File 8 MGA

(Gp-4) TEST REPORT

XB-70A

FLIGHT 1-5

(No. 1 Air Vehicle, No. 5 Flight)

16 February 1965

Joseph F. Cotton

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Test Director (Copilot)

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XB-70 JOINT TEST FORCE (FTTB)

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TABLE OF CONTENTS

		Page No.
I.	SUMMARY	1
II.	TEST LOG	3
III.	DATA	9
	1. Fuel Data	9
	2. Hydraulic Systems Data	10
IV.	ENGINEERING COMMENTS	11
	1. Flight Controls	11
	2. Aerodynamic Oscillations	11
	3. Propulsion	11
	4. Left Hand Rear Brake Lock-up	12
	5. No. 4 Primary Hydraulic Pump Oscillations	12
	6. No. 6 ADS Vibration	12
	7. Drag Chute Failure To Deploy	13
	8. Electrical and Environmental Systems	13
	a. Master Caution Light	13
	b. Air Induction Control System	13
	9. Instrumentation	13
	10. NASA Supersonic Transport Tests and Instrumentation	14
	a. Landing Gear Cameras	14
	b. Landing Rate of Sink Sensors (arms)	14
	c. Cabin and Ballast Bay Microphones	14
	d. Velocity Acceleration Altitude (VGH) Recorder	14
	e. Runway Noise	14
	f. Sonic Boom	14
V.	OBSERVATIONS AND COMMENTS BY THE COPILOT	15
	1. Preflight, Engine Start and Taxi	15
	2. Takeoff and Climb	15
	3. Supersonic	16
	4. Descent and Landing	18
VI.	CONCLUSIONS	19
VII.	RECOMMENDATIONS	20

I. SUMMARY:

1. The fifth flight (Flight 1-5) of XB-70 No. 001, crewed by Mr. Al White, North American Aviation, Inc (NAA), Pilot, and Colonel Joseph Cotton, Air Force Flight Test Center (AFFTC), Copilot, was accomplished on 16 Feb 65. The flight originated at AF Plant #42, Palmdale, California where the aircraft had undergone layup since 24 Oct 64 for completion of Phase II Proof Loading Tests. Flight termination was at Edwards AFB, California. Total flight time was one hour and ten minutes of which thirty-nine minutes were at supersonic speeds.

2. The takeoff, at a gross weight of 402,000 pounds, was delayed approximately thirteen minutes by high indicated vibrations in No. 6 Accessory Drive System (ADS) and instability on No. 4 engine primary hydraulic pump. Primary pitch trim control was lost for a short period immediately after takeoff. An abnormally slow landing gear retraction cycle was followed by normal flap retraction.

3. The flight proceeded to 38,000 feet and Mach 0.96, where the wing tips were folded to the 25 degree position. A supersonic climb was then made to 41,000 feet and after a level acceleration to Mach 1.4, stability maneuvers were performed and the wing tips folded to the full down 65 degree position. Soon after full wing tip fold, a lateral-directional "wallowing" was experienced. The wing tips were returned to the 25 degree position, the Flight Augmentation Control System (FACS) was engaged, and the tips were again folded to 65 degrees. Lateral-directional stability was improved with the FACS engaged, and it was decided to continue acceleration to Mach 1.6 at 45,000 feet. Lateral-directional instability and difficulty in maneuvering the aircraft were again experienced but to a lesser degree than originally encountered at Mach 1.4.

4. While operating at Mach 1.6 and 45,000 feet, two muffled rumbles were heard by the crew and high exhaust gas temperature (EGT) was noted on No. 6 engine. The engine was throttled back, the bypass doors were opened to 200 then 410 square inches, and the aircraft was slowed to Mach 1.4 at 40,000 feet where the bypass doors were closed.

5. Stability maneuvers were performed at Mach 1.2 and decel-eration and descent started. Wing tips were returned to the full up position at Mach 0.9 and 30,000 feet. As the aircraft passed through 15,000 feet at 300 KIAS, both throat panels were closed to the Mach 2.1 position. Descent continued to the Edwards AFB traffic pattern and a smooth landing at a gross weight of approximately 290,000 pounds was made on runway 04. The extraction chute became entangled in the engine nozzles and the main drag chutes failed to deploy. Moderate braking was used to bring the aircraft to a comfortable stop.

6. Significant "firsts" accomplished during Flight 1-5 are as follows:

a. Flight operations at Mach 1.6, 45,000 feet, the highest speed and altitude thus far.

b. Full wing tip fold of 65 degrees.

c. Successful flight operation of engine air bypass doors and inlet duct throat panels.

d. XB-70/Boeing 707 comparative runway takeoff noise measurements were recorded for Federal Aviation Agency (FAA) and National Aeronautics and Space Administration (NASA) supersonic transport studies.

e. The XB-70 sonic boom signature was obtained by the Beatty, Nevada NASA ground station.

