File 8 MGA

(Gp-4) TEST REPORT

XB-70A

FLIGHT 1-9

(No. 1 Air Vehicle, No. 9 Flight)

2 April 1965

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XB-70 JOINT TEST FORCE (FTTB)

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I. SUMMARY:

1. The ninth flight (Flight 1-9) of XB-70, No. $62\text{-}001_1$, with Mr. Al White, North American Aviation, Inc (NAA), Pilot and Colonel Joseph F. Cotton, Air Force Flight Test Center (AFFTC), Copilot, was completed on 2 Apr 65. Takeoff from Edwards AFB runway 22 was at 1116 hours PST, and landing on Edwards runway 04 occurred at 1210 hours PST. The takeoff gross weight of 505,000 pounds was the heaviest to date. Total flight time, which was cut short by failure of the Utility No. 1 (U_1) hydraulic system, was fifty-four minutes. Twenty minutes of the flight were in actual weather. Supersonic speeds were not achieved due to the U_1 failure. The emergency landing was at 419,800 pounds.

2. The preflight inspection and engine starts were com-pleted without difficulty and the taxi to runway 22 was accomplished with the now familiar and expected moderate to heavy airframe vibra-tions resulting from brake chatter.

3. During the maximum afterburner takeoff and near refusal speed, rpm and exhaust gas temperature (EGT) "cave in" on engines No. 3 and No. 5 were noted. As it was too late to abort, the takeoff was continued with these engine rpm's near 96% and with No. 3 EGT at 760° and No. 5 at 800°. This condition continued during the initial climb. When power was reduced to military, all engines appeared normal and a decision was made to continue flight in accordance with an alternate, subsonic, lower altitude test plan.

4. After approximately thirty minutes of flight and just after fuel tank 6 became empty, the U_1 hydraulic system status lights indicated system failure. Altitude at this time was 34,000 feet. A let down and turn to base was immediately initiated and the gear was extended with the electrical emergency system. Cross system hydraulic fluid transfer (from U_2 to U_1), (as noted during previous U_1 failures) was again very evident. U_2 fluid level dropped to 0 prior to the landing.

5. A straight in approach to the very heavy weight landing was accomplished and heavy braking was used to bring the aircraft to a safe stop. Only two of the three drag chutes deployed satisfactorily.

II. TEST LOG:

0815	External and EE bay inspection started by pilots.
0900	Pressure suit donning started.
0930	Copilot in seat.
0938	Copilot pressure suit checkout complete.
0940	AICS package power switch turned on.
1017	Started No. 3 engine - 510° EGT EDV and 2 green hyd O.K.
1018	Started No. 1 engine - 440° EGT EDV and 2 green hyd O.K.
1019	Started No. 2 engine - 480° EGT EDV and 2 green hyd O.K.
1020	Started No. 4 engine - 510° EGT EDV O.K.
1021	Started No. 6 engine - 470° EGT EDV 33% and 2 green O.K.
1022	Started No. 5 engine - 510° EGT EDV 34% and 2 green O.K.
1024	All engines at idle
	No. 4 generator on - checks normal.
1026	Start hydraulic service.
1032	End hydraulic service.
1033	Bleed air check.
1037	Control cycles - data off at completion (C/N 138).
1041	Engine No. 1 idle to mil (Data 385)
	Engine No. 2 idle to mil (Data 418).
1042	Engine No. 3 idle to mil (Data 448).
1042:30	Engine No. 4 idle to mil (Data 478).
	Slow cutting back on temp (to 780°).
1043	Tank No. 6 auto - No. 3 tank 26,000 pounds (Data 503)
	Engine No. 5 idle to mil (Eng Vib. 40% to 50%) (Data 530).
1044	Engine No. 6 idle to mil (Data 572).
1044:20	Engine No. 5 mil run again -
	at 85% ADS Vib 35% Eng Vib 12%
	at mil ADS Vib 40% Eng Vib 30% - 40% - 520 EGT.
1045:25	All engines to mil (Data 666) No vib problems.
1046	Fuel tank SW to Auto.
1048	Close cabin door.
1049	Open door to get tool box and close - Fans on - EE Temp 61° and holding.
1051	Clearance to taxi to runway 22 - wind 220° at 10 knots with gusts to 18 knots - altimeter setting 29.85.
1051:10	Engage steering.
1051:30	Radios on.
1052	Bypass door check.
1055:30	Taxi out (Data 1224), fuel totalizer 234,000 pounds ATC cleared 2000I as filed - IFF squawk Mode 3 - Code 05.
1101	Stop at hot gun line to inspect tires after chatter (some skidding and smoke) - Takeoff performance predictions were: Refusal - 165 KIAS - Rotation - 190 KIAS - Takeoff - 210 KIAS.

