a separately funded program element and making it a subsystem component of the A-10 program element. In late 1973, the Air Force Systems Command requested Air Staff authority to combine the A-10 aircraft system program element and the GAU-8/A gun system program element. Combining the program elements, it was argued, would place the gun program management under the “same overall cost, schedule, and performance, as the other aircraft subsystems and would provide the management flexibility which could be used to allay the “extremely tight” funding for the GAU-8/A program.¹⁰

While the Air Staff acknowledged that a “funding flexibility” would result from combining the program element numbers, the request was denied. Lt Gen William J. Evans, the Air Staff Deputy Chief of Staff/Research and Development, noted that while earlier combinations of program elements would have been advantageous, that time had passed. Subsequently, the Assistant Deputy Chief of Staff/Research and Development in Air Force Headquarters, Maj Gen Harold E. Collins, cited the 1973 action of the Congress calling for a separate 30mm gun program element and the continuing “intense” and “special” interest of the Congress in both the A-10 and the GAU-8/A program as sufficient reasons for retaining the separate program elements. Adding the GAU-8 element to the A-10 program could be construed as a cost overrun.¹¹



GAU-8/A installed in YA-10

While “design-to-perform” was the dominate consideration in ammunition development, the cost of that ammunition relative to the life of a gun system was a significant item which strongly influenced program decisions. A statement of this effect in a 1970 study using the technique of Combat Cost Analysis highlighted the relative cost of ammunition:

Research and Development accounted for only 1% of the total funds expended over the life of a gun system. Ammunition for over 90%, gun investment for 4%, and operation and maintenance for 5%.¹²

Predicted costs for the GAU-8 followed this pattern with ammunition costs 86% of a predicted \$700M program. While design-to-cost goals were not established for the 30mm family of ammunition, the Air Force did provide estimates of average unit costs for each type of round at the different times indicated in Table 12. The planned procurement for 30mm ammunition would call for the quantities and funds as shown in Table 13.

	<u>DPC 103A (Nov 73)</u>	<u>DSARC IIIA (Jul 74)</u>	<u>Nov 75</u>
Production Span	4 yrs.	4 yrs.	7 yrs.
Round			
TP	20M rds./\$5.50	10M rds./\$4.63	12.6M rds./\$6.07
HEI	10M rds./\$7.30	15M rds./\$6.00	24.6M rds./\$6.81
APIT	20M rds./\$11.90	25M rds./\$9.20	16.4M rds./\$12.93
<i>Note: Unit costs expressed in FY73 dollars using the indicated quantities. The cost variations shown reflected for the most part changes in quantities, schedule and mix. Round quantities expressed in millions of dollars.</i>			

	<u>FY75</u>	<u>FY76</u>	<u>FY77</u>	<u>FY78</u>	<u>FY79</u>	<u>FY80</u>	<u>FY81</u>	<u>Total</u>
Training Rds.								
Qty (000)	200	400	1080	2015	2230	3360	3360	12645
TY& (M)	4.9	9.4	21.8	18.0	22.0	34.4	35.9	146.4
Combat Rds.								
HEI Qty (000)	175	326	1376	5820	6040	5980	5942	25659
TY\$ (M)	5.3	9.7	34.4	71.2	67.1	70.4	74.0	332.1
APIT Qty (000)	83	650	1710	3613	4817	4727	4505	20159
TY\$ (M)	6.3	26.8	64.0	78.3	100.6	99.5	99.8	475.3
Total Cost (TY\$)	16.5	45.9	120.2	167.5*	189.7	204.3	209.7	953.8
Total Rds. Qty (000)								58463
<i>* Includes \$16.4M advance buy items for the FY78 buy (\$4.5M for the TP rounds and \$11.9M for the combat rounds).</i>								
<i>Projected funding is for hardware ammunition, program management, date, GEM, tooling, quality assurance, etc.</i>								
<i>SOURCE: AFSC FY DP (D-6) a/o 9 Jan 76.</i>								

The final production decision would seem to affirm that while the GAU-8 ammunition was expensive, the expense was justified.

