(Gp-4) TEST REPORT

XB-70A

FLIGHT 1-15

(No. 1 Air Vehicle, No. 15 Flight)

27 July 1965

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XB-70 JOINT TEST FORCE (FTTB)

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I. SUMMARY:

1. The fifteenth flight (Flight 1-15) of the XB-70 No. 62-001 was completed 27 July 1965. Programmed objectives of obtaining inlet performance and heat soaking at 2.8 Mach were achieved. The purpose of the heat soak was to demonstrate structural integrity following previous in-flight failures before further expanding the flight envelope to Mach 3.0. This flight plan was implemented at the request of the Air Force in lieu of the contractor proposed Mach 3.0 flight.

2. The flight crew was Mr. Al White, North American Aviation, Inc (NAA), Pilot and Lt Colonel Fitzhugh Fulton, Air Force Flight Test Center, AFFTC, Copilot. Takeoff occurred at 0706 PDT from Edwards AFB runway 04 at a gross weight of 522,300 pounds. Landing on Edwards AFB runway 04 at a gross weight of 285,000 pounds was at 0849 PDT. Total flight time was 1:43 hours, total supersonic 1:05 hours of which :20 was at 2.8 Mach.

3. As a result of a fuel leak from tank No. 6 into the right wheel well, the landing gear was not retracted until tank No. 6 was emptied at about 20,000 feet in the climb. The 20 minute cruise at Mach 2.8 is even more significant as a result of this since the aircraft is usually in level flight acceleration at 32,000 feet at the time tank No. 6 empties. Indications were that sufficient power and fuel capacity existed to obtain Mach 3.0 cruise.

4. During postflight inspection immediately after flight, the only significant structural failure discovered was a void in the right inlet duct roof. During refueling for Flight 1-16 numerous fuel leaks appeared in the areas of tanks No. 1 and 2. Subsequent inspection revealed honeycomb face sheet separations adjacent to many of the frames in these tanks plus other structure problems. A detailed analysis of these failures and their relationship to the rest of the aircraft is necessary. Additional flights to demonstrate structural integrity within the present flight envelope appears highly desirable before subjecting the aircraft to higher aerodynamic and heat loads.

5. After landing, brake tests were conducted with new sintered iron linings on the rear brakes only. The tests were inconclusive. Excessive chatter was still experienced and the brakes appeared to be extremely sensitive in the manual mode.

II. CONFIGURATION CHANGES PRIOR TO FLIGHT 15:

1. Air Induction Control System:

a. No. 2 right hand buzz light - sensor replaced.

b. Right hand throat ramp rate changed from normal to low and vice versa. Is now the same as left hand.

2. Propulsion:

a. Engines No. 3 and 4 vibe pickups relocated to 4 o'clock position.

b. Auxiliary Drive Subsystem (ADS) oil pressure light system reworked to operate the same as engine oil pressure.

c. Throttle switches reset to eliminate inadvertent engine shutdown.

3. Avionics:

a. Altitude tape indicators replaced.

b. Central Air Data System (CADS) calibrated.

c. Total temperature system calibrated.

4. Hydraulics and Landing Gear:

a. U_1 No. 3 status light repaired - replaced pressure switch.

b. Revised brakes (sintered linings) installed on aft trucks.

c. Landing gear operations accomplished.

d. Nose wheel steering filter check.

5. Structural Repairs:

a. Left hand and right hand wing lower surface.

b. Right hand forward fuselage.

c. Left hand lower fuselage.

d. Right hand wing - perk pins added at weld joint inboard to outboard.

e. Right hand duct roof perk pins added.

f. Right hand fuselage; outboard of weapons bay; cracked "T" repaired.

6. Flight Augmentation Control System (FACS):

a. Yaw No. 1 and pitch solenoid valves replaced.

7. Miscellaneous:

a. No. 2 ADS vibe pickup mounting bracket tightened.

b. Windshield - leaks in area repaired.

c. Pilot's side window - replaced desiccant.

d. Pilot's tape recorder - revised to record only intercom and the radio selected by the pilot.

e. Tank No. 3 - fuel leak repaired.

f. Nose wheel steering switch guard removed.

III. TEST LOG:

0345	Pilots at aircraft.
0530	Copilot in cockpit with pressure suit checks complete.
0535	Pilot in cockpit with pressure suit checks complete.
0545	Throats set at 2.43 with wheels and biased to 2.40 with standby switches.