Test Log (Cont'd)

1103	Fuel	T	(232.0)	4	(37.3)	7R	(10.5)
		1	(25.2)	6L	(32.3)	8L	(9.5)
		2	(29.9)	6R	(36.8)	8R	(9.4)
		3	(33.5)	7L	(10.6)		

1109	Stop on runway 22 with brake chatter (Reset inst counter).
1110	Heading 224° in aircraft (Data 074) (Takeoff to the west) Wind 230° at 14 knots (Gusts to 18).
1113:15	Two minute warning.
1114:30	Up on power (Data 351) 85% (lite 3, 4; 2, 5; and 1, 6).
1115:20	Brake release (maximum afterburner).
1116:45	Master caution light Pull No. 3 back (No. 3 under temp at 760°) No. 5 started to unwind (96° and 800°).
1118	Out of afterburner. U_1 - 180, P_2 - 200, No. 3 now 875°, No. 5 now 870°, nozzles 40° (all engines in military).
1119	Start to put gear up.
1119:25	Gear up and gear door closed.
1120	Flaps up.
1120:20	No. 5 engine Hi Vib (55% to 60%).
1121	Advance No. 3 (Data 725) Heavy roll back to 90% then to 96% - Temp 770°.
1121:40	Getting funny noise in aircraft at 380 knots at 7,000 feet (Slowed down and noise gone).
1122:40	Data off.
1123	Engine No. 5 to idle - up slowly (Data on 880) - Stop 85%, then mil (ADS 40%, Engine 30%).
1124	(Data on 919) Light afterburner - roll back to 95% - then up to 97% - 98% - temp was down to 750° at maximum afterburner.
1125	Data off.
1126	Go ahead with alternate card - leave engines No. 3 and No. 5 at mil (No. 3 and No. 5 O.K. when out of afterburner) - climbing to 25,000 feet.
1131	Entered cloud at approximately 15,000 feet.
1132:15	20,000 feet and climbing - getting wing tip buffet.
1133:10	Light afterburners, Engines No. 1 and No. 6. (90° T/A Data on 1470).
1134	Data 1504 to maximum afterburner No. 1 and No. 6 (EGT and nozzles look good) (Air vehicle in climb at 347 KIAS).
1134:30	Hydraulics good.

Test Log (Cont'd)

1135	Tank 6L (10.7) 6R (11.3) T (187.5) 345 knots - 24,500 feet - .82 Mach.
1136	Out of clouds at 28,400 feet (Data 1638). No. 2 EGT 840° - 855° - Oscillation, nozzle oscillation 1°.
1137	(Data 1712) 74° T/A Engines No. 1 and No. 6 (Some clouds still - continuing to 35,000 feet).
1137:30	354 KIAS - 27,800 feet - .89 Mach (Data 1740).
1140:45	U_2 - 175, U_1 - 200+, P_1 - 200, P_2 - 185 (445 gross weight).
1141	(Data on 1936) Light No. 4 - Off 1965 No. 2 EGT - Slow oscillation 835° - 870°.
1141:30	31,000 feet - .875 Mach - aircraft buffet - 180,000 pounds fuel - 20° right bank 6L (4.7) - 6R (4.1) - Cabin 6,500 - EE 48 (2018 C/N).
1143:30	NH_3 490 - water 4,500 - No. 5 ADS 45% - 50% Vib Three engines at maximum afterburner and three engines in mil (Air vehicle just creeping up). Total fuel 172.0.
1144	Lost U_1 hydraulics Slow down (Verify Tank 6 pumps off) No. 1, 2 and 3 engine status lights amber Alt 33,000 feet U_2 135% Eng No. 4, No. 5 and No. 6 to 90%.
1146	At .8 Mach - B-58 at .76 (30,000 feet) Cockpit buzz in the cockpit at .86.
1146	Emergency elect SW down (270 to 280 knots).
1146:30	Gear coming down slow but down O.K. 3 Green - Red in handle (Data 2280).
1147:30	U_2 50% and holding.
1149	U_2 42% and holding.
1151:30	U_2 32% Tank No. 4 32.3.
1153	Power up a little and U_2 quantity up a little.
1154	Copilot out of seat to select gear doors open.
1154:30	U_2 50% (Data 2834).
1155	Total fuel 159.0 (Door switch to door open).
1156	Set gear electrical emerg SW to normal (counter 2834) (10,800 feet) U_2 34% and holding (Left hand gear doors oscillating - no pressure).