NOTES

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2. PMP 100-2, 10 Jan 73 (Doc 3).
3. Department of Defense Directive, DoDD 5000.1, subj: Acquisition of Major Defense Systems, 13 Jul 71 (Doc 43).
4. PMP 100-2, 10 Jan 73 (Doc 3).
5. PMD P-2P006(1), 30 Jul 71 (Doc 23).
6. MOU, Memorandum of Agreement for the 30mm Close Air Support GAU-8 Gun Program, 1 Sep 73 (Doc 45). See also Memorandum of Agreement, Lt Gen James T. Stewart, ASD/CC, and Maj Gen J. C. Maxwell, ADTC/CC, subj: [Management of GAU-8/A Gun Program], 15 Oct 71, as cited in History, Aeronautical Systems Division, FY 72, Vol I, pp. 162, 182.
7. PMP 100-3, 1 May 74 (Doc 22).
8. Program Memo (C/GDS-81), Program Memorandum 121, (previously DCP 103), 30mm Close Air Support Gun (GAU-8), 29 Oct 75, revised 8 Dec 75, updated to 22 Mar 76 (Doc 35).
9. Ltr, Dep Dir of Dev & Acq, DCS/R&D, HQ USAF, to AFSC/SD/AC, subj: Consolidation of A-10 and GAU-8 Program Elements, 21 Nov 73.
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11. Ltr, Lt Gen William J. Evans, DCS/R&D, HQ USAF, to AFSC/CV, subj: Consolidation of A-10 and GAU-8 Program Elements (Your ltr, 31 Jan 74), 21 Feb 74 (Doc 48); Ltr, Maj Gen Harold E. Collins, Asst DCS/R&D, HQ USAF, to AFSC/CV, subj: Consolidation of A-10 and GAU-8 Program Elements (Your ltr, 31 Jan 74), 3 Apr 74 (Doc 49).
12. Rept, Close Air Support Gun System Independent Estimate, 26 Oct 70. Prepared by the Independent Cost Estimate Team, Armament Development and Test Center, Eglin AFB, Florida.

PART IV: Backmatter



Dual-purpose wind tunnel tests matching the A-10 with the television-guided Maverick air-to-ground missile completed at Arnold Engineering Development Center in June 1975

GLOSSARY

A-9	Air Force designation for Northrop Corporation A-X prototype
A-10	Air Force designation for Fairchild Hiller Corporation A-X prototype
AAA	antiaircraft artillery
AAFSS	advanced aerial fire support system
A/C	acft, aircraft
ADF	automatic direction finder
ADTC	Armament Development and Test Center
AE	armed escort
AF	Air Force
AFB	Air Force Base
AFATL	Air Force Armament Laboratory
AFCCS	Chief of Staff, United States Air Force
AFCMD	Air Force Contracting Management Division
AFCVC	Vice Chief of Staff, United States Air Force
AFFE	Air Force Flight Evaluation
AFFTC	Air Force Flight Test Center
AFLC	Air Force Logistics Command
AFRDQ	Directorate of Operational Requirements and Development Plans, Deputy Chief of Staff/Research and Development, Headquarters United States Air Force
AFSC	Air Force Systems Command
AFTEC	Air Force Test and Evaluation Center
AH-56A	Cheyenne helicopter
AM	amplitude modulation
AOMC	Aerojet Ordnance and Manufacturing Company
ANG	Air National Guard
AP	Armor Piercing
APHE	Armor Piercing High Explosive
API	Armor Piercing Incendiary
APIT	Armor Piercing Incendiary Tracer
AFPRO	Air Force Plant Representative Office
AFPRs	Air Force Plant Representatives
AR	armed reconnaissance
ASD	Aeronautical Systems Division
Asst	Assistant
atch	attachment(s)
A-X, AX	attack experimental
BAC	Budget at Completion
BFDW	Basic Flight Design Weight
C	Confidential

CA	California
CAIG	Cost Analysis Improvement Group
Capt	Captain
CAS	close air support
CD	contract definition
CDP	contract definition phase
CDR	Critical Design Review
CEP	circular error probable
CFP	Concept Formulation Package
Chmn	Chairman
CLASS	close air support system
CMSEP	Contractor Management System Evaluation Program
Comdr	commander
Comm	Committee
Cong	Congress
CPP	Competitive Prototype Phase
CRSR	Contract Funds Status Report
CSAF, C/S	Chief of Staff, United States Air Force
CSF	close support fire
CY	Calendar Year
DCP	Development Concept Paper
DCS	deputy chief of staff
DCS/S	Deputy Chief of Staff Systems
DDR&E	Director of Defense Research and Engineering
DEPSECDEF	Deputy Secretary of Defense
Dep	Deputy
dev	development
DIPEC	Defense Industrial Plant Equipment Center
Dir	director(ate)
doc	document
DoD, DOD	Department of Defense
DSARC	Defense Systems Acquisition Review Council
DTC	Design-to-Cost
DT&E	Development Test and Evaluation
DU	Depleted Uranium
EAC	Estimated Cost at Completion
ECU	Electronic Control Unit
EMI	Electromagnetic Interference
FAA	Federal Aviation Administration
FAC	forward air control(ler)
FEBA	forward edge of the battle area