Engine Starts - Manual

0609	Start engine No. 4 EGT 540° 1st peak; 590° 2nd peak; all O.K.
0610	Start engine No. 3 EGT 550° 1st peak; 580° 2nd peak; O.K.
0611:30	Start engine No. 1 EGT 470° 1st peak; slow acceleration; 500° 2nd peak. No. 1 primary status sticking before start, sticking one-half way at idle.
0613	Start engine No. 2 - EGT 520° 1st peak; 550° 2nd peak. No. 2 primary status sticking but O.K. at idle.
0615	Start engine No. 6 - EGT 500° 1st peak; 540° 2nd peak; O.K.
0616	Start engine No. 5 - EGT 530° 1st peak; slow acceleration.
0617	C/N 10638 bleed air check.
0619	Generator checks.
0620	Service hydraulics to 160%.
0626	Tank No. 1 not feeding - sump 28,400 lbs.
0628	Flight control checks.
0636	Data On C/N 776; MIL power; C/N 831 Off. High vibration on No. 6 engine until throttle was "bodied" then went to 30% - 35%.
0637	All hydraulics 160% except P_1 175%. Tank No. 1 Off at 24,400 lbs.
0640	Disconnect air conditioning.
0644	Start taxi.
0649	Data On - brake test stop from 28 mph. AUTO braking. Data Off C/N 1638. A little brake chatter right only (one fore and aft strut cycle). Sump 24,000 lbs.
0651	Tank No. 6 to AUTO and feeds.
0655	Wind calm.
0659	Data On 2101, stop on runway 04, Off 2131. Pilot reports "chatter considerably better than it had been." There were several cycles of fore and aft strut oscillation (strut walk) during chatter just prior to stopping. Ground crew inspect gear - right strut leak stopped. Reset counter.
0700	Total fuel 251,500 lbs. All to AUTO.
0704	Data on 358; advance power; light afterburners 3 & 4; 2 & 5; 1 & 6.

Test Log (Cont'd)

0706 Brake release; maximum afterburner; 35 seconds to 150 knots.

0708 Flaps up; No. 6 engine caused flicker on master caution light.

0710 Primary radio out, could hear but not transmit. AUX COOL turned back on when EE temperature to 80°.

0711 Cycled refer switch - looks O.K. AUX COOL is off.

0715 EE temperature 58°.

0717 Climbing through 17,000 feet.

0721 20,000 feet TB-58 259 KIAS; B-70 268 KIAS.

0722 Throttle back to hold 20,000 feet. No. 4 tank starts feeding. Retract gear.

0723 Maximum afterburner to climb. Hydraulics look good.

0724 Tips to one-half, all cooling doors closed.

0727 Windshield up.

0728 Data and cabin recorder on, through Mach jump. Bypass 200 sq in; anti-collision light off.

0730 32,000 feet, 1.17 Mach over NASA Boom Station. C/N 1862.

0732 Cabin recorder off.

0733 Tips full down; bypass to 400 sq in; speed near 1.4 Mach.

0736 Throats to AUTO.

0737 B-70 reports light turbulence; B-58 reports none, a little below and behind B-70 at 38,000 feet.

0738 1.94 Mach aircraft, throats 1.92 left and 1.94 right.

0739 Through Mach 2.0.

0740 Starting inlet and put aircraft in bit of climb. Shock in lower yellow, bypass left 650 sq in, right 610 sq in.

0743

Engine No.	1	2	3	4	5	6
EGT - °C	805	810	820	815	805	810
Nozzle - %	99	90	93	94	95	98

545 KIAS - 59,000 feet
Shocks real sensitive throughout green area.

0746 20° bank. Shocks in high green. Bypass left 390 sq in, right 420 sq in.

0747 Bobweight free.

0749 2.6 Mach, 418° total temperature, 63,000 feet. Throttles 100° in 20° bank; bypass left 420 sq in, right 450 sq in. Shock mid to high green.

0750 522 KIAS CADS and 518 KIAS pneumatic. Lost ground radar track.

0751 Opening bypass doors causes airframe buffet. Back to MAX afterburner.
2.58 Mach in turn, shocks going to lower green.

Test Log (Cont'd)

0752	Data on 3182, FACS off for lateral directional maneuver. C/N 3250 Data off. Radar track good now.
0753	Flashing master caution - cause undetermined. 64,000 feet, 520 KIAS, 2.63 Mach 424° total temperature MAX afterburner power.
0755	2.7 Mach, Data on C/N 3373, FACS off, lateral directional maneuver off 3410. Shock position .6 with bypass to 360 sq in left, 375 sq in right. 75% data remaining - On.
0757	2.78 Mach, 497° total temperature, 65,500 lbs. C/N 3535, shock position .6, throats left 2.78 Mach and right 2.75 at 2.79 aircraft Mach.
0758	Mach 2.8, 66,000 feet, throttling back. Total temperature 506°. C/N 3565 cabin recorder on.
0759	Total temperature 510°. Dampers off C/N 3615, lateral directional maneuver. FACS On; 2.81 Mach turning right.
0800	Still turning. Shock to top green; 2.81 Mach and climb slightly when closing bypass doors. Total temperature 507°, throttles 98°.
	C/N 3726. Shock position on line between green and yellow. Bypass left 310 sq in, right 320 sq in. Aircraft accelerates to 2.82 Mach, throttling back. Peak total temperature 514°. Shock to .6 left 340 sq in, right 360 sq in at 3750 C/N.
0802	With shocks oscillating around bottom green, 390 sq in left and right. C/N 3791, throats 2.81 Mach left and 2.77 Mach right at 2.80 Mach aircraft.
0803	Throttles 95°; shock to crosshatch at 470 sq in left and right; getting light aircraft buffet and stopped bypass movement. To MAX afterburner; duct performance to low at C/N 3873. To bottom green - moderate aircraft buffet. Throats left 2.68 and right 2.62.
0804	Throat to normal performance.
0806	Shock position .6; bypass left 340 sq in and right 350 sq in. Throats 2.80 left and 2.76 right at 2.80 Mach aircraft.
0807	Good stabilized point C/N 4095 throttles 95°.
0809	Right turn at Needles.
0811	18° bank; shock position lower green, bypass left 390 sq in and right 380 sq in. Holding speed and altitude with total temperature 500°.
0811:30	After setting bypass need only to make a very little movement of shock once speed and altitude is stabilized. Throats left 2.82 and right 2.78 at 2.81 Mach aircraft. Lost ground radar track.