Test Log (Cont'd)

1157:45	Flaps to down Select gear electrical emergency SW to down (Got flap pressure light).					
1159	U_2 quant now 0° Got gear warning horn But 3 green lights for gear.					
1202	Total fuel (151.0)					
	4	(20.8)	6L	(2.02 and off)	8L	(8.9)
	3	(30.4)	6R	(1.6)	8R	(9.0)
	2	(28.8)	7L	(10.2)		
	1	(25.4)	7R	(10.3)		
1206	U_2 pressure O.K.					
1209	TD, chute out at 190 - 2 chutes.					
1210	Shut down engines No. 1 and No. 6 (Data off).					
1211:30	Stop at hot gun line (Brake chatter on right hand side) (Flap pressure light still on).					

III. DATA:

1. Fuel Data:

Time	1016	1043	1046	1103	1115	1131	1142	1159	1202
Event	Prior to Start	All Engines Running	All Engines Running	End of Runway	Brake Release	In Climb		Gear Down Return to Base	Down Wind
Transfer Condition	None	Tank 6 to Auto	6 Auto	6 Auto	6 Auto	6 Auto	Tank 6 Off		
Tank*									
1	24.8		25.1	25.2					25.4
2	29.9		29.8	29.9					28.8
3	33.5	26,000	33.5	33.5					30.4
4	37.3		37.3	37.3					20.8
6L	38.2		35.3	32.3		10.7	4.7		2.02
6R	38.3		34.9	31.8		11.3	4.1		1.6
7L	10.5		10.4	10.6					10.2
7R	10.5		10.5	10.5					10.3
8L	9.2		9.2	9.2					8.9
8R	9.2		9.2	9.4					9.0
Total	243.5		238.0	232.0	227.0	187.5	180.0	159.0	151.0

* Fuel quantity times 1,000

2. 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.
1035	162	190	160	190	160	185	158	185
1106	145		140		150		140	
1118			200		180			
1141	200		185		200+		175	
1144			LOST U_1	PRESSURE				
1144							135	
1147:30							50	
1149							42	
1151:30							32	
1154:30							50	
1156							34	
1159							0	
1209	LAND							

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

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

IV. ENGINEERING COMMENTS:

1. Utility No. 1 Hydraulic Line Failure:

a. Approximately 30 minutes after takeoff and while engine problems were being investigated (subsonic at 33,000 foot altitude), the pilot reported the loss of Utility No. 1 system and that all Utility No. 1 status indicators were amber. During post flight inspection a line failure was found in the lower right hand No. 6 tank at the Utility No. 1 fuel pump/motor hydraulic manifold. The line was almost completely separated adjacent to the manifold brazed fitting.

b. A fix is in progress which adds metal flexible hydraulic lines and additional pump/motor support using the hydraulic motor manifold as the attaching point. This fix is being made to all four pumps in lower left and right tank No. 6.

2. Cross System Leakage:

a. After losing Utility No. 1 (U_1) hydraulic system pressure the landing gear was extended as soon as the aircraft was below gear limit speed. As has occurred on previous flights where utility system pressure was lost and on ground tests, cross system leakage was evident. From the time of the failure until the aircraft was shut down on the taxiway 28 minutes later, approximately seven gallons of hydraulic fluid was lost from the Utility No. 2 (U_2) system in lowering the gear and subsequent cross system leakage (emergency gear lowering should require less than two gallons). The aircraft had approximately four and one-half gallons usable remaining after shutdown which is almost two gallons below the 0% reading in the cockpit. In an attempt to reduce the hydraulic fluid transfer, the landing gear system was depressurized by placing the electrical emergency lowering switch to "normal" with the landing gear handle in the down position. The door open switch had been put in the open position to prevent gear doors closing on any residual U_1 system pressure which would cause an additional loss of fluid from U_2 system. The left gear door began to oscillate with the system depressurized and the electrical emergency switch was again placed "down" to pressurize the system so that the door would not be damaged. It is not evident that this procedure will prevent transfer because of the limited time the system was depressurized.

b. This hydraulic quantity data presumes that the cockpit hydraulic quantity indications are correct. The indicating system is suspected of causing some of the inconsistent readings which are possibly due to foaming in the reservoir or corrections resulting from the temperature compensation to the indicating system. The pilot reported one instance of reservoir level increasing with increasing engine rpm and there was one other instance of level change which might be contributed to an engine rpm change when the aircraft was

being slowed to lower the gear after the U_1 line failure. The most apparent reason for reservoir level change with engine rpm is a change in return fluid temperature to the reservoir. This could cause the indicating system to be corrected to a "false" system average temperature thus over-compensating.

