Jan 67

XB-70A - 62-001 (#1)

Design for the aircraft was initiated November 1955
Contract was awarded December 1957
Mock-up completed March 1959
Roll-out May 1964
First Flight 21 September 1964
Last flight, from Edwards AFB, Calif., to Wright-Patterson AFB, Ohio, 4 February 1969.

Aircraft built by North American Aviation, Inc., at their facility at the Air Force Plant 42, Palmdale, Calif. Equipped with General Electric YJ-93 engines (six).

Pilots:
Alvin S. White, NAA test pilot
Donald L. Mallick, NASA pilot
Van H. Shepard, NASA pilot
Colonel Joseph F. Cotton, USAF (AFFTC) pilot
Lt Col Fitzhugh L. Fulton Jr., USAF (AFFTC) pilot following retirement from the Air Force, 31 July 1966, Fulton became a XB-70A pilot for NASA.
Lt Col Emil Sturmthal, USAF (AFFTC) pilot

#1 Flight Highlights:

First flight at Mach 3.0 speed 14 October 1965.
Flight #17; duration, two minutes.
Longest (time) flight 6 January 1966; time 3:40 hours (all sub-sonic); flight #30.
Longest supersonic flight 2 December 1966; time 1:22 hours; flight #23.
Shortest takeoff (in first 50 flights) 4,853 feet on first flight
Heaviest takeoff (first 50 flights) weight was 525,640 pounds; flight #26
Shortest landing distance (first 35 flights), 7,950 feet; flight #4.

Flight time through January 1967 (flight #60)

Subsonic	1.0 to 1.99M	2.0 to 2.49M	2.5 to 2.99M	3.0M	Total S.Sonic	Total Time
68:08	26:35	13:45	4:42	:02	45:04	113:12

CHAPTER IV

SELECTED SYSTEMS

XB-70 Program

At the 11 December 1964 Designated Systems Management Group Meeting, the Secretary of the Air Force directed the B-70 System Program Office to present in March 1965 a current study concerning the feasibility of extending the B-70 flight test program beyond the approved 130 test hours. The B-70 office had to consider three options: the current 130 hour program, a 180 hour flight test program, and a program which would expend the approved $1.5 billion. At the 15 March 1965 briefing, the B-70 office analyzed these three options. The first option involved an anticipated first flight date of 15 July 1965 for the second air vehicle and flight test completion of both aircraft by 30 November 1965. The cost for this program would total $1.4383 billion. This option would obtain information which would barely attain an essential understanding of subsystem behavior and confidence in sustained mach three flight. Total flight time would be 120 hours.

The second option encompassed a 180 hour flight program with termination at the end of March 1966. This approach would cost $1.4556 billion and would provide a minimum airworthiness evaluation of the air vehicle and subsystems and would establish limited handling qualities, limited air vehicle and engine performance, and limited inlet duct characteristics.

The last option would extend the program to the end of November 1966. There would be a total of 312 flight hours and such a program would involve the entire $1.5 billion. This approach would provide time to adequately evaluate the air vehicle and subsystems in order to permit operation in a flight envelop that would be compatible with a possible follow-on research program.

For the B-70 System Program Office, it was apparent, considering that $1.4383 billion had already been invested in the program, that the first option would only provide a minimum return. The second option would yield a 50 percent greater return for an additional 1.2 percent expenditure. The last approach would yield 170 percent greater return for 4.3 percent greater expenditure.[1]

Following this presentation, the Secretary of the Air Force directed the B-70 office to proceed with the second option but to provide the capability for additional flight hours by procuring certain long lead time support items for the two air vehicles.[2] The Air Force, however, was also considering a cooperative test program for the B-70 with the National Aeronautics and Space Administration (NASA).