Test Log (Cont'd)

0816 Increase throttles 5°.
0818 To MIL power.
0819 44,500 lbs total fuel. 2.5 Mach, bobweight locked.
0821 Cabin at 6,500 feet at 64,500 feet, 400 knots.
0822 Bypass left 930 sq in and right 830 sq in. Went below Mach 2.0.
0823 Below 56,000 feet - Data Off C/N 5100.
0824 At 1.7 Mach, throats 1.69 right and 1.70 left. Bypass left 930 sq in and right 890 sq in.
0827 Rpm to release.
0828 Close bypass to 400 sq in, 1.4 Mach.
0830 Tips to one-half. LN_2 7/8, NH_3 470; water 1200; EE 45°.
0833 Engines No. 1, 6, 3 and 4 throttles back. Subsonic holding 350 knots.
0835 FACS off.
0836 Windshield down.
0837 Tips up.
0840 Gear down O.K.
0841 Flaps down; tank No. 6 on 2 minutes.
0843 U_1 quantity down to 85% then 78% slowly holding
0846 Tank No. 3 - 17,000 lbs; total 27,000 lbs.
0847 Gear camera on.
0847:30 Touchdown - drag chutes deploy O.K. Chase reports smoke from left truck.
0848:30 Off runway.
Park on taxiway - left brake seemed to be grabbing to pilot. A little chatter on right. Left brake smoking.
0851 Engine idle readings:

	1	2	3	4	5	6
Rpm - %	61.8	60.9	61.5	61.5	61.6	62.0
EGT - °C	430	430	460	460	450	420
Nozzle - %	75	66	70	71	71	75

Data C/N 6730.

MIL power:

	1	2	3	
Rpm - %	99.9	100	100.5	Data
EGT - °C	900	880	885	C/N 6797
Nozzle - %	42	44	42	

	4	5	6	
Rpm - %	100.3	100	100.5	
EGT - °C	870	880	900	Data
Nozzle - %	40	41	46	C/N 6867
Vibs ADS - %	5	15	18-20	
Vibs Eng - %	20-25	25-30	35-40	

0854 Data On 6196. Flight control full throws, Off 6596.
0856 Moving - rear only AUTO brakes; stop from 10 knots C/N 7035; pilot reports pretty good chatter. Several cycles of fore and aft strut oscillation (Strut Walk) on both sides.

Test Log (Cont'd)

0856	Rear only manual brakes; stop from 10 knots - tapping brakes left skid spot marks with wheels locking up. Rear only AUTO brakes; stop from 5 knots - chatter. Rear only manual brakes; stop from 5 knots - left side locked up when brakes just barely touched. C/N 7156 data off.
0859	Taxi in; flap handle is up but flaps are down and flap pressure lite. C/N 7260 throats set at 2.4 and full closed (3.05 left and 3.10 right). Tried putting flaps up again.
0901	Shutdown Nos. 1 and 6.
0903	Park on runup pad - no chatter on stop.
0906	Shutdown all engines.