c. At the time the U_1 system failed, the aircraft was subsonic at 33,000 feet approximately 97 nautical miles straight line distance from Edwards AFB or about 32 nautical miles east of Owens Lake. Immediately after the failure, the heading was changed about 110° to return to Edwards and the aircraft was slowed down to lower the gear in accordance with emergency procedures. The aircraft was still 24 miles and 10 minutes out when the U_2 cockpit indicator showed 0 quantity. Even though there is considerable reserve below the 0 indication, the pilots have no further indication of impending failure making any flight operations beyond this point untenable.

d. On Flight 1-6 the aircraft was stopped on the lake bed 32 minutes after the failure in U_1 system. The failure occurred when the aircraft was subsonic at 35,000 feet and about 10 nautical miles northwest of Beatty or 133 nautical miles straight line distance from Edwards. A straight-in approach was made to the lake bed and because of the lake bed landing, loss of the U_2 system would not have been critical. U_2 quantity indicated 0 at touchdown.

e. These two emergency landings indicated that with the present systems, we should not expect to land at distances greater than 100 - 150 nautical miles from where a utility hydraulic system failure has occurred, i.e., there should always be an emergency landing site within 100 - 150 mile radius of the flight path if brakes, steering, and drag chute are necessary to recover the aircraft. This is obviously not acceptable and action is needed to improve hydraulic line reliability, reduce or eliminate cross system leakage under failed conditions, and increase the range and accuracy of the hydraulic quantity indicating systems.

3. <u>Propulsion:</u>

Engines No. 2 (S/N 170-567), No. 3 (S/N 170-555), and No. 5 (S/N 170-552) malfunctioned during the flight. The various problem areas, analysis of the problem and corrective action are as follows:

a. Engine No. 2 had a nozzle area control (NAC) and exhaust gas temperature (EGT) oscillation in flight. The average nozzle area oscillated through approximately 1.5% while the EGT oscillated through approximately 15° C. Peak EGT oscillation was approximately 35°C. After the flight the engine was removed from the air vehicle and run in the General Electric (G.E.) test cell. During the test the NAC-EGT in-flight oscillation characteristics were duplicated. The

temperature amplifier and the T_5 reset were checked and found to be operating properly. When the NAC position was held constant the EGT remained constant. Engine No. 2 (567) will be replaced in the air vehicle by engine No. 170-562. G.E. will continue the NAC investigation.

b. Engines No. 3 (S/N 170-555) and No. 5 (S/N 170-552) experienced severe speed cave in (abnormal rpm roll back) while selecting afterburner. At military power the engines operated normally but as afterburner was selected the engine speed would drive down 4 to 10 percent. The same type speed cave in was experienced on Flights 1-7 and 1-8. Engine No. 5 also indicated high vibration (55 to 60 percent on the engine and 45 to 50 percent on the auxiliary drive subsystem (ADS) in-flight. A post flight engine run was made with engine No. 5 in the air vehicle. A slight speed cave in (1 to 2 percent) occurred. No high vibration characteristics were observed. Engine No. 3 could not be run because of the in-flight failure of a hydraulic line on the U_1 system. The engines were removed from the air vehicle for G.E. test cell runs. Intermittent speed cave in was obtained on engine No. 5. Cavitating the main fuel pump and dumping the Pc servo fuel pressure caused the most consistent cave in. No high vibration characteristics were observed during the cell run. The speed cave in problem ceased after the fuel line to the servo filter screen was disconnected in order to inspect the fuel servo filter. Disconnecting the fuel line drains the main fuel control (MFC) case, thereby releasing any pressure that may have been built up. The MFC has been removed from the engine and sent to Woodward for further investigation. Engine No. 170-582, which is an air vehicle No. 2 engine, was run in the cell. A partially clogged servo fuel pressure filter was simulated by boring a one-eighth inch hole in the filter. Cave in similar to that during flight occurred. Varying Pc bleed flow caused the amount of speed cave in to vary as minimum afterburner was selected. After engine No. 170-582 was removed from the cell the No. 3 engine (S/N 170-555) was run. The engine cave in symptoms were the same as those experienced initially with engine No. 5. The servo fuel filter was removed, inspected and found to be dirty. A clean filter was installed and the cave in problem disappeared. The fuel pump was cavitated and the problem occurred again. Inspection of the filter revealed that it was from 50 to 75 percent clogged. The material which clogged the filter is a glass fiber. It is suspected that the material which contaminated the filter came from the main fuel filter or the fuel pump and that the pump cavitation caused it to dislodge. A post flight inspection of engine No. 3 revealed foreign object damage (FOD) on the first four stages of the compressor. The most serious damage consisted of a one-eighth inch nick in the leading edge of a first stage blade and a nick of undetermined depth in the leading edge of a fourth stage blade. The nick in the first stage blade was benched out prior to the test cell run. Damage to the second and third stages consists of minor scratches. After the engine is removed from the test cell, the upper half of the