On 31 March 1965, the Assistant Vice Chief of Staff for the Air Force requested systems command headquarters to begin negotiations with NASA for an agreement for their use of an XB-70 in an aeronautical research program. A planning conference between the B-70 office and Andrews headquarters personnel was then held in early May, followed by a series of conferences in June and July. On 20 July, a presentation

was given by the B-70 office to the Assistant Secretary of the Air Force for Research and Development on the objectives and approaches to a joint Air Force and NASA flight test program. At the end of August, a more detailed presentation on the subject was given to the Secretary of the Air Force. Finally, in the 8 October 1965 Designated Systems Management Group Meeting, the Air Force Secretary approved an Air Force and NASA flight research program.

This agreement was reflected in the Development Directive Number 52 which was issued on 17 December 1965. The new program was to be an 18 month flight research program which was to begin upon completion of the current 180 hour Air Force experimental program. Under this arrangement, the Director of Research Vehicles, under the Deputy for Systems Management of the Aeronautical Systems Division, would be responsible for administrative management of the joint program. Operational control of the aircraft and all flight operations were the responsibility of the XB-70 Test Force Director at the Air Force Flight Test Center. Instrumentation surveillance and flight planning technical direction would be provided by the NASA flight research center.

The objectives of the Air Force part of this program were the acquisition of aerodynamic and subsystem data on a large, high mach number air vehicle and the investigation of other areas leading to improved components and subsystems for future military aircraft. The NASA program was to be directed toward the accumulation of pertinent

data for the development and operation of aircraft capable of supersonic or hypersonic cruise.[3]

During January and the first half of February 1965, the first air vehicle was undergoing structural repairs and Phase II proof tests at the North American Aviation Palmdale facility. On 25 February, the first airplane accomplished its sixth flight, which lasted 53 minutes. The aircraft reached 34,500 feet and mach 0.97. The flight, however, had to be prematurely terminated because of malfunctions in the cooling and hydraulic systems. In contrast, the seventh flight, occurring on 4 March, achieved all major test objectives. This flight lasted one hour and 37 minutes, reaching 39,000 feet and mach 1.4. Three engine starts were accomplished and the angle of the wing tips was changed from 25 to 65 degrees.

The eighth flight was accomplished on 24 March. Most test objectives were also achieved on this one hour and 40 minute flight. Maximum conditions were mach 2.14 and 56,000 feet. A significant accomplishment on this flight was the operation of the engine inlets in a "started" condition: the B-70's shock wave was moved into the inlets. The wing tips were folded to the 65 degree position for the portion of the flight above mach 1.4. During this flight, flutter, stability and control data was obtained.

On 2 April, the ninth flight took place and lasted 54 minutes. Immediately after takeoff, improper functioning of two engines in the

afterburner mode limited maximum operation of these engines and an alternate test mission was chosen. Shortly after reaching 30,000 feet, a utility hydraulic system lost pressure and fluid, and the mission had to be aborted. This malfunction, it was determined, had been caused by a broken stainless steel line. After the sixth flight, the thickness of these lines had been increased; however, later analysis indicated that this particular malfunction had been caused by fuel pump cavitation. The fuel tank emptied, pump cavitation created a high frequency vibration which induced a significant load on the fuel line. Such lines were then replaced by shorter, more flexible lines.

The tenth flight took place on 20 April, and all major test objectives were achieved. Fifty minutes of the one hour and 42 minute flight were over mach 2. During this mission aerodynamic data was obtained and air induction control system and ram purge tests were conducted at speeds and altitudes to mach 2.25 and 57,500 feet. A noteworthy accomplishment was the operation of the variable position ramp and windshield to the high speed position. During landing procedures, the right main gear had to be recycled for satisfactory retraction.

The first air vehicle accomplished the eleventh flight on 28 April. Flutter, air induction control system, and stability and control data was obtained on this flight. A malfunction of the pitch augmentation servo cylinder occurred during flight which resulted in

difficulty in controlling a pull-up maneuver. After landing was completed, the rear main gear brakes locked during braking tests.