II. TEST LOG:

0715	Pilots in cockpit Fuel gage test, full-325,000 lbs., empty - 0000
0716	Primary trim check complete.
0717	FACS check - pitch augmentation malfunction.
0727	Pitch augmentation caution light stayed out. Yaw augmentation No. 1 caution light stayed out. Yaw augmentation No. 2 does not engage.
0738	Instrumentation package secured. Telemetry check O.K.
0740	Outside air temperature 22° F. Engine fire detector No. 3, lights off, aft bad.
0755	All circuit breakers in except Q bellows pitot heat and those with red tags.
0800	UHF radio check O.K. Fuel tank reading (See fuel card). Hydraulic reading (See hydraulic card).
0815	AICS checks, right bypass full closed, shows 40 sq. in. on indicator and right hand bypass caution light is on.
0827	Servicing hydraulics.
0830	Check CADS altitude hold - worked on 2nd position.
0833	Ready to start engines.
0835	Manual start engine No. 3 - EGT 480° - EDV 35% - all O.K.
0836	Manual start engine No. 1 - EGT 470° - EDV 36% - all O.K., C/N 30175.
0838	Manual start engine No. 2 - EGT 450° - EDV 34% - all O.K.
0839	Manual start engine No. 4 - EGT 510° - EDV 36% - all O.K., C/N 30318.
0841	Manual start engine No. 6 - EGT 470° - all O.K. - Utility slow coming in.
0842	Manual start engine No. 5 - EGT 500° - EDV 34% - all O.K., C/N 30470.
0844	Pick up checklist - Pg N-13: Cabin heat not working.
0845	Electric check O.K.
0846	Hydraulic check - P_1-172, P_2-170, U_1-152, U_2-135. ADS N_2 - #1 - 38%, #2 - 38%, #3 - 35%.
0847	Start flight controls check - all O.K.
0852	Flaps down time - 14.3 seconds.
0854	Alternate throttle check - O.K.
0855	Service hydraulics.
0856	Run engines to 100% - check T.M. hydraulic monitor - all O.K.
0900	U_2-178, U_1-180, P_2-170, P_1-170 ADS N_2 - #1 - 45%, #2 - 41%, #3 - 40%
0902	Reset time code generator.
0909	P_1-170, U_2-170, P_2-172, U_1-162, service complete. Full bypass air selected.
0910	Close cabin door - cabin temperature 62° F - coming down to 55° F.

Test Log, Flight 1-5 (Cont'd)

0910 Ground safety pins and canard covers removed
Air conditioning disconnected.

0916 Wind 0 kts @ 330° on run pad.
Nose wheel steering taxi and engaged, checked in disengaged.
Master caution light "ON" and cannot be punched "OFF".

0923 Start taxi - tank #4 on and quantity 9500# - total fuel 147,750#.

0925 Use runway 7 for takeoff - tower.
Winds 4 kts at 360°.

0926 Turn west on taxiway.

0930 Fuel reading (See card).

0935 Line up on runway - fuel 13,000# less than planned for takeoff, tank #1 - 1,000 lbs.

0936 Data on C/N 1175 - Flt. control cycles.
Pitch: Aft - Fwd. - Neutral
Roll: Lt. - Rt. - Neutral
Yaw: Lt rudder - Rt. - Neutral data off C/N 1223.
Wind 2 kts at 0° Temp. 61° F.
Chase 2 airborne.

0938 Data on C/N 1320.
Data off C/N 1337, reset data
Start before takeoff checklist.
VGH recorder on.
Wheels, tires, and brakes ground checked O.K., nose gear steering engaged.
AICS indicates M 1.67 on both throats, FACS off, right bypass doors 10 sq. in.
Tank #6 on, tanks 2 and 4 in auto, tank 4 - 2200 lbs.,
Liquid nitrogen - 15/16, pitot heat on,
Ammonia - 480, and water 4300.
Hold-to check black mark (Teflon Seal) fwd. mixer bay area.

0941 Tank #6 on; Tank #4 - 2200 lbs.; Tanks #2 and 4 - Auto.

0943 4 min. warning - total fuel 142,500 lbs.
All FACS lights on, right bypass door open light on, both throat panel extend lights "ON", master caution light "ON".

0945 Data on C/N 391.

0947 Data on C/N 500 - come up on power.

0948 Min A/B engines 3 and 4; 2 and 5; 1 and 6.
Bring engine #4 to Idle - Hyd. pump instability (T.M. Van)
ADS vibe engine #6 at 80% - reduce power, data off.

0949 Run up engine #6 - Data on C/N 665 - ADS vibe 60 to 80% in Min. A/B - dataoff C/N 695.

0950 Run engine #4 at 78 to 80% rpm - Hyd. Press. steady in cockpit.

0952 ADS vibe engine #6 - 18% at Idle.

0954 Run up engine #6:

rpm	Idle	85	100	Mil	A/B
Percent ADS vibe	18	18	40 to 60	40 to 60	80

0956 ADS vibe caution light comes on at high power setting.

Test Log, Flight 1-5 (Cont'd)