stator case will be removed and a more detailed inspection will be made. Engine S/N 170-555 will be replaced in the air vehicle by engine S/N 170-563.

4. Heavy Weight Landing:

This landing exceeded by far any previous use of the landing gear brake system while installed in the aircraft and probably approached the energy absorption levels of an aborted takeoff. After initial touchdown ballooning was experienced and, as a result, the landing was fairly long; but touchdown loads were apparently very low as evidenced by the distance the rear main wheels rolled before the forward mains touched down. Deceleration data indicated that the pilot did not use maximum braking through much of the ground roll. Landing conditions were:

a. Landing gross weight 419,800 pounds.

b. Initial touchdown was at 2,754 feet from the west end of the runway; and after ballooning, the main gear stabilized on the ground at 3,939 feet.

c. Touchdown ground speed was at 211 KIAS with a slight tail wind (240°/5-6 knots) after the initial ballooning.

d. The pilot chute first appeared five seconds after the main gear was on the ground and the main chutes were fully deployed (2 chutes only) at 6,489 feet one-half second after the nose wheels were on the ground.

e. The aircraft was turned off the east end of runway (14,734 feet) on to taxiway 1 at about 7 knots.

f. Low speed brake chatter inspection of the brakes after the landing indicated that they were still serviceable and with the exception of the right hand forward brake assembly, they were all re-installed. The right hand forward brake got the hottest and appeared to take the greatest braking energy. There was some transfer of brake material to the brake discs; however, it appears that they could be cleaned up and re-used. Representative discs and plates were returned to B. F. Goodrich for evaluation. This inspection is also being made because of concern about water splashed on to the hot brake when the fire department sprayed under it and around the wheels for cooling after the landing. This may have been the cause of the welding of brake material to the discs. There were no tire failures from the landing, and tires did not appear to be hot. Tires are rejected for wear when through the fourth ply. Tires 9 and 10 were worn through 9 plies each and were the worst; however, they were worn through 3 plies each prior to the takeoff. Main gear tires 3, 7 and 8 were

new prior to flight and were through 1 to 2 plies after landing. It should be noted that there is a greater amount of rubber with the two outer plies and rate of wear through plies increases beyond this point.

5. Master Caution Light:

Initiation of the master caution light during the flight was caused by faulty COOK 1 AMP. relays in the master caution circuit. After the flight, ten of these relays were removed and checked. Seven of the removed relays did not pass test requirements.

6. Flap Pressure Light:

When the flaps were lowered, the flap pressure caution light came on. A specific open wire was identified in the flap pressure light circuitry after flight, but this open circuit did not cause the malfunction. Contamination in the flight control primary 1 hydraulic system is the most probable cause of this malfunction. Flap operation was satisfactory.

7. Instrumentation:

Data processing and subsequent print out of digital instrumentation data was hampered by erroneous timing and digital word bits. A portion of this data had to be processed manually in order to identify and remove the erroneous bits and provide factual parameter data. Data loss occurred from irregularities in 17 parameters caused by calibration difficulties or instrumentation malfunctions.

8. NASA Tests and Instrumentation Operation:

a. Airborne Instrumentation:

The internal noise microphone system was never turned on. All other instrumentation functioned well and provided good data. The landing gear camera pictures were somewhat dark, but usable.

b. Sonic Boom:

Due to the problems encountered during the flight, supersonic speed was not achieved.

c. Runway Noise:

No attempt was made to record takeoff or landing noise data for this flight.