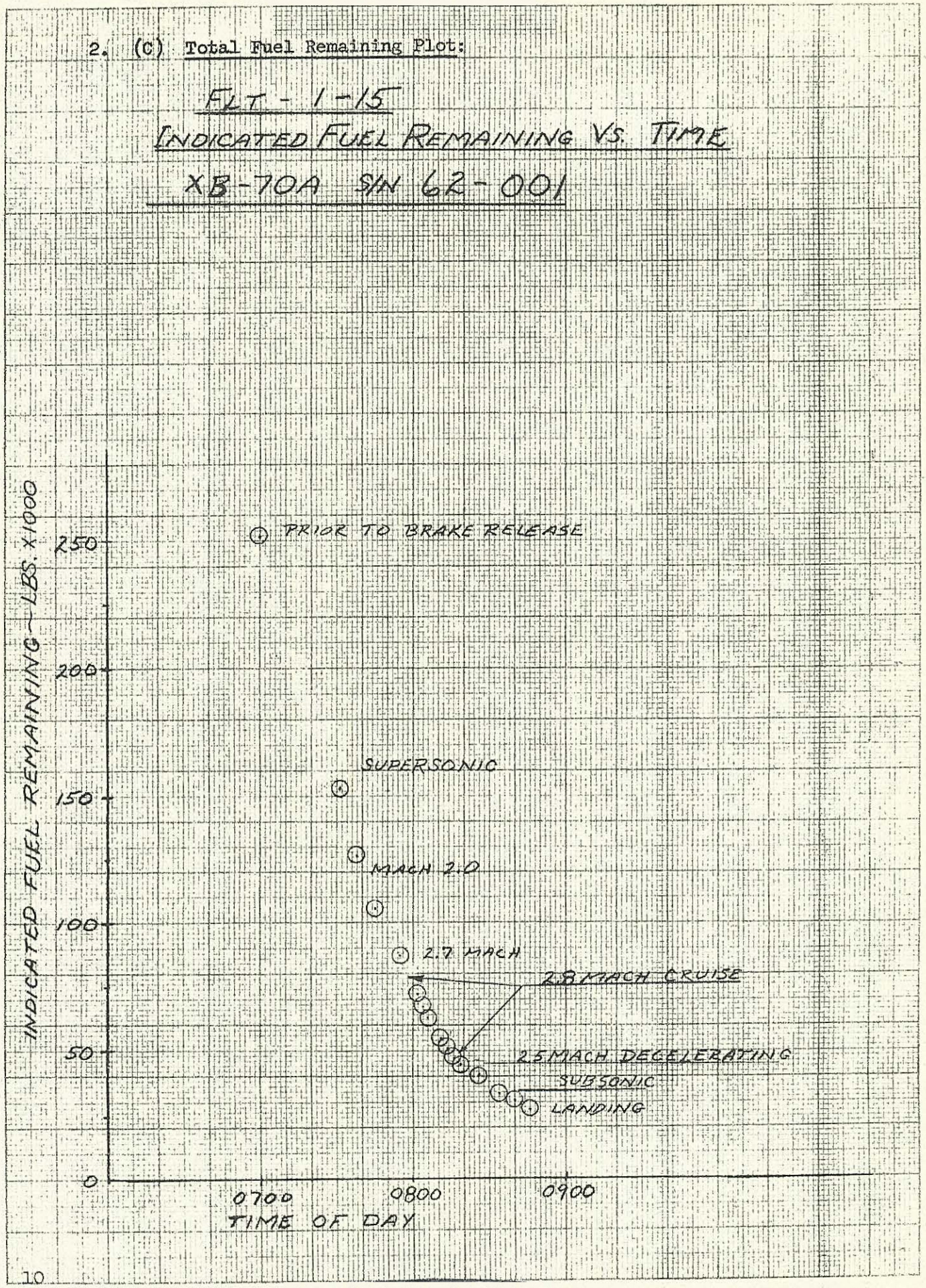
IV. DATA: ____

1. Fuel Data:

Time	0700	0722	0728	0731	0740	0742	0751	0755	0814	0819	0834	0846
Event	Prior to Brake Release	20,000' 268 Kt	Super-sonic		Mach 2.0		2.6 Mach 63,000'	2.7 Mach 64,000'	2.8 Mach	2.5 Mach Descend	Subsonic	Landing
ransfer ondition	Tank No.6 Feeding	Tank No. 6 Off	#2 Feed-ing - #4 Stopped	#2 Stop-ped - #4 Feeding	No. 4 Off	No. 2 Off	No. 7 Off	No. 8 Feeding	No. 8 Off			
Tank*												
1	34.6		21.1					27.0	12.0	7.0		
2	29.0		24.7	18.7	6.5	.2						
3	32.5										23.5	17.7
4	37.0	Feeding		Feeding	.2							
6L	34.0	2.1										
6R	33.7	1.4										
7L	10.7						1.5					
7R	10.7						1.5					
8L	13.9								.2			
8R	13.8								.2			
Totals	251.5			152.5				87.5	50.5	44.5	33.5	27.0

* Fuel quantity times 1,000 pounds

2. (C) Total Fuel Remaining Plot:



3. Hydraulic Quantity Log:

	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.
0624	160*	190**	160	175	160	175	160	182
0714	200		200		180		195	
0726	198		200		200		180	
0804	200		152		181		145	
0810	200		172		180		170	
0821	198						160	
0827	198		183		170		180	
0843					83 → 78			
0846					80 Holding			
0910					60			

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

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

V. ENGINEERING COMMENTS:

1. Structural Failures:

A prime objective of this flight was to demonstrate structural integrity of the No. 1 XB-70 following repair of previous in-flight failures. This was felt to be reasonably well borne out when the only failure known immediately after flight was the void in the left duct roof which occurred during air vehicle cool down after the flight. However, when refueling for Flight 1-16, excessive fuel leakage at several forward fuselage points from tanks No. 1 and 2 caused Flight 1-16 to be cancelled. The air vehicle was then defueled and the tanks were entered for structure inspection and repair. At this time all leaks and repairs have not been identified but voids have been found between the inner face sheet and the honeycomb core adjacent to several frames in tanks No. 1 and 2. In some cases voids are both forward and aft of the same frame station in the same area. It is obvious that failures which resulted in fuel leaks were either generated or significantly increased in magnitude during Flight 1-15. Voids around the frame stations which did not result in leaks may have occurred during manufacturing assembly of the aircraft or developed during the flight program and discovered at this time. The cause of these voids is not known at this time.

2. Left Inlet Duct Roof Void:

A large void developed in the left inlet duct roof, station 1721 - 1730, shortly after Flight 1-15. The void was observed to develop during the postflight inspection. The face sheet and a portion of the core were removed in the void area. Tee fittings were installed in the de-cored area and cluster pins welded into the remaining core for attachment of the doubler.

3. Tank No. 6 Fuel Leak:

After fueling for Flight 1-15, a leak of 34 drops/minute was found in the right wheel well forward compartment from tank No. 6 sump. At the request of the Air Force, the flight plan was revised to leave the gear extended until tank No. 6 was empty in order to purge fuel from the compartment. After the flight, the lower portion of tank No. 6 left and 6 right were entered to repair leaks.