0957 Fuel total 137,500 lbs. - leave vibe selector on #6.
0958 All ADS vibe read above 100% on test.
All eng. vibe read 90% on test.
Data control advises #001 of decision to continue flight.
1000 Coming up on power: Data on C/N 1310.
Min A/B engines 3 and 4.
Min A/B engines 2 and 5.
Min A/B engines 1 and 6.
Brake release - Mobil Comm. Temp 68° F - Wind 0.
Rotate at 170 KIAS - Lift off 196 KIAS
Airborne - takeoff roll 6,000 ft.
1002 Primary trim lost - 7,500 ft. - 254 KIAS - 118,500 lbs., fuel 88° throttle angle set on all engines by the copilot.
1003 Data off C/N 1470.
1004 Data on C/N 1571 - Gear handle up.
1005 Slow retraction - 53 seconds - C/N 1589 - 230 KIAS.
Pitch trim working - Data off C/N 1639.
1006 Data on C/N 1655 - Flaps up C/N 1660 - 237 KIAS.
Flap retraction time 16 seconds - Data off C/N 1685.
1007 Approaching Edwards - Tank #4 - 2,000 lbs., stay on #6

Eng. No.	1	2	3	4	5	6
ADS vibe	22	5	12	30 to 40	5 to 10	50 to 60

1008 Turning left, climbing through 22,000 feet.
1009 .95 Mach, 32,000 ft., - Data on C/N 1880 - Wing tips to 25°
1010 Aux cool off - cabin 6,500 to 7,000 feet.
Data off C/N 1936.
1012 Going supersonic.
1013 Total fuel - 98,000 lbs., tank 4 - 2,000 lbs., tank 1 - 2,000 lbs., tank 6 on, tank 2 Auto.
1014 Flt. level 39,000 feet and accelerating.
Climbing at 390 KIAS to 41,000 feet.
1015 Anti-collision light off.
1016 Fuel reading - tank 6L - 11,000 lbs., tank 6R - 12,800 lbs.,
Coming up on 1.4 Mach.
1017 Data on C/N 2312, 1.2 G pull up - Card 3, Point 1
1018 Point 2, Card 3 - Pilot did not like sideslip, repeat point, slow cycle.
1019 Wind up turn to the left - 1.4 G (Point #4).
Data off C/N 2466 - 43,000 feet altitude.
1020 Data on C/N 2495 - tips down to 65° - time 39 seconds.
437 KIAS; 1.41 Mach No.; 42,700 feet; fuel 84,500 lbs.
1021 Air vehicle wallowing - large diversions.
Pilot reports aircraft very difficult to fly.
1022 Put tips up to 25° - C/N 2626.
1023 Coming up on Mono Lake; AICS cooling light on.
Punch-light stays out; data off C/N 2719.

Test Log, Flight 1-5 (Cont'd)

1024 Data on C/N 2757; all augmentation on; air vehicle flys nicely now.
Mach No. XB-70 1.46; TB-58 - 1.44.

1025 Data off C/N 2766; total fuel 75,500 lbs
#1 - 1,750; #2 - 25,700; #3 - 33,600; #4 - 2,500;
#6L - 5,000; #6R - 5,000; #7L - 99,500; #7R - 99,600;
#8L - 100; #8R - 200

1026 Right turn; E.E. Bay Temp. 43°; cool in cockpit,
Total fuel 73,000 lbs; 1.42 Mach; 41,500 feet; 5° elevon trailing edge down.
Chase #4 over Owens Lake, has XB-70 in sight

1028 XB-70 approaching Coaldale
XB-70 indicates M 1.43; B-58 chase indicates M 1.42.

1029 Data on C/N 3055; Mach 1.43; put tips down to 65°.
Yaw aug. working, tips down in 35 seconds.
Air vehicle feels lighter in roll than at 25° tips.
Total fuel 66,000 lbs; ADS and engine vibe O.K.

1030 Data off C/N 3124, Max A/B Climb,
heading 135° to Beatty; 40 nautical miles out of Coaldale.

1031 Chase drop back for ground sonic boom measurements.
Climbing at 43,000 feet; 1.47 Mach

1032 Data on C/N 3210, T/A 108°, 44,000 feet, 1.46 Mach.
Tank #6 - off; Tank 6L and 6R each have 2,000 lbs., remaining.
Total fuel 61,000 lbs; Lt bypass door at 50 sq. in.

1033 Data on C/N 3270; level at 45,000 feet, 1.5 Mach.
Aircraft difficult to turn smoothly.
Start level acceleration

1034 1.6 Mach, 45,000 feet; compressor stall -2 bangs.
Power reduced, decel to 1.4 Mach - out of A/B on engines 1 & 6.
Tank #4 empty; tank #2 on, passed ground boom station,
make turn to the left

1035 Engine #6 has high temperature condition.
Open bypass doors to 200 sq. in.
EGT holding 900° on engine #6; nozzle 4.
Go to 400 sq. in., on Lt. & Rt. bypass doors, no apparent trim change.
Total fuel 55,000 lbs; tank #2 - 17,700 lbs.

1036 Three Sisters Lakes at 1 o'clock.
1.45 Mach, all engines to Military Power.

1037 Start descent to 40,000 feet; total fuel 53,000 lbs.,
tank #2 - 16,000

Data on short interval at C/N 3524; light A/B on engines 3 & 4.
Yaw damper does not help a great deal.
1.35 Mach; bypass door pos. - Lt 410 sq. in.; Rt - 420 sq. in.