During the twelfth flight which lasted one hour and 25 minutes, all primary test objectives were achieved. After reaching maximum speed of mach 2.6, however, buffeting and vibration were noticed from engine number five. Engines four and five were then shut down when overheating occurred. A four-engine landing was made on the lake bed as a precautionary measure. Also the canard flaps did not extend and the drag chutes did not deploy for the landing. Post-flight inspection revealed that the triangular portion of the leading edge of the apex of the delta wing and the bottom face sheet of the honeycomb panel had separated from the aircraft and entered the right engine inlet duct. Engines four, five, and six suffered extensive foreign object damage. To a lesser degree, engines one and two also suffered similar damage.

After replacing the damaged engines and repairing the wing damage, a fuel leak was then discovered in fuselage tank number four which resulted in cancellation of the thirteenth flight. After repairing the area around a brazed "T" fitting and a spring seal of the tank, this flight then took place on 16 June. Here all major test objectives were achieved during a flight which lasted one hour and 37 minutes. Twenty-two minutes were above mach 2.5. Aerodynamic and propulsion data was obtained at high altitudes and speeds. During the last portion of the flight, the fluid level in the primary number two hydraulic system

began decreasing. The source of this leak was later found to be a metal seal on the end plate of the primary pump on engine number six. Post-flight inspection revealed a honeycomb panel void in the roof of the left inlet duct.

During flight number 14 which occurred on 1 July, the unique aircraft attained 12 minutes of flight at mach 2.8. During this flight, however, two small areas of the outer skin separated from the fuselage. Inspection after the flight also revealed another panel void, this time on the lower surface of the right wing.

The fifteenth flight took place on 27 July, and the air vehicle reached a speed of mach 2.82 and a total temperature of 514 degrees Fahrenheit. The primary purpose of this flight was to obtain aerodynamic heating data at a high mach number, and this was accomplished by 20 minutes flight at mach 2.8. Inspection did reveal minor structural damage.

The next flight was scheduled for 9 August but had to be cancelled because of fuel leaks. Investigation determined that there were numerous small voids around the tank walls, floors, and structural frames. After repairing these deficiencies, the sixteenth flight occurred on 22 September, and all major test objectives were achieved. The maximum observed flight conditions were mach 2.81 and 66,400 feet. The highest temperature was 511 degrees. Several face sheet creases and honeycomb panel voids in the inlet duct areas and a faulty fuel line were discovered after this flight.

The seventeenth flight was accomplished on 14 October. Here the first air vehicle went to 70,000 feet during a flight which lasted one

hour and 47 minutes. The total temperature of the vehicle was 586 degrees. During the flight, a piece of the outer face sheet separated from the underside of the left wing. Also some panel voids occurred on the aircraft.

On 4 November, the eighteenth flight took place. The purpose of this two hour and four minute flight was to obtain propulsion data under subsonic and supersonic conditions. This was accomplished with five engine shutdowns and airstarts. The nineteenth flight followed on 8 November and accomplished similar objectives. The duration was two hours and 23 minutes. On 12 November, the twentieth flight, lasting 2 hours and 25 minutes, took place. Thirty minutes after takeoff, however, scheduled testing had to be discontinued because of loss of power from number four generator. The aircraft then conducted air-speed calibration runs. The twenty-first flight followed on 18 November. During this one hour and 51 minute flight, maximum conditions reached were mach 1.8 and 45,800 feet.

The next flight had to be delayed because of a cracked left main landing gear actuating cylinder bracket, but the twenty-second flight took place on 30 November. This flight lasted one hour and 59 minutes, with maximum flight conditions of mach 2.34 and 56,000 feet. During landing roll, nose wheel steering became inoperative and the left main gear rear tires blew. Flight number twenty-three soon followed on 2 December with maximum conditions of mach 2.46 and 60,000 feet.

On 7 December, the twenty-fourth flight was accomplished. Total flight time was two hours and 26 minutes. About 40 minutes after take-off, an altitude of 60,000 feet and a speed of mach 2.4 was attained. Low oil pressure was indicated on engine number six and a five engine landing had to be made. It was later discovered that a cracked oil line had caused the malfunction.

The twenty-fifth flight took place on 10 December. The purpose of this flight was to expand the medium speed and altitude portion of the XB-70 flight envelope. Flight number twenty-six followed on 14 December, but had to be conducted at low altitudes and airspeeds due to adverse weather conditions at Edwards Air Force Base.