4. Brake Tests:

a. Brake rotors with a new sintered iron lining were used for the first time on the aircraft in an attempt to reduce low speed brake chatter. New rotors were installed on the rear brakes only for test. Data was recorded during normal stops in the AUTO mode and during low speed stops (rear brakes only) in the AUTO and MANUAL modes.

b. Observations and pilot comments indicate that the tests were inconclusive and further experience is needed to determine if the new lining is any improvement. Brake chatter occurrence has varied widely on previous stops and while chatter experienced with the new lining was less than the worst experienced with the original lining, it was still objectionable. Also, tests are required with the new lining on all brakes. Very little braking was used in the landing roll because of heavy smoke from the left brake. First indications, when using the new lining during manual braked stops, show that the wheels are easily locked up and the tires skidded.

5. Flaps:

During taxi in from the flight, the pilot selected flaps "up." The flaps failed to retract. A flap pressure warning light was also observed. This appears to have been a dual failure in the flap control valves as compared to problems on previous flights where the pressure warning light was observed. During ground test, with single hydraulic system pressure, the flaps were operated satisfactorily. The control valves from both primary 1 and 2 actuators were removed, flushed and reinstalled. Had this malfunction occurred when the flaps were selected up after takeoff, instead of on the ground after landing, the flight would have been aborted or limited to below flap limit speed. The problem does not appear to have been fixed by corrective action after previous flights. Further investigation and/or redesign is necessary to insure that flights will not be aborted because of this problem.

6. NASA Supersonic Transport Instrumentation:

a. Landing Gear Instrumentation and Cameras:

The landing gear cameras were not installed for this flight. Landing rate of sink was obtained for the right main gear only. The instrumentation leads to the left main gear rate of sink arm were used for another transducer. Data was not recording at the time of nose gear touchdown.

b. Cabin and Ballast Bay Microphones:

Internal noise measurements were made during the transonic acceleration and during cruise at Mach 2.8.

c. Velocity Acceleration and Altitude (VGH) Recorder:

Good VGH records were obtained in both the XB-70A and the TB-58 chase aircraft for this flight. There was, however, no appreciable turbulence for comparison of the response of the two aircraft.

d. Sonic Boom:

Some boom overpressure measurements were made at the Federal Aviation Agency (FAA) Vortac Station near Coaldale, Nevada as the XB-70A passed nearly overhead at Mach 1.2 and 32,000 feet (27,000 feet above the station). The pressure traces showed definite near field effects and recorded an average maximum overpressure of 2.8 psf.

VI. OBSERVATIONS AND COMMENTS BY THE COPILOT:

1. Introduction:

a. The flight was scheduled for 0700 hours takeoff. The primary purpose of the flight was to heat soak the airplane for approximately 20 minutes during flight at 2.80 Mach; disengage flight augmentation control system (FACS) at 2.60, 2.70 and 2.80 Mach; obtain airspeed check with B-58; and evaluate the wheel brake changes.

b. The airplane was airborne at 0706 and landed one hour and forty-three minutes later. The flight went extremely well and all test objectives were accomplished even though a fuel leak from tank No. 6 caused a requirement to leave the landing gear extended until all fuel in tank No. 6 was depleted.

2. Preflight and Flight Preparation:

I arrived at the airplane around 0345 and everything appeared to be progressing normally. After a walk around inspection, I attended an engineering and maintenance status briefing. The airplane status was the same as briefed the day before. At approximately 0450, Mr. White and I entered the physiological van where we donned pressure suits. I was in the cockpit at 0530 with all connections fastened and my pressure suit checked out. Five minutes later Mr. White had completed his checkout also.

3. In the Cockpit Prior to Taxi:

The starting gross weight was approximately 539,000 pounds which included an indicated 263,500 pounds of fuel. Both inlets were set as planned to 2.43 Mach with the control wheels and then biased to 2.40 Mach with the standby switches. Engine starts began at 0609 and all engines were running normally at idle power by 0618 hours. The maximum exhaust gas temperature (EGT) encountered during 1st peak was 550 degrees. The only problems encountered were a slow acceleration from 35% to idle rpm on No. 1 engine and sticking primary hydraulic status indicators on engines No. 1 and 2. The No. 1 status indicator had been sticking during engine runs and this condition was expected. A small glycol leak was reported in the right wheel well, therefore, the gear doors were opened for an inspection. The ground crew determined that the leak was not excessive and the gear doors were closed again. Tank No. 1 was turned on to refill tank No. 3 and to reduce the nose gear load. Approximately three minutes elapsed before any transfer could be detected. No reason for the delayed fuel transfer was found since tank No. 3 was down to 28,400 pounds and should have accepted the fuel. The transfer was stopped with 34,400 pounds remaining in tank No. 1. All engines checked satisfactorily during military power

runs although No. 6 showed high engine vibrations until the throttle was rapidly retarded and advanced"(bodied)." The No. 6 engine vibration remained higher than any of the other engines throughout the flight but was within acceptable limits. The hydraulic systems were serviced to 160% prior to disconnecting hydraulic GPU's.

4. Taxi:

The airplane was taxied from the run station at 0648. During the taxi out, data was recorded when the airplane was stopped from approximately 25 knots speed with light to moderate braking with the selector in normal. Moderate chatter occurred below about 5 knots. During the westbound travel at around 20 knots speed on the main ramp area, the airplane seemed to get in frequency with the spacing of the concrete blocks and a continuous moderate frequency oscillation was felt in the cockpit. It was of no particular consequence although it was distracting. When the fuel level in tank No. 3 dropped to 24,000 pounds, tank No. 6 was turned to automatic and refilled tank No. 3. During the stop on the runway, brake data was again recorded. The brake chatter was mild. The ground crew observed the flight control movements and made a visual inspection of the airplane. A previously reported hydraulic leak in the right main gear strut that had been fixed prior to taxi out was checked O.K.