1038 Data off C/N 3645; close bypass doors; turn to right; some turbulence, Chase #4 in position; retract tips to 25° - C/N 3588
Time 32 seconds; Lt hand indicator part white in transit.

1039 Some rumbles or turbulence; bypass doors 420 sq. in. will close on roll out; chase reports turbulence
Air vehicle flys smoothly with 25° wing tips.

1041 Total Fuel 45,000 lbs., tank #2 - 7,500 lbs.; data on C/N 3830.
Close bypass doors with standby switches; leave data on.

1042 Decel to 1.2 Mach, headed for Bakersfield.

1043 Data off C/N 3878; bypass doors opened slightly, reason unknown.

1044 Bypass doors closed; FACS off.
Lt bypass door indicator shows 40 sq. in.
Standby and primary AICS switches off.
Bypass wheels full forward; manual mode.

1046 Stabilized at 1.21 Mach; B-58 1.19 Mach.
Data on C/N 4071, pull up - 1.35 G - marker.
Sideslip - 2°, back off to 1°, release C/N 4120.
Very slow cycle, about 3 cycles to damp out.
Wind up turn to the right, marker 1.4 G.

1047 Data off C/N 4176, cabin recorder - ready.

1048 Total fuel 36,500 lbs.; tank #2 - off; tank #1 - 2,200 lbs.

1049 Engines 1, 2, 5 & 6 to Idle Power, decel toward EAFB
Anti-collision lights on and rpm lockup release.
50% data tape remaining.

1051 Total fuel 33,000 lbs., all fuel switches off, go subsonic.
.9 Mach, noise level increases.

1052 .85 Mach, wing tips up.

1053 Fuel - 30,000 lbs., in sump tank. No fuel available in other tanks.

Airspeed Calib.	A/S	Mach No.	Alt.	Ctr. No.
XB-70	300	.76	28,900	4555
Pacer	291	.72	--	--

Cool in cockpit, selected auto heat, 2 to 3 o'clock setting.

1056 20,000 feet, bypass doors, Lt - 10 sq. in.; Rt - 40 sq. in.

1058 Wind 4 kts at 360°, Aux cool on.
Fuel: tank #3 - 27,700 lbs.; total - 32,500 lbs.
Passing through 15,000 feet

1059 Throat at 2.1 Mach number - no problems - Lt hand throat indicator hung up a little. Throat closed with manual wheels, engines 1, 2, 5 & 6 at Idle.

1100 Passing through 10,000 feet; REFER - OFF. Adding power and it appears all O.K.
Airspeed Calib.: tape 250.5 KIAS, 10,000 feet, 261 KIAS on pneumatic system. Data was "OFF" - repeat point; 254 KIAS; 10,000 feet.

Test Log, Flight 1-5 (Cont'd)

1102 Gear down at 243 KIAS - gear extension time 25 seconds.

1103 Flaps down - time 15.5 seconds - land on runway 040
Wind 360° at 4 knots.
Data off C/N 5176, weight 290,000 lbs., 216 KIAS base leg, 196 KIAS approach, and flare at 186 KIAS.
Airspeed calib. XB-70 - 239 KIAS, pacer - 231 KIAS
FACS off. Tank 3 - 22,500. Totalizer - 27,000 lbs.

1106 Total fuel 23,500 lbs; data on C/N 5330.

1110 Touchdown, pilot drag chute hung up - no deployment of main drag chute.
Some brake chatter, jettison drag chute - nothing happened as main drag chute had not been withdrawn from compartment.

1113 Engine run up at end of runway:

Eng No.	1	2	3	4	5	6	
A8	72	70	71	73	69	70	Idle Pwr
EGT	430	425	430	450	430	410	
Vibe ADS	10	12	12	10	10	10	
Vibe Eng	8	10	8	8	5	5	

Burst to military power. Data on C/N 5836.

1114

Eng. No.	1	2	3	4	5	6
A8	40	38	39	42	36	39
EGT	880	875	880	900	880	910
Vibe ADS	20	10	10	30	10	20
Vibe Eng	20	30	30	10	40	10