On 20 December, flight number twenty-seven was completed. The crew accomplished the major tests, although some of those scheduled were not completed because of a lack of fuel. A unique accomplishment of this flight was the satisfactory operation of the aircraft from the closed escape capsule of the copilot. The next flight occurred on 22 December and lasted two hours and 35 minutes. Adverse weather conditions delayed any further flight testing for the remainder of the year.[4]

On 29 May 1965, North American Aviation held an informal rollout ceremony at its Palmdale facility for the second XB-70 air vehicle. The first flight of this aircraft then took place on 17 July. Low speed handling qualities were evaluated and stability and control characteristics were investigated throughout the flight. The maximum flight conditions

attained during the one hour and 13 minute flight were mach 1.41 and 42,000 feet. The second flight followed on 10 August. This flight was terminated short of the planned two hours because of a gradually decreasing fluid quantity indication in a utility hydraulic system. Post-flight inspection revealed foreign object damage in engines numbers two, four, and six.

The third flight occurred on 18 August and lasted one hour and 58 minutes. The maximum speed was 1.45 and the maximum altitude was 46,000 feet. Some problems were encountered with the trim system and a utility hydraulic system. One of the engines also indicated an overheating condition. The fourth flight of the second air vehicle followed on 20 August, and all objectives were accomplished in a flight which last two hours and four minutes. Stability and control checks, an evaluation of low speed handling qualities, and an engine air start all were accomplished. The maximum speed was mach 1.44 and altitude, 42,000 feet.

After completion of this fourth flight for the second air vehicle, the air induction control system was then installed, and the fifth flight on 17 September was conducted with this system in operation. System performance tests were made at mach 1.6 and 41,000 feet, and mach 1.8 and 45,000 feet with excellent results. The sixth was scheduled for 23 September but had to be aborted due to faulty performance on the number two engine. It was, however, accomplished on 29 September. This

flight, unfortunately, had to be terminated before achieving all test objectives due to a malfunction of the right by-pass door and a resultant malfunction of number six engine. Some problems were also encountered with the operation of the automatic air induction control system. Maximum performance during this sixth flight was mach 2.23 and 54,000 feet.

Prior to the completion of the planned test objectives, the seventh flight also had to be terminated. This was the result of high exhaust gas temperature on number two engine and occurred during an unscheduled unstart of the left inlet duct which was being controlled by the automatic induction control system. At that point, the second engine was shutdown and further testing discontinued.

The primary objectives of the eighth flight which took place on 11 October was to obtain further data on the performance of the automatic induction control system. Subsonic engine shutdown and restart tests were scheduled for this flight but had to be discontinued after engine number five would not restart. Flight number nine of 16 October was more successful. Here maximum flight conditions were mach 2.43 and 59,000 feet. The scheduled automatic induction control system tests were completed but the programed engine shutdowns and restarts were not attempted due to turbulent air conditions.

All scheduled testing was completed on the tenth flight of the second air vehicle which was accomplished on 26 October. Along with the

successful operation of the automatic control systems, medium speed stability and control checks were made. Temperature reached on this flight was 326 degrees. On 2 November another successful flight was made and the maximum conditions were mach 2.45 and 59,000 feet. Automatic air induction control system tests were performed and data was obtained during intentional duct unstarts and automatic recoveries.

During the first half of November, the second vehicle underwent extensive structural inspection prior to flights exceeding mach 2.5. The twelfth flight, however, was delayed from 19 to 29 November because of bad weather conditions. On this latter date, the second vehicle started its flight testing mission, but a visual check of the aircraft by chase pilots shortly after takeoff showed the nose gear door to by partially open. Scheduled testing was then cancelled and alternate, gear down tests were conducted.