5. Takeoff and Initial Climb:

The indicated fuel quantity six minutes prior to brake release was 251,500 pounds. All fuel tank switches were set to automatic. The airplane compass heading indicated 45° instead of the correct 43° when lined up on the runway. The engines were set two at a time into afterburner and brake release occurred at 0706 hours. The brake release was relatively smooth and the throttles were advanced to maximum afterburner. All engines checked good and the acceleration appeared satisfactory. Thirty-five seconds were required to attain 150 knots speed. Rotation was initiated at 194 KIAS and lift-off occurred at 210 KIAS. This lift-off was about 4 knots lower than planned and the initial climb and acceleration rate was noticeably slow. After reaching about 225 KIAS, both the climb and acceleration rate seemed to increase considerably. During the initial climb out, the master caution flashed on momentarily several times but the reason could not be determined. After a satisfactory hydraulic check, the flaps were retracted and the climb continued at 260 KIAS with the landing gear still extended. Upon turning off the AUX COOL switch, the electronic equipment (EE) temperature increased to 80°. The AUX COOL switch was turned back on and it was found that the "coolant circ" switch had been inadvertently left off. It was turned on and the REFER switch recycled. AUX COOL was again turned off and the EE temperature was normal for the remainder of the flight. Four minutes

after takeoff, the No. 1 UHF transmitter failed. The receiver was still O.K. The No. 2 UHF was set to the primary frequency and the mission continued with excellent communications.

6. Climb and Accelerate:

With maximum afterburner power set and holding approximately 260 KIAS, there was light airframe buffet. The climb was continued to 20,000 feet where power was reduced slightly to hold the altitude until tank No. 6 was emptied. An airspeed check with the gear extended near 20,000 feet showed 268 KIAS on the XB-70 and 259 KIAS on the B-58. Within one minute after level off, tank No. 6 had stopped feeding with 3,500 pounds remaining and tank No. 4 had begun to transfer. The landing gear was retracted and locked up in 22 seconds. Maximum afterburner was reset and the wing tips set at 25°. As the airplane climbed at .95 Mach, the windshield ramp was raised to the "high speed" position. After reaching 32,000 feet, a level acceleration was begun and the airplane was supersonic at 0728. The bypass doors were set to 200 and the FACS turned on. The TACAN locked on Coaldale and the sonic boom measuring station at that location was flown over at an altitude of 32,000 feet while still accelerating near 1.3 Mach. I flew the airplane for about six or seven minutes during this period and noted that with the nose ramp up, it is very easy to let a wing drop when occupied with other cockpit duties. Constant attention to the attitude indicator is required since there is no outside horizon reference except on the side the pilot is seated. The bypass doors were set at 400 and the wing tips lowered to 65° near 1.4 Mach. The throats were set to automatic near 1.7 Mach. The throats controlled excellently throughout the flight and when the airplane was at 1.94 Mach, they were 1.92 left and 1.94 right. After reaching 575 KIAS, a constant indicated airspeed (IAS) climb was initiated to 50,000 feet and thereafter the indicated speed was gradually decreased to 525 KIAS at 66,000 feet. This was 2.8 Mach. The inlets were started near 2.1 Mach and at approximately 2.2 Mach, the shocks were fairly steady in the lower yellow at bypass settings of 550 left and 610 right. At 545 KIAS, 59,000 feet (approximately 2.4 Mach), the bypasses were opened slightly to move the shocks into the upper green prior to turning right just south of Rome, Oregon. The shock indicators became extremely sensitive throughout the green area and oscillated plus or minus one-fourth inch without any bypass door movement. The throttles were retarded slightly to hold 2.6 Mach in the turn and with a 20° right turn at 63,000 feet the bypass doors were 420 left and 450 right with shock positions in the mid to high green. The bobweight was set to "free" at 2.6 Mach and an airspeed check at the pilot's station showed 522 KIAS on the tape instruments versus 518 KIAS on the pneumatic instrument. During the turn between 60° and 150° heading, the glare from the sun caused both pilots considerable trouble. At one point, it was impossible for me to see the shock and throat indicators until I lowered my head

below the top of the instrument panel. The thought occurred to me at that time, "if we are going to have any emergency I hope it waits until I can see."

7. FACS Off Tests at 2.6, 2.7 and 2.8 Mach:

The bypass doors were opened slightly to move the shocks down to the lower green area prior to turning the FACS off. The shock position indicators became even more oscillatory and the bypass door opening caused a light airframe buffet. While still in the turn, all FACS were turned off at 2.6 Mach without any noticeable tendency for divergence from the flight path or attitude. When the FACS were turned on again, there was a small "thump" in the airframe as the augmentation reengaged. During the acceleration from 2.60 to 2.70 Mach, the master caution light flashed on several times for no apparent reason. At 2.70 Mach, while still turning slightly, the FACS were turned off and again the airplane stability appeared to be very good. The pilot made pitch, roll and yaw inputs to see if any type of oscillation would occur but the airplane showed no tendency for an oscillation to become excited. When the FACS were turned on, the airframe "thump" was felt again. The shocks were set at .6 SPR to accelerate to 2.80 Mach. The shocks cannot be set exactly at .6 SPR because of the needle oscillation but they can be averaged reasonably well. The bypass door settings were 360 left and 375 right at approximately 2.75 Mach. The throats continued to control extremely well in automatic and showed 2.78 left and 2.75 right with 2.79 airplane Mach. After reaching 2.80 Mach, the shocks were reduced to lower green and the FACS turned off. Stability on all three axes appeared good. When the FACS were turned on again, the airframe "thump" did not occur and the data should be checked to ascertain that the FACS did actually disengage when the switch was turned off.