1117 Data off C/N 5902.

1118 Shut down engines 1 & 6.

1120 All ADS peg out on vibe test.
Eng. vibe read 90 to 95 on test.
U_1 system lost a little, U_2 picked it up.

1124 Data on C/N 6369 - control cycles.
Pitch: Aft - Fwd - Neutral.
Roll: Lt - Rt - Neutral.
Rudder: Lt - Rt - Neutral.

1126 Shut down Engine No. 2.

1128 Shut down Engine No. 5 - release brakes.

1129 Shut down Engine No. 3 - shut down Engine No. 4.

III. DATA:

1. Fuel Data:

Time	0800	0913	0931	0945	0959	1013	1025	1031	1034	1048	1053	1125
C/N	---	649	---	391	---	---	2766	---	---	---	---	6400
Event	Prior to Engine Start	After Engine Start	Taxiing	Line up on runway	Coming up on power	Going super-sonic	1.42 M 41,500'	1.47 M 43,000' Max A/B Accel	1.6 M 45,000'	Decel Super-sonic	Air Spd calib .76 M 28,900'	Shut down
Tank config-uration		Tank 4 is on	Tank 4 is on	Tank 6 to on 2&4 -auto	Tank 6 is on 2&4 - auto	Tank 6 is on 2 - auto	Tank 6 is on 2 - auto	Tank 6 off 4 - on	Tank 2 on	Tank 2 off	All except sumps empty	
1	50	50	1,000	1,650	1,850	2,000	1,750			2,200		400
2	25,500	25,650	25,800	25,850	25,900		25,700					100
3	33,800	33,750	33,700	33,600	33,600		33,600				30,000	14,200
4	27,150	12,750	5,800	2,300	2,350	2,000	2,500		empty			300
6L	38,900	38,850	38,800	38,800	35,700	11,000	5,000	2,000				1,500
6R	38,780	38,800	38,900	38,700	36,250	12,800	5,000	2,000				800
7L	99,500	99,500	99,550				99,500					99,550
7R	99,500	99,500	99,500				99,600					99,600
8L	99,550	99,750	100		200		-100					300
8R	99,500	99,850	99,850		300		-200					750
Total	164,500	151,000	145,000	142,500	137,500	98,000	75,500	61,000		36,500		19,500

2. Hydraulic Systems Data:

	P_1		P_2		U_1		U_2	
Time	F.L.	H.P.	F.L.	H.P.	F.L.	H.P.	F.L.	H.P.
0909*	170		172		162		170	
0925	170	185	170	205	158	200	170	195
0940	162	190	160	205	150	200	172	200
0953	160	185	158	210	148	200	170	200
1115	155	185	148	185	110	175	178	205
1120	158	185	172	190	115	172	188	205

F.L. - Fluid Level % (full - 200%)

H.P. - Head Pressure, pounds per square inch

*Servicing completed

IU. ENGINEERING COMMENTS:

1. Flight Controls:

The flight control system worked normally with the following exception. The primary pitch trim disengaged for about 3 minutes just after takeoff. This is the third occurrence in five flights that the primary pitch trim was lost early in flight. Subsequent to Flight 1-5, a procedural change to the preflight check, to center the trim mechanisms just before takeoff with the trim takeoff switch, was effected in an attempt to eliminate the problem.

2. Aerodynamic Oscillations:

During the flight, with the Flight Augmentation Control System (FACS) "OFF" and with the wing tips extended to the 65 degree position, oscillations of about one-fourth of a cycle per second occurred in yaw and roll with the aircraft velocity between Mach 1.4 and 1.6. Maximum amplitudes of $\pm 0.8^{\circ}$ in yaw and $\pm 4.0^{\circ}$ in roll occurred at the initial 65° wing tip position. Later in the flight, at the same Mach points with FACS "ON", (No. 2 yaw damper system was inoperative) the amplitude of oscillations was reduced. Extensive detailed data analysis of aerodynamic parameter printouts is necessary to define this problem area.

3. Propulsion:

a. During the flight an exhaust gas overtemperature (EGT) condition occurred at 1.6 Mach and 45,000 feet on Engine No. 170-580 (Pos. #6). The power setting was reduced when the cockpit EGT indicator showed 905 to 910° F. The engine was removed from the air vehicle and taken to General Electric (G.E.)/Edwards for inspection and test cell runs. Test cell runs showed that the temperature amplifier, nozzle area control and the main fuel control were malfunctioning as follows:

(1) The temperature amplifier varied at military power approximately 14° F.

(2) The nozzle area control went full open due to a mechanical failure during an engine acceleration from 80 percent to minimum afterburner.

(3) The rpm speed roll-back was from 3.5 to 4 percent during afterburner lights.

(4) The main fuel control on the acceleration schedule was from 5 to 7 percent below the nominal schedule.

The three controls (temperature amplifier, nozzle area control and main fuel control) will be replaced and the engine will then be re-run in the test cell and returned to spare status if satisfactory. The main fuel control will be sent to Woodward Controls and the nozzle area control and temperature amplifier to G.E./Evendale for inspection.

Engine No. 170-580 will be replaced by Engine No. 170-565.

b. Engine No. 170-558 (Pos. #4) had minor foreign object damage (FOD) on 12 blades of the first stage of the compressor. This FOD was benched out by North American Aviation, Inc., (NAA) with the engine still installed in the air vehicle. No FOD was visible on the second stage of the compressor.

4. Left Hand Rear Brake Lock-up:

During the first several feet of the takeoff roll the left hand bogie rear wheels were locked. Data showed that they released at $9\frac{1}{2}$ knots. A stuck relay in the brake hold system is suspect as the cause of the lock-up. This relay was subsequently bypassed by the 10 knot relay and the brakes operated satisfactorily for the remainder of the flight. After the flight the relay was checked on the ground but the problem did not repeat. This relay was removed, tested, and found to have a mechanical failure. The flat spots resulting from the locked brakes required removal and replacement of the No. 7 and 8 tires.