On 1 December, flight number thirteen for the second air vehicle was flown with a duration of two hours and two minutes. Here the maximum were mach 2.67, 64,000 feet and 430 degrees. The majority of the scheduled tests were completed and no major problems were encountered. The fourteenth flight followed on 3 December, with maximum performance of mach 2.87 and 69,000 feet. Most of the scheduled testing was completed including a successful ram purge pressurization test at mach 2.7 and 50,000 feet. A touch-and-go landing was made prior to terminating the flight. When the throttles were advanced, engine number five stalled and overheated. This condition was later determined to have

resulted from the ingestion of a small section of the face sheet which had separated from the floor of the right inlet duct. Engine number six also suffered similar damage.

On the fifteenth flight which occurred on 11 December, the second air vehicle reached mach 2.94, 70,600 feet and 556 degrees. An inspection of the structure after the flight revealed several face sheet creases and a panel void. On 21 December, flight number sixteen took place and was similarly successful with maximum conditions of mach 2.95, 71,500 feet and 535 degrees. A broken oil line did cause minor engine problems, and a tire tread separation on landing did cause minor damage to a wheel door. There were no further second vehicle flights for the rest of the month.[5]

CHAPTER IV

REFERENCES

1. Rpt., B-70 SPO, subj.: XB-70 Flight Program Options, 15 March 1965.

2. Management Summary, B-70 SPO, 2 April 1965.

3. Briefing Synopsis, B-70 SPO, 15 Feb. 1966.

4. Flight test descriptions of the first XB-70 were taken from Management Summaries, B-70 SPO, 26 Feb. 1965; 5 and 26 March 1965; 8 and 23 April 1965; 6, 13 and 27 May 1965; 17 and 24 June 1965; 1, 16, and 29 July 1965; 12 and 26 Aug. 1965; 23 Sep. 1965; 7, 14, 21 Oct. 1965; 10, 18, and 24 Nov. 1965; 2, 9, 16, 22, and 29 Dec. 1965.

5. Flight test descriptions of the second XB-70 were taken from Management Summaries, B-70 SPO, 22 July 1965; 12, 19, and 26 Aug. 1965; 23 and 30 Sep. 1965; 7, 14, 21, and 28 Oct. 1965; 4 Nov. 1965; 2, 16, and 22 Dec. 1965.

6. Command Data Book, May 1961, p. 7-35.

7. System Package Program, C-141 SPO, March 1962, pp. 2-2 and 2-8.

8. Program Change Proposal, C-141A-63-1, 3 May 1963; Management Summary, C-141 SPO, 19 Feb. 1965.

9. Memo., R. V. Burnett, Ch., Fin. Mgmt. Div., C-141 SPO to Dir., C-141 SPO, subj.: Increased Estimates for C-141 Program, 30 April 1963.

10. Memo., Col. A. R. Walker, Asst./Staff Support, ASD, to Hq. AFSC, subj.: C-141A Cargo Transport Budget Revision Program Proposal, 10 May 1963.

11. Memo., E. L. Gentit, Ch., Prog. Control Ofc., C-141 SPO to Dir., C-141 SPO, subj.: PCP Status, 22 May 1963.

12. TWX, SCCPS 31-5-43, Hq. AFSC to Hq. ASD, 31 May 1963.

13. Program Staff Study, C-141 SPO, subj.: Proposed Budget FY 65/66-68, 1 June 1964; memo., Burnett to Dir., C-141 SPO, subj.: PCP 64-62 Airlift PCP, including C-141A, 30 June 1964.

ANNEX E - ADDITIONAL AF MANPOWER REQUIRED AND "OUT-OF-POCKET" COSTS IN TERMS OF DOLLARS

This annex is not subject to USAF/NASA negotiation but rather is a local assessment of the impact of the workload.

1. No additional AFFTC manpower is required.

2. "Out-of-pocket" costs in terms of dollars is as follows:

Appropriation	Object Class	Amount FY-67	Amount FY-68
3500	1100	66,642	266,571
3600	1100	23,493	93,972
3600	2300	6350	25,200
3600	2500	86000	4,000
3600	2600	203,006	914,600
3600	3100	31,250	125,000
	TOTALS -	$ 416,741	1,429,343