8. 2.8 Mach Heat Soak and Duct Performance:

At 0758 the airplane reached 2.80 Mach while southbound over Bonneville, Utah at 66,000 feet. The total temperature was 506°F. The shocks were moved from .6 SPR to top of green for duct performance data. The shock indicators stabilized on the line between green and yellow and at 2.82 Mach, the bypass doors were 310 left and 320 right (C/N 3720). The highest speed of the flight occurred here when we went momentarily to 2.83 Mach. Total temperature indicated 514°F. The shocks were lowered to .6 SPR and the bypass doors were at 340 left and 360 right (C/N 3758). The shocks were then lowered to where they oscillated plus or minus one-fourth inch around the lower green area. With an airplane Mach of 2.80, the throats were 2.81 left and 2.77 right and the bypass doors were 390 left and 390 right (C/N 3791). At this time, the airplane had been at 2.80 Mach for 4 minutes and was 140 miles north of Morman Mesa, Utah with 72,000 pounds of fuel remaining. The throttle angle was around 95°. When the bypass doors were

opened to set the shocks at the crosshatch position, the throttles were advanced to maximum afterburner to hold the speed. The flight plan called for setting the shocks to the crosshatch position and then opening the bypass doors 100 square inches more; however, light to moderate airframe buffet occurred with the shocks set in the crosshatch position. It was decided not to open the bypass doors any further. They were at 470 left and 470 right. The duct performance switch was moved from NORMAL to LOW (C/N 3873) and the throats went to 2.68 left and 2.62 right. The shock positions moved up to the lower green when the throats were changed to LOW. The duct performance switch was reset to NORMAL and the shocks reset to .6 SPR for 2.80 Mach cruise. The throttles had to be retarded after NORMAL was reselected. A stabilized point was obtained (C/N 4095) at 2.80 Mach with throats 2.80 left and 2.76 right and the bypass doors 340 left and 350 right. Total fuel was 63,000 pounds and the throttle angle was 95°. The bypass doors had not been moved for about two minutes prior to that time. Once the airplane is fairly well stabilized, the bypass doors require very little copilot manipulation. While still holding 2.80 Mach, the bypass doors were moved into the lower green area in preparation for a right turn. The turn was started 89 miles north of Needles and with an 18° bank angle, the speed and altitude were steady with 100° throttle angle and bypasses 390 left and 380 right. I flew for two minutes at 2.80 Mach and the airplane appeared very stable. It was, however, easy to gain or lose a few hundred feet of altitude. The airplane did not seem to be over sensitive either laterally or directionally. The mission objective of 20 minutes at 2.80 Mach was attained at 0758 with 44,500 pounds of fuel remaining.

9. Deceleration and Descent:

All throttles were retarded to military power for deceleration after the shocks' positions were set in the crosshatch area. The bobweight was locked below 2.60 Mach. The bypass doors were set at 930 left and 880 right to position the shocks in the green at 2.10 Mach prior to unstarting the inlets. The inlets unstarted around 2.0 Mach without any noticeable change in flight characteristics or noise level. All throttles were retarded to 40° at 2.0 Mach. I began flying the airplane around 1.50 Mach and flew the remainder of the flight, including the landing. The bypass doors were closed to 400 at around 1.4 Mach but the wing tips remained at 65° until 1.28 Mach in an attempt to allow the photo chase airplane a chance to obtain photos. I did not detect any significant change in flight characteristics when the wing tips were moved from 65° to 25°. As the airplane became subsonic, the bypass doors were closed and 1, 3, 4 and 6 throttles retarded to idle. FACS was turned off for the remainder of the flight. Below 20,000 feet, the windshield ramp was raised causing the noise level to increase. When the wing tips were raised to UP at approximately 325 KIAS, there was a very noticeable increase in roll power and

lateral sensitivity. The slight overcontrolling tendency was overcome within a few seconds.

10. Approach and Landing:

The speed was reduced below 200 KIAS and the landing gear extended at around 12,000 feet. It locked down in approximately 30 econds and the U quantity dropped to 78%. All other hydraulic s quantities and pressures were satisfactory. The flaps were then ex-tended. The tower reported wind was 210 at 6 knots with 04 the active runway. The total fuel was 27,000 pounds with 17,700 pounds in tank No. 3. Best flare speed was computed as 194 knots IAS. The airplane was turned in on final approach about four or five miles out at approx-imately 3,000 feet above the ground. The air was smooth and it was very easy to establish the desired final approach speed of 210 KIAS. The landing camera was turned on at approximately 200 feet. Speed was gradually reduced to 194 KIAS over the end of the runway and a smooth touchdown occurred at 180 KIAS. Both lateral and pitch control were positive during the flare and no overcontrolling tendency was encountered. After touchdown, the nose was lowered and the drag chute deployed. Both chutes inflated normally. Light braking was first initiated at approximately 130 knots but the helicopter immediately called out, "heavy smoke from the left brake." The brake application was discontinued and the smoke stopped. Each time the brakes were applied, the smoke could be seen. The chute was jettisoned around 50 knots and the airplane was stopped with very little braking.