5. No. 4 Primary Hydraulic Pump Oscillations:

Hydraulic pressure oscillations of about 300 - 1,000 psi peak-to-peak were observed on telemetry during this flight. After the flight the pump and ripple damper were replaced. The ripple damper is to be x-rayed for possible internal failure; and also, the pump and ripple damper are to be test run on the hydraulic test stand (SPAR).

6. No. 6 ADS Vibration:

After advancing the throttle on No. 6 engine just prior to the takeoff roll the pilot reported 80% ADS No. 6 vibration. This indication was rechecked several times at high power. The system was then checked with the test circuit and all ADS vibration indications went over 100% indicating a malfunction. A decision was made to continue the flight. ADS vibration indications appeared satisfactory for the remainder of the flight except for No. 6 which remained high. After the flight the No. 6 pickup was found to be defective, thus causing the high indications. A bad relay was found to be the cause of the indicators registering 100% during tests. The pickups used for ADS are the same as those used on the engine but they are exposed to much higher "g" loads than in the engine environment. This probably contributes to their failure. In the future, NAA flight test plans to calibrate pickups in the ADS bays prior to each flight to locate faulty pickups.

7. Drag Chute Failure To Deploy:

In the deployment sequence of the drag chute the doors opened, the pilot chute deployed and blossomed, and the extraction chute deployed and blossomed. The extraction chute then dropped below the upper surface of the aft fuselage and became entangled between No. 3 and No. 4 engine nozzles. The main chute bags were only partially withdrawn and the main drag chutes did not deploy. There was no apparent malfunction in the main chute bags. Prior to this flight the bridles on the pilot and extraction chutes were shortened to reduce deployment time. The pilot chute bridle was reduced from 15 to 9 feet and the extraction chute bridle was reduced from 11 to 4 feet. The extraction chute bridle is being returned to its original length to prevent recurrence.

8. Electrical and Environmental Systems:

Preliminary data indicates that the electrical and environmental systems performed as expected except for the following discrepancies:

a. Master Caution Light:

The master caution light remained on throughout the flight. The difficulty was isolated to the master caution light circuit because other associated warning lights were not indicating concurrently. Subsequent to the flight, inspection of the master caution light relays revealed that 5 out of 13 of the Cook one-half amp. universal relays had failed thus causing the erroneous indications.

b. Air Induction Control System (AICS):

During the flight the AICS cooling caution light came on. The copilot pushed the master caution light and the AICS cooling caution light went out. Subsequent analysis showed that the AICS cooling system shifted normally from the number one system to the number two system. This is a design feature. The AICS cooling system was ground checked normal after the flight, and the reason for the caution light coming on remains unknown.

9. Instrumentation:

Instrumentation performed normally with the exception of 38 of the 742 parameters. Sixteen of the 38 parameters had some usable data but required further extrapolation due to calibration irregularities. Of the remaining 22 parameters of bad data, 6 parameters were not operational prior to flight thus leaving 16 parameters unaccounted.

10. NASA Supersonic Transport Tests and Instrumentation:

a. Landing Gear Cameras:

The cameras were turned on prior to touchdown but the two main gear cameras jammed and provided no data. The nose gear and drift angle cameras functioned properly.

b. Landing Rate of Sink Sensors (arms):

Rate of sink arms were installed for the first time on this flight. The nose gear arm unlocked and fell during the takeoff roll, but no damage resulted. The left main arm was not electrically connected. The sensor wires were used to permit measurement of bogie fold actuator load. The data from the nose gear and right main gear rate of sink arms was of excellent quality.

c. Cabin and Ballast Bay Microphones:

The internal noise microphone in the cabin and the panel response microphone in the ballast bay were installed and operational for the first time on Flight No. 5. Both microphones and the recorder functioned correctly; however, the sensitivity levels of the microphones were set a bit low resulting in poor quality data.

d. Velocity Acceleration Altitude (VGH) Recorder:

A good VGH record was obtained for the entire flight.

e. Runway Noise:

An array of eight microphones were placed along the Palmdale runway to record noise during the takeoff for Flight No. 5. In addition, NAA placed three microphones at the three mile point off the end of runway 7. Excellent sound recordings of the XB-70 takeoff were made. About 30 minutes after the XB-70 departed, a Trans World Airlines' Boeing 707-331B made two landings and two takeoffs on the same runway to permit direct noise correlation between the XB-70 and a subsonic jet civil transport. The data is presently being analyzed and will be published by NASA.

f. Sonic Boom:

NASA set up microphones for sonic boom pressure level measurements at the radar site near Beatty, Nevada. The XB-70 passed within 13 miles of the site at Mach 1.6 and 45,000 feet and produced a definite boom signature at the measurement station. The B-58 chase aircraft was about 3,000 feet aft, flying at Mach 1.45 and similarly produced good boom data at the microphones. As with the runway noise data, the results will be published by NASA.

V. OBSERVATIONS AND COMMENTS BY THE COPILOT:

1. Preflight, Engine Start and Taxi:

The exterior equipment area and crew compartment preflight inspections were started at 0615 and required one hour to complete. We strapped in and started the pre-engine start checklist at 0715. Inlet inspection by the ground crew delayed engine start 15 minutes.