FFP	firm fixed price
F&FP	Force and Financial Program
FLIR	forward looking infrared
FM	frequency modulation
FOUO	For Official Use Only
FQT	full qualification test
FRC	Fairchild Republic Company
FSD	Full Scale Development
F-X	fighter experimental
FY	fiscal year
FYDP	Five Year Defense Program
g, G	gravity
GAO	General Accounting Office
GAU	Gun, Automatic
GDS	General Declassification Schedule
GE	General Electric
GFAE	Government- furnished aerospace equipment
GFE	Government- furnished equipment
HDP	High Density Penetrator
HE	High Explosive
HEAT	High Explosive Anti-Tank
HEI	High Explosive Incendiary
Hist	history, historian
HQ, Hq	headquarters
HUD	heads up display
IAG	Industry Advisory Group
ibid.	ibidem, in the same place
ICAS	integrated armament control system
IFF	identification, friend or foe
I&L	Installations & Logistics
ILS	instrument landing system
IOC	initial operational capability
IOT&E	Initial Operational Test and Evaluation
IR	infrared
JTCG	Joint Technical Coordinating Group
JTCG/ME	Joint Technical Coordinating Group for Munitions Effectiveness
KIAS	knots indicated air speed
LGA	light ground attack

LLTV	low-light- level television
LORAN	long- range navigation
Ltr	Letter
Maj	Major
mm	millimeter
MOB	main operating base
Msg	message
MTAP	Management Techniques Application Plan
MTI	moving target indicator
NASA	National Air and Space Administration
N/C	Numerically-controlled
n.d.	no date
NM	New Mexico
NOD	night observation device
NOFORN	Not Releasable to Foreign Nationals
OASD	Office of the Assistant Secretary of Defense
OASD (SA)	Office of the Assistant Secretary of Defense (Studies and Analysis)
ODDR&E	Office of the Director of Defense Research and Engineering
OSD	Office of the Secretary of Defense
PE	Program Element
PI	Proposal Instructions
plng	planning
PMD	Program Management Directive
PMRT	Procurement Management Review Team
Pres	President
prog	program
PRR	Production Readiness Reviews
PTDP	Preliminary Technical Development Plan
PUD	Parallel Undocumented Development
QA	Quality Assurance
QT	Qualification Test
RAD	Requirements Action Directive
R&D	research and development
RDT&E	research, development, test and evaluation
recce	reconnaissance
rept	report
reqmts	requirements
revd	revision

revd	revised
RFP	request for proposal
RMS	Range Measuring System
ROAD	Reorganization Objective Army Division
RTD	Research and Technology Division
RFP	Request for Proposal
S	Secret
SA	Systems Analysis
SAF	Secretary of the Air Force
SAFIL	Assistant Secretary of the Air Force (Installations and Logistics)
SAM	surface-to-air missile
SAPHE	Semi-Armor Piercing High Explosive
SAR	Selected Acquisition Report
SAW	special air warfare
SAWF	special air warfare forces
SCAD	Subsonic Cruise Armed Decoy
SDR	System Development Directive
SECAF	Secretary of the Air Force
SECDEF	Secretary of Defense
secy	secretary
Sess	Session
SFC	specific fuel consumption
SIF	selective identification feature
Sgt	Sergeant
S.L.	sea level
SLS	sea level static
SMD	System Management Directive
SOR	Specific Operational Requirement
SPD	System Program Directive
SPO	system program office
SSAC	Source Selection Advisory Council
SSB	single sideband
SSgt	Staff Sergeant
STOL	short takeoff and landing
Subj	Subject
sys	system
TAC	Tactical Air Command
TACAN	tactical air navigation
TAH	Temperature Altitude Humidity
TASCS	tactical air support control system
TC	Target Cost
TCV	Target Cost Variance

TDP	Technical Development Plan
Tech	Technical
TFX	tactical fighter experimental
TP	Target Practice
TPP	Total Procurement Package
TY	Then Year
U	Unclassified
UE	unit equipment
UHF	ultra high frequency
UNO	upon notification of the originator
USAF	United States Air Force
VAL	visual light- attack
VCS	Vice Chief of Staff, United States Air Force
VHF	very high frequency
VOR	VHF omnirange
VRFW-S	Vehicle Rapid Fire Weapon System-Successor
V/STOL	vertical/short takeoff and landing
VTOL	vertical takeoff and landing
WEACOM	Weapons Command
WSEG	Weapons System Evaluation Group
XCL	Excluded from General Declassification Schedule
SGDS	Exempt from General Declassification Schedule

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