11. After Landing:

After clearing the runway, data was taken with the engines at both idle and military power. During taxi in, brake checks using aft brakes only were accomplished with AUTO and MANUAL selections. Brake chatter occurred on all stops and the brakes would lock almost every time the brakes were applied. After taxiing to the run station, all engines were shutdown at 0906 with 10,300 pounds of fuel remaining in tank No. 3.

12. Systems:

a. Environmental:

The system worked extremely well. The cabin temperature selector was set in automatic at about the 11 o'clock position shortly after engine start and left at that position until 1.4 Mach where it was set on position 2, as called for on the check list. The cabin was comfortable throughout the flight and when both pilots raised their visors at around 20,000 feet prior to landing, the cabin was still comfortable. No further adjustments were made after setting position 2.

The copilot's vent flow appeared to be low prior to takeoff. This is the second flight that this problem has been encountered. The EE temperature was 45° to 50° during most of the flight. The only time it went higher was when the coolout circulation switch was inadvertently left off prior to takeoff. It had gone up to 80° when AUX COOL was turned off but came down rapidly when all switches were properly set.

b. Fuel:

The fuel system was set in automatic prior to takeoff and operated perfectly. The unusable fuel in tank No. 6 (3,700 pounds) and tank No. 7 (3,800 pounds) is excessive. All other tanks fed out very well. The No. 1 fuel tank was slow to transfer when turned on after engine start.

c. Hydraulic:

All quantities remained steady throughout the flight until the landing gear was extended when U_1 dropped to 78%. The P_2 pressure gage had an oscillation between 4,000 and 5,400 pounds that appeared to be an electrical short.

d. Expendables:

The water, ammonia, LN_2 and liquid oxygen consumption was satisfactory. There was 1,000 pounds of water remaining even though only 2,000 pounds were serviced prior to flight.

13. Maintenance Discrepancies:

a. A fuel leak in the right gear well from tank No. 6 was leaking excessively.

b. The UHF No. 1 transmitter failed shortly after takeoff.

c. The copilot's radio and interphone jackbox is tied into the pilot's headset.

d. The primary hydraulic status indicator for No. 1 engine was sticking and unreliable.

e. The primary hydraulic status indicator for No. 2 engine was sticking just after engine start.

f. A small glycol leak developed in the right wheel well prior to taxi out but was determined to be acceptable for flight.

g. The No. 1 fuel tank did not begin transferring until three minutes after the switch was turned on prior to taxi out.

h. The No. 6 engine vibrations were high until the engine was "bodied."

i. The master caution flashed on two times during the flight for no observable reason.

j. The left brake appeared to be grabbing when applied during landing roll.

k. The primary No. 2 hydraulic system gage oscillated between 4,000 and 5,400 pounds and appeared to be an electrical short in the gage.

l. The flaps would not retract after landing.

VII. CONCLUSIONS:

1. This was an extremely successful flight. Twenty minutes of sustained 2.80 Mach flight was accomplished. The maximum speed and altitude attained were 2.83 Mach and 67,000 feet. Maximum observed total temperature was 514°F.

2. Acceleration to 2.83 Mach and 67,000 feet with about 20 minutes of flight above 2.8 Mach indicated ample power to reach Mach 3 flight.

3. Extensive honeycomb structural damage, mainly within fuel tanks No. 1 and 2, was found following this flight. Internal tank damage was not discovered until fuel leaks occurred when refueling for Flight 1-16.

4. Systems which gave overall satisfactory performance were:

Engines	Wing Fold	TACAN
Fuel	Nose Ramp	IFF
Electrical	Drag Chute	Fire Detector
Hydraulic	Nose Wheel Steering	Flight Instruments
Environmental	Landing Gear	Oxygen
Flight Controls	AICS	Instrumentation

5. Fuel leaks in the right wheel well caused revision of flight plan by increasing gear extended flight time.

6. Controlling the shock positions this flight was less effort than on previous flights. The shock position indicators are still too sensitive in the green area and must be averaged rather than setting an exact value. After the 2.80 Mach cruise was established, there were periods of several minutes when no movement of the bypass doors was necessary.

7. The automatic inlet control worked very well although there was approximately .02 to .03 Mach difference between the left and right throat indications.

8. Opening the bypass doors to position the shocks to the crosshatch position caused light airframe buffet. Further opening of the bypass doors caused increased buffet.

9. Flight characteristics were very good and airplane response during approach and landing was satisfactory.

10. When the nose ramp is up, constant reference to the flight instruments is required to prevent an inadvertent bank.

11. Glare on the pressure suit helmet face place is completely unacceptable when flying into the sun.

12. The flaps failed to retract after landing.

13. Brake chatter is still objectionable.

VIII. RECOMMENDATIONS:

1. Expand the structural investigations which were completed prior to Flight 1-15 to include all failures through Flight 1-15. Determine from this investigation the possible need to modify the present aerodynamic and/or thermal restrictions on air vehicle No. 1

2. Establish "go - no go" fuel leak criteria.

3. Repair and/or redesign the flap control valve system to preclude flap retract failures.

4. Improve the shock position indicating system to allow more precise shock positioning.

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