The engines were started in 7 minutes with exhaust gas temperatures (EGT) from 450 to 510°. Following the air induction control system (AICS) and flight control checks, the engines were advanced one at a time to 100% rpm for a telemetry check of the hydraulic pumps. Hydraulic systems service levels were 160 to 170 percent. The gross weight at start of taxi was 409,000 lbs. The pre-taxi checks had required 17,000 lbs., of fuel, all from Tank No. 4.

During taxi I observed that the up and down cockpit movements were less than we had previously experienced and nose wheel steering was smooth but the brakes caused moderate to heavy airframe vibration when applied at slow speed. At 0935 we were lined up on Runway 7. Predicted takeoff data was: Rotate at 170 KIAS, lift off at 190 KIAS in 6,000 ft.

I had observed the following discrepancies:

a. One loop of the No. 3 engine fire detector system tested bad.

b. The right bypass area counter remained at 10 to 40 square inches and its caution light remained on.

c. Both throat panel extend caution lights remained on with the throat panels full open.

d. Yaw augmentation system No. 2 would not engage.

e. The master caution light remained on continuously, it could not be punched off.

2. Takeoff and Climb:

The takeoff was delayed 13 minutes because of high indicated vibration (80%) on No. 6 Accessory Drive System (ADS) and instability on No. 4 engine primary pump. We did not consider the high No. 6 ADS vibration as valid because the cockpit vibe indicators went off scale

during the push to test check. The hydraulic pump stability improved at high power and the decision was to go. Power advance technique was to take all engines to 85% rpm and to go into minimum afterburner (MIN A/B) with 3 and 4, then 2 and 5, and finally 1 and 6. The total fuel at brake release was 137,000 lbs., 18,000 less than planned. Brakes were released and power advanced to maximum afterburner (MAX A/B) during the initial roll. The brake release was rough and uneven which caused the airplane to swerve to the right resulting in a nose wheel steering disengagement. The steering was immediately re-engaged successfully.

Rotation was initiated at 170 KIAS and I observed us airborne at 196 KIAS. Except for the abrupt brake release and steering disengagement, the takeoff roll and initial climb were normal and absent of any great amount of longitudinal or directional oscillations. Al reported loss of primary pitch trim in the initial climb and at his request, I made the power reduction to 88° throttle angle (T/A) at 254 KIAS and 7,500 feet. Fuel totalizer was 118,500 lbs. The gear retraction was initiated at 230 KIAS and required 53 seconds. The flaps were started up at 237 KIAS and retracted in 16 seconds. A 400 KIAS and .95 Mach climb was made over Edwards with a right turn to Lake Isabella and on north toward Coaldale VORTAC. There was some mild airframe buffet and cockpit rumbling in the climb which disappeared about 400 KIAS and near .9 Mach in the climb. This noise and disturbance seemed more pronounced in both their presence and disappearance than on any previous flight.

At .96 Mach and 38,000 feet, chase reported the engine cooling doors all closed, the wing tips were put down to one-half and I observed the cabin altitude was 6,500 feet. The wing tips went down together causing little or no lateral or longitudinal trim change.

3. Supersonic:

We went supersonic at 1012 at a gross weight of 359,000 lbs. A 390 KIAS climb was made to 41,000 feet. A level acceleration was made to 1.4 Mach at 41,000 feet with flight augmentation control system (FACS) disengaged where two pullups and releases were made to 1.2 G. Two constant heading right sideslips were accomplished out to about 3°. The airplane's recovery response with released controls was very slow. A windup turn to the left to near 1.4 G was completed at 43,000 feet.

Photo Chase 3 was short of fuel and had to go home before the wing tips were put full down. The wing tip selector was placed to full down at 42,700 feet, 437 KIAS and 1.41 Mach. I timed their travel from half to full in 39 seconds. The gross weight was 345,500 lbs. I had the feeling that the tips extended symmetrically and did not require any great attention to control or trim. Soon after both tips were down,

a lateral-directional wallowing was experienced which was also observed and reported by Chase 1. It appeared to me that the directional disturbance was from 1 to 2 degrees of sideslip, the roll was 5 to 10 degrees with a cycle every 2 or 3 seconds. The behavior was sufficiently disturbing that we left the tips full down for only about 2 minutes. When raising wing tips, I observed the left wing indicator showing part white, not all barber pole, while in transit. All augmentation was turned on in preparation to put the tips to full down again. The AICS COOL caution light came on but extinguished when I pushed the master caution light. Abeam Mud Lake and approaching the northern boundry of the planned flight path, a right turn was made to pass over Coaldale VORTAC enroute to the NASA Beatty Boom Site. The tips were at half and we observed 1.46 Mach while the TB-58 reported 1.44 Mach. Gross weight was 334,000 lbs. The cabin was a bit cool and the Electronic Equipment Bay (EE) temp. was 43°.