V. OBSERVATIONS AND COMMENTS BY THE COPILOT:

1. Preflight, Engine Start and Taxi:

a. External and electronic equipment bay inspections were initiated at 0815. Preflight activities by the maintenance crew made a complete and final inspection impossible. The remaining check list items were finally checked by maintenance crewmen under the direction of Max Wells from Mobilcom after Mr. White (A1) and I were in the cockpit. This arrangement is necessary because of the lead time required to get suited up.

b. I donned my full pressure suit and was in the seat at 0930. Eight minutes were required to hook up and pressure check the suit. The air induction control system (AICS) package power switch was turned on at 0940. Engine starts, using the manual tech-nique, were initiated at 1017 and were completed in seven minutes. Engine starting peak exhaust gas temperatures (EGT's) ranged between 440°C and 510°C. The hydraulic status indicators functioned properly. Hydraulic systems service required six minutes. Service levels were 160% with head pressure of 185 to 190 psi. Bleed air check was initiated at 1033 and control cycles were observed by telemetry at 1037. All fuel pumps were left off until 1043 when tank 6 was turned to AUTO with tank 3 quantity of 26,000 pounds.

c. Winds from 220° at 10 to 18 knots required a takeoff on runway 22. Taxi was initiated at 1055 with a fuel totalizer of 234,000 pounds. Cockpit pitch oscillations varied from the light to amusing variety but I didn't think the brake chatter was as great as I'd experienced on previous flights. Airplane vibrations resulting from brake application, were still moderate to heavy and undesirable when bringing the airplane to a stop. Hydraulic fluid levels were 140% to 150% prior to line up. External and pre-takeoff checks were completed and line up on the runway was made at 1109. The aircraft heading was 224°. Chase No. 1 (Lt Colonel Fulton and Mr. Shepard in TB-58 #662) reported the first layer of clouds at 4,500 feet; tops had been reported at 24,000 feet, wind was 230° at 14 knots. Discrepancies noted prior to takeoff were:

(1) With right bypass door wheel closed, the bypass area counter wanders from a maximum of 320 to a minimum of 80 square inches.

(2) Left bypass door caution light comes on with area counter zero and control wheel positioned to the closed position.

(3) No. 5 engine vibration needle oscillated from 40% to 50% and caused frequent blinking of the vibration caution light.

(4) Altitude indications were not correct in the digital window with the pilot selection and both toggles in readout.

2. Takeoff and Climb:

a. Approximately two minutes prior to brake release, the throttles were all advanced to 85% rpm. I positioned the crew air shutoff "T" handle one-fourth to one-half inch down from the full up position. Al went into afterburner, two engines at a time, starting with No. 3 and No. 4, followed by No. 2 and No. 5, and finally No. 1 and No. 6. During light "off" I observed and reported rpm rollback on No. 3 to 94% and No. 5 to 93%. They recovered while No. 1 and No. 6 were lighted and all engines looked good at the 70° throttle angle. With "interval short" data was turned on at counter number (C/N) 351. The fuel totalizer was 227,000 pounds.

b. The brake release at 1115 was absent of the chatter and yaw I last observed on Flight No. 5. The throttles were advanced slowly to maximum afterburner. During the power increase I reported nozzles and EGT looking good and was satisfied with power at maximum afterburner. With my attention on the engine instruments during power advance, and searching for the cause of the master caution light coming on during the initial roll, I failed to turn the REFER on after the power advance. The takeoff and initial climb were accomplished on AUX COOL. Near refusal speed I rechecked the engine instruments and first saw No. 3 near 96% rpm, 760° EGT and 90% nozzle. At first the low EGT was not apparent since the needle wasn't too far below the lower of the two EGT red lines. With time, since the flight, to study the effect of two red lines I am now in favor of making a color or marking change or eliminating the lower one. No. 5 engine rpm was also near 96% and 800° EGT. I could hardly believe my eyes since they had looked good after light "off" and during the initial roll. I realized it was too late to call abort and only hoped this wouldn't become a habit and spread to other engines. To say the least, it was an uncomfortable feeling. With my attention on these more important things I failed to observe the lift-off speed. The master caution light continued to blink for no apparent reason.

c. During the initial climb No. 3 and No. 5 remained low in rpm and EGT, and with Al's O.K. I pulled No. 3 out of afterburner where it looked O.K. With sufficient speed (near 250 KIAS) we reduced all engines to military power where they all appeared normal; hydraulic fluid level on U_1 was 180% and P_2 200%. All nozzles were near 40% and No. 3 and No. 5 EGT's were 875° and 870° respectively. The gear and flaps were retracted and we remained below cloud just north of base to trouble shoot the engines. The master caution light insisted on blinking for no apparent reason. No. 5 engine vibrations at 55% to 60% continued to illuminate the high vibration caution light.

Lighting No. 3 afterburner caused it to roll back to 90% and 770° EGT. With throttle advance, the nozzle opened some with very little EGT increase. No. 5 was reduced to idle, advanced to 85% and on to MIL where its vibration was auxiliary drive subsystem (ADS) 40% and ENG 30%. At light "off" it rolled back to 95% and at 90° throttle angle (T/A) the temp was 750° EGT so it was reduced to MIL. The repeated engine condition was almost exactly as seen on takeoff.

d. During this engine investigation (time 1122 C/N 810) I felt a buzz in the airframe with an associated audible hum; the speed was 387 KIAS, .66 Mach and 7,400 feet. With a slight reduction in speed this condition disappeared and was not felt or heard again. At 1123, C/N 866, I discovered the REFER was not on and turned it on with an electronic equipment (EE) temp of 62°. The right bypass area counter was oscillating from 110 to 120 square inches. Later in flight the counter drifted as low as 50 square inches. By 1128 it was evident that the engine condition would not permit us to continue with the planned mission so it was decided to try for stability and performance data at .8 Mach, 25,000 feet in SOA ALPHA. Engines No. 3 and No. 5 were to be kept at MIL or below. A military power climb was initiated and we entered clouds at 15,000 feet at 1131. We were north of base and headed for Owens Lake. No. 1 and No. 6 engines were placed in maximum afterburner while climbing at 347 KIAS. The fuel total was 187,500 pounds with 6 left 10,700 and 6 right 11,300 pounds at .82 Mach and 24,500 feet -- we were still in cloud 20 miles south of Owens Lake. At 27,000 feet I observed a cabin altitude of 6,000 feet. At 1136, C/N 1638 we were breaking out in the clear at 28,000 feet. At C/N 1712 No. 2 EGT was oscillating from 840°C to 855°C with a 1% to 1-1/2% nozzle fluctuation. At 1137:30, C/N 1740, the IAS was 354 knots at 27,800 feet and .89 Mach. There was still some cirrus clouds around so to get well on top we initiated a climb to 35,000 feet for data at .9 Mach. In a 20° bank right turn at 31,000 feet we experienced low speed buffet onset at .875 Mach and a gross weight near 445,000 pounds. C/N 1936, No. 4 engine afterburner was lit. No. 2 engine EGT was now fluctuating with irregularity from 835°C to 870°C. Hydraulic quantities were U_1 - 200 +, U_2 - 175, P_1 - 200, P_2 - 185. At C/N 2018 tank 6 left was 4,700 pounds and 6 right 4,100 pounds, cabin altitude 6,500 feet, EE temp 48°F, water 4,500 and ammonia 490.

e. On a heading of 115°, just above 34,000 feet, with No. 1, No. 4 and No. 6 engines in maximum afterburner and the others in MIL., I had just called out a fuel totalizer of 172,000 pounds where I was to turn the tank 6 pumps switch off when we lost U_1 hydraulic system. Engines No. 1, No. 2 and No. 3 utility status indicators went amber. U_2 quantity was 135% - 140%.

3. Emergency Descent:

I maintained engines No. 4, No. 5 and No. 6 at 99% and Al started a let down. Just prior to gear extension a buzz and hum noise started in the cockpit and continued until the gear was extended. A bit less than 280 KIAS I put the emergency electrical switch down. The gear showed safe with three green lights and the normal handle was placed down at C/N 2288. U_2 continued down to 50%, later went to 32% and back again to 50% with a power increase. The red light remained in the gear handle since the doors were still open. At the direction of George Lodge at Data Control I got out of the seat and went aft and placed the landing gear door switch to the "door open" position. At C/N 2834 we placed the electrical emergency switch to normal. U_2 quantity was now 34% and holding steady. Van Shepard, in Chase 1, reported the left main gear door was oscillating -- this was due to the fact that there was no pressure holding the doors wide open. The electrical emergency gear switch was then placed down to stop the door oscillation. Soon thereafter the U_2 quantity went to zero. The flaps were extended and as soon as they indicated down, the flap pressure caution light came on. The U_2 and both primary hydraulic pressures remained steady near 4,000 psi.

4. Landing:

The wind was 240° at 5 to 6 knots so we entered a downwind just west of Boron for a left pattern to land on runway 04. The landing gear horn blew almost continuously, and was very annoying, so I kept the button depressed. The fuel totalizer was 151,000 pounds on the downwind. Best flare speed was 218 KIAS. Final approach speed was initially 240 KIAS decreasing to 230 KIAS. Chase called out altitude and I turned the landing camera on at about 50 feet. I couldn't tell when we were on the ground so was neither sure of distance down or speed at touchdown. I estimate a touchdown speed of 205 KIAS. Al called for, and I deployed the chute at 190 KIAS. Two of the three chutes developed and were jettisoned at 60 KIAS. Heavy braking was used to stop the aircraft.

5. Pilot Write-Ups:

a. During maximum afterburner on engines No. 3 and No. 5 the rpm rolled back 4% to 5% and the EGT reduced to 760° and 800°C.

b. Engine No. 2 EGT oscillated between 810° and 840° at military power.

c. Engine No. 5 vibrations were high at times during flight.

d. U_1 hydraulic system failed during flight.

e. Flap pressure light came on, remained on when the flaps were lowered.

f. Master caution light came on intermittently during flight for no apparent reason.

g. Right bypass door indicator wandered from 320 to 280 square inches with wheels full forward -- was erratic.

h. Left bypass door open light comes on occasionally with wheels forward.

6. Pressure Suit and Capsule:

a. This was my first flight in the full pressure suit and, in general, I considered the operation and comfort better than I had expected. The silver and black gloves are a great improvement over the much slicker and apparently thicker brown ones. My body and feet were comfortable.

b. The less desirable conditions were associated with the helmet and face plate. Reflections of the nose, cheeks and chin on the inside of the helmet face plate, when flying into the sun, are a hinderance to good vision. Relief from this condition is highly desirable. The helmet face plate heat for the copilot has a three position control, FULL, OFF and HALF. The half selection was used and still caused a higher than desired temperature level on the face which I believe resulted in increased perspiration. This was not a serious objection and more experience is needed before I arrive at any firm opinion on the effects and recommendations.

c. The altimeter located in the left leg of the pressure suit makes it less than comfortable and convenient to keep the data card holder or check list attached and properly positioned on the left leg. In this application I don't see any real need for the altimeter and have requested it be removed.

d. The intercom and command radio audio levels were noticeably low and required use of the maximum positions on the volume controls. Since the flight, it has been determined that the helmet ear cups and pads were not aligned with the ears properly and I feel confident this condition has been corrected.

e. The capsule seat, harness, and most of the associated equipment are comfortable and satisfactory. Since the two position (NORMAL - 100%) vent lever detent has been increased I have not found it inadvertently knocked out of the pre-selected position. I find the arm rests are a general nuisance. The arms and hands are always

on the move so I never find a need or the time to let them rest. I do experience repeated elbow interference and try to remember to keep them mechanically collapsed and stowed. I would favor them being deleted unless they are essential for arm support during ejection.

VI. CONCLUSIONS:

1. Improper afterburner operation on engines No. 3 and No. 5 dictated an alternate subsonic flight plan and failure of the U_1 hydraulic system forced an air abort.

2. Systems which gave overall satisfactory performance were:

Fuel	Instrumentation
Landing gear	Electrical
Nose wheel steering	Fire detector engine and ADS
Brakes	IFF
Flaps	Flight instruments
Communications	Oxygen
Environmental	Flight controls
TACAN	Drag chute

3. The engine speed cave in was probably caused by a partially clogged servo pressure fuel filter.

4. The accuracy of the hydraulic quantity indicating system was questionable and the range of indication does not indicate the lowest usable level.

5. Cross system hydraulic (U_1 to U_2) leakage was excessive.

6. The heavy weight landing was a very successful demonstration of the ability of the brakes to stop the airplane and satisfactorily dissipate high energy levels.

7. Brake chatter was not as great as had been experienced on previous flights.

8. Master caution circuit relay failures were excessive.

9. Contamination in the flight control hydraulic system is the suspected cause of loss of one mode of flap control as indicated by the flap pressure indicator.

10. Landing gear warning audio signal sounded continuously with the gear down and could not be reset.

11. Two red lines on the engine EGT gages prevent quick and accurate interpretation of the indicator.

12. The escape capsule arm rests are not required for arm support during flight operation yet are frequently hit with the elbows which necessitates stowage.

13. The high vibration readings on engine No. 5 were probably caused by instrumentation malfunctions.

14. The voice cockpit recorder had excessive distortion during flight.

VII. RECOMMENDATIONS:

1. Improve hydraulic line reliability.

2. Take adequate precautions to insure that clogged filters will not cause engine power loss or flame out at high power settings and high speeds.

3. Reduce or eliminate utility hydraulic cross system leakage after failure of one utility system.

4. Increase the range and accuracy of the hydraulic indicating system.

5. Install more reliable master caution light circuit relays.

6. Flush and remove contamination in the flap control hydraulic system.

7. Eliminate the audio distortion in the cockpit voice recorder.

8. Replace lower red line on EGT indicators with a dissimilar shape and different colored marking.