With augmentation engaged (except yaw 2) we rolled out towards Beatty and at Mach 1.43, the tips were again selected to full down. Travel time from half to full tips was 35 seconds. Chase reported the airplane looked steadier and we could feel the yaw damper working. Al commented that the roll power seemed higher with full tips than at the 25° position. With augmentation on the airplane, lateral direction behavior was some improved but it still retained the demonstrated will to wallow. We decided to go for the high Mach number rather than open the bypass doors at this time. The stability maneuvers and FACS transients were deleted since the airplane didn't feel too good in this configuration. Mach 1.6 was indicated at 45,000 feet. The two chase planes started dropping back as we approached the boom site at Beatty. A five degree heading change to the left was executed and Al reported difficulty turning. At Mach 1.6 we felt and heard two muffled rumbles which we thought could have been compressor stalls. Al noted the derated No. 6 engine EGT was just over 900° C and throttled it back. I opened the bypass doors to 200 then 410 square inches. The gross weight was 316,000 lbs. Chase 4 pulled in for photos, throttles were reduced to MIL, and the wing tips were brought up to half at 40,000 feet and just under 1.4 Mach in 32 seconds. Again the left tip indicator showed partial white during the retraction. The afterburners were lit (except No. 6) to maintain 1.4 Mach and I closed the bypass doors with the standby switches. We encountered some rough air, thought it could be engine troubles so I again opened the bypass doors to 430 square inches. I turned the standby system selector switches from primary to off before I rolled the manual wheels forward and the doors came open again. I wasn't sure at that time what caused this but rolled the bypass wheels forward, turned the mode switches off and again closed the doors with the standby switches and they remained closed.

4. Descent and Landing:

Stability maneuvers were performed at 1.2 Mach and we started deceleration and descent at a gross weight of 297,000 lbs. We went subsonic at 1051 at 33,000 feet and the tips were brought up just under .9 Mach at 30,000 feet. The cockpit noise increased in the vicinity of .85 Mach. The cockpit temperature was cool with the selector in automatic and the knob set at the 2 to 3 o'clock position. The pacer reported a speed of 291 KIAS when our central air data system (CADS) tape indicated speed was 300 KIAS and the pneumatic indicated speed was 307 KIAS. I closed both throat panels with the manual wheels to the 2.1 Mach position as we passed through 15,000 feet. Except for the left throat indicator hanging up for a few seconds, the throat operation and power available all appeared normal. The gear was extended at 243 KIAS at an estimated time of 25 seconds. The flaps extension time was 15½ seconds. The landing gross weight was 290,000 lbs.,and a totalizer of 27,000 as we came down final. The speed down final was 196 to 200 KIAS. The SST landing gear cameras were turned on prior to touchdown. The touchdown was a good one within the first 2,500 feet. The landing was made on Runway 04 at 1111 PST. The drag chute hung up and failed to deploy. Moderate braking and some chatter brought us to a comfortable stop. The wind was 4 knots from the north. Engine runs were performed before clearing the runway. The last engine was shut down at 1129 with a fuel totalizer of 19,500 lbs.

The following discrepancies were observed from lineup on the runway to shutdown:

a. No. 6 ADS vibration indicator was high at 80%.

b. No. 4 primary hydraulic pump was unstable at some power settings, reported by hydraulics monitor.

c. The brakes did not release properly which caused the aircraft to swerve and nose steering disengagement.

d. The primary pitch trim was inoperative for a short period of time in the initial climb.

e. No. 6 engine over-temped.

f. The AICS cooling system caution light came on in flight.

g. The left wing tip indicator showed part white instead of all barber pole while the tips were in transit.

h. The drag chute did not deploy.

VI. CONCLUSIONS:

1. The "firsts" of wing tip fold to 65° and bypass door and throat panel operation were achieved successfully. Bypass door opening to 400 square inches did not appear to cause the expected nose up trim change.

2. The aircraft systems which gave overall satisfactory operation were:

Nose wheel steering	Hydraulics
Fuel	Wing fold
ARC-50 radios	Flaps
TACAN	Environmental
Intercom	Air induction control
Oxygen	Instrumentation
Landing gear	Electrical power supply
Engines	

3. Moderate to heavy airframe vibrations resulted from brake applications at slow taxi speeds.

4. Continuous illumination of the Master Caution Light throughout the flight resulted from failure of Cook one-half ampere universal relays.

5. Delayed brake release of wheels 7 and 8 caused the air-craft to swerve and nose wheel steering disengagement during the initial takeoff roll.

6. Primary pitch trim was lost during the initial climb.

7. Cockpit buffet and noise disappeared in the climb near .9 Mach and reappeared in the descent at .85 Mach.

8. The lateral-directional behavior with the wing tips at 65° and FACS off was unexpected, uncomfortable, and caused concern. These aerodynamic oscillations appear to be pilot induced as a result of the low aileron control forces.

9. Hydraulic fluid levels indicated some transfer of fluid from Utility No. 1 to Utility No. 2.

10. The drag chute failure was a result of decreasing the length of the extraction chute bridle which caused the main chute bags to be only partially withdrawn.

11. The new exterior paint job stayed on.

12. The flight was a big step forward and very successful.

VII. RECOMMENDATIONS:

1. Investigate and determine probable cause of uneven brake release.

2. Eliminate brake chatter present during the low speed portion of stops.

3. Increase the aileron control force.

4. Determine cause of drag chute failure and continue action toward achieving three fully developed